SYSTEMATIC DESCRIPTIONS

Subclass RADIOLARIA Müller, 1858

[=Polycystina EHR., 1838; Rhizopoda radiata MULLER, 1858; Echinocystida CLAPAREDE, 1858; Rhizopoda HKL., 1861; Cytophora HKL., 1862]

Marine pelagic protozoans emitting many slender radially disposed pseudopodia; with a tough-walled, generally porous central capsule separating the protoplasm into 2 regions. A rigid skeleton, mainly external but partly internal, and commonly siliceous, is usually present; hard parts may consist of spicules. *Cam.-Rec.*

Order PORULOSIDA Haeckel, 1887

[as Porulosa; emend. CAMPBELL, herein]
[=Holotrypasta HKL., 1887]

Pores distributed everywhere on the surface of the globular central capsule. *Cam.-Rec.*

Suborder ACANTHARINA Haeckel, 1862

[as Acantharia; emend. CAMPBELL, herein]
[=Panacantha HKL., 1878; Acanthometrea HERTWIG, 1879; Actipylea HKL., 1887]

Central capsule with a thin simple membrane; skeleton centrogenous, composed of acanthin or strontium sulphate. *Eoc.-Rec.*

MORPHOLOGICAL FEATURES

The Acantharina are distinguished from all other Radiolaria by the distinctive centrally generated **centrogenous skeleton** composed of radial spines, which arise at the central point of the central capsule and which are invariably solid. The regularity in arrangement of the spines is remarkable, for only in one subdivision do they depart from the plan of circles expressed by the **Müllerian law (icosacanthic law)** (Fig. 1). The 20 spines emerge from the body along 5 circles which are comparable to the **equatorial**, 2 **tropical** and 2 **circumpolar** circles of the terrestrial globe. In some genera the constant 20 spines are dissimilar in size and form, but even among these the 5 zones may be distinguished. Four **equatorial spines** may be set apart from the 16 others by size or other differentiation. When these principal spines are recognized, the others can be seen to consist of 8 polar **spines**, which lie in the same meridional planes **(perradial planes)** as the 4 **principal spines,** and 8 **tropical spines**, which lie in 2 different perradial planes, intersecting the others at an angle of 45 degrees. All equatorial spines are exactly alike in some groups, whereas in others, the 2 opposite spines of one equatorial axis are much larger or different in form from those of the crossing axis. The major equatorial axis with the large spines is termed the **hydrotomical axis** and the minor axis with smaller spines, the **geotomical axis.**

The central junction of the **radial spines** is effected in 4 different ways: (a) by the simple apposition of the pyramidal central ends or bases of the spines; (b) by a **basal leaf cross** (4 broad wings on each spine), supported one upon the other; (c) by the central fusion of the meeting bases of the 20 spines; and (d) by the fusion of each of the opposite spines in pairs. Of these different types, the first is the most common and is the kind displayed by *Acanthometron*. The spines at the central base are pointed in the form of a pyramid, and the triangular faces of the neighboring pyramids are simply placed one against the other. The second type (basal leaf cross) is exemplified in *Phyllostaurus*; it apparently developed from the first type. Immediately above the basal pyramid, rising from its radial edges are 4 broad, thin, triangular leaves or wings; the meeting edges of adjacent wings are placed in such manner that between bases of each group of 3 or 4 adjacent spines a hollow, pyramidal space remains. The apex of this pyramidal space is directly toward the center of the sphere but separated from it by the small basal pyramid; its open end is directed outward. The 22 hollow, pyramidal spaces are disposed as 4 **equatorial spaces,** 8 **perizonal spaces,** 8 **peripolar spaces,** and 2 opposite **polar spaces.** These spaces are 4-sided, except for the peripolar ones, which are 3-sided. The third type of central junction results from the fusion of all the spines as a solid star of 20 rays *(Astrolithium)*. **Diametral spines** characterize the fourth type *(Acanthochiasma)*. These are simple opposite spines which are fused basally into one spine passing through the diameter of the central capsule; these spines may be loosely crossed. Some spines are twisted like a screw or are spirally convoluted.

The **radial spines** may be of one of 3 basic forms: (a) those of circular cross section; (b) those of ellipsoidal or lanceolate cross section; and (c) those of square cross section. The apex of the spine is usually pointed but may be truncate or bifid or even 4-sided pyramidal; in some the apex is toothed. Bifid spines may be so deeply cleft as to become forked. The lateral transverse processes or **apophyses** of the radial spines are significant structures. They are wanting in some groups, whereas in others they are perfectly free; or in more complex types, their meeting ends may form a **lattice shell.** The apophyses carry 2 or 4 opposite processes, or 4 crossed ones.

Among the divisions of the Acantharina, the Acanthophracti display extensive complexity of structure brought about by differences in the growth of the radial spines. The equal spines of the Dorataspidicae have equidistant outgrowths or **shields** from one or more levels which by their fusion result in one or more latticed concentric shells, whereas the spines of unequal length in the Belonaspidicae are expressed by characteristic changes in the skeleton and axial relations. In the Dorataspidicae, innumerable tiny plates **(aglets)** unite with each other along the sutures to form a pavemented shell; each aglet is pierced by a minute pore. The surfaces of such shells are commonly **dimpled.** The **perispinal pores** or holes of *Porocapsa* and *Cannocapsa* result from the internal development of radial spines which fail to reach the surface; the radial spines of these genera are shorter than the shell radius and do not reach its outer wall. But in an ideal prolongation of each spine the shell is pierced by a single large opening, the **perispinal pore** or hole, composed of 4 united aspinal pores; some perispinal pores are cruciform. In other genera, **radial tubes** result from prolongation of the holes as centrifugal cylinders, of which there is one in each ideal prolongation of the inner spine of the shell. The pores or meshes, especially in the Dorataspididae, are varied and generally may be differentiated into 2 groups, designated as **sutural pores** and **parmal pores.** The sutural pores are bordered by the meeting branches of the apophyses of 2, 3, or 4 adjacent spines and consequently also by the sutures along which they join. The parmal pores, on the contrary, are bordered only by the united branches of the apophyses of a single spine and pierce the shield or lattice plate formed by the apophysis. The parmal pores again can be divided into 2 different groups, termed **aspinal pores** and **coronal pores.** Aspinal pores are those which lie immediately at the sides of the radial spine and are bordered by the primary branches of its apophysis. Coronal pores are those which lie at the periphery of the lattice plates, surrounding in a circle or crown the aspinal pores and not touching the spine itself. The number and size of the coronal pores is commonly large and the pores themselves may vary in form. Peculiar accessory spines called **by-spines,** cover the surface of many members of the Dorataspidicae; commonly these are parallel to the radial spines from the lattice plates of which they arise. They tend to be perpendicular to the branched ends of the apophyses, so that a pair of divergent by-spines belonging to the meeting apophyses of the 2 adjacent spines arises near each suture. These by-spines are rarely bristle-like; generally they undulate, recurve, and are forked or arborescent. The 20 plates found in the shells of some Hexalaspididae bear high **crests** or **combs** on the surface separating the funnel-shaped dimples. Swollen knobs or **condyles** occur in some Dorataspididae on the apophyses, and on the shell surface where they may be connected across the sutural divisions.

Important large monographs by POPOFSKY (30-34) and SCHEWIAKOFF (45) give data on biology, life-histories, cytology, and ecology of the Acantharina. SCHEWIAKOFF divides the group into 4 "orders": Holacantha, Symphyacantha, Chaunacantha, and Arthracantha. He lists 17 families, of which 10 are new.

Division ASTROLOPHI Campbell, nov.

[=Acanthometrida HKL., 1862]

Lattice-shell lacking; skeleton composed of radial rods. *Eoc.-Rec.*

Superfamily ASTROLOPHICAE Haeckel, 1882

[*ex* Astrolophida; emend. CAMPBELL, herein]
[=Actinelida HKL., 1887]

Diametral spines 10 to 200, not disposed

according to the Müllerian law. *Eoc.-Rec.*

Family ASTROLOPHIDAE Haeckel, 1882

[as Astrolophida; emend. CAMPBELL, herein]

Spines radiating from common center within spherical capsule. *Rec.*

Astrolophus HKL., 1882 [**A. stellaris* HKL., 1887]. Variable number of simple radial spines, different in size, intermingled.——FIG. 9,*5*. *A. solaris* HKL., Rec., ×150 (42).

Actinelius HKL., 1865 [**A. pupureus;* SD herein] [=*Podactinelius* SCHRÖDER, 1906]. A variable number of simple spines, all similar in size and form.

A. (Actinelius) [=*Actinelarium* HKL., 1887 (obj.)]. Radial spines cylindrical, conical, or spindle-shaped, circular in section.——FIG. 9,*1*. *A. (A.) primordialis* HKL., Rec., ×50 (42).

A. (Actinelidium) HKL., 1887 [**A. protogenes*]. Radial spines compressed, 2-edged, elliptical in section.

A. (Actinelonium) HKL., 1887 [**A. pallidus* HKL., 1865; SD herein]. Radial spines quadrangular, prismatic or pyramidal, square in section.

Family LITHOLOPHIDAE Haeckel, 1862

[as Lithophida; emend. CAMPBELL, herein] [=Gigartaconidae SCHEW., 1926 *(partim)*]

Spines within a conical space or quadrant of a sphere, developed from a common center. *Rec.*

Lithophus HKL., 1862 [**L. rhipidium;* SD herein] [=*Gigartacon* SCHEW., 1926 *(partim)*]. Variable number of quadrangular divergent spines, united at their pyramidal bases at apex of conical central capsule.

L. (Lithophus) [=*Lithophidium* HKL., 1887 (obj.)]. Radial spines 10 to 20 (commonly 12 to 16).

L. (Litholopharium) HKL., 1887 [**L. pyramidalis;* SD herein]. Radial spines 10.——FIG. 9,*7*. *L. (L.) decapristis* HKL., Rec. ×100 (42).

Family ACANTHOCHIASMATIDAE Haeckel, 1862

[as Acanthochiasmida; emend. CAMPBELL, herein] [=Chiastolida HKL., 1887]

Simple diametral spines loosely crossed at center. *Eoc.-Rec.*

Subfamily ACANTHOCHIASMATINAE Haeckel, 1862

[as Acanthochiasmida *(partim)*; emend. CAMPBELL, herein] [=Acanthoplegmida SCHEW., 1926]

Diametral spines 10, derived from the concrescence of 20 radial spines. *Rec.*

Acanthochiasma KROHNE, 1860 [**A. rubescens*] [=*Acanthocyrta, Acanthoplegma, Acanthocolla, Acanthospira* SCHEW., 1926 *(partim)*]. Characters of subfamily.

A. (Acanthochiasma) [=*Acanthochiasmarium* POP., 1904 (obj.)] Spines cylindrical or conical; circular in section.——FIG. 9,*2*. *A. (A.) cruciata* POP., Rec., ×240 (48).

A. (Acanthochiasmidium) POP., 1904 [**A. plana;* SD herein]. Spines compressed and sharply pointed at ends.

A. (Acanthochiasmonium) POP., 1904 [**A. quadrangula;* SD herein]. Spines prismatic; square in section.

Subfamily CHIASTOLINAE Haeckel, 1887

[as Chiastolidina; emend. CAMPBELL, herein]

Diametral spines 16, derived by the concrescence of 32 radial spines. *Eoc.-Rec.*

Chiastolus HKL., 1887 [**C. amphicopium*] FIG. 9,*3*. **C. amphicopium*, Rec., ×50 (42).

Superfamily ACTINASTRICAE Popofsky, 1904

[as Actinastra; emend. CAMPBELL, herein]

Radial spines 18 to 32, not disposed according to Müllerian law. *Rec.*

Family ACTINASTRIDAE Popofsky, 1904

[=Astrolophida HKL., 1882 *(partim)*]

Radial spines 32, simple. *Rec.*

Actinastrum HKL., 1887 [**A. legitimum;* SD herein]. Spines disposed in 4 meridional planes with distal ends in 5 parallel zones; central ends of spines supported one on another in spherical central capsule.

Family ROSETTIDAE Popofsky, 1904

Radial spines 20, arranged in a rosette. *Rec.*

Rosetta POP., 1904 [**R. triangularis;* SD herein]. Spines spear-shaped.——FIG. 9,*9*. **R. triangularis*, Rec., ×400 (48).

Family TRIZONIDAE Popofsky, 1904

Radial spines 18 similar in form and length, arranged in 3 girdle zones, each with 6 spines. *Rec.*

Trizona POP., 1904 [**T. brandti*].——FIG. 9,*8*. **T. brandti*, Rec., ×500 (48).

Superfamily ASTROLONCHICAE Haeckel, 1882

[*ex* Astrolonchida; emend. CAMPBELL, herein] [=Acanthonida HKL., 1882]

Radial spines 20, arranged according to Müllerian law. *Mio.-Rec.*

Family ASTROLONCHIDAE Haeckel, 1882

[as Astrolonchida; emend. CAMPBELL, herein] [=Acanthometridae, Acanthonidae POP., 1904; Pseudolithidae, Acanthometridae, Stauroconidae, Conaconidae, Phyllostauridae, SCHEW., 1926 *(partim)*]

Spines nearly equal in length and similar in form. *Mio.-Rec.*

Subfamily ASTROLONCHINAE Haeckel, 1882

[as Astrolonchida *(partim)*; emend. CAMPBELL, herein] [=Phractacanthida HKL., 1887]

Each spine with 2 opposite apophyses or lateral transverse processes; less commonly with 2 longitudinal rows of opposite apophyses. *Rec.*

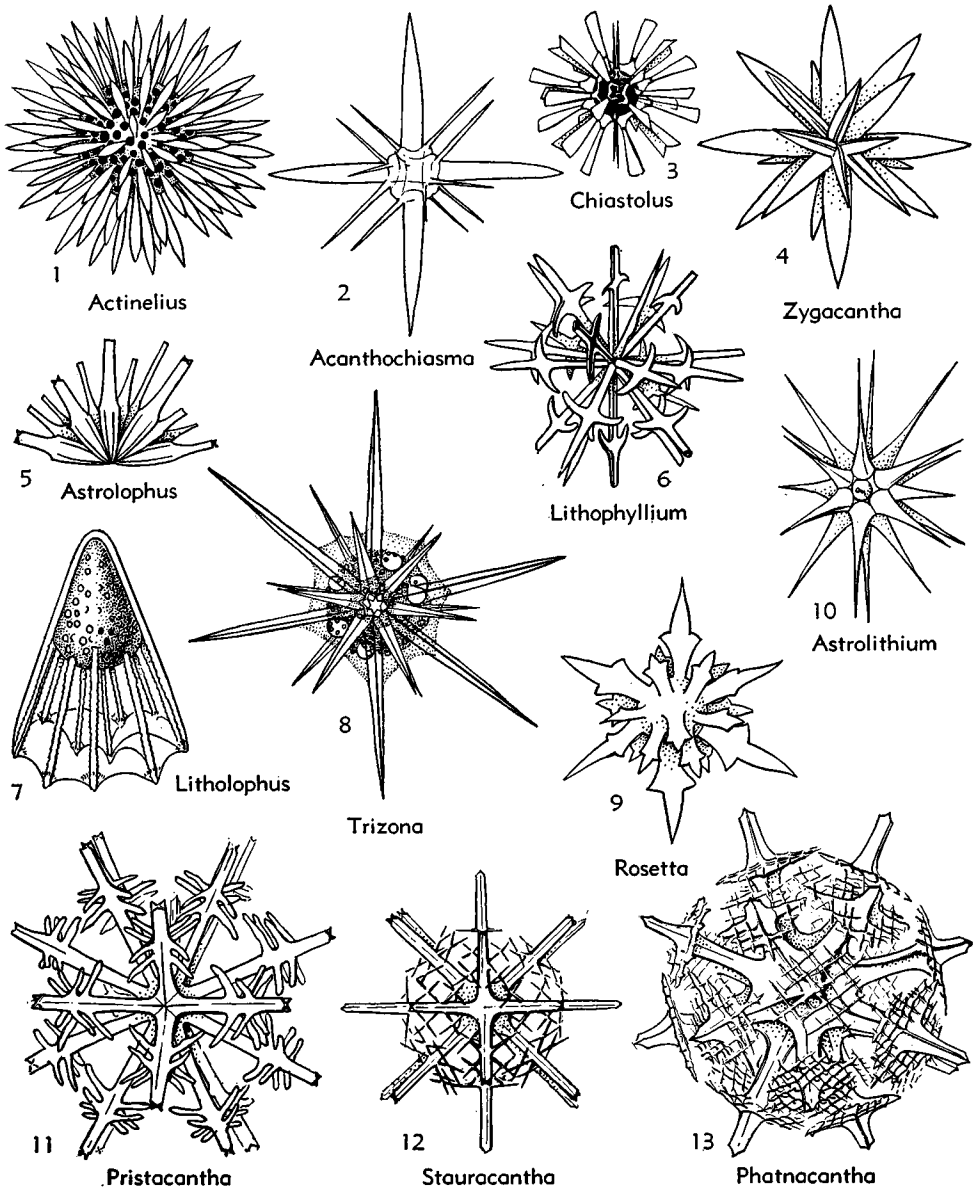

FIG. 9. Astrolophidae, Litholophidae, Acanthochiasmatidae, Rosettidae, Trizonidae, Astrolonchidae (p. D32-D34).

Astrolonche HKL., 1882 [**A. bicruciata* HKL., 1887]. Each spine with 4 to 8 or more simple apophyses arranged in 2 opposite longitudinal rows, or rarely in 6 opposite rows.

A. (Astrolonche) [=*Astroloncharium* HKL., 1887 (obj.)]. Each spine with 2 longitudinal rows of apophyses, opposite in one meridional plane.

A. (Astrolonchidium) HKL., 1860 [**Acanthometra serrata* HKL., 1860; SD herein]. Each spine with 3 parallel double rows of opposite apophyses.

Dicranophora SCHEW., 1926 [**D. bütschlii*]. Spines 4-edged, proximally flattened and cylindrical distally, each with 2 forked apophyses forming lattice-shell at center where basal pyramids occur.

Doracantha HKL., 1882 [**D. doraspis* HKL., 1887]. Each spine with 2 latticed or fenestrated apophyses.

Lithophyllium MÜLLER, 1858 [**L. foliosum*]. Each spine with 2 unbranched opposite apophyses.——FIG. 9,*6*. *L. gladiatum* HKL., Rec., ×100 (42).

Phractacantha HKL., 1882 [**P. bifurca* HKL., 1887]. Each spine with 2 branched but not latticed opposite apophyses.

Subfamily STAURACANTHINAE Haeckel, 1887

[as Stauracanthida; emend. CAMPBELL, herein]

Each spine with cross of 4 free apophyses or crossed longitudinal rows of apophyses. *Rec.*

Stauracantha HKL., 1882 [**S. orthostaura* HKL., 1887]. Apophyses branched but not latticed.

S. (Stauracantha) [=*Stauracanthonium* HKL., 1887 (obj.)]. Apophyses not forked but crossed by perpendicular branches in tangential planes parallel to cross of quadrangular spine.—FIG. 9,*12*. **S. (S.) orthostaura*, Rec., ×100 (42).

S. (Stauracanthidium) HKL., 1887 [**S. stauraspis*; SD herein]. Apophyses forked, each spine with 2 divergent branches not parallel to cross axis of quadrangular spine.

Phatnacantha HKL., 1882 [**P. tessaraspis* HKL., 1887]. Apophyses forming a lattice plate by communicating branches.——FIG. 9,*13*. *P. icosaspis* HKL., Rec., ×150 (42).

Pristacantha HKL., 1887 [**P. octadon*; SD herein]. Simple apophyses 8 to 16 or more, arranged in 4 longitudinal rows in pairs forming a cross.——FIG. 9,*11*. **P. octadon*, Rec., ×100 (42).

Xiphacantha HKL., 1862 [**Acanthometra quadridentata* MÜLLER, 1858]. Apophyses simple.

X. (Xiphacantha) [=*Xiphacanthonia* HKL., 1887 (obj.)]. Apophyses small, toothlike or hooked, not winglike; spine edges commonly narrow.

X. (Xiphacanthidium) HKL., 1887 [**X. ciliata*; SD herein]. Apophyses broad, compressed, winglike large plates; spine edges commonly broad, prominent.

Subfamily ZYGACANTHINAE Haeckel, 1887

[as Zygacanthida; emend. CAMPBELL, herein]

Spines lacking apophyses or lateral transverse processes. *Mio.-Rec.*

Zygacantha MÜLLER, 1858 [**Z. lanceolata*; SD herein] [=*Conacon, Tetralonche* SCHEW., 1926 *(partim)*]. Spines simple, compressed, 2-edged, elliptical or rhomboidal in section. *Rec.*

Z. (Zygacantha) [=*Zygacantharium* HKL., 1887 (obj.); *Stellolonche* POP., 1904]. Spine at central base without leaf cross and with hollow pyramidal compartments.——FIG. 9,*4*. *Z. (Z.) latifolia* POP., Rec., ×240 (48).

Z. (Zygacanthidium) HKL., 1887 [**Zygacantha dichotoma* MÜLLER, 1858; SD herein] [=*Amphistaurus, Stauracon* SCHEW., 1926 *(partim)*]. Spines at central bases with cross of 4 prominent leaves; adjoined edges of lamellae forming 22 hollow pyramidal compartments.

Z. (Zygacanthonium) HKL., 1887 [**Astrolithium dicopum* HKL., 1862; SD herein]. Spines at center perfectly grown together, forming a solid star of 20 rays.

Acanthometron HKL., 1887 [**Acanthometra pellucida* MÜLLER, 1858; SD herein] [=*Amphiacon, Stauracon* SCHEW., 1926 *(partim)*]. Round, cylindrical, or conical radial spines, without basal leaf cross. *Rec.*

A. (Acanthometron) [=*Acanthometrella* HKL., 1887 (obj.)]. Radial spines of similar size and form without basal leaf cross or apophyses.

A. (Acanthopophysa) POP., 1904 [**A. armatum*; SD herein]. Similar radial spines with apophyses.

A. (Amphimetron) POP., 1904 [**A. spinosum*; SD herein]. Two radial spines longer than 18 others.

A. (Quadrimetron) POP., 1904 [**A. arachnoide*; SD herein]. Four radial spines longer than 16 others.

Acanthonia HKL., 1882 [**Acanthometra tetracopa* MÜLLER, 1858] [=*Conacon, Heterocon* SCHEW., 1926 *(partim)*]. Spines at central base 4-edged, prismatic or pyramidal. *Rec.*

A. (Acanthonia) [=*Acanthonium* HKL., 1887 (obj.); *Acolonche, Quadristaurus* POP., 1904]. Spines at central base without leaf cross and hollow pyramidal compartments.

A. (Acanthonidium) HKL., 1887 [**Acanthometra echinoides* CLAPARÈDE & LACHMANN, 1858; SD herein] [=*Amphiacantha, Stellacantha* POP., 1904]. Spines at central base with broad leaf cross composed of 4 prominent lamellae; meeting edges form 22 hollow compartments.

A. (Acantholithium) HKL., 1887 [**A. stellata*] [=*Heliolithium* SCHEW., 1926]. Spines at central base fused as a solid star of 20 rays.

Astrolithium HKL., 1860 [**A. bifidum* HKL., 1862] [=*Pseudolithium* SCHEW., 1926 *(partim)*]. Long radial spines grown together at central base as a solid star of 20 rays. *Mio.-Rec.*——FIG. 9,*10*. *A. bulbiferum* HKL., Rec., ×150 (42).

Phyllostaurus HKL., 1862 [**Acanthometra sicula*]. Spines with basal leaf cross at central base; 4

prominent lamellae propped on one another, forming 22 hollow compartments. *Rec.*

P. (Phyllostaurus). Radial spines of similar size and form.

P. (Acostaurus) HKL., 1887 *(partim)* [**P. aequatoralis*; SD herein]. Four radial spines stouter and longer than 16 others.

P. (Phyllolonche) POP., 1904 [**P. conicus;* SD herein]. Four radial spines very much longer than 16 others.

Family ACANTHOSTAURIDAE Haeckel, 1882

[as Acanthostaurida; emend. CAMPBELL, herein] [=Quadrilonchida HKL., 1887; Acanthometridae, Stauroconidae SCHEW., 1926]

Spines of very different sizes, 4 equatorial ones much larger than others. *Rec.*

Subfamily ACANTHOSTAURINAE Haeckel, 1882

[as Acanthostaurida *(partim)*; emend. CAMPBELL, herein]

Spines simple, lacking apophyses. *Rec.*

Acanthostaurus HKL., 1862 [**Acanthometra puperascens* HKL., 1860; SD herein]. Equatorial spines equal and similar; 8 tropical and 8 polar spines nearly equal.

A. (Acanthostaurus) [=*Acostaurus* HKL., 1887]. All 20 spines separated, with center united only by triangular faces of leaf-shaped edges of their pyramidal bases.

A. (Staurolithium) HKL., 1862 [**Astrolithium cruciatum* HKL., 1860]. All 20 spines fused at center forming a single star-shaped mass.

Belonostaurus HKL., 1887 [**B. quadratus;* SD herein]. Equatorial spines 4, much longer than others; 8 tropicals very different from 8 polars.

Lonchostaurus HKL., 1862 [**Acanthometra hastata* HKL., 1860; SD herein]. Equatorial spines 4, differing in size and form, principal one in longitudinal axis, larger than laterals, opposites of each pair equal; 16 other spines much smaller (8 tropicals commonly larger than 8 polars).—— FIG. 10,*1*. *L. bifurcus* HKL., Rec., ×100 (42).

Zygostaurus HKL., 1887 [**Z. amphithecus;* SD herein]. Equatorial spines 4, unequal in size and form, both laterals in transverse axis equal but both in longitudinal axis very different, frontal larger than caudal; other spines as in *Lonchostaurus*.——FIG. 10,*2*. *Z. sagittalis* HKL., Rec., ×100 (42).

Subfamily LITHOPTERINAE Haeckel, 1887

[as Lithopterida; emend. CAMPBELL, herein]

Two opposite transverse apophyses on all or part of the 20 spines. *Rec.*

Lithoptera MÜLLER, 1858 [**L. fenestrata;* SD herein]. Apophyses branched or latticed.

L. (Lithoptera) [=*Lithopteroma* HKL., 1887 (obj.)]. Apophyses on all spines.

L. (Lithopteranna) HKL., 1887 [**L. tetraptera;*

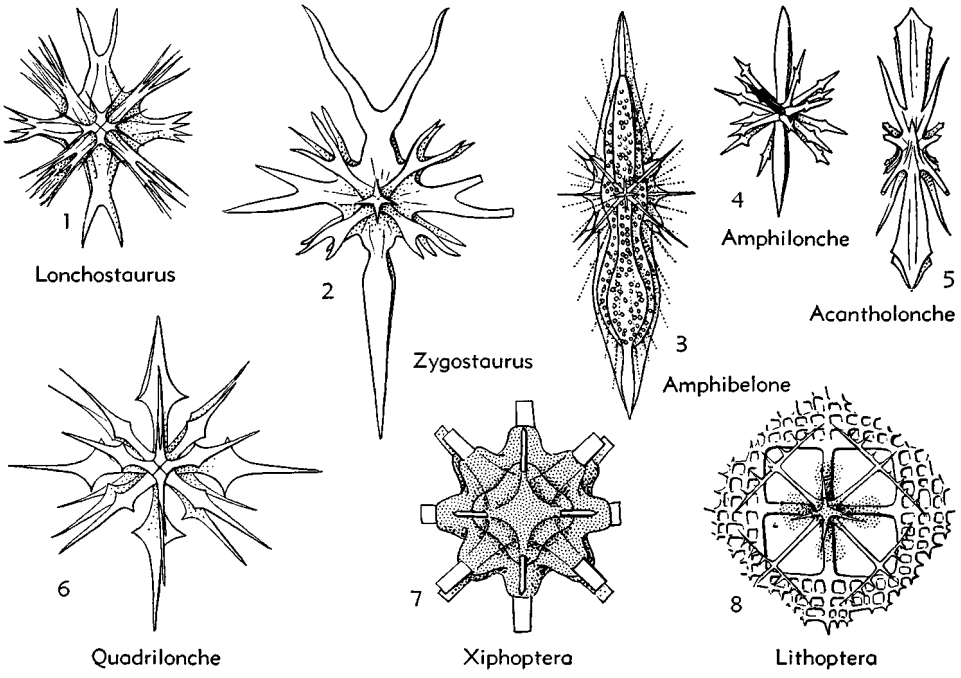

FIG. 10. Acanthostauridae, Acantholonchidae (p. D35, D36).

SD herein][=*Acanthoptera* Pop., 1904]. Apophyses only on 4 equatorial spines.

L. (Lithopterella) Hkl., 1887 [**L. quadrata;* SD herein]. Apophyses on 4 equatorial and 8 tropical spines; 8 polar spines without apophyses. ——Fig. 10,*8*. **L. (L.) quadrata* Rec., ×100 (42).

Quadrilonche Hkl., 1887 [**Q. tetrastaura;* SD herein]. Apophyses simple.

Q. (Quadrilonche) [=*Quadriloncharium* Hkl., 1887 (obj.)] Apophyses on equatorial spines.

Q. (Quadrilonchidium) Hkl., 1887 [**Q. mesostaura;* SD herein]. Apophyses on all spines.——Fig. 10,*6*. **Q. (Q.) mesostaurus* Rec., ×150 (42).

Xiphoptera Hkl., 1882 [**X. tessaractena* Hkl., 1887]. Apophyses branched but not latticed on some or all spines.——Fig. 10,*7*. *X. dodecactena* Rec., ×100 (42).

Family ACANTHOLONCHIDAE Haeckel, 1882

[as Acantholonchida; emend. Campbell, herein] [=Amphilonchida, Amphilithida Hkl., 1882; Acanthometridae, Amphilithidae, Gigartaconidae, Phyllostauridae Schew., 1926 *(partim)*]

Like Acanthostauridae except that 2 opposite equatorial spines in the longitudinal axis are much larger than the 18 others. *Rec.*

Acantholonche Hkl., 1882 [**A. amphipolaris* Hkl., 1887]. Two principal spines similar, others very unequal, small, with 8 tropicals and 2 transverse equatorials much larger than rudimentary polars. ——Fig. 10,*5*. *A. peripolaris* Hkl., Rec., ×100 (42).

Amphibelone Hkl., 1862 [**Acanthometra anomalia* Hkl., 1860][=*Cruciforma* Mielck, 1907]. Frontal and caudal spines very different, others small, nearly equal.

A. (Amphibelone) [=*Amphibelonium* Hkl., 1887 (obj.)]. All 20 spines separate but with triangular sides of their triangular bases in contact at center without prominent leaf cross.——Fig. 10,*3*. *A. (A.) cultellata* Hkl., Rec., ×100 (42).

A. (Amphibelithium) Hkl., 1887 [**A. clavaria*]. All spines fused at center in star form.

Amphilonche Hkl., 1862 [**A. belonoides;* SD herein][=*Acantholonche* Pop., 1904 (*non* Hkl., 1882), *Zygolonche* Pop., 1904; *Cruciforma* Pop., 1906; *Heteracon* Schew., 1926 *(partim)*]. Frontal and caudal principal spines similar, 18 others smaller and nearly equal.

A. (Amphilonche) [=*Amphiloncharium* Hkl., 1887 (obj.)]. Spines united at center by triangular faces of their pyramidal bases without basal leaf cross.——Fig. 10,*4*. *A. (A.) diodon* Hkl., Rec., ×100 (42).

A. (Amphilithium) Hkl., 1882 [**A. concreta* Hkl., 1887]. Spines basally fused into single star with 2 large and 18 small rays.

A. (Amphilonchidium) Hkl., 1887 [**Acanthometra ovata* Müller, 1858; SD herein][=*Zygolonchidium* Pop., 1904; *Amphistaurus* Schew., 1926 *(partim)*]. Broad leaf cross formed by 4 prominent triangular lamellae; pyramidal compartments 22.

Division ACANTHOPHRACTI Hertwig, 1879

[as Acanthophractida; emend. Campbell, herein]

Lattice shell complete. *Rec.*

Superfamily DORATASPIDICAE Haeckel, 1862

[*ex* Drataspida; emend. Campbell, herein] [=Haplophracta, Sphaerophracta Hkl., 1887; Stratosphaera, Ramosphaera Pop., 1906 *(partim)*]

Simple spherical shell composed of 20 to 80 aglets, each with a single aspinal pore; radial spines disposed according to Müllerian law. *Rec.*

Family DORATASPIDIDAE Haeckel, 1862

[as Drataspida; emend. Campbell, herein] [=Dictyacanthidae Schew., 1926 *(partim)*; *non* Drataspidae Pop., 1906 (=Belonaspididae)]

Shell composed of branched apophyses of 20 equal radial spines. *Rec.*

Subfamily DORATASPIDINAE Haeckel, 1862

[as Drataspida *(partim)*; emend. Campbell, herein] [=Diporaspida Hkl., 1887; Drataspinae Pop., 1906]

Shell composed of meeting branches of 2 opposite apophyses on each spine or of 20 perforated plates produced by concrescence of branches. *Rec.*

The Drataspidinae are classed as shown below, or are divided alternatively into 2 groups, termed Cladophracta and Peltophracta (20). A second scheme includes groups called Laevisphaerida and Asprosphaerida (30).

Tribe DORATASPIDIDES Haeckel, 1862

[as Drataspida *(partim)*; emend. Campbell, herein] [=Ceriaspida Hkl., 1887]

Spherical shell composed of 20 perforated plates produced by union of branches of apophyses; meshes partly sutural and partly parmal. *Rec.*

Drataspis Hkl., 1860 [**D. loricata* Hkl., 1862; SD herein][=*Thoracaspis* Hkl., 1882 *(partim)*; *Coscinaspis* Hkl., 1887 *(partim)*]. Two aspinal pores in each plate, surface of shell without combs, dimples, and by-spines.

D. (Drataspis) [=*Drataspidium* Hkl., 1887 (obj.)]. Sutures 54; each pole of main axis bear-

ing 2 hexagonal plates meeting in a polar suture and 2 minor pentagonal plates not meeting; entire shell has 8 hexagonal and 12 pentagonal plates (8 tropicals, 4 polars).——FIG. 11,*6*. *D. (D.) typica* HKL., Rec., ×150 (42).

D. (Doratasparium) HKL., 1887 [**D. fusigera;* SD herein]. Sutures 52; each pole of main axis with 4 plates meeting at a point; entire shell has 4 hexagonal plates (equatorial) and 16 pentagonal plates (8 tropicals, 8 polars).

Acontasparium HKL., 1887 [**A. lanceolatum*] [=*Acontaspis* HKL., 1882; *Globispinum* POP., 1906]. Plates smooth, perforated by 80 to 200 parmal pores (2 aspinal, 2 coronal, 2 sutural ones in each plate), surface without by-spines.

Acontaspis HKL., 1882 [**A. hastata* HKL., 1887] [=*Acontasparium, Acontaspidium* HKL., 1887 (obj.)] Surface of shell dimpled and with network of prominent crests.——FIG. 11,*14*. **A. hastata,* Rec., ×150 (42).

Ceriaspis HKL., 1882 [**C. lacunosa* HKL., 1887]. Surface of shell with many dimples separated by network of elevated combs; no by-spines.

C. (Ceriaspis) [=*Ceriasparium* HKL., 1887 (obj.)]. Small funnel-shaped dimples 70 to 100, each with 1 or 2 pores at bottom; plates with 20 large dimples in center, 2 aspinal pores and 50 to 100 small dimples containing 1 sutural pore; no blind dimples.

C. (Ceriaspidium) HKL., 1887 [**C. inermis;* SD herein]. Funnel-shaped dimples 176 to 182, partly closed at bottom or perforated by 1 or 2 pores; blind dimples 104 to 108, at corners of 20 plates.——FIG. 11,*5*. *C. (C.) favosa* HKL., Rec., ×150 (42).

Coscinaspis HKL., 1887 [**C. peripora;* SD herein] [=*Craniaspis* POP., 1906]. Plates perforated by 80 to 200 parmal pores (2 aspinal, 2 to 10 coronal on each); surface without by-spines.

C. (Coscinaspis) [=*Coscinasparium* HKL., 1887 (obj.)]. Plates smooth, without crests or dimples.——FIG. 11,*12*. *C. (C.) parmipora* HKL., Rec., ×150 (42).

C. (Coscinaspidium) HKL., 1887 [**C. ceriopora*]. Surface dimpled; prominent crests form network.

Diporaspis HKL., 1887 [**D. nephropora;* SD herein]. Like *Dorataspis* but with 52 sutures and many by-spines.

D. (Diporaspis) [=*Diporasparium* HKL., 1887 (obj.)]. Each pole of main axis with 4 plates which meet at common point; shell with 4 hexagonal (equatorial) and 16 pentagonal plates (8 tropicals, 8 polars).——FIG. 11,*7*. **D. (D.) nephropora,* Rec., ×200 (42).

D. (Diporaspidium) HKL., 1887 [**D. zygopora*]. Shell with 8 hexagonal plates (4 equatorial, 4 polar) and 12 pentagonal plates (8 tropical, 4 polar).

Hystrichaspis HKL., 1887 [**H. pectinata;* SD herein] [=*Siphonaspis* HKL., 1887 (obj.)]. Like *Ceriaspis* but with numerous by-spines.

H. (Hystrichaspis) [=*Hystrichasparium* HKL., 1887 (obj.)]. Plates with 2 large dimples in center (each with 1 to 3 pairs of pores) and 50 to 100 small dimples (each with sutural pores); no blind dimples.——FIG. 11,*9*. **H. (H.) pectinata,* Rec., ×150 (42).

H. (Hystrichaspidium) HKL., 1887 [**H. dorsata;* SD herein]. Differs from *Ceriaspidium* only in having by-spines.

Stegaspis HKL., 1882 [**Orophaspis diporaspis* HKL., 1887] [=*Orophaspis* HKL., 1887 (obj.)]. Like *Dorataspis* but 2 simple or branched free apophyses extend outside of shell on opposite sides of each radial spine.

S. (Stegaspis). Apophyses with anastomosed branches forming perforated shields.

S. (Orophasparium) HKL., 1887 [**Orophaspis astrolonche* HKL., 1887; SD herein]. Apophyses not branched.

S. (Orophaspidium) HKL., 1887 [**Orophaspis furcata;* SD herein]. Apophyses branched but not anastomosed.——FIG. 11,*10*. **S. (O.) furcata* (HKL.), Rec., ×150 (42).

Tribe PHRACTASPIDIDES Haeckel, 1887

[as Phractaspida; emend. CAMPBELL, herein]

Shell composed of meeting branches of apophyses, without perforated plates; all meshes sutural. *Rec.*

Phractaspis HKL., 1882 [**P. prototypus* HKL., 1887] [=*Phractasplenium* HKL., 1887 (obj.)]. Condyles of apophysis branch ends without spines.

P. (Phractaspis) [=*Phractasparium* HKL., 1887 (obj.)]. Shell with 22 meshes and 40 sutures, each spine with 4 branches, apophyses simply forked.——FIG. 11,*13*. *P. (P.) complanata* HKL., Rec., ×150 (42).

P. (Phractaspidium) HKL., 1887 [**P. constricta;* SD herein]. Meshes 40 to 80, sutures 80 to 100, each spine with 6 to 8 branches, apophyses doubly forked or even highly ramified.

Pleuraspis HKL., 1882 [**P. horrida* HKL., 1887]. Condyles of apophysis branch ends with by-spines.

P. (Pleuraspis) [=*Pleurasparium* HKL., 1887 (obj.)]. Shell with 20 to 24 meshes and 36 to 48 sutures, each spine commonly with 4 branches bearing 2 simply forked apophyses.——FIG. 11,*17*. **P. (P.) horrida,* Rec., ×150 (42).

P. (Pleuraspidium) HKL., 1887 [**P. ramosa*]. Mostly with 40 to 80 meshes, 80 to 100 sutures, and each spine with 6 to 8 branches bearing apophyses forked at least twice.

Subfamily TESSARAPELMATINAE Campbell, nov.

[=Tessaraspida HKL., 1887]

Like Doratasplidinae except that each radial spine bears 4 crossed apophyses, opposite in pairs. *Rec.*

Tribe TESSARAPELMATIDES Campbell, nov.
[=Tessaraspida Hkl., 1887 *(partim)*]

Shell composed of 20 perforated plates or fenestrated shields, each with at least 4 pores. *Rec.*

Tessarapelma Hkl., 1882 [**Tessaraspis arachnoides* Hkl., 1887][=*Tessaraspis* Hkl., 1887 (obj.)]. Plates with 80 aspinal pores (4 crossed pores on each plate); surface smooth, without by-spines.

T. (Tessarapelma) [=*Tessarasparium* Hkl., 1887 (obj.)]. Condyles of adjacent plates connected by permanent open sutures.

T. (Tessaraspidium) Hkl., 1887 [**Tessaraspis concreta;* SD herein]. Sutures of adjacent plates obliterated.——Fig. 11,*2*. **T. (T.) concretum* (Hkl.), Rec., ×150 (42).

Haliommatidium Müller, 1858 [**H. echinoides;* SD herein] [=*Lychnaspis* Hkl., 1862, obj., *non* Schew., 1926 (=*Phatnaspis*)]. Differs from *Tessarapelma* in having numerous by-spines.

H. (Haliommatidium) [=*Lychnaspidium* Hkl., 1887 (obj.)]. Sutures between plates obliterated.

H. (Lychnasparium) Hkl., 1887 [**Lychnaspis undulata* Hkl., 1887; SD herein]. Condyles of adjacent plates connected by permanent open sutures.——Fig. 11,*3*. **H. (L.) undulatum* (Hkl.), Rec. ×150 (42).

Hylaspis Hkl., 1887 [**H. serrulata;* SD herein]. Like *Icosaspis* but surface with many by-spines. ——Fig. 11,*1*. **H. serrulata,* Rec., ×150 (42).

Icosaspis Hkl., 1882 [**I. tabulata* Hkl., 1887] [=*Dictyacantha* Schew., 1926 *(partim)*]. Plates perforated by 160 to 300 parmal pores (4 crossed aspinal pores in each plate, surrounded by 4 to 12 coronal pores), surface without by-spines.

I. (Icosaspis) [=*Icosasparium* Hkl., 1887 (obj.)]. Condyles of adjacent plates jointed by permanent open sutures.——Fig. 11,*4*. **I. (I.) elegans* Hkl., Rec., ×100 (42).

I. (Icosaspidium) Hkl., 1887 [**Haliommatidium tetragonopum* Hkl., 1862; SD herein][=*Tignisphera* Pop., 1906]. Sutures obliterated.

Tribe STAURASPIDIDES Haeckel, 1887
[as Stauraspida; emend. Campbell, herein]

Shell composed of meeting branches of crossed apophyses only, or with 4 to 12 perforated plates formed by spines, each plate bearing 4 crossed pores. *Rec.*

Stauraspis Hkl., 1882 [**S. cruciata* Hkl., 1887]. Without perforated plates; branch ends of condyles of apophyses without by-spines.

S. (Stauraspis) [=*Stauraspharium* Hkl., 1887 (obj.)]. Apophyses unbranched, each spine with 4 sutural condyles.

S. (Stauraspidium) Hkl., 1887 [**S. stauracantha;* SD herein]. Apophyses branched, each spine with 8 to 20 sutural condyles.——Fig. 11,*8*. **S. (S.) stauracantha,* Rec., ×150 (42).

Dodecapsis Hkl., 1887 [**D. tricinata;* SD herein]. Plates 12, formed by united apophysis branches of 4 equatorial and 8 polar spines, otherwise like *Zonaspis*.——Fig. 11,*15*. **D. tricinata,* Rec., ×200 (42).

Echinaspis Hkl., 1882 [**E. dichotoma* Hkl., 1887]. Differs from *Stauraspis* in having by-spines on condyles of branch ends.——Fig. 11,*11*. *E. echinoides* Hkl., Rec., ×150 (42).

Zonaspis Hkl., 1887 [**Z. cingulata;* SD herein] [=*Sonaspis* Delage & Herouard, 1896 (obj.)]. Plates 4, formed by union of apophysis branches of 4 equatorial spines, each with 4 crossed aspinal pores; apophysis branches of 16 other spines (8 tropical and 8 polar) not forming a lattice plate; each condyle like by-spines.——Fig. 11,*16*. *Z. equatorialis* Hkl., Rec., ×150 (42).

Family ASTROCAPSIDAE Haeckel, 1887
[as Astrocapsida; emend. Campbell, herein]

Radial spines equal, joined at center, short (enclosed within shell), or long (extended beyond shell); shell bears 20 large perispinal pores or 80 small aspinal pores. *Rec.*

Subfamily ASTROCAPSINAE Haeckel, 1887
[as Astrocapsida *(partim)*; emend. Campbell, herein]

Radial spines connected with porous shell, as long as its radius or longer; shell pierced by 80 aspinal pores, 4 around each spine. *Rec.*

Astrocapsa Hkl., 1887 [**A. stellata;* SD herein]. Spines longer than radius of shell, with free external prolongations piercing perispinal holes, 4 aspinal pores around each spine.——Fig. 12,*2*. *A. coronata* Hkl., middle part of spine with 4 aspinal pores, Rec., ×200 (42).

Sphaerocapsa Hkl., 1882 [**S. cruciata* Hkl., 1887]. Spines without external prolongation, their distal ends inserted into perispinal holes, each having 4 aspinal pores.——Fig. 12,*1*. **S. cruciata,* Rec., ×75 (42).

Subfamily CENOCAPSINAE Haeckel, 1887
[as Cenocapsida; emend. Campbell, herein]

Radial spines lacking. *Rec.*

Cenocapsa Hkl., 1887 [**C. nirvana*]. Shell cavity simple, pierced by 20 perispinal pores.——Fig. 12,*5*. **C. nirvana,* entire shell with pavement of small plates and 20 cruciform perispinal pores. Rec., ×100 (42).

Subfamily POROCAPSINAE Haeckel, 1887
[as Porocapsida; emend. Campbell, herein]

Radial spines not connected with porous shell, shorter than radius, with 20 perispinal pores. *Rec.*

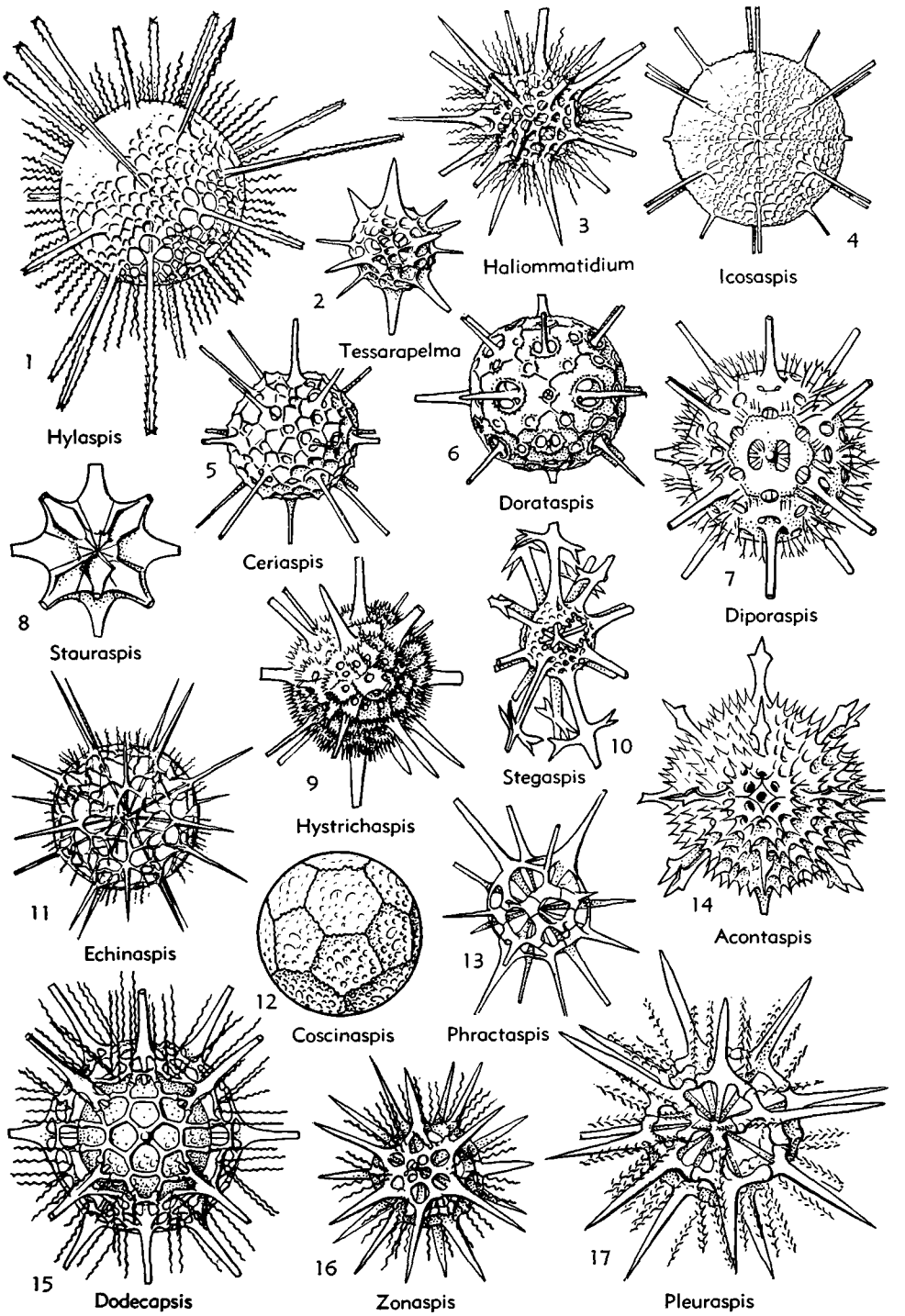

FIG. 11. Doratospididae (p. D37, D38).

Porocapsa HKL., 1887 [**P. murrayana;* SD herein]. Distal ends of spines not connected with perispinal pores, which are simple, not prolonged into radial tubes.——FIG. 12,*4*. **P. murrayana,* central capsule filled with vacuoles and many small granules in central radii. Rec., ×100 (42).

Cannocapsa HKL., 1887 [**C. stethoscopium;* SD herein]. Like *Porocapsa* but perispinal pores prolonged outward as radial tubes.——FIG. 12,*3*. **C. stethoscopium,* Rec., ×100 (42).

Family ASPIDOMMATIDAE Campbell, nov.

[=Ommatida HKL., 1862 *(partim)*; Phractopeltida, Phractopelmida HKL., 1882; Diplophracta HKL., 1887]

Like Dorataspididae, shell composed of branched apophyses of 20 radial spines, but has a double spherical shell. *Rec.*

Aspidomma HKL., 1862 [**Haliomma hystrix* MÜLLER, 1858; SD herein] [=*Phractopeltis* HKL., 1882 (obj.)]. No free apophyses outside shell wall.

A. (Aspidomma) [=*Phractopeltidium* HKL., 1887 (obj.)]. Outer shell composed of 20 plates with sutures grown together.

A. (Phractopeltaris) HKL., 1887 [**Phractopelta dorataspis;* SD herein]. Outer shell wall with plates separated.——FIG. 12,*7*. **A. (A.) dorataspis* (HKL.), Rec., ×150 (42).

Dorypelma HKL., 1882 [**Dorypelta stauroptera* HKL., 1887] [=*Dorypelta* HKL., 1887 (obj.)]. External free apophyses on 8 tropical spines and 4 polars; 4 equatorials and 4 polars simple.

D. (Dorypelma) [=*Dorypeltarium* HKL., 1887 (obj.)]. Free apophyses unbranched.

D. (Dorypeltidium) HKL., 1887 [**Dorypelta furcata;* SD herein]. Free apophyses branched, not anastomosed.

D. (Dorypeltonium) HKL., 1887 [**Dorypelta tessaraspis;* SD herein]. Free apophyses anastomosed.——FIG. 12,*8*. **D. (D.) tessaraspis* (HKL.), Rec., ×150 (42).

Octopelta HKL., 1887 [**O. scutella;* SD herein]. External free apophyses on 8 tropicals; 4 equatorials and 8 polars simple.——FIG. 12,*9*. **O. scutella,* prox. part of 2 meeting spines, Rec., ×150 (42).

Pantopelta HKL., 1887 [**P. icosaspis*]. Each spine with 2 free external apophyses.——FIG. 12,*6*. **P. icosaspis,* section through double shell, Rec., ×150 (42).

Stauropelma HKL., 1882 [**Stauropelta cruciata* HKL., 1887] [=*Stauropelta* HKL., 1887 (obj.)]. External free apophyses on 8 tropicals and 8 polars; 4 equatorials simple.——FIG. 12,*10*. **S. cruciatum* (HKL.), Rec., ×150 (42).

Superfamily BELONASPIDICAE Haeckel, 1887

[*ex* Belonaspida; emend. CAMPBELL, herein] [=Prunophracta HKL., 1887; Ramososphaera POP., 1906 *(partim)*; Pseudolithidae SCHEW., 1926 *(partim)*]

Elliptical, lenticular or diploconical lattice shell composed of branched apophyses of spines, the 20 radial spines of different sizes meeting at center and disposed according to the Müllerian law. *Rec.*

Family BELONASPIDIDAE Haeckel, 1887

[as Belonaspida; emend. CAMPBELL, herein] [=Dorataspidae POP., 1906]

Simple ellipsoidal lattice shells; 2 opposite equatorial spines larger than 2 others. *Rec.*

Subfamily BELONASPIDINAE Haeckel, 1887

[as Belonaspida *(partim)*; emend. CAMPBELL, herein] [=Coleaspida HKL., 1887]

Shell has 40 parmal pores (2 aspinal pores in each plate) and mostly no coronal pores. *Rec.*

Belonaspis HKL., 1882 [**B. pandanus* HKL., 1887]. Surface with many by-spines but lacking dimples or crests.——FIG. 13,*6*. *B. datura* HKL., Rec., ×150 (42).

Coleaspis HKL., 1882 [**C. coronata* HKL., 1887]. Like *Belonaspis* but has network of prominent crests on dimpled surface.

C. (Coleaspis). Both equatorial spines nearly like 18 others.

C. (Coleaspidium) HKL., 1887 [**C. hydrotomica*]. Both equatorial spines much larger and peculiarly different in form from 18 others.——FIG. 13,*3*. **C. (C.) hydrotomica,* Rec., ×150 (42).

Cribosphaera POP., 1906 [**Coscinaspis polypora* HKL., 1887]. Shell smooth, with many sutural and coronal pores in addition to parmal pores.——FIG. 13,*2*. **C. polypora* HKL., single lattice plate, Rec., ×150 (42).

Dictyaspis HKL., 1887 [**Dorataspis solidissima* HKL., 1862; SD herein]. Like *Coleaspis* but lacks by-spines.

Thoracaspis HKL., 1882 [**T. ellipsoides* HKL., 1887]. Like *Belonaspis* but lacks by-spines.——FIG. 13,*1*. *T. bipennis* (HKL.), Rec., ×150 (42).

Subfamily PHATNASPIDINAE Haeckel, 1887

[as Phatnaspida; emend. CAMPBELL, herein]

Shell has 80 to 2,000 parmal pores (2 aspinal pores on each plate) and 2 to 100 coronal pores. *Rec.*

Phatnaspis HKL., 1882 [**P. lacunaria* HKL., 1887]. Lacks by-spines.

P. (Phatnaspis) [=*Phatnasparium* HKL., 1887 (obj.)]. Compressed spine on each rhomboidal

plate bordered at edges by aspinal pores and at sides by primary diagonal crests.——FIG. 13,*4*. *P. (P.) cristata* HKL., Rec., ×150 (42).

P. (Phatnaspidium) HKL., 1887 [**P. haliommidium;* SD herein]. Cylindrical or quadrangular spine on each plate bordered by 4 aspinal pores forming cross.

P. (Phatnasplenium) HKL., 1887 [**P. orthopoda;* SD herein]. Like *P. (Phatnaspis)* but placement of pores and crests interchanged.

Family HEXALASPIDIDAE Haeckel, 1887

[as Hexalaspida; emend. CAMPBELL, herein]

Simple discoidal or lenticular shells composed of branched apophyses of spines; 6 large spines in hydrotomical axis along margin, other spines small. *Rec.*

Hexalaspis HKL., 1887 [**H. heliodiscus;* SD herein]. Spines not surrounded by prominent sheaths.

H. (Hexalaspis) [=*Hexalasparium* HKL., 1887 (obj.)]. Six hydrotomical spines equal.——FIG. 13,*5*. **H. (H.) heliodiscus,* Rec., ×150 (42).

H. (Hexalaspidium) HKL., 1887 [**H. sexalata;* SD herein]. Two opposite equatorial hydrotomical spines much larger than 4 others (polars).

Hexacolpus HKL., 1887 [**H. nivalis;* SD herein]. Six hydrotomical spines surrounded by prominent sheaths, other spines rudimentary.

H. (Hexacolpus) [=*Hexacolparium* HKL., 1887 (obj.)]. Hydrotomical spines nearly equal.

H. (Hexacolpidium) HKL., 1887 [**H. trypanon;* SD herein]. Equatorials much larger than 4 polars.——FIG. 13,*10*. *H. (H.) infundibulum* HKL., Rec., ×150 (42).

Hexaconus HKL., 1887 [**H. ciliatus;* SD herein]. Like *Hexacolpus* but 14 nonhydrotomical spines well developed.

H. (Hexaconus) [=*Hexaconarium* HKL., 1887 (obj.)]. Hydrotomical spines equal.

H. (Hexaconidium) HKL., 1887 [**H. echinatus;* SD herein]. Equatorial spines much larger than 4 polars.——FIG. 13,*8*. **H. (H.) echinatus,* Rec. ×150 (42).

Hexonaspis HKL., 1887 [**H. hexapleura;* SD herein]. Like *Hexacolpus* but hydrotomical spines not surrounded by sheaths.

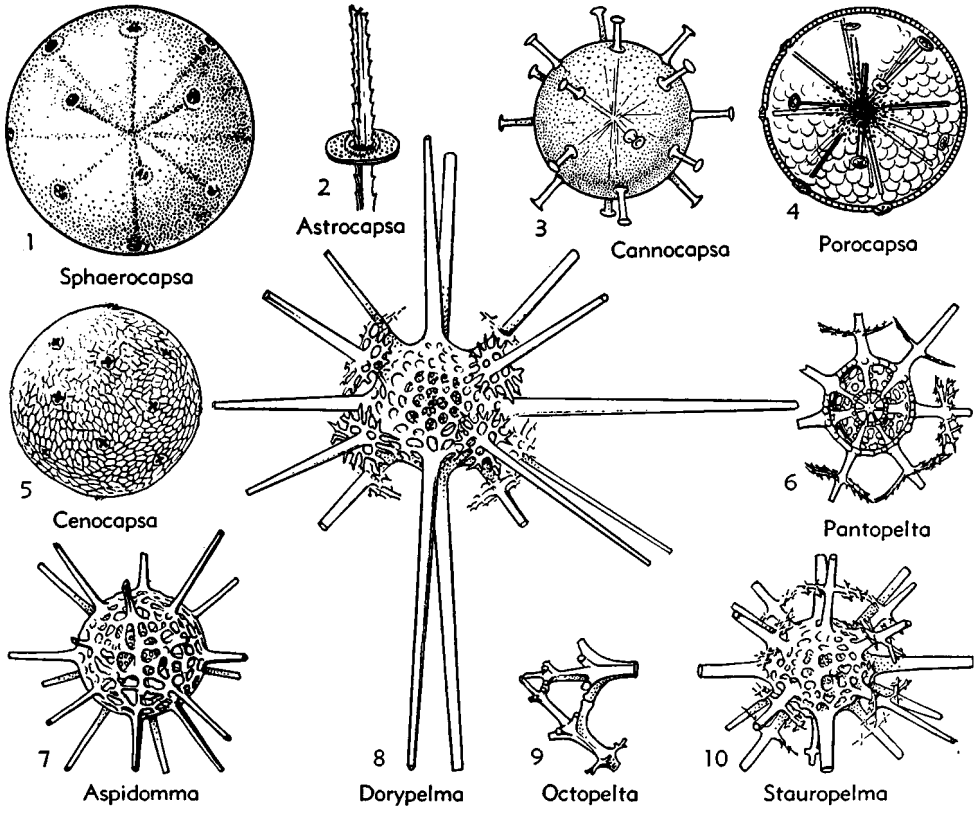

FIG. 12. Astrocapsidae, Aspidommatidae (p. D38-D40).

H. (Hexonaspis) [=*Hexonasparium* HKL., 1887 (obj.)]. Hydrotomical spines equal.

H. (Hexonaspidium) HKL., 1887 [**H. hastata;* SD herein]. Equatorials much larger than 4 polars.—FIG. 13,*9*. **H. (H.) hastata,* Rec., ×150 (42).

Family DIPLOCONIDAE Haeckel, 1862

[as Diploconida; emend. CAMPBELL, herein]

Simple discoidal shells with 2 very large equatorial spines developed from a minute central lattice shell, surrounded by conical to cylindrical or compressed sheaths. *Rec.*

Diploconus HKL., 1862 [*non* Zittel, 1868][**D. fasces;* SD herein]. Equatorial spines exceptionally large, others small and curved; resembles Roman fascis.

D. (Diploconus) [=*Diploconium* HKL., 1887 (obj.)]. Shell elliptical in cross section, compressed from both poles of sheath axis.

D. (Diploconulus) HKL., 1887 [**D. amalla;* SD herein]. Shell circular in cross section, not compressed.——FIG. 13,*11*. **D. (D.) amalla,* Rec., ×150 (42).

Diplocolpus HKL., 1887 [**D. costatus;* SD herein]. Small spines rudimentary or externally absent.

D. (Diplocolpus) [=*Diplocolpulus* HKL., 1887 (obj.)]. Shell circular in cross section.——FIG. 13,*7*. **D. (D.) costatus,* Rec., ×150 (42).

D. (Diplocolpium) HKL., 1887 [**D. sulcatus;* SD herein]. Shell elliptical in cross section, compressed from both poles.

Suborder SPUMELLINA Ehrenberg, 1875

[as Spumellaria; emend. CAMPBELL, herein]
[=Peripylea HERTWIG, 1879; Peripylaria HKL., 1882]

Simple thick-walled central capsule uniformly pierced by fine pores; generally spherical skeleton opaline siliceous but may be lacking; protoplasm may be highly vacuolated. *Cam.-Rec.*

MORPHOLOGICAL FEATURES

The Spumellina are a primitive group of Radiolaria in which the central capsule is usually enclosed by a peripherally generated siliceous shell, and a globular form that distinguishes many free-floating organisms. In some Spumellina, lattice shells are lacking, and simple disjoined needle-like, radiate, or otherwise modified **spicules** may occur. In some large Collodari, very large peculiar duplex-branched double spicules occur. Fused spicules compose the lattice shell in one group of these forms. Spicules are frequent fossils. More often the spumelline shell is developed as a hollow lattice or fenestrate sphere having similar or dissimilar pores; rarely these develop internal or external tubules. Complex Spumellina may have 5 or more concentric shells, which may be alike or unlike in numerous ways; rarely cubical internal shells are found. The outermost shell is termed the **cortical shell,** and the innermost, the **medullary shell;** there may be, however, several concurrent cortical or medullary shells. The concentric shells are united and supported by **radial beams,** which have constant numbers and positions in the different groups. A few forms have only a single shell and enclosed internal beams. The surface may be smooth or rough, and the pores may be flush or marked by elevated hexagonal or otherwise-shaped framework containing them and spines of various shapes and sizes. The spines are commonly distributed evenly, rising from the pore frames, or they may be restricted to opposed poles. Some are needle-like, others swordlike, and still others form tripartite blades. The 2 opposite main spines may be dissimilar in size; rarely they are joined at the free tips with a ring around the lattice shell. Long **principal spines,** 1 to 6 in number, occur on some types of Spumellina, tending to be arranged in opposite pairs disposed along mutually perpendicular axes of a cube. Any of these spines can be found among members of the Spumellina having a single or a number of concentric shells, and the range of combinations is great. In some species, spines are very numerous and less ordered in arrangement. In addition to the types of main spines described, accessory needle-like **by-spines** are common. Shells having these by-spines tend to resemble a burr and undoubtedly they float more easily than shells which lack such spines.

Less abundant than the naked, spiculate, or latticed spherical forms, but comprising an important shell type in the Spumellina, is a lattice shell produced along a single axis and thus of elliptical outline. **Spongy** shells are more common among these elliptical shells than in the spherical ones. In them the spongy shell is cortical. Spines similar to those found among spherical types occur and are similar or dissimilar in the same ways. Peculiar **polar tubules** occur in the main axis at opposed poles, and

such do not occur in spherical Spumellina. **Thorns** similar to those found on a rose stem occur in all the above types of shell. Also in both main types and in others, a **pylome** or osculum occurs as a large opening, usually only in the outermost of several concentric shells. Peculiar **twin shells,** usually resulting from constrictions, distinguish a few Ellipsidiicae.

In most flattened or discoidal Cenodiscicae which are produced by unequal growth in 2 axes, a porous **sieve plate** or perforated lidlike disc occurs, and concentric rings surround the central chamber. Spines radiate from this center so as to subdivide the rings into radial chambers. In some, also, the central chamber may have spirally wound laminae around it. In others, a phacoid or lenticular shell occurs, and branched or unbranched radial spines may radiate from the margin, giving rise to a sunburst or starlike form. In other Cenodiscicae, the shell has a spongy texture in whole or part and there may be spongy arms or projections which are either forked or simple. An outer mantle or veil surrounds the shell in some of these, and an interbrachial spongy veil **(patagium)** connects the extended arms of some. Spiral laminae occur in the central part of many shells of this type.

Girdles of simple or triradiate form surround the central chamber of a few aberrant Laracariicae, and **gates**, consisting of large fissure or openings, are found between the girdles. The girdles are developed from elliptical latticed rings which enclose the primary shell; they may lie in 1 to 3 different planes. Gates may be **fenestrated.** Trizonal growth results from the development of alternately placed girdles. Large vaulted domes **(cupolas)**, with or without fenestrated veils, distinguish most girdled forms. Some have repeated annular divisions. Finally, the ultimate members of this superfamily become **planispiral**, like *Nautilus,* or asymmetrically spiral **(helicoidal)**, as in

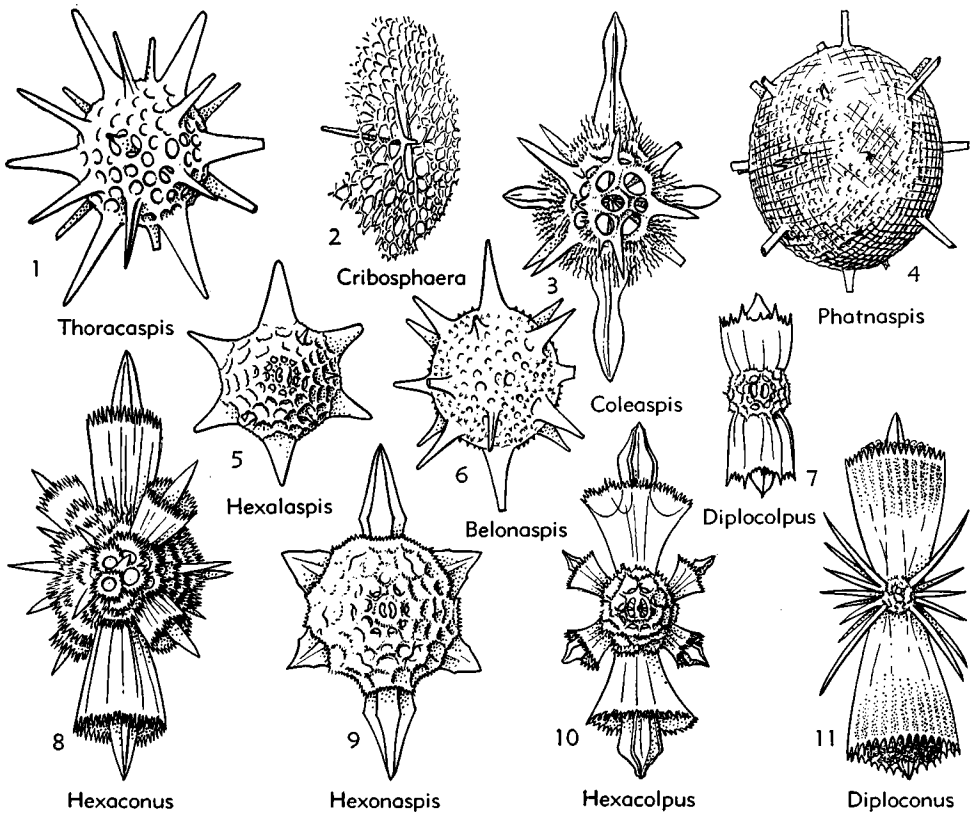

FIG. 13. Belonaspididae, Hexalaspididae, Diploconidae (p. D40-D42).

Helix. The terminus of this series is an irregular heap of chambers.

Descriptions of the biology, including reproduction and ecology, of the Spumellina are given by DREYER (16), HAECKER (22), and HAECKEL (20).

Division COLLODARI Haeckel, 1882

[as Collodaria; emend. CAMPBELL, herein]
[=Sphaerocollida POP., 1911]

Large spherical cells; with discrete spicules, or shells composed of fused spicules. *Ord.-Rec.*

Superfamily THALASSICOLICAE Haeckel, 1862

[*ex* Thalassicolida; emend. CAMPBELL, herein]
[=Colloidea HKL., 1887]

Skeleton consists only of isolated spicules within protoplasm, or entirely lacking. *Dev.-Rec.*

Family THALASSICOLIDAE Haeckel, 1862

[as Thalassicolida; emend. CAMPBELL, herein]
[=Thalassophysidae BRANDT, 1902]

Growth solitary, individuals not associated in colonies. *Dev.-Rec.*

Thalassicola HUXLEY, 1851 [**T. nucleata*][=*Calcaromma* THOMPSON, 1877]. Nucleus spherical, unbranched; no intracapsular alveoles but large round ones in extracapsular calymma. *Dev.* (Texas)-*Rec.*

T. (Thalassicola) [=*Thalassicollidium* HKL., 1887 (obj.)]. Membrane of central capsule areolated, with small polygonal plates and very numerous fine radial pores. *Dev.-Rec.*——FIG. 14. *T. (T.) melacapsa* HKL., Rec., ×112 (42).

T. (Thalassicollarium) HKL., 1887 [**T. zanclea* HKL., 1862; SD herein]. Membrane of central capsule structureless but with abundant pores. *Rec.*

Myxobrachia HKL., 1870 [**M. pluteus*][=*Thalassophysa* HKL., 1882 (obj.)]. Like *Thalassicola* but nucleus in central capsule papillate or branched. *Rec.*

Procyttarium HKL., 1879 [**P. primordiale*] [=*Actissa* HKL., 1887 (obj.)]. Nucleus spherical, simple; no alveoles within or outside central capsule. *Rec.*

P. (Procyttarium). Capsule spherical.

P. (Actidiscus) HKL., 1887 [**P. discoides;* SD herein]. Capsule lenticular, one axis shortened.

P. (Actilarcus) HKL., 1887 [**P. larcoides*]. Capsule lenticular, 3 axes different.

P. (Actiprunum) HKL., 1887 [**P. prunoideum;* SD herein]. Capsule ellipsoidal.

Thalassolampe HKL., 1862 [**T. margarodes;* SD herein]. Like *Procyttarium* but with large round alveoles in central capsule. *Rec.*——FIG. 15,*1*. *T. maxima* HKL., Rec., ×2.5 (42).

Thalassopila HKL., 1882 [**T. cladococcus* HKL., 1887]. Nucleus papillate or branched; large round alveoles in central capsule but not outside. *Rec.*——FIG. 15,*2*. **T. cladococcus*, Rec., ×10 (42).

Family CRISTALLOSPHAERIDAE Popofsky, 1911

Many discrete skeletal bodies in globular or irregular mass of protoplasm. *Rec.*

Cristallosphaera POP., 1911 [**C. cristalloides*]. Irregular hexagonal raised meshes on skeletal bodies.——FIG. 15,*3*. **C. cristalloides*, Rec., ×200 (48).

Family COLLOZOIDAE Haeckel, 1862

[as Collozoida; emend. CAMPBELL, herein]

Growth exclusively colonial. *Rec.*

Collozoum HKL., 1862 [**C. inerme;* SD herein]. No. spicules or other skeletal parts.

C. (Collozoum) [=*Collodinum* HKL., 1887 (obj.)]. Central capsule subspherical.

C. (Collodastrum) HKL., 1887 [**C. pelagicum* HKL., 1862; SD herein]. Capsule irregular.

C. (Collodiscus) HKL., 1887 [**C. coeruleum* HKL., 1862; SD herein]. Capsule discoidal.

C. (Collophidium) HKL., 1887 [**C. serpentinium;* SD herein]. Capsule cylindrical, contorted.——FIG. 15,*6*. **C. serpentinium*, Rec., ×5 (42).

C. (Colloprunum) HKL., 1887 [**C. ovatum;* SD herein]. Capsule ellipsoidal.

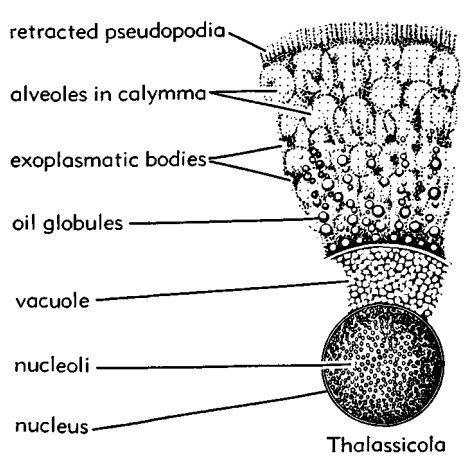

FIG. 14. Thalassicolidae (p. D44).

Superfamily THALASSOSPHAERICAE Haeckel, 1862

[*ex* Thalassosphaerida; emend. CAMPBELL, herein] [=Beloidea HKL., 1887]

Skeleton imperfect, commonly composed of many spicules irregularly distributed in calymma. *Ord.-Rec.*

Family THALASSOSPHAERIDAE Haeckel, 1862

[as Thalassophaerida; emend. CAMPBELL, herein] [=Physematidae BRANDT, 1902]

Growth invariably solitary. *Rec.*

Thalassosphaera HKL., 1862 [*non* HKL., 1887] [**Sphaerozoum bifurcum* HKL., 1860] [=*Thalassoxanthium* HKL., 1887 (obj.)]. Spicules branched or compound; no alveoles.

T. (Thalassosphaera) [=*Thalassoxanthoma* HKL., 1887 (obj.)]. Needle-like simple or bifurcate branches at ends of rodlike spicules.

T. (Thalassoxanthella) HKL., 1887 [**T. medusium;* SD herein]. Spicules with 3 or more branches diverging from points on spicules.—— FIG. 15,*8*. *T. (T.) cervicorne* HKL., Rec., ×150 (42).

Calosphaera CAMPBELL, 1951 [*pro Thalassosphaera* HKL., 1887 (*non* HKL., 1862)] [**Thalassosphaera belonium* HKL., 1887]. Spicules unbranched; no alveoles.

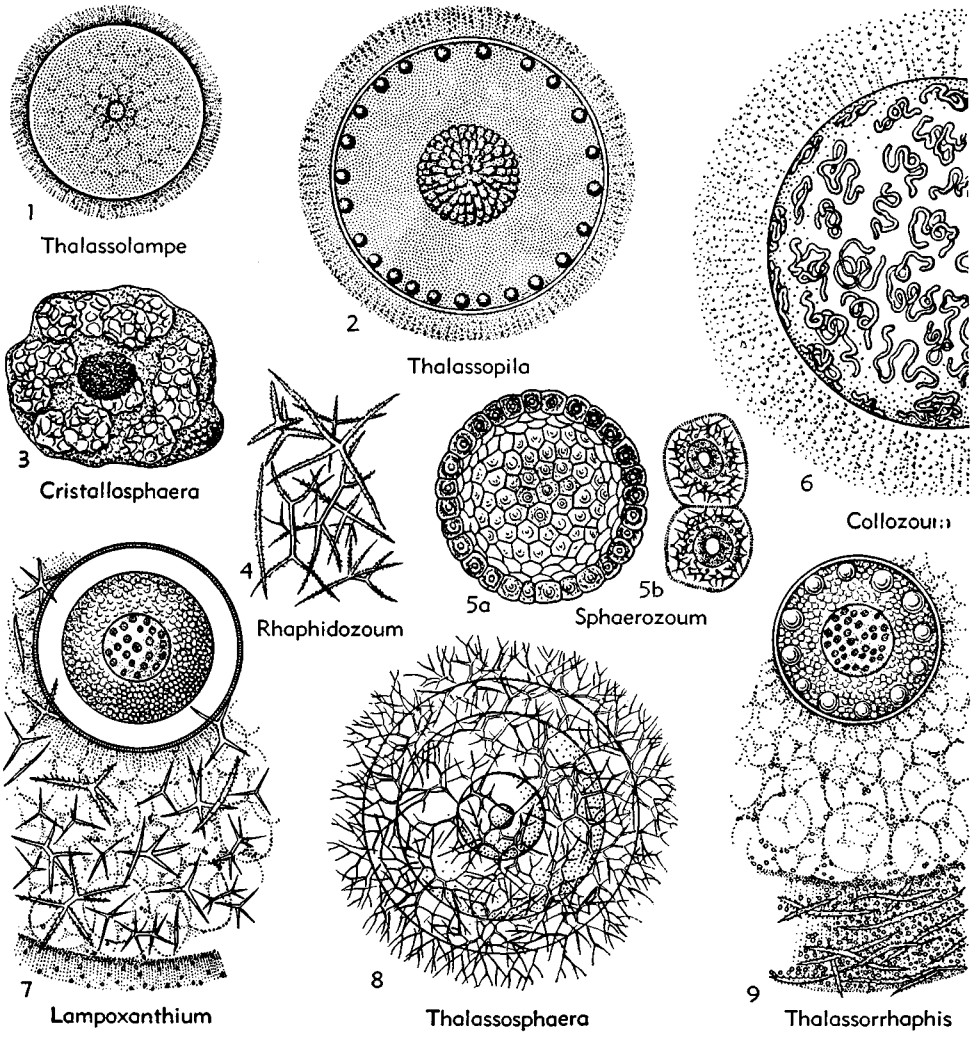

FIG. 15. Cristallosphaeridae, Collozoidae, Thalassosphaeridae, Sphaerozoidae (p. D44-D46).

Lampoxanthium HKL., 1887 [**L. tetractinium;* SD herein]. Many large alveoles in calymma but none in central capsule; spicules branched.

L. (Lampoxanthium) [=*Lampoxanthella* HKL., 1887 (obj.)]. Spicules radiate, all similar.

L. (Lampoxanthomma) HKL., 1887 [**L. punctatum;* SD herein]. Spicules with branches at ends, all similar.

L. (Lampoxanthura) HKL., 1887 [**L. pandora*]. Spicules partly simple radiate, partly twinned-radiate.——FIG. 15,*7*. **L. (L.) pandora,* capsule with fine pore canals, dark nucleoli in nucleus, spicules scattered in alveolated calymma, Rec., ×50 (42).

Physematium MEYEN, 1834 [**P. atlanticum*]. Spicules unbranched; many large alveoles in central capsule but not in calymma.

Thalassorrhaphis CAMPBELL, 1953 [*pro Thalassoplancta* HKL., 1887 (*non* HKL., 1862)][**Thalassoplancta brevispicula* HKL., 1887 (=*Lampoxanthium brevispiculum* HKL., 1887)][=*Thalassoraphis* CAMPBELL, 1951 (obj.)]. Spicules unbranched; many large alveoles in calymma. ——FIG. 15,*9*. **T. brevispicula* (HKL.), central capsule with clear vacuoles, oil droplets, and spicules in cortex, alveolate calymma, Rec., ×50 (42).

Family SPHAEROZOIDAE Haeckel, 1862

[as Sphaerozoida; emend. CAMPBELL, herein]

Growth exclusively colonial. *Ord.-Rec.*

Sphaerozoum MEYEN 1834 [**S. fuscum;* SD herein (=*S. punctatum* MÜLLER, 1858)]. Spicules branched or radiate, of a single kind. *Ord.*(N.Y.)-*Rec.*

S. (Sphaerozoum) [=*Sphaerozonoceras* HKL., 1887 (obj.)]. Spicules rodlike, with 1 to 4 rays at each end. *Ord.*(N.Y.)-*Rec.*——FIG. 15,*5*. *S. (S.) alveolatum* HKL., Rec.; *5a,* gross structure, ×15; *5b,* cells showing spicules and thick-walled alveoles, ×50 (42).

S. (Sphaerozonactis) HKL., 1887 [**S. triactinium;* SD herein]. Spicules radiate, 3 to 4 branches from a single point. *Rec.*

S. (Sphaerozonura) HKL., 1887 [**S. geminatum;* SD herein]. Spicules rodlike, with variable number of branches at each end. *Rec.*

Belonozoum HKL., 1887 [**Sphaerozoum spinulosum* MÜLLER, 1858; SD herein]. Spicules simple, not branched or radiate. *Rec.*

Rhaphidozoum HKL., 1862 [**Thalassicola acufera* MÜLLER, 1855]. Spicules partly simple and partly branched or radiate. *Rec.*

R. (Rhaphidozoum) [=*Rhaphidonactis* HKL., 1887 (obj.)]. Two to 4 shanks on radiate spicules.

R. (Rhaphidiceras) HKL., 1887 [**Sphaerozoum neapolitanum* BRANDT, 1881; SD herein]. Complex spicules with rays at both ends.

R. (Rhaphidonura) HKL., 1887 [**R. pandora;* SD herein]. Complex spicules include both radiate type with rays from central point and branched type with rays at both ends.——FIG. 15,*4*. **R. (R.) pandora,* group of spicules, Rec., ×100 (42).

Family MEYENELLIDAE Davis, 1950

Spicules with 3 to 4 rounded, club-shaped, or forked rays arising from common center. *Jur.*

Meyenella DAVIS, 1950 [**M. meyenella*]. Spicules not forked.

Palaeacantus DAVIS, 1950 [**P. spinosus*]. Spicules forked, Y- or H-shaped.

Family THALASSOTHAMNIDAE Haecker, 1906

Relatively huge, solitary forms with globular or branched central capsule, bearing one double spicule. *Rec.*

Thalassothamnus HAECKER, 1906 [**T. genista;* SD herein]. Capsule globular or lobate; central rod of spicule generally separated.——FIG. 16,*9*. *T. ramosus* HAECKER, Rec., ×15 (43).

Conostylus POP., 1907 [**C. diploconus;* SD herein]. Central rod of spicule solidly fused.——FIG. 16,*5*. **C. diploconus,* Rec., ×500 (48).

Cyrtocladus SCHRÖDER, 1906 [**C. gracilis;* SD herein]. Central rod of spicule partly fused; capsule dendritic.——FIG. 16,*8*. **C. gracilis,* Rec., ×15 (43).

Family LITHACANTHIDAE Popofsky, 1909

Single spicule with 4 to 6 mutually perpendicular rays diverging from common point and all in 1 or in 2 planes. *Rec.*

Lithacanthus POP., 1909 [**L. aculeatus;* SD herein]. Spicules 6-rayed.——FIG. 16,*3*. **L. aculeatus,* Rec., ×250 (35).

Tetracanthus POP., 1909 [**T. simplex*]. Spicule 4-rayed.——FIG. 16,*4*. **T. simplex,* Rec., ×250 (48).

Superfamily OROSPHAERICAE Haeckel, 1887

[*ex* Orosphaerida; emend. CAMPBELL, herein]
[=Phaeosphaeria HKL., 1879 *(partim)*]

Perfectly developed lattice shells. *Rec.*

Family OROSPHAERIDAE Haeckel, 1887

[as Orosphaerida; emend. CAMPBELL, herein]

Shell relatively large, spherical, rarely polyhedral or ellipsoidal, formed of thick bars; nodal points of coarse, irregular poly-

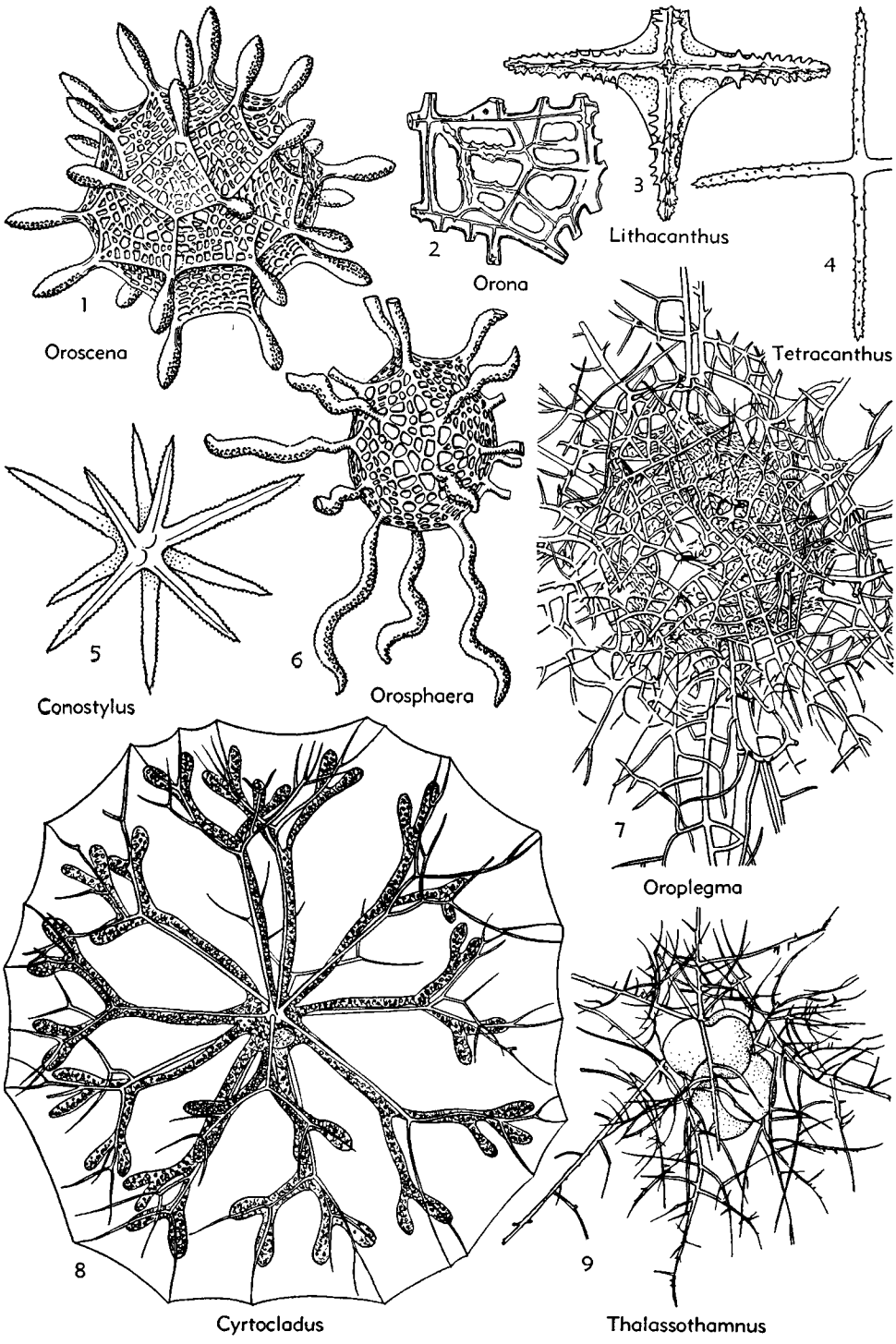

FIG. 16. Thalassothamnidae, Lithacanthidae, Orosphaeridae (p. D46-D48).

gonal meshes without starlike nodal points. *Rec.*

Subfamily OROSPHAERINAE Haeckel, 1887
[as Orosphaerida *(partim)*; emend. CAMPBELL, herein] [=Oronida HKL., 1887]

Surface of shell without pyramidal or tentlike elevations. *Rec.*

Orosphaera HKL., 1882 [**O. hastigera* HKL., 1887]. Shell subspherical, with many radial spines.

O. (Orosphaera) [=*Oronium* HKL., 1887 (obj.)]. Radial spines unbranched or lacking.——FIG. 16,*6*. *O. (O.) serpentina* HKL., Rec., ×20 (42).

O. (Orothamnus) HKL., 1887 [**O. arborescens;* SD herein]. Radial spines branched.

Orona HKL., 1887 [**O. maxima;* SD herein]. Shell subspherical, without radial spines.——FIG. 16,*2*. **O. maxima,* fragment of framework with air-filled central canals, Rec., ×150 (42).

Subfamily OROSCENINAE Haeckel, 1887
[as Oroscenida; emend. CAMPBELL, herein]

Shell surface with many pyramidal or tentlike elevations. *Rec.*

Oroscena HKL., 1887 [**O. gegenbauri;* SD herein]. Subspherical or polyhedral, with radial spines.

O. (Oroscena) [=*Oroscenium* HKL., 1887 (obj.)]. Spines unbranched.——FIG. 16,*1*. **O. (O.) gegenbauri,* Rec., ×20 (42).

O. (Orodendrum) HKL., 1887 [**O. huxleyi;* SD herein]. Spines branched.

Oroplegma HKL., 1887 [**O. diploplegmium;* SD herein]. Spongy shell enveloped by loose spongy skeleton; many radial spines.

O. (Oroplegma) [=*Oroplegmium* HKL., 1887 (obj.)]. Outer skeleton a fenestrate lamina.——FIG. 16,*7*. *O. (O.) diplosphaera* HKL., Rec., ×20 (42).

O. (Orodictyum) HKL., 1887 [**O. spongiosum;* SD herein]. Outer skeleton a complex framework.

Division SPHAERELLARI Haeckel, 1882

[as Sphaerellaria; emend. CAMPBELL, herein]

Shell latticed or spongy. *Cam.-Rec.*

Superfamily LIOSPHAERICAE Haeckel, 1882

[*ex* Liosphaerida; emend. CAMPBELL, herein] [=Sphaeroidea HKL., 1887]

Spherical latticed or spongy shells or concentrically multiple. *Cam.-Rec.*

Family LIOSPHAERIDAE Haeckel, 1882

[as Liosphaerida; emend. CAMPBELL, herein] [=Cenosphaeridae DEFLANDRE, 1952]

Without spines on shell surface. *Cam.-Rec.*

Subfamily LIOSPHAERINAE Haeckel, 1882
[as Liosphaerida *(partim)*; emend. CAMPBELL, herein] [=Carposphaerida HKL., 1882]

Two concentric lattice shells joined by radial beams. *Ord.-Rec.*

Liosphaera HKL., 1882 [**L. hexagonia* HKL., 1887]. Both shells cortical. *Ord.-Rec.*

L. (Liosphaera) [=*Melitomma* HKL., 1887 (obj.) *(partim)*]. Pores in both shells nearly equal in size and form. *Ord.*(Eng.)*-Rec.*——FIG. 17,*1b*. **L. (L.) hexagonia,* Rec., ×150 (42).

L. (Craspedomma) HKL., 1887 [**L. polypora;* SD herein]. Pores of both shells irregular. *Rec.*——FIG. 17,*1a*. **L. (L.) polypora,* Rec., ×150 (42).

Melitosphaera HKL., 1882 [**Carposphaera capillacea* HKL., 1887][=*Carposphaera* HKL., 1882; *Anthomma* (obj.), *Melitomma* HKL., 1887 (obj.) *(partim)*]. One shell medullary and one cortical. *Jur.-Rec.*

M. (Melitosphaera) HKL., 1882. Pores regular and similar, circular or hexagonal, within hexagonal frames. *Jur.-Rec.*——FIG. 17,*4a*. *M. (M.) melitomma* (HKL.), Rec., ×200 (42).

M. (Cerasosphaera) HKL., 1882 [**Carposphaera cerasus* HKL., 1887]. Cortical shell pores circular, without hexagonal frames; all pores regular, similar. *Eoc.-Rec.*——FIG. 17,*4b*. *M. (C.) minima* CL.-C., U.Eoc., Calif., ×150 (39).

M. (Phaenicosphaera) HKL., 1887 [**Carposphaera nodosa;* SD herein]. Cortical pores round, irregular, dissimilar. *Rec.*——FIG. 17,*4c*. **M. (P.) nodosa,* Rec., ×200 (42).

M. (Prunosphaera) HKL., 1882 [**Carposphaera prunulum* HKL., 1887]. Cortical shell pores polygonal, irregular, dissimilar. *Rec.*

Subfamily ETHMOSPHAERINAE Haeckel, 1862
[as Ethmosphaerida; emend. CAMPBELL, herein]

Single lattice shell. *Cam.-Rec.*

Ethmosphaera HKL., 1862 [**E. siphonophora*] [=*Etmosphaera* VINASSA, 1900 (obj.)]. Pores prolonged outward in conical or cylindrical tubules. *Cret.* (Italy), *Eoc.* (Calif.)*-Rec.*

E. (Ethmosphaera) [=*Ethmosphaerella* HKL., 1887 (obj.)]. Pore tubules conical. *Cret.-Rec.*——FIG. 17, *3b*. *E. (E.) polysiphonia* HKL., Rec., ×150 (42).

E. (Ethmosphaeromma) HKL., 1887 [**E. stenosiphonia;* SD herein]. Pore tubules cylindrical. *Eoc.-Rec.*——FIG. 17,*3a*. *E. (E.) ethmosiphonia* CL.-C., Eoc., Calif. ×150 (39).

Cenosphaera EHR., 1854 [**C. plutonis*][=*Caenosphaera* BERTOLINI, 1935 (obj.)]. Pores simple. *Cam.*(Cosmop.)*-Rec.*

C. (Cenosphaera) [=*Circosphaera* HKL., 1887 (obj.)]. Pores circular, subregular, similar, without hexagonal frames. *Cam.-Rec.*——FIG. 17,*6d*. *C. (C.) compacta* HKL., Rec., ×150 (42).

C. (Cyrtidosphaera) HKL., 1862 [**C. reticulata*]

[=*Ceriosphaera* HKL., 1882]. Pores irregularly polygonal, dissimilar, with polygonal frames. *Rec.*——FIG. 17,*6b*. *C. (C.) coronata* HKL., Rec. ×200 (42).

C. (Phormosphaera) HKL., 1882 [**C. primordialis* HKL., 1887]. Like *C. (Cenosphaera)* but pores may be hexagonal. *Mio.-Rec.*——FIG. 17,*6a*. *C. (P.) durhami* C.-CL., Mio., Calif., ×150 (35).

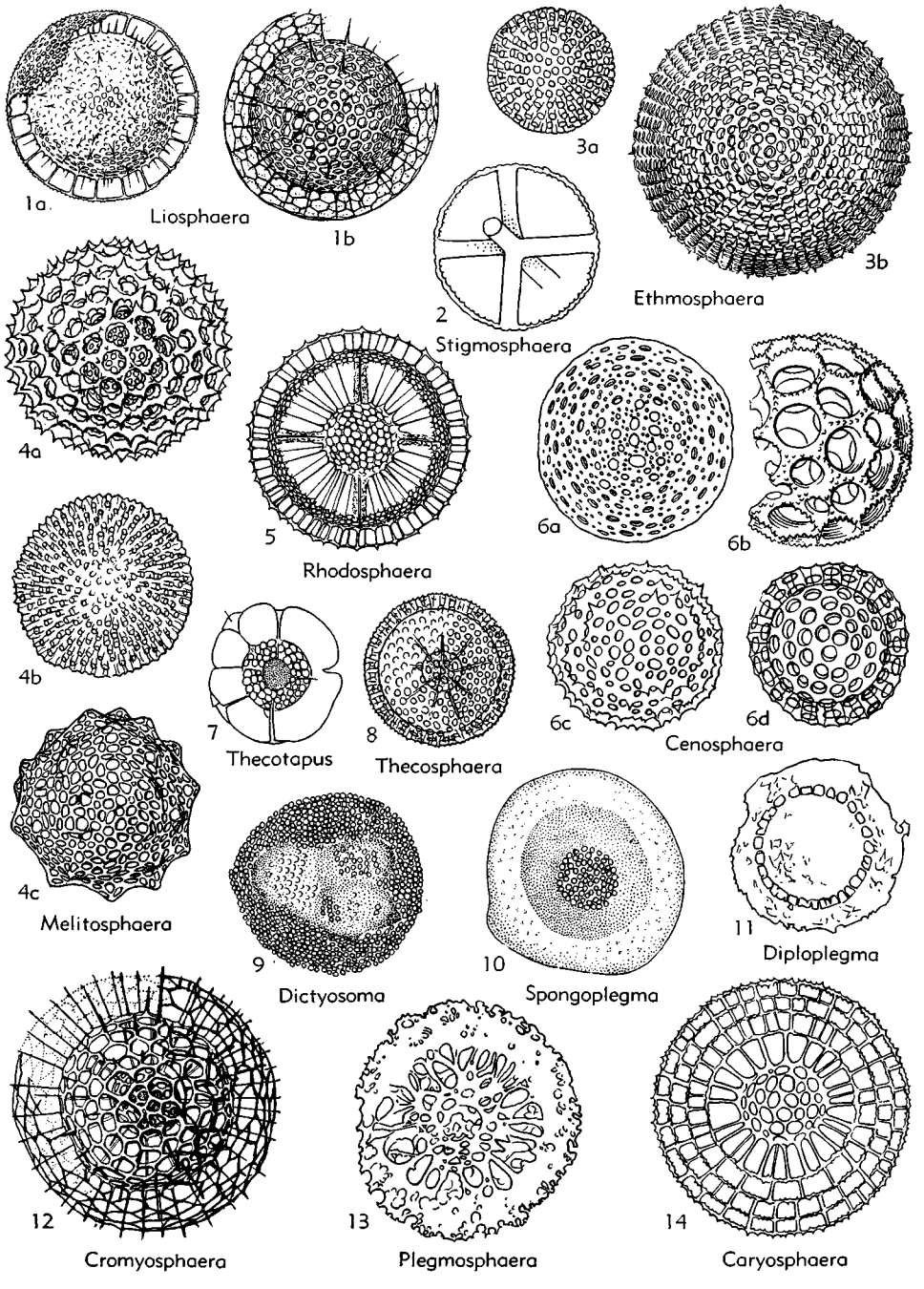

FIG. 17. Liosphaeridae (p. D48-D50).

C. (Porosphaera) HKL., 1887 [**C. antiqua;* SD herein]. Pores round or irregular, dissimilar, without frames. *Mio.-Rec.*——FIG. 17,*6c*. *C. (P.) aspera* STÖHR, Mio., Italy, ×150 (53).

Sethosphaera HKL., 1882 [**S. entosiphonia* HKL., 1887]. Pores prolonged inward as conical or cylindrical tubules. *Rec.*

Stigmosphaera HKL., 1887 [**S. actinocentra;* SD herein]. Radial beams diverge from point, bifurcate, and join inner shell surface. *Carb.-Rec.*——FIG. 17,*2*. *S. mira* RÜST, L.Carb., Ger., ×125 (51).

Subfamily THECOSPHAERINAE Haeckel, 1882
[as Thecosphaerida; emend. CAMPBELL, herein]

Three concentric lattice shells joined by radial beams. *Jur.-Rec.*

Thecosphaera HKL., 1882 [**T. tripodictyon* HKL., 1887][=*Teocommides* BERTOLINI, 1935]. Two medullary shells and one cortical. *Jur.-Rec.*

T. (Thecosphaera) [=*Thecosphaerantha* HKL., 1887 (obj.)]. Cortical shell pores circular or hexagonal, regular, in hexagonal frames; all pores alike. *Jur.-Rec.*

T. (Thecosphaerella) HKL., 1887 [**Haliomma inerme* HKL., 1860; SD herein]. Like *T. (Thecosphaera)* but all pores circular, without hexagonal frames. *Eoc.-Rec.*——FIG. 17,*8*. *T. (T.) californica* CL.-C., U.Eoc., Calif., ×150 (39).

T. (Thecosphaerina) HKL., 1887 [**T. capillacea;* SD herein]. Cortical pores polygonal, irregular, dissimilar. *Rec.*

T. (Thecosphaeromma) HKL., 1887 [**T. maxima;* SD herein]. Like *T. (Thecosphaerina)* but pores round. *Rec.*

Rhodosphaera HKL., 1882 [**R. hexagonia* HKL., 1887]. One medullary shell and 2 cortical ones. *Dev.-Rec.*

R. (Rhodosphaera) [=*Rhodosphaerella* HKL., 1887 (obj.)]. Pores of both cortical shells regular, similar. *Dev.-Rec.*——FIG. 17,*5*. *R. (R.) crucifera* RÜST, U.Carb., Ger., ×75 (51).

R. (Rhodosphaeromma) HKL., 1887 [**R. palliata;* SD herein]. Pores of both cortical shells irreguular, dissimilar. *Rec.*

Thecotapus CAMPBELL, 1951 [*pro Thecosphaera* RÜST, 1885 (*non* HKL., 1882)][**Thecosphaera unica* RÜST, 1885]. Like *Rhodosphaera* but with minute pores in inner cortical shell and large circular pores with delicate frames in outer one. *Jur.*——FIG. 17,*7*. **T. unicus* (RÜST); Jur., Switz., ×100 (51).

Subfamily CROMYOSPHAERINAE Haeckel, 1882
[as Cromyosphaerida; emend. CAMPBELL, herein]

Four concentric shells joined by radial beams. *Cret.-Rec.*

Cromyosphaera HKL., 1882 [**C. quadriplex* HKL., 1887][=*Cromyosphaerium* HKL., 1882 (obj.)]. Two medullary shells and 2 cortical ones.——FIG. 17,*12*. *C. antarctica* HKL., Rec., ×200 (42).

Subfamily CARYOSPHAERINAE Haeckel, 1882
[as Caryosphaerida; emend. CAMPBELL, herein]

Five or more concentric shells joined by radial beams. *Dev.-Rec.*

Caryosphaera HKL., 1882 [**C. polysphaerica* BÜTSCHLI, 1882]. Two medullary shells and 3 cortical ones.——FIG. 17,*14*. *C. groddecki* RÜST, Dev., Ger., ×80 (51).

Subfamily PLEGMOSPHAERINAE Haeckel, 1882
[as Plegmosphaerida; emend. CAMPBELL, herein]

Shell partly or wholly a spongy framework. *Cam.-Rec.*

Plegmosphaera HKL., 1882 [**P. maxima* HKL., 1887][=*Enneaplegma* HKL., 1882]. Hollow spongy sphere without medullary shell. *Mio.-Rec.*

P. (Plegmosphaera) [=*Plegmosphaerantha* HKL., 1887 (obj.)]. Smooth inner and outer sides of spongy shell, closed by lattice plate with polygonal meshes. *Rec.*

P. (Plegmosphaerella) HKL., 1887 [**P. entodictyon;* SD herein]. Smooth inner side but outer side rough, spongy, thorny, closed by smooth lattice plate. *Rec.*

P. (Plegmosphaeromma) HKL., 1887 [**P. exodictyon*]. Rough spongy inner side without lattice plate, outside closed by smooth lattice plate. *Rec.*

P. (Plegmosphaerusa) HKL., 1887 [**P. leptoplegma;* SD herein]. Both sides of spongy wall rough, spiny, without lattice plate. *Mio.-Rec.*——FIG. 17,*13*. *P. (P.) churchi* C.-CL., Mio., Calif., ×150 (35).

Dictyosoma MÜLLER, 1858 [**D. spongiosum*][=*Spongodictyon* HKL., 1862 (obj.)]. Spongy sphere enclosing 2 medullary lattice shells. *Jur.-Rec.*

D. (Dictyosoma) [=*Dictyoplegma* HKL., 1862 (obj.)]. Spongy cortical layer in contact with outer medullary shell. *Jur.-Rec.*——FIG. 17,*9*. *D. (D.) integrum* RÜST, Jur., Ger., ×110 (51).

D. (Spongodictyoma) HKL., 1862 [**D. trigonizon* HKL., 1860; SD herein][=*Dictyosoma* HKL., 1862 (obj.)]. Smooth lattice plate or 3rd medullary shell inside spongy cortical shell. *Rec.*

Diploplegma HINDE, 1890 [**D. cinctum;* SD herein]. Spongy or irregularly reticulate cortical and large medullary shells. *Ord.*——FIG. 17,*11*. **D. cinctum*, Ord., Scot., ×100 (44).

Spongoplegma HKL., 1882 [**S. urschauense* RÜST, 1885]. Spongy cortical shell and single medullary one. *Cam.-Rec.*——FIG. 17,*10*. **S. urschauense*, Jur., Ger., ×75 (51).

Styptosphaera HKL., 1882 [**S. spumacea* HKL., 1887]. No medullary shell. *Plio.-Rec.*

Family PROTOSPHAERIDAE Cayeux, 1897

Spherical lattice shell with many isolated spicules. *Cret.*

Protosphaera CAYEUX, 1897 [**P. hexagonalis*]. Small sharp points between pores.

Family COLLOSPHAERIDAE Haeckel, 1862

[as Collosphaerida; emend. CAMPBELL, herein] [=Radiolaria polyzoa MULLER, 1858]

Growth colonial, individuals joined by alveolar jelly and anastomosing pseudopodia; each central capsule with distinct, somewhat irregular shell. *Ord.-Rec.*

Subfamily COLLOSPHAERINAE Haeckel, 1882

[as Collosphaerida *(partim)*; emend. CAMPBELL, herein] [=Acrosphaerida HKL., 1882]

Single lattice shell present. *Ord.-Rec.*

Collosphaera MÜLLER, 1855 [**C. huxleyi;* SD herein] [=*Dermatosphaera* EHR., 1860]. Simple smooth shell. *Rec.*

C. (Collosphaera) [=*Discollosphaera* HKL., 1887 (obj.)]. Form irregular.——FIG. 18,*1*. *C. (C.) polygona* HKL., Rec., (42).

C. (Eucollosphaera) HKL., 1887 [**C. primordialis;* SD herein]. Form regular spherical.

Buccinosphaera HKL., 1887 [**B. invaginata;* SD herein]. Inwardly directed tubes with fenestrate walls. *Rec.*——FIG. 18,*2*. **B. invaginata,* large crystals in each cell, Rec., ×250 (42).

Caminosphaera HKL., 1887 [**C. furcata;* SD here-

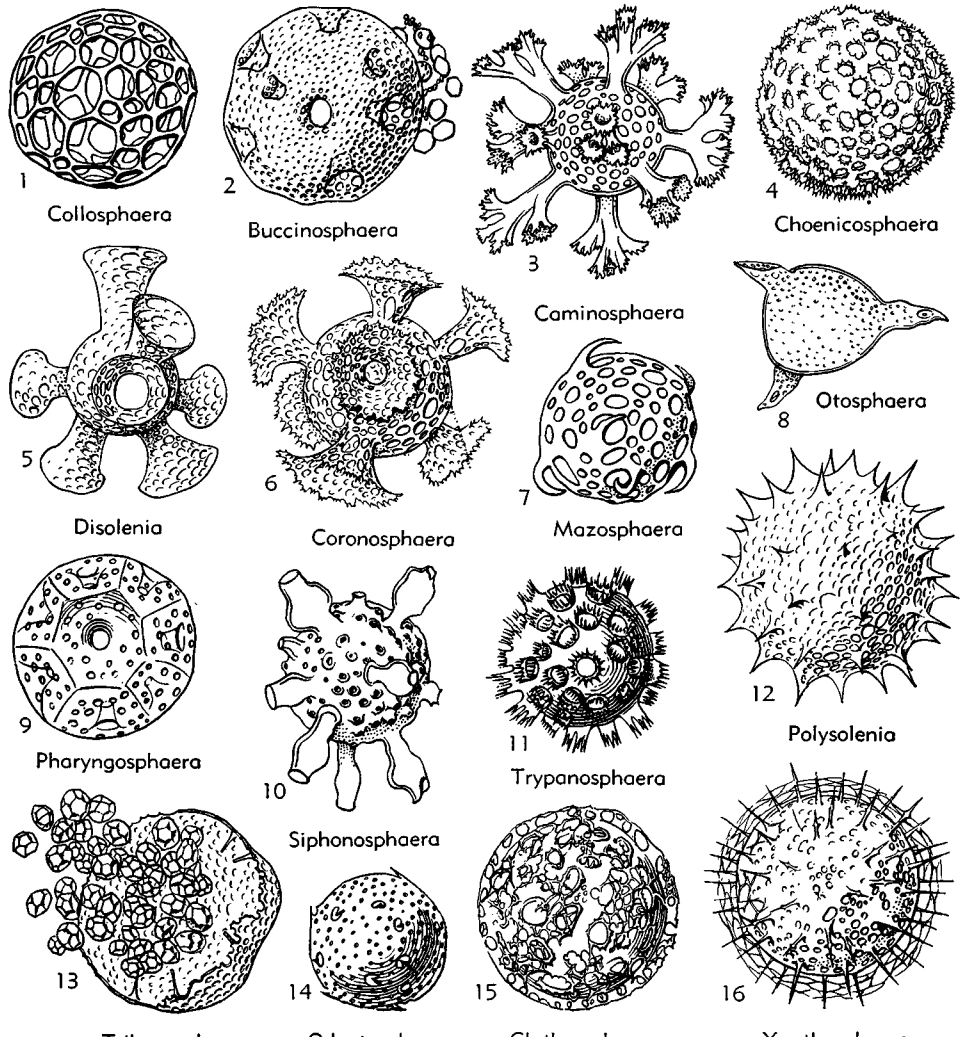

FIG. 18. Collosphaeridae (p. D51, D52).

in]. Pores prolonged outward in solid-walled branched tubules. *Rec.*——Fig. 18, *3. C. dendrophora* Hkl., Rec., ×150 (42).

Choenicosphaera Hkl., 1887 [**C. murrayana;* SD herein]. Radial spines form coronals around large pores. *Ord.*(N.Y.)-*Rec.*

C. (Choenicosphaera) [=*Choenicosphaerula* Hkl., 1887 (obj.)]. Crown of spines around each pore. *Ord.-Rec.*——Fig. 18,*4. *C. (C.) murrayana,* Rec., ×150 (42).

C. (Choenicosphaerium) Hkl., 1887 [**C. flammabunda;* SD herein]. Crown of spines only around large pores. *Rec.*

Coronosphaera Hkl., 1887 [**C. diadema;* SD herein]. Pores prolonged outward in fenestrate tubules with crown of spines around mouth. *Rec.* ——Fig. 18,*6. C. calycina* Hkl., Rec., ×150 (42).

Disolenia Ehr., 1860 [**D. follis*][=*Pentasolenia, Tetrasolenia, Trisolenia* Ehr., 1872; *Solenosphaera* Hkl., 1887 (obj.)]. Like *Coronosphaera* but no spines at tubule mouths. *Rec.*

D. (Disolenia) [=*Solenophracta* Hkl., 1887 (obj.)]. Tubules cylindrical.

D. (Solenosphenia) Hkl., 1887 [**Solenosphaera ascensionis;* SD herein]. Tubules conical, narrowing outward.

D. (Solenosphyra) Hkl., 1887 [**Solenosphaera cornucopia;* SD herein]. Tubules funnel-shaped, flaring outward.——Fig. 18,*5. *D. (S.) cornucopia* (Hkl.), Rec., ×150 (42).

Mazosphaera Ehr., 1860 [**M. laevis;* SD herein]. Pores prolonged outward in simple solid-walled tubules with tooth at mouth. *Rec.*——Fig. 18,*7. M. hippotis* Hkl., Rec., ×200 (42).

Myxosphaera Brandt, 1885 [**Thalassicola coerula* Schneider, 1858]. Small close-packed simple shells, bluish. *Rec.*

Odontosphaera Hkl., 1887 [**O. monodon;* SD herein]. Single spine at edge of each large pore. *Rec.*——Fig. 18,*14. *O. monodon,* Rec., ×150 (42).

Otosphaera Hkl., 1887 [**O. polymorpha;* SD herein]. Like *Mazosphaera* but walls of tubules fenestrate. *Rec.*——Fig. 18,*8. *O. polymorpha,* Rec., ×150 (42).

Pharyngosphaera Hkl., 1887 [**P. stomodaea*]. Pores prolonged inward by solid-walled tubules. *Rec.*——Fig. 18,*9. *P. stomodaea,* Rec., ×200 (42).

Polysolenia Ehr., 1872 [**P. setosa*][=*Acrosphaera* Hkl., 1882 (obj.)]. Surface with irregularly scattered radial spines. *Rec.*——Fig. 18,*12. P. echinoides* (Hkl.), Rec., ×200 (42).

Siphonosphaera Müller, 1858 [**S. tubulosa*]. Like *Mazosphaera* but mouths of tubules truncate, smooth. *Ord.*(N.Y.)-*Mio.* (Italy)-*Rec.*

S. (Siphonosphaera) [=*Holosiphonia* Hkl., 1887 (obj.)]. All pores with tubules. *Ord.-Rec.*

S. (Merosiphonia) Hkl., 1887 [**S. socialis;* SD herein]. Some pores lacking tubules. *Rec.*—— Fig. 18,*10. S. (M.) pipetta* Hkl., Rec., ×150 (42).

Tribonosphaera Hkl., 1882 [**T. centripetalis* Hkl., 1887]. Simple shell with inwardly directed beams. *Rec.*——Fig. 18,*13. *T. centripetalis,* Rec., ×250 (42).

Trypanosphaera Hkl., 1887 [**T. trepanata;* SD herein]. Like *Coronosphaera* but tubules solid-walled. *Rec.*

T. (Trypanosphaera) [=*Trypanosphaerula* Hkl., 1887 (obj.)]. All pores with tubules.——Fig. 18,*11. *T. (T.) trepanata,* Rec., ×150 (42).

T. (Trypanosphaerium) Hkl., 1887 [**T. coronata;* SD herein]. Some pores lack tubules.

Subfamily CLATHROSPHAERINAE Haeckel, 1882

[as Clathrosphaerida; emend. Campbell, herein[

Two concentric lattice shells. *Rec.*

Clathrosphaera Hkl., 1882 [**C. circumtexta* Hkl., 1887]. Outer surface smooth.

C. (Clathrosphaera) [=*Clathrosphaerula* Hkl., 1887 (obj.)]. Shells joined by hollow tubes.—— Fig. 18,*15. *C. (C.) circumtexta,* Rec., ×200 (42).

C. (Clathrosphaerium) Hkl., 1887 [**C. arachnoides;* SD herein]. Shells joined by solid rods.

Xanthosphaera Hkl., 1882 [**X. capillacea* Hkl., 1887]. Outer shell with spiny surface.——Fig. 18,*16. X. erinacea* Hkl., Rec., ×200 (42).

Family DORYSPHAERIDAE Vinassa de Regny, 1898

Lattice shell single or concentrically multiple, with a single polar spine. *Ord.-Mio.*

Dorysphaera Hinde, 1890 [**D. reticulata*][=*Monostylus* Cayeaux, 1897]. Single shell with one main spine, but short ones may cover surface. *Ord.*(Scot.)-*Mio.*(Italy).——Fig. 19,*3. D. ehrenbergi* Vinassa, Mio., Italy, ×150 (55).

Doryconthidium Vinassa, 1898 [**D. cayeuxi*]. Three concentric shells, secondary spines numerous. *Jur.-Mio.*——Fig. 19,*8. D. vinassianum* Carnevale, Mio., Italy, ×110 (36).

Dorydictyum Hinde, 1890 [*D. *simplex*]. Single shell with uniform reticulate lattice, fine alveoles; robust styliform main spine with length nearly equal to shell diameter. *Ord.-Cret.*——Fig. 19,*2. *D. simplex,* Ord., Scot., ×100 (44).

Dorylonchidium Vinassa, 1898 [**D. hindei* Vinassa, 1898]. Two concentric shells, secondary spines present. *Paleoc.-Mio.*

D. (Dorylonchidium) [=*Dorylonchella* Cl.-C., 1942 (obj.)]. Surface smooth or roughened by short, thin spines or thorns. *Paleoc.-Mio.*—— Fig. 19,*7a. D. (D.) monoxiphos* Cl.-C., U.Eoc., Calif., ×150 (39).

D. (Dorylonchomma) CL.-C., 1942 [**D. fructiforme*]. Surface with stout, scattered spine or thorns. *Eoc.*——FIG. 19,*7b*. *D. (D.) grande* CL.-C., U.Eoc., Calif., ×100 (39).

Doryplegma HINDE, 1890 [**D. nasutum;* SD herein]. Cortical shell irregularly latticed or spongy, enclosing medullary shell. *Ord.*——FIG. 19,*4*. **D. nasutum,* Ord., Scot., ×100 (44).

Family STYLOSPHAERIDAE Haeckel, 1882

[as Stylosphaerida; emend. CAMPBELL, herein]

Lattice shell single or concentrically multiple, with 2 prominent polar spines, or rarely more, oppositely placed in one axis. *Cam.-Rec.*

Subfamily STYLOSPHAERINAE Haeckel, 1882

[as Stylosphaerida *(partim)*; emend. CAMPBELL, herein] [=Sphaerostylida HKL., 1882]

Two concentric lattice shells. *Dev.-Rec.*

Stylosphaera EHR., 1847 [**S. hispida* EHR., 1854; SD FRIZZELL 1951]. Two spines of equal length and form, or rarely with 3 to 5 spines. *Dev.-Rec.*

S. (Stylosphaera) [=*Stylosphaerella* HKL., 1887 (obj.)]. Pores nearly equal and similar; surface thorny or spiny. *Dev.-Rec.*——FIG. 19,*5b*. *S. (S.) melpomene* HKL., Rec., ×200 (42).

S. (Stylosphaerantha) HKL., 1887 [**S. calliope;* SD herein]. Like *S. (Stylosphaera)* but surface without spines or thorns. *Eoc.-Rec.*——FIG. 19,*5c*. **S. (S.) calliope,* Rec., ×200 (42).

S. (Stylosphaerissa) HKL., 1887 [**S. nana;* SD herein]. Pores irregular, dissimilar; surface without spines or thorns.——FIG. 19,*5a*. **S. (S.) nana,* Rec., ×300 (42).

S. (Stylosphaeromma) HKL., 1887 [**S. thalia;* SD herein]. Like *S. (Stylosphaerissa)* but with spines or thorns. *Rec.*

Saturnulus HKL., 1882 [**S. circulus* HKL., 1887]. Tips of polar spines joined by circular or elliptical ring. *Cret.-Rec.*——FIG. 19,*1*. *S. ellipticus* HKL., Rec., ×200 (42).

Sphaerostylus HKL., 1882 [**S. zittelii* RÜST, 1885]. Two free polar spines dissimilar. *Jur.-Rec.*

S. (Sphaerostylus) [=*Sphaerostylantha* HKL., 1887 (obj.)]. Pores regular, similar; surface without spines or thorns. *Jur.-Rec.*——FIG. 19,*6b*. *S. (S.) minutus* CL.-C., U.Eoc., Calif., ×150 (39).

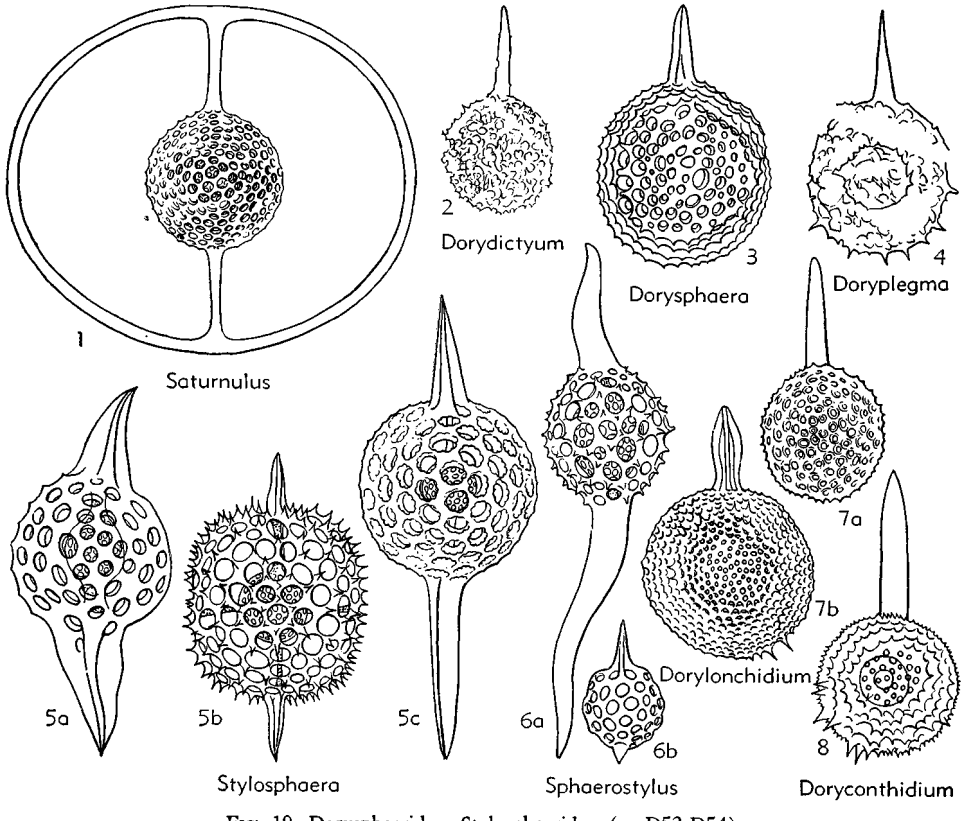

FIG. 19. Dorysphaeridae, Stylosphaeridae (p. D52-D54).

S. (Sphaerostyletta) HKL., 1887 [**S. diadema*]. Pores regular, similar; surface spiny or thorny. *Rec.*

S. (Sphaerostylissa) HKL., 1887 [**S. cottus;* SD herein]. Pores irregular, dissimilar; surface without spines or thorns. *Rec.*

S. (Sphaerostylomma) HKL., 1887 [**S. ophidium*]. Pores irregular, dissimilar; surface with spines or thorns. *Rec.*——FIG. 19,*6a*. **S. (S.) ophidium,* Rec., ×150 (42) .

Subfamily XIPHOSTYLINAE Haeckel, 1882

[as Xiphostylida; emend. CAMPBELL, herein]
[=Saturnalinae DEFLANDRE, 1952]

Single lattice shell present. *Cam.-Rec.*

Xiphostylus HKL., 1882 [**X. attenuatus* RÜST, 1885]. Polar spines dissimilar. *Cam.-Rec.*

X. (Xiphostylus) [=*Xiphostylantha* HKL., 1887 (obj.)]. Pores regular, similar; surface without spines or thorns. *Cam.-Rec.*——FIG. 20,*7a*. *X. (X.) alcedo* HKL., Rec., ×200 (42).

X. (Xiphostyletta) HKL., 1887 [**X. pictus;* SD herein]. Pores regular, similar; surface spiny or thorny. *Rec.*——FIG. 20,*7b*. **X. (X.) pictus,* Rec., ×150 (42).

X. (Xiphostylissa) HKL., 1887 [**X. trogon;* SD herein]. Pores irregular, dissimilar; surface without spines or thorns. *Rec.*——FIG. 20,*7d*. **X. (X.) trogon,* Rec., ×200 (42).

X. (Xiphostylomma) HKL., 1887 [**X. emberiza;* SD herein]. Pores irregular, dissimilar; surface with spines or thorns. *Rec.*——FIG. 20,*7c*. **X. (X.) emberiza,* Rec., ×200 (42).

Saturnalis HKL., 1882 [**S. circularis* HKL., 1887]. Tips of polar spines joined by circular or elliptical ring. *Cret.-Rec.*

S. (Saturnalis) [=*Saturnalina* HKL., 1887 (obj.)]. Ring smooth. *Cret.*(Cosmop.)-*Rec.*(Circumtrop.). ——FIG. 20,*3a*. *S. (S.) circoides* HKL., Rec., ×200 (42).

S. (Saturnalium) HKL., 1887 [**S. rotula;* SD herein]. Ring spiny. *Cret.*(Cosmop.)-*Rec.*(trop.). ——FIG. 20,*3b*. **S. (S.) rotula,* Rec., ×200 (42).

Stigmosphaerostylus RÜST, 1892 [**S. notabilis*] [=*Stigmosphaerocephalus* POP., 1911 (obj.)]. Polar spines similar; shell interior with 4 strong beams in equatorial plane in right-angle cross. *L.Carb.,* Ger.——FIG. 20,*10*. **S. notabilis,* L.Carb., Ger., ×75 (51).

Xiphosphaera HKL., 1882 [**X. tredecimporata* RÜST, 1885]. Two similar polar spines, rarely 3 to 5. *Ord.-Rec.*

X. (Xiphosphaera) [=*Xiphosphaerantha* HKL., 1887 (obj.)]. Pores regular, similar; surface without spines or thorns. *Rec.*——FIG. 20,*9d*. *X. (X.) venus* HKL., Rec., ×200 (42).

X. (Xiphosphaerella) HKL., 1887 [**X. pallas;* SD herein]. Pores regular, similar; surface papillose to spiny or thorny. *Eoc.-Rec.*——FIG. 20,*9a*. **X. (X.) pallas,* Rec., ×150 (42).

X. (Xiphosphaerissa) HKL., 1887 [**X. ceres;* SD herein]. Pores irregular, dissimilar; surface without spines or thorns. *Ord.-Rec.*——FIG. 20,*9b*. *X. (X.) macracantha* RUEDEMANN & WILSON, Ord., N.Y., ×150 (50).

X. (Xiphosphaeromma) HKL., 1887 [**X. vesta;* SD herein]. Pores irregular, dissimilar; surface spiny or thorny. *Rec.*——FIG. 20,*9c*. **X. (X.) vesta,* Rec., ×150 (42).

Subfamily AMPHISTYLINAE Haeckel, 1882

[as Amphistylida; emend. CAMPBELL, herein]

Three concentric lattice shells. *Jur.-Rec.*

Amphistylus HKL., 1882 [**A. clio* HKL., 1887]. Polar spines dissimilar; surface without spines or thorns. *Jur.-Rec.*——FIG. 20,*2*. *A. zitteli* Vinassa, U.Jur., Italy, ×200 (55).

Amphisphaera HKL., 1882 [**A. neptunus* HKL., 1887][=*Amphisphaeridium* HKL., 1887]. Polar spines similar. *Cret.-Rec.*

A. (Amphisphaera) [=*Amphisphaerantha* HKL., 1887 (obj.)]. Pores regular, similar; surface without spines or thorns. *Cret.-Rec.*——FIG. 20,*1a*. *A. (A.) ceres* CL.-C., U.Eoc., Calif., one spine broken, ×200 (39).

A. (Amphisphaerella) HKL., 1887 [**A. apollo;* SD herein]. Pores regular, similar; surface spiny or thorny. *Rec.*

A. (Amphisphaerissa) HKL., 1887 [**A. cronos;* SD herein]. Pores irregular, dissimilar; surface without spines or thorns. *Rec.*——FIG. 20,*1b*. *A. (A.) pluto* HKL., Rec., ×200 (42).

A. (Amphisphaeromma) HKL., 1887 [**A. mars;* SD herein]. Pores irregular, dissimilar; surface shiny or thorny. *Rec.*

Saturninus HKL., 1882 [**S. triplex* HKL., 1887]. Tips of polar spines joined by circular or elliptical ring. *Cret.-Rec.*

Subfamily CROMYOSTYLINAE Haeckel, 1882

[as Cromyostylida; emend. CAMPBELL, herein]

Four concentric lattice shells, 2 medullary and 2 cortical. *Rec.*

Cromyostylus HKL., 1882 [**C. gladius* HKL., 1887]. Polar spines dissimilar.

Stylocromyum HKL., 1882 [**S. amphipyramis* HKL., 1887; SD herein]. Polar spines similar.

Subfamily CARYOSTYLINAE Haeckel, 1882

[as Caryostylida; emend. CAMPBELL, herein]

Five or more concentric lattice shells. *Rec.*

Caryostylus HKL., 1882 [**C. hexalepas* HKL., 1887][=*non Caryoxiphus, Caryodoras, Caryolonche* HKL., 1882]. Polar spines similar.

Subfamily SPONGOSTYLINAE Haeckel, 1882

[as Spongostylida; emend. CAMPBELL, herein]

Spherical spongy shells, with or without enclosed lattice shells. *Cret.-Rec.*

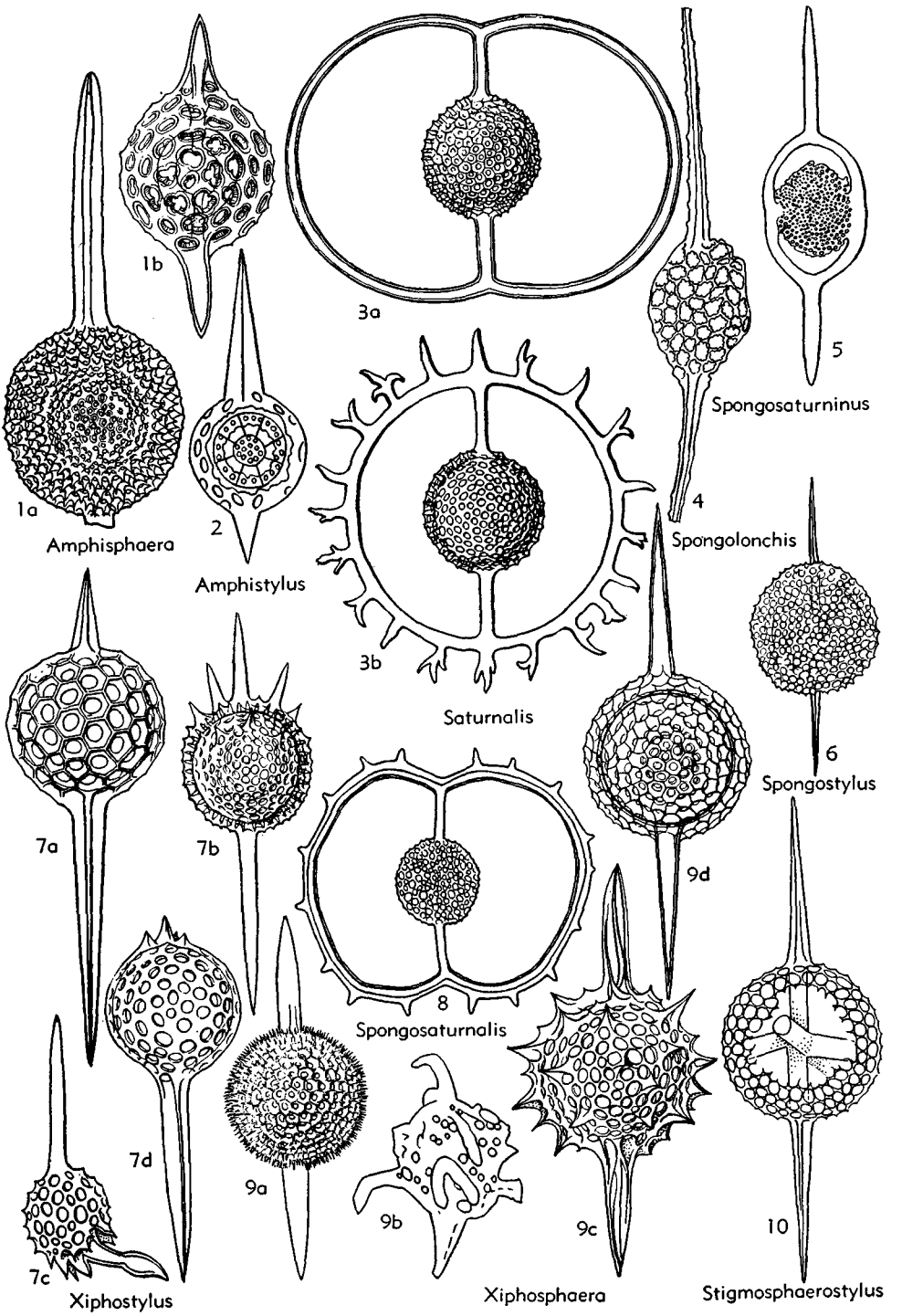

FIG. 20. Stylosphaeridae (p. D54-D56).

Spongostylus HKL., 1882 [**S. hastatus* HKL., 1887] [=*Spongostylium* HKL., 1882]. One simple medullary shell. *Rec.*——FIG. 20,*6*. *S. gladiatus* (EHR.), Rec., ×200 (41).

Spongolonchis HKL., 1887 [**S. compacta* HKL., 1887] [*non Spongolonche* HKL., 1882]. Solid spongy shell. *Cret.-Rec.*——FIG. 20,*4*. *S. grandis* C.-CL., Cret., Calif., ×100 (35).

Spongosaturnalis C.-CL., 1944 [**S. spiniferus*]. Solid spongy shell, tips of polar spines joined by circular or elliptical ring. *Cret.*——FIG. 20,*8*. **S. spiniferus,* Cret., Calif., ×100 (35).

Spongosaturninus C.-CL., 1944 [**S. ellipticus*]. Like *Spongosaturnalis* but has 2 medullary lattice shells. *Cret.*——FIG. 20,*5*. **S. ellipticus,* Cret., Calif., ×100 (35).

Spongostylidium HKL., 1882 [**S. streptacanthum* HKL., 1887]. Like *Spongosaturninus* but lacks a ring. *Rec.*

Family TRIPOSPHAERIDAE Vinassa de Regny, 1898

Single or multiple concentric spongy or latticed shells with 3 to 4 equidistant main radial spines. *Ord.-Cret.*

Triposphaera HINDE, 1890 [**T. peachi;* SD herein] [=*Trisphaera* SQUIN., 1904]. Spongy cortical shell, latticed medullary one; 3 main radial spines and many small by-spines. *Ord.-Cret.*(Italy).——FIG. 21,*1*. *T. armata* HINDE, Ord., Scot., ×150 (44).

Phyletripes CAMPBELL, 1951 [*pro Hexastylus* RÜST, 1885 (*non* HKL., 1882)] [**Hexastylus primaevus* RÜST, 1885]. Single smooth lattice shell, 3 short, blunt main spines. *Jur.*——FIG. 21,*2*. **P. primaevus* (RÜST), L.Jur., Switz., ×100 (51).

Rüstia VINASSA, 1898 [**Stauracontium inequale* RÜST, 1892]. Three concentric lattice shells, 4 main radial spines in opposite pairs. *U.Jur.*——FIG. 21,*7*. *R. elegantula* VINASSA, U.Jur., Sicily, ×150 (55).

Trilonche HINDE, 1899 [**T. vetusa;* SD herein]. Two concentric lattice shells; 3 main radial spines, by-spines present or absent. *Dev.*(Austral.)-*L.Carb.*(Eng.).——FIG. 21,*3*. **T. vetusa,* Dev., Austral., ×200 (44).

Xiphostaurus VINASSA, 1898 [**Staurostylus xiphophorus* RÜST, 1892]. Three concentric lattice shells; 4 main radial spines with one much elongated. *U.Jur.*——FIG. 21,*6*. *X. titonicus* VINASSA, U.Jur., Italy, ×200 (55).

Family STAUROSPHAERIDAE Haeckel, 1882

[as Staurosphaerida; emend. CAMPBELL, herein]

Lattice shell single or concentrically multiple, with 4 main radial spines in a plane forming a right-angle cross. *Cam.-Rec.*

Subfamily STAUROSPHAERINAE Haeckel, 1882

[as Staurosphaerida *(partim)*; emend. CAMPBELL, herein] [=Staurostylida HKL., 1882]

Single lattice shell present. *Ord.-Rec.*

Staurosphaera HKL., 1882 [**S. crassa* DUNIKOWSKI, 1882]. Main radial spines similar. *Ord.-Rec.*

S. (Staurosphaera) [=*Staurosphaerissa* HKL., 1887 (obj.)]. Pores irregular, dissimilar; surface smooth. *Eoc.-Rec.*——FIG. 21,*17c*. *S. (S.) megapora* (EHR.), U.Eoc., ×100 (41).

S. (Staurosphaerantha) HKL., 1887 [**S. cruciata;* SD herein]. Pores regular, similar; surface smooth. *Ord.-Rec.*——FIG. 21,*17b*. *S. (S.) sancta* RUEDEMANN & WILSON, Ord., N.Y., ×100 (50).

S. (Staurosphaerella) HKL., 1887 [**S. philippi;* SD herein]. Pores regular, similar; surface spiny. *Rec.*——FIG. 21,*17a*. **S. (S.) philippi,* Rec., ×150 (42).

S. (Staurosphaeromma) HKL., 1887 [**S. bartholomaei;* SD herein]. Pores irregular, dissimilar; surface spiny. *Rec.*

Staurostylus HKL., 1882 [**S. graecius* HKL., 1887]. Opposite pair of main radial spines larger than other. *Jur.-Rec.*——FIG. 21,*16*. *S. italicus* RÜST, Cret., Italy, ×60 (51).

Stylostaurus HKL., 1882 [**S. caudatus* HKL., 1887]. One main spine elongated. *Ord.-Rec.*——FIG. 21,*5*. **S. caudatus,* Rec., ×200 (42).

Subfamily STAUROLONCHINAE Haeckel, 1882

[as Staurolonchida; emend. CAMPBELL, herein]

Two concentric lattice shells. *Cam.-Rec.*

Staurolonche HKL., 1882 [**S. robusta* RÜST, 1885] [=*Staurobelone, Staurodoras* HKL., 1887; (*non Staurodoras,* HKL., 1882)]. Main spines unbranched. *Cam.-Rec.*

S. (Staurolonche) [=*Staurolonchantha* HKL., 1887 (obj.)]. Pores regular, similar; surface smooth. *Cam.-Rec.*——FIG. 21,*10*. *S. (S.) pertusa* HKL., Rec., ×150 (42).

S. (Staurolonchella) HKL., 1887 [**S. straussii;* SD herein]. Pores regular, similar; surface spiny. *Rec.*

S. (Staurolonchissa) HKL., 1887 [**S. holbachii;* SD herein]. Pores irregular, dissimilar; surface smooth. *Rec.*

S. (Staurolonchura) HKL., 1887 [**S. epicurii;* SD herein]. Pores irregular, dissimilar; surface spiny. *Rec.*

Cromyostaurolonche CL.-C., 1944 [**C. cruciformis*]. Cortical shell spongy; main spines unbranched. *Mio.*——FIG. 21,*14*. **C. cruciformis,* Mio., Calif., ×150 (39).

Staurancistra HKL., 1882 [**S. quadricuspis* HKL., 1887]. Like *Staurolonche* but main spines branched. *Mio.*——FIG. 21,*13*. *S. elegans* VINASSA, Mio., Italy, ×200 (55).

Staurolonchidium HKL., 1887 [**Haliomma perspicuum* EHR., 1875; SD herein]. Pair of opposite main spines larger than others. *Jur.-Rec.*——FIG.

21,*11*. *S. tuberosum* Rüst, Cret., Italy, ×90 (51).

Stauroxiphus Hkl., 1887 [**S. gladius*]. One of main spines larger than others. *Rec.*——Fig. 21,*12*. **S. gladius*, Rec., ×200 (42).

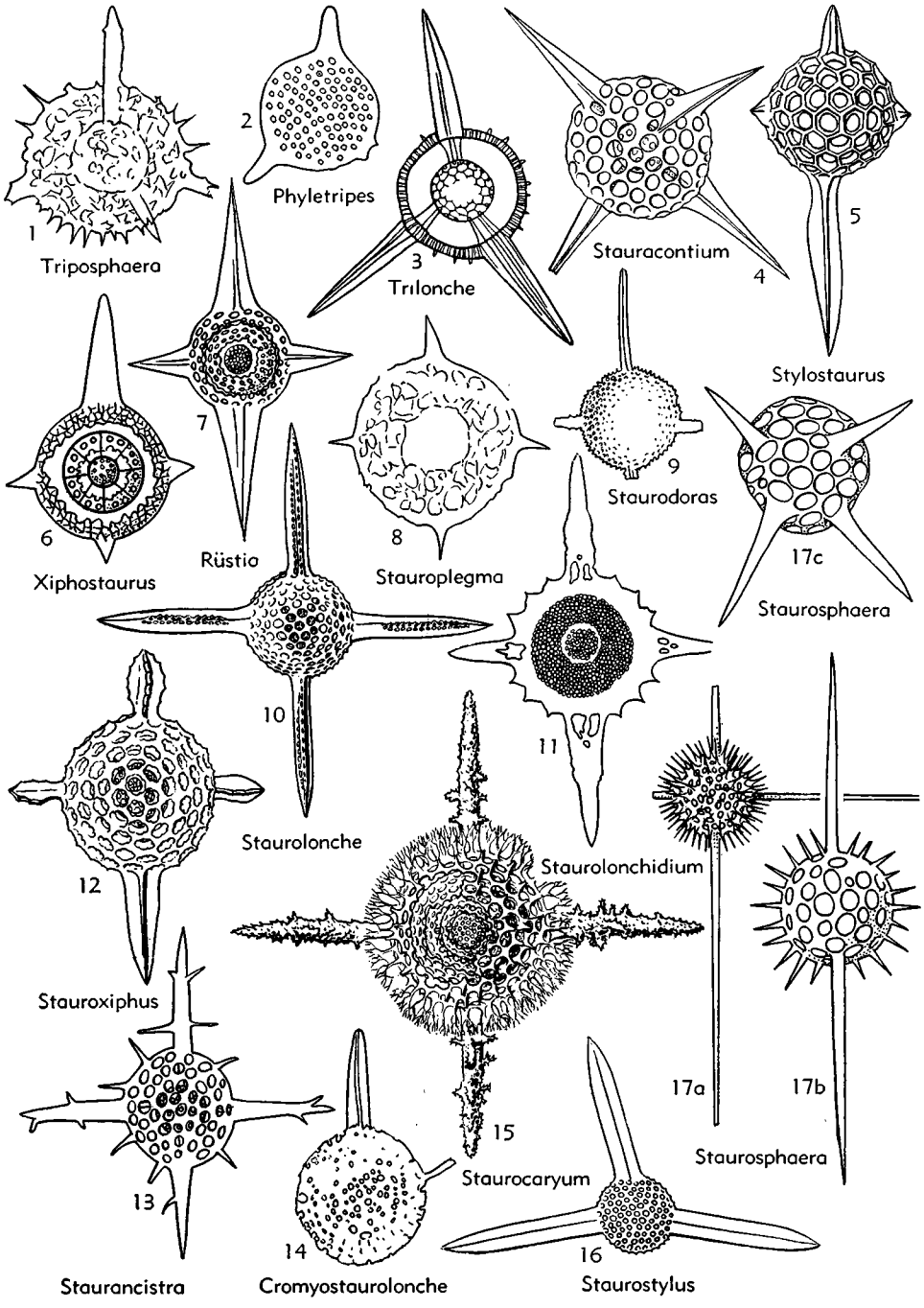

Fig 21. Triposphaeridae, Staurosphaeridae (p. D56-D58).

Subfamily STAURACONTIINAE Haeckel, 1882
[as Stauracontida; emend. CAMPBELL, herein]

Three concentric lattice shells. *Jur.-Rec.*

Stauracontium HKL., 1882 [**S. cruciferum* HKL., 1887]. *Jur.-Rec.*

S. (Stauracontium) [=*Stauracontarium* HKL., 1887 (obj.)]. Pores regular, similar; surface smooth. *Jur.-Rec.*——FIG. 21,*4*. *S. (S.) tetracanthium* (EHR.), Rec., ×200 (41).

S. (Stauracontellium) HKL., 1887 [**Actinomma daturaeforme* STÖHR, 1880; SD herein]. Pores regular, similar; surface spiny. *Rec.*

S. (Stauracontidium) HKL., 1887 [**S. antarcticum*]. Pores irregular, dissimilar; surface smooth. *Rec.*

S. (Stauracontonium) HKL., 1887 [**S. setosum;* SD herein]. Pores irregular, dissimilar; surface spiny. *Rec.*

Subfamily STAUROCROMYINAE Haeckel, 1882
[as Staurocromyida; emend. CAMPBELL, herein]

Four concentric lattice shells. *Cret.-Rec.*

Staurocromyum HKL., 1882 [**S. quadruplex* HKL., 1887]. Main spines unbranched. *Cret.-Rec.*

Cromyostaurus HKL., 1882 [**C. verticellatus* HKL., 1887]. Main spines branched. *Rec.*

Subfamily STAUROCARYINAE Haeckel, 1882
[as Staurocaryida; emend. CAMPBELL, herein]

Five or more concentric lattice shells. *Rec.*

Staurocaryum HKL., 1882 [**S. arborescens* HKL., 1887].——FIG. 21,*15*. **S. arborescens,* Rec., ×100 (42).

Subfamily STAURODORADINAE Haeckel, 1882
[as Staurodorida; emend. CAMPBELL, herein]

Shell comprising a solid spongy sphere. *Ord.-Rec.*

Staurodoras HKL., 1882 [**S. mojsisovicsii* DUNIKOWSKI, 1882]. Lacks differentiated medullary lattice shells. *Jur.-Rec.*——FIG. 21,*9*. *S. eocenica* CL.-C., U.Eoc., Calif., ×150 (39).

Stauroplegma HINDE, 1890 [**S. brevispina*]. Medullary shells present. *Ord.*——FIG. 21,*8*. **S. brevispina,* Ord., Scot., ×150 (44).

Family PENTASPHAERIDAE Squinabol, 1904

Single lattice shell with 5 radial spines in a single plane. *Cret.*

Pentasphaera SQUIN., 1904 [**P. longispina*]. Spines equidistant.——FIG. 22,*5*. **P. longispina,* Cret., Italy, ×100 (52).

Family CUBOSPHAERIDAE Haeckel, 1882

[as Cubosphaerida; emend. CAMPBELL, herein]

Lattice shell single or concentrically multiple, with 6 main radial spines in two planes, meeting at right angles. *Dev.-Rec.*

Subfamily CUBOSPHAERINAE Haeckel, 1882
[as Cubosphaerida *(partim)*; emend. CAMPBELL, herein] [=Hexacaryida HKL., 1882]

Five or more concentric shells. *Rec.*

Cubosphaera HKL., 1887 [**C. cubaxonia* HKL., 1887; SD herein]. Main spines all similar, unbranched.——FIG. 22,*7*. **C. cubaxonia,* Rec., ×200 (42).

Hexacaryum HKL., 1882 [**H. arborescens* HKL., 1887]. Main spines all similar, branched.——FIG. 22,*4*. **H. arborescens,* Rec., ×200 (42).

Subfamily HEXASTYLINAE Haeckel, 1882
[as Hexastylida; emend. CAMPBELL, herein]

Single lattice shell present. *Jur.-Rec.*

Hexastylus HKL., 1882 [*non* RÜST, 1885 (=*Phyletripes* CAMPBELL, 1951)] [**H. phaenaxonius* HKL., 1887] [=*Exastylus* VINASSA, 1898; *Hexastilus* PRINCIPI, 1909 (obj.)]. Main spines similar. *Jur.-Rec.*

H. (Hexastylus) [=*Hexastylanthus* HKL., 1887 (obj.)]. Pores regular, similar; surface smooth. *Jur.-Rec.*——FIG. 22,*6c*. **H. (H.) phaenaxonius,* Rec., ×200 (42).

H. (Hexastylettus) HKL., 1887 [**H. solonis;* SD herein]. Pores regular, similar; surface spiny. *Rec.*——FIG. 22,*6b*. **H. (H.) solonis,* Rec., ×200 (42).

H. (Hexastylissus) HKL., 1887 [**H. triaxonius;* SD herein]. Pores irregular, dissimilar; without secondary spines. *Rec.*——FIG. 22,*6a*. **H. (H.) triaxonius,* Rec., ×400 (42).

H. (Hexastylurus) HKL., 1887 [**H. dictyotus;* SD herein]. Pores irregular, dissimilar; surface spiny. *Rec.*——FIG. 22,*6d*. **H. (H.) dictyotus,* Rec., ×270 (42).

Hexacladus VINASSA, 1900 [**H. pantanellii*] [=*Xexacladus* VINASSA, 1900 (obj.)]. Each main spine with distal trifurcations. *Mio.*——FIG. 22,*3*. **H. pantanellii,* Mio., Italy, ×400 (55).

Hexapyramis SQUIN., 1903 [**H. pantanellii*]. Main spines latticed pyramids, unbranched or branched distally. *Cret.*——FIG. 22,*1*. **H. pantanellii,* Cret., Italy, ×60 (52).

Hexastylarium HKL., 1887 [**H. elongatum*] [=*Exastylarium* VINASSA, 1898 (obj.)]. An opposite pair of spines larger than others. *Jur.* (Italy)-*Rec.*——FIG. 22,*2*. *H. dunikowskyi* VINASSA, U.Jur., Italy, ×200 (55).

Hexastylidium HKL., 1882 [**H. rhomboides* HKL., 1887]. Spines of one opposite pair not alike, those of the other pairs equal. *Rec.*

Subfamily HEXALONCHINAE Haeckel, 1882
[as Hexalonchida; emend. CAMPBELL, herein]

Two concentric lattice spheres. *Dev.-Rec.*

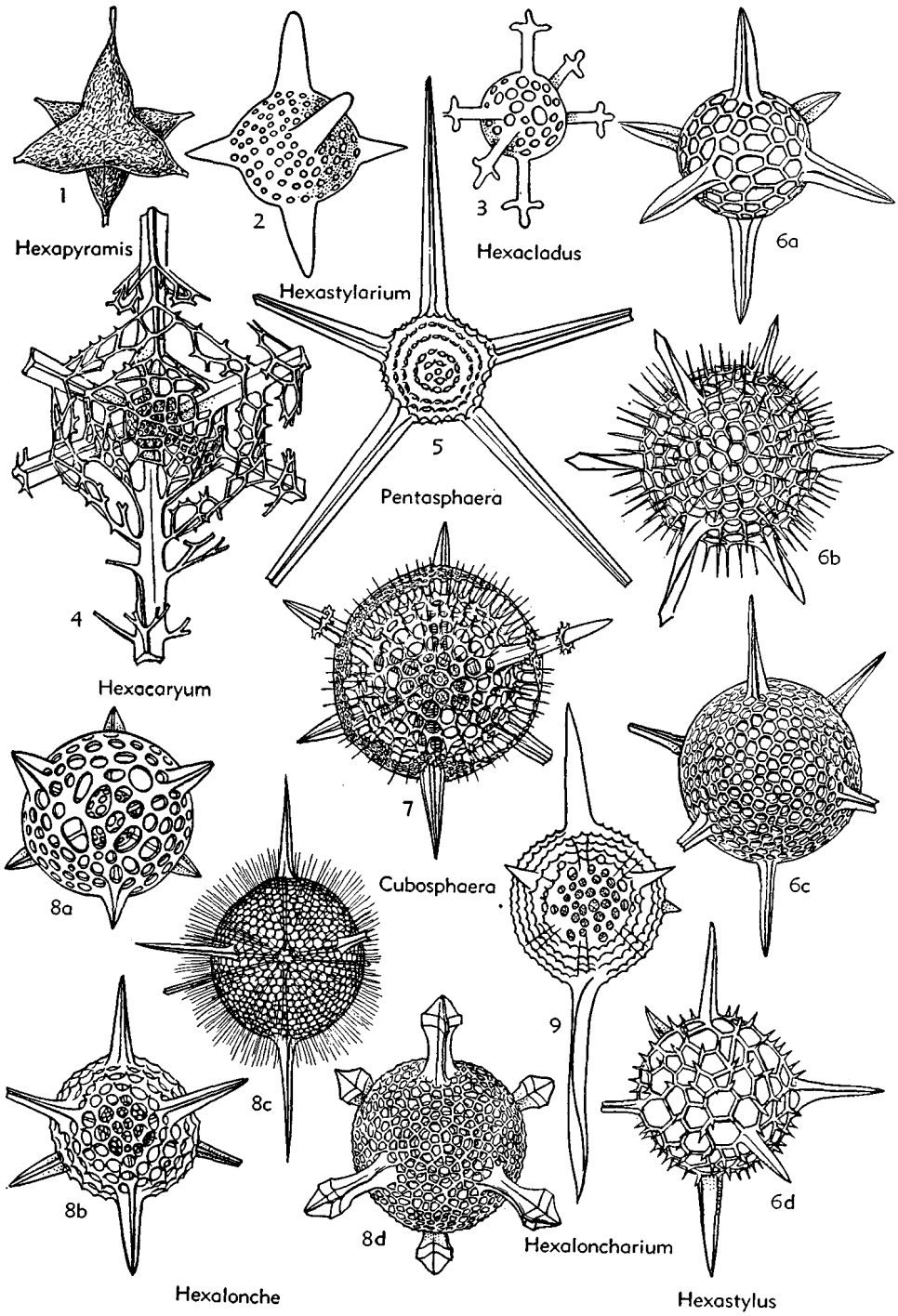

FIG. 22. Pentasphaeridae, Cubosphaeridae (p. D58-D60).

Hexalonche HKL., 1882 [**H. phaenaxonia* HKL., 1887]. Main spines all similar, unbranched. *Dev.-Rec.*

H. (Hexalonche) [=*Hexalonchara* HKL., 1887 (obj.)]. Pores regular, similar; surface without by-spines. *Dev.-Rec.*——FIG. 22,*8d*. *H. (H.) rosetta*, Rec., ×200 (42).

H. (Hexalonchetta) HKL., 1887 [**H. amphisiphon*; SD herein]. Pores regular, similar; surface spiny. *Rec.*——FIG. 22,*8c*. **H. (H.) amphisiphon*, Rec., ×150 (42).

H. (Hexalonchilla) HKL., 1887 [**H. pythagorea*; SD herein]. Pores irregular, dissimilar; surface without by-spines. *Rec.*——FIG. 22,*8a*. **H. (H.) pythagorea*, Rec., ×200 (42).

H. (Hexalonchusa) HKL., 1887 [**H. philosophica*; SD herein]. Pores irregular, dissimilar; surface spiny. *Rec.*——FIG. 22,*8b*. **H. (H.) philosophica*, Rec., ×200 (42).

Hexaloncharium HKL., 1887 [**H. philosophicum*; SD herein]. One pair of spines different from others. *Mio.-Rec.*——FIG. 22,*9*. *H. archimedes* VINASSA, Mio., Italy, ×200 (55).

Hexalonchidium HKL., 1882 [**H. axonometrum* HKL., 1887]. Spines of one opposite pair not alike, those of other pairs equal. *Rec.*

Hexancistra HKL., 1882 [**H. tricuspis* HKL., 1887]. Main spines all similar, branched. *Rec.*

H. (Hexancistra) [=*Hexancora* HKL., 1887 (obj.)]. Each spine with 3 simple branches.——FIG. 23,*7b*. **H. (H.) tricuspis*, Rec., ×150 (42).

H. (Hexapitys) HKL., 1882 [**H. mirabilis* HKL., 1887]. Each spine with 3 rows of verticillate lateral branches.——FIG. 23,*7a*. **H. (H.) mirabilis*, Rec., ×150 (42).

Subfamily HEXACONTIINAE Haeckel, 1882

[as Hexacontida; emend. CAMPBELL, herein]

Three concentric lattice shells. *Eoc.-Rec.*

Hexacontium HKL., 1882 [**H. phaenaxonium* HKL., 1887]. Main spines all similar, unbranched. *Eoc.*(Italy)-*Rec.*

H. (Hexacontium) [=*Hexacontanna* HKL., 1887 (obj.)]. Pores regular, similar; surface smooth. *Eoc.-Rec.*——FIG. 23,*8c*. *H. (H.) axotrias* HKL., Rec., ×150 (42).

H. (Hexacontella) HKL., 1887 [**H. favosum*; SD herein]. Pores regular, similar; surface spiny. *Rec.*——FIG. 23,*8a*. *H. (H.) floridum* HKL., Rec., ×200 (42).

H. (Hexacontosa) HKL., 1887 [**H. axophaenum*; SD herein]. Pores irregular, dissimilar; surface smooth. *Rec.*

H. (Hexacontura) HKL., 1887 [**H. papillosum*; SD herein]. Pores irregular, dissimilar; surface spiny.——FIG. 23,*8b*. **H. (H.) papillosum*, Rec., ×200 (42).

Hexacontarium HKL., 1887 [**H. dentatum*; SD herein]. One pair of opposite spines larger than others. *Rec.*

Hexadendron HKL., 1882 [**H. quadricuspis* HKL., 1887]. Main spines all similar, but branched. *Rec.*——FIG. 23,*9*. *H. bipinnatum* HKL., Rec., ×200 (42).

Subfamily HEXACROMYINAE Haeckel, 1882

[as Hexacromyida; emend. CAMPBELL, herein]

Four concentric lattice shells. *Mio.-Rec.*

Hexacromyum HKL., 1882 [**H. elegans*][=*Hexacromidium* HKL., 1882 (obj.)]. Main spines all similar.——FIG. 23,*6*. **H. elegans*, Rec., ×200 (42).

Subfamily CENTROLONCHINAE Campbell, nov.

Main spines joined at center of single or multiple concentric lattice shell. *Rec.*

Centrolonche POP., 1911 [**C. hexalonche*]. Single lattice shell.——FIG. 23,*1*. **C. hexalonche*, Rec., ×300 (48).

Centracontarium POP., 1911 [**C. hexacontarium*]. Two concentric lattice shells.——FIG. 23,*4*. **C. hexacontarium*, Rec., ×150 (48).

Stylacontarium POP., 1911 [**C. bispiculum*]. Three concentric shells; all but one pair of opposite spines restricted to interior.——FIG. 23,*5*. **S. bispiculum*, Rec., ×200 (48).

Subfamily HEXADORADINAE Haeckel, 1882

[as Hexadorida; emend. CAMPBELL, herein]

Spongy spherical or octahedral shell, with or without medullary lattice shells. *Cret.-Rec.*

Hexadoras HKL., 1882 [**H. axophaena* HKL., 1887]. Single medullary lattice shell. *Cret.-Rec.*——FIG. 23,*3*. *H. tyrelli* C.-CL., Cret., Calif., ×150 (35).

Cubaxonium HKL., 1887 [**H. spongiosum*]. Solid spongy shell. *Rec.*

Hexadoridium HKL., 1882 [**H. streptacanthum* HKL., 1887]. Two concentric medullary lattice shells. *Cret.-Rec.*——FIG. 23,*2*. *H. magnificum* C.-CL., Cret., Calif., ×100 (35).

Family ASTROSPHAERIDAE Haeckel, 1882

[as Astrosphaerida; emend. CAMPBELL, herein]
[=Astrosphaeridae MAST, 1910]

Lattice shell single or concentrically multiple, with 8 or more (commonly 20 to 60) radial spines. *Cam.-Rec.*

Subfamily ASTROSPHAERINAE Haeckel, 1882

[as Astrosphaerida *(partim)*; emend. CAMPBELL, herein]
[=Diplosphaerida HKL., 1882; Haliommida HKL., 1887]

Two concentric shells. *Cam.-Rec.*

Astrosphaera HKL., 1887 [**A. hexagonalis*; SD herein]. Two extracapsular shells joined by long radial spines; both shells with by-spines. *Rec.*

A. (Astrosphaera) [=*Astrosphaerella* HKL., 1887 (obj.)]. Main spines unbranched.——FIG. 24,*3b*. **A. (A.) hexagonalis,* Rec., ×150 (42).

A. (Astrosphaeromma) HKL., 1887 [**A. sideraea;* SD herein]. Main spines with 3 rows of lateral branches.——FIG. 24,*3a*. *A. (A.) stellata* HKL., Rec. ×150 (42).

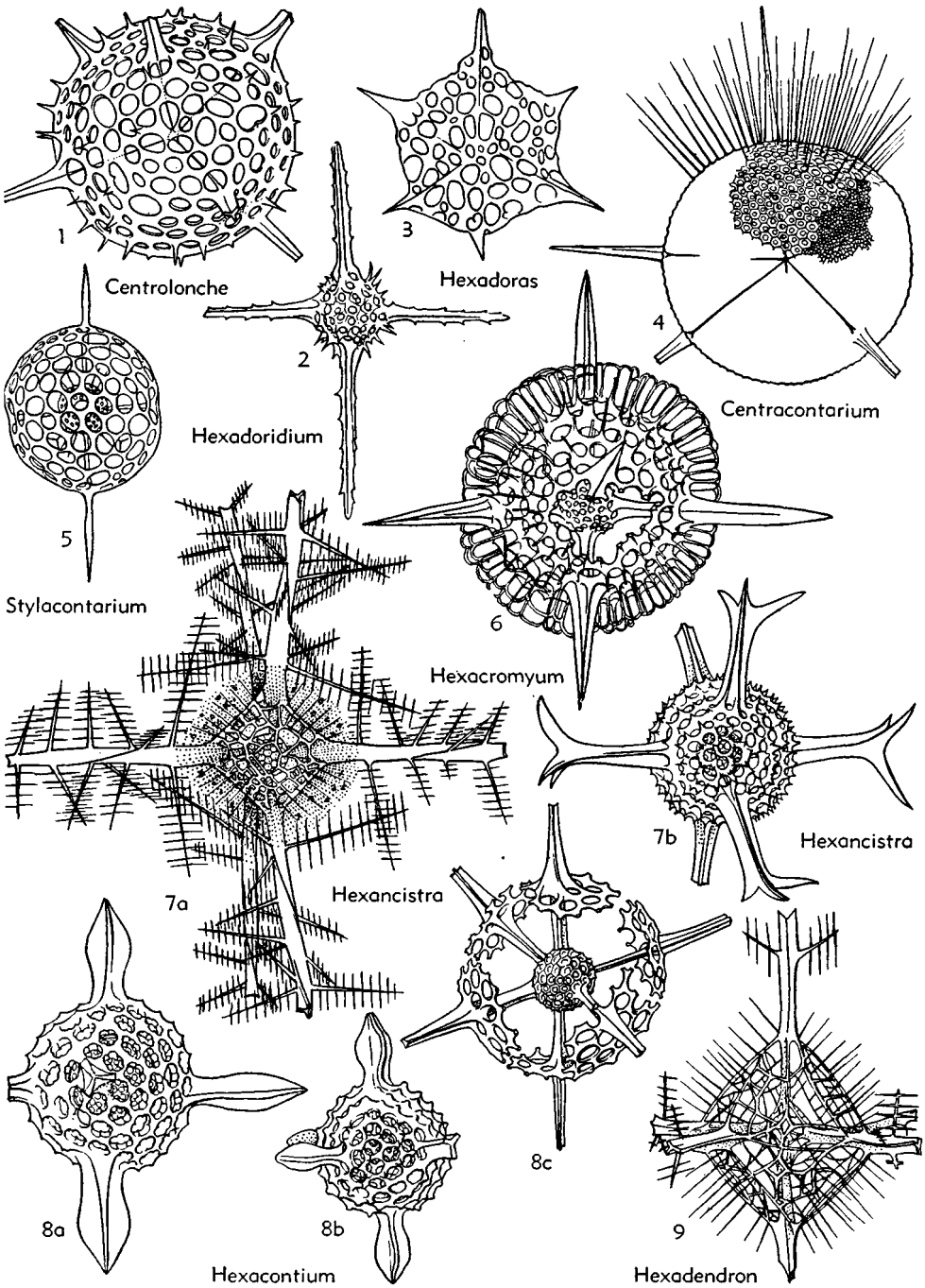

FIG. 23. Cubosphaeridae (p. D60).

Diplosphaera HKL., 1860 [**D. gracilis* HKL., 1862]. Resembles *Astrosphaera* but outer shell lacks by-spines. *Rec.*

D. (Diplosphaera) [=*Diplosphaeromma* HKL., 1887 (obj.)]. Radial spines with 3 rows of lateral branches.

D. (Diplosphaerella) HKL., 1887 [**D. hexagonalis*]. Radial spines simple.——FIG. 25,*4*. **D. (D.) hexagonalis*, Rec., ×100 (42).

Drymosphaera HKL., 1882 [**D. hexagonalis* HKL., 1887]. Like *Astrosphaera* but inner shell lacks by-spines. *Rec.*

D. (Drymosphaera) [=*Drymosphaerella* HKL., 1887 (obj.)]. Radial by-spines unbranched.——FIG. 24,*4a*. *D. (D.) polygonalis* HKL., Rec., ×100 (42).

D. (Drymosphaeromma) HKL., 1887 [**D. dendrophora;* SD herein] [=*Drymyoma* JÖRG., 1905 (obj.)]. Radial by-spines branched.——FIG. 24,*4b*. **D. (D.) dendrophora*, Rec., ×100 (42).

Elatomma HKL., 1887 [**E. pinetum;* SD herein]. A cortical and a medullary shell, former covered by branched radial spines. *Rec.*

E. (Elatomma) [=*Elatommella* HKL., 1887 (obj.)]. Outer shell pores regular, similar.

E. (Elatommura) HKL., 1887 [**E. juniperinum;* SD herein]. Outer shell pores irregular, dissimilar.——FIG. 24,*2*. **E. (E.) juniperinum*, Rec., ×200 (42).

Haliomma EHR., 1838 [**H. aequoreum* EHR., 1844] [=*Sethosphaera* HKL., 1879 (obj.)]. Like *Elatomma*, but outer shell covered by unbranched radial spines, similar. *Ord.-Rec.*

H. (Haliomma) [=*Haliommura* HKL., 1887 (obj.)]. Outer shell pores irregular, dissimilar, spines not covering whole surface. *Ord.-Rec.* ——FIG. 24,*1c*. *H. (H.) compactum* HKL., Rec., ×200 (42).

H. (Haliommantha) HKL., 1887 [**H. castanea* HKL., 1862; SD herein]. Outer shell pores regular, similar; surface wholly covered by radial spines. *Rec.*

H. (Haliommetta) HKL., 1887 [**H. circumtextum;* SD herein]. Outer shell pores regular, similar, spines not wholly covering surface. *Rec.*——FIG. 24,*1b*. **H. (H.) circumtextum* Rec., ×200 (42).

H. (Haliomilla) HKL., 1887 [**H. capillaceum* HKL., 1862; SD herein]. Outer shell pores irregular, dissimilar, radial spines covering whole surface. *Rec.*——FIG. 24,*1a*. *H. (H.) rhodococcus* (HKL.), Rec., ×200 (42).

Heliosoma HKL., 1882 [**H. radians* HKL., 1887]. Like *Elatomma* but outer shell covered by unbranched main spines and smaller by-spines. *Cam.-Rec.*

H. (Heliosoma) [=*Heliosomantha* HKL., 1887 (obj.)]. Outer shell pores regular, similar. *Cam.-Rec.*——FIG. 25,*6a*. **H. (H.) radians*, Rec., ×150 (42).

H. (Heliosomura) HKL., 1887 [**H. hastatum;* SD herein]. Outer shell pores irregular, dissimilar. *Rec.*——FIG. 25,*6b*. **H. (H.) hastatum*, Rec., ×200 (42).

Heteracantha MAST, 1910 [**H. dentata;* SD herein]. Main spines mostly 3-angled; by-spines branched and unbranched; thick-walled shell with funnel-shaped pores. *Rec.*——FIG. 25,*1*. **H. dentata*, Rec., ×300 (47).

Heterosoma MAST, 1910 [**H. heptacanthum;* SD herein]. Main spines unbranched, by-spines branched. *Rec.*——FIG. 25,*2*. **H. heptacanthum*, Rec., ×300 (47).

Leptosphaera HKL., 1887 [**L. hexagonalis;* SD herein]. Like *Elatomma* but by-spines lacking. *Rec.*

L. (Leptosphaera) [=*Leptosphaerella* HKL., 1887 (obj.)]. Radial spines unbranched.——FIG. 25,*3*. **L. (L.) hexagonalis*, Rec., ×100 (42).

L. (Leptosphaeromma) HKL., 1887 [**Diplosphaera spinosa* HERTWIG, 1879; SD herein]. Radial spines with 3 rows of lateral branches.

Subfamily HELIOSPHAERINAE Haeckel, 1882

[as Heliosphaerida; emend. CAMPBELL, herein] [=Coscinomida HKL., 1887; Monosphaerinae MAST, 1910]

Single shell present. *Ord.-Rec.*

Heliosphaera HKL., 1862 [**H. echinoides*]. Radial spines of 2 kinds, large and small. *Ord.-Rec.*

H. (Heliosphaera) [=*Heliosphaerantha* HKL., 1887 (obj.)]. Pores regular, similar. *Rec.*——FIG. 25,*9*. *H. (H.) hexagonaria* HKL., Rec., ×150 (42).

H. (Heliosphaeromma) HKL., 1887 [**H. polygonaria;* SD herein]. Pores irregular, dissimilar. *Rec.*

Acanthosphaera EHR., 1858 [**A. haliphormis* EHR., 1861]. Pores not tubulate, radial spines unbranched, similar. *Ord.-Rec.*

A. (Acanthosphaera) [=*Rhaphidosphaera* HKL., 1882 (obj.)]. Pores irregular, dissimilar, spines not at all nodal points. *Ord.-Rec.*——FIG. 25,*7c*. *A. (A.) angulata* HKL., Rec., ×150 (42).

A. (Rhaphidocapsa) HKL., 1887 [**A. mucronata;* SD herein]. Pores regular, similar, spines not at all nodal points. *Rec.*——FIG. 25,*7a*. *A. (R.) clavata* HKL., Rec., ×150 (42).

A. (Rhaphidococcus) HKL., 1862 [**Heliosphaera tenuissima* HKL., 1862; SD herein]. Pores regular, similar, radial spines at all nodal points. *Rec.*——FIG. 25,*7b*. *A. (R.) castanea* HKL., Rec., ×150 (42).

A. (Rhapidodrymus) HKL., 1887 [**A. capillaris;* SD herein]. Pores irregular, dissimilar, radial spines at all nodal points. *Rec.*

Cladococcus MÜLLER, 1856 [**C. arborescens* MÜLLER, 1858]. Radial spines branched but stem not forked. *Rec.*

C. (Cladococcus) [=*Cladococcalis* HKL., 1887 (obj.)]. Branches not ramified, pores regular, similar.

C. (Cladococcinus) HKL., 1887 [**C. quadricupis;* SD herein]. Branches not ramified, pores irregular, dissimilar.

C. (Cladococcodes) HKL., 1887 [**C. scoparius;* SD herein]. Branches ramified, pores regular, similar.——FIG. 25,*10a*. **C. (C.) scoparius*, Rec., ×150 (42).

C. (Cladococcurus) HKL., 1887 [**C. abietinus;* SD herein]. Branches ramified, pores irregular, dissimilar.——FIG. 25,*10b*. *C. (C.) dendrites* HKL., Rec., ×100 (42).

Conosphaera HKL., 1882 [**C. platyconus* HKL., 1887]. Radial spines comprise fenestrate-walled hollow cones. *Jur.-Rec.*——FIG. 25,*5*. *C. orthoconus* HKL., Rec., ×100 (42).

Coscinomma HKL., 1887 [**C. amphisiphon;* SD herein]. Single shell with hollow conical tubular spines, as well as solid radial spines. *Rec.*

C. (Coscinomma) [=*Coscinommarium* HKL., 1887 (obj.)]. Pores prolonged both inside and outside surface.——FIG. 25,*8*. **C. amphisiphon*, Rec., ×150 (42).

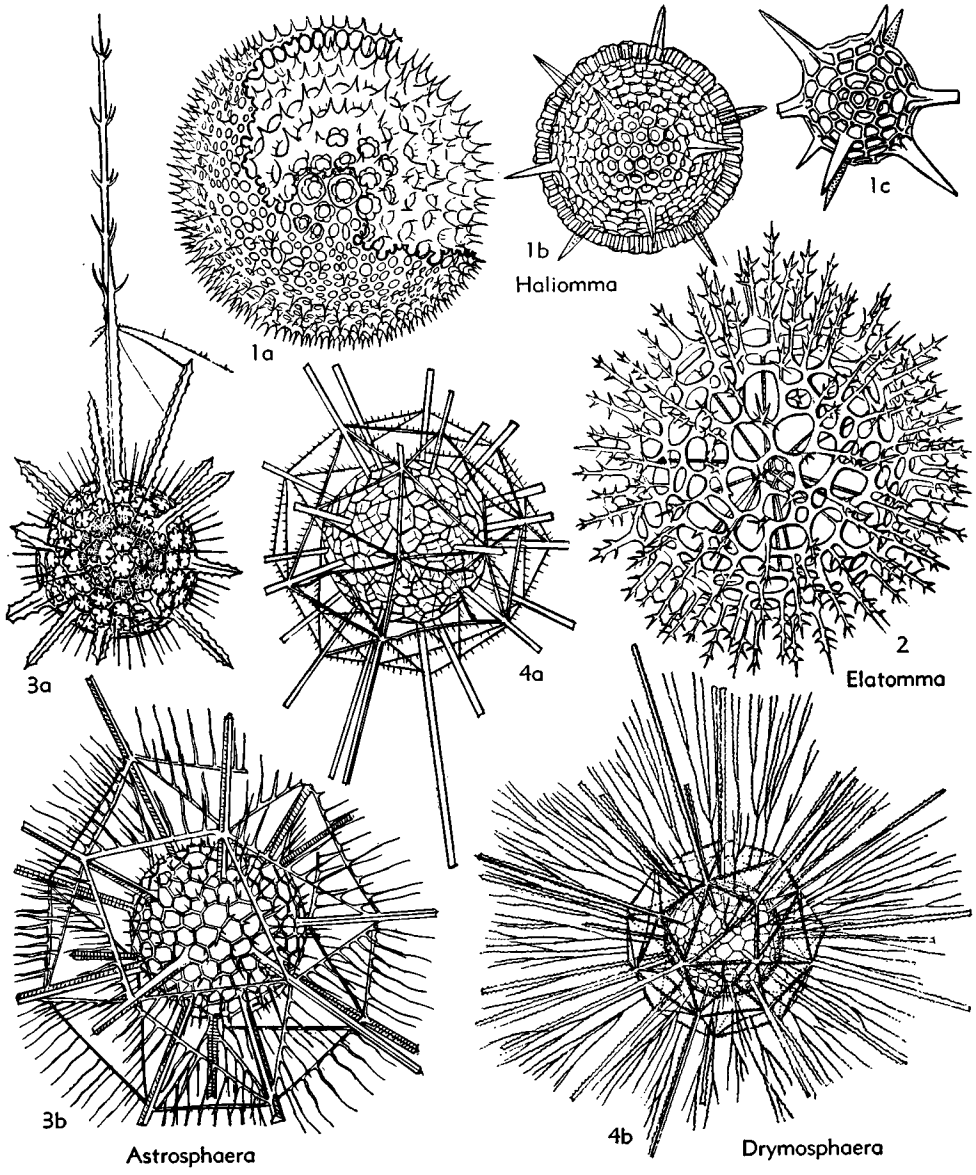

FIG. 24. Astrosphaeridae (p. D61, D62).

C. (Coscinommonium) HKL., 1887 [**C. endosiphon*]. Pores prolonged internally; not external.

Elaphococcus HKL., 1882 [**C. furcatus* HKL., 1887]. Radial spines with forked stems. *Rec.*

E. (Elaphococcus) [=*Elaphococcinus* HKL., 1887 (obj.)]. Pores regular, similar.

E. (Elaphococculus) HKL., 1887 [**E. dichotomus;* SD herein]. Pores irregular, dissimilar.

Subfamily ACTINOMMATINAE Haeckel, 1862

[as Actinommida; emend. CAMPBELL, herein] [=Heterosphaerinae MAST, 1910]

Three concentric lattice shells. *Dev.-Rec.*

Actinomma HKL., 1862 [**Haliomma trinacrium* HKL., 1860]. Radial spines unbranched, all similar. *Dev.-Rec.*

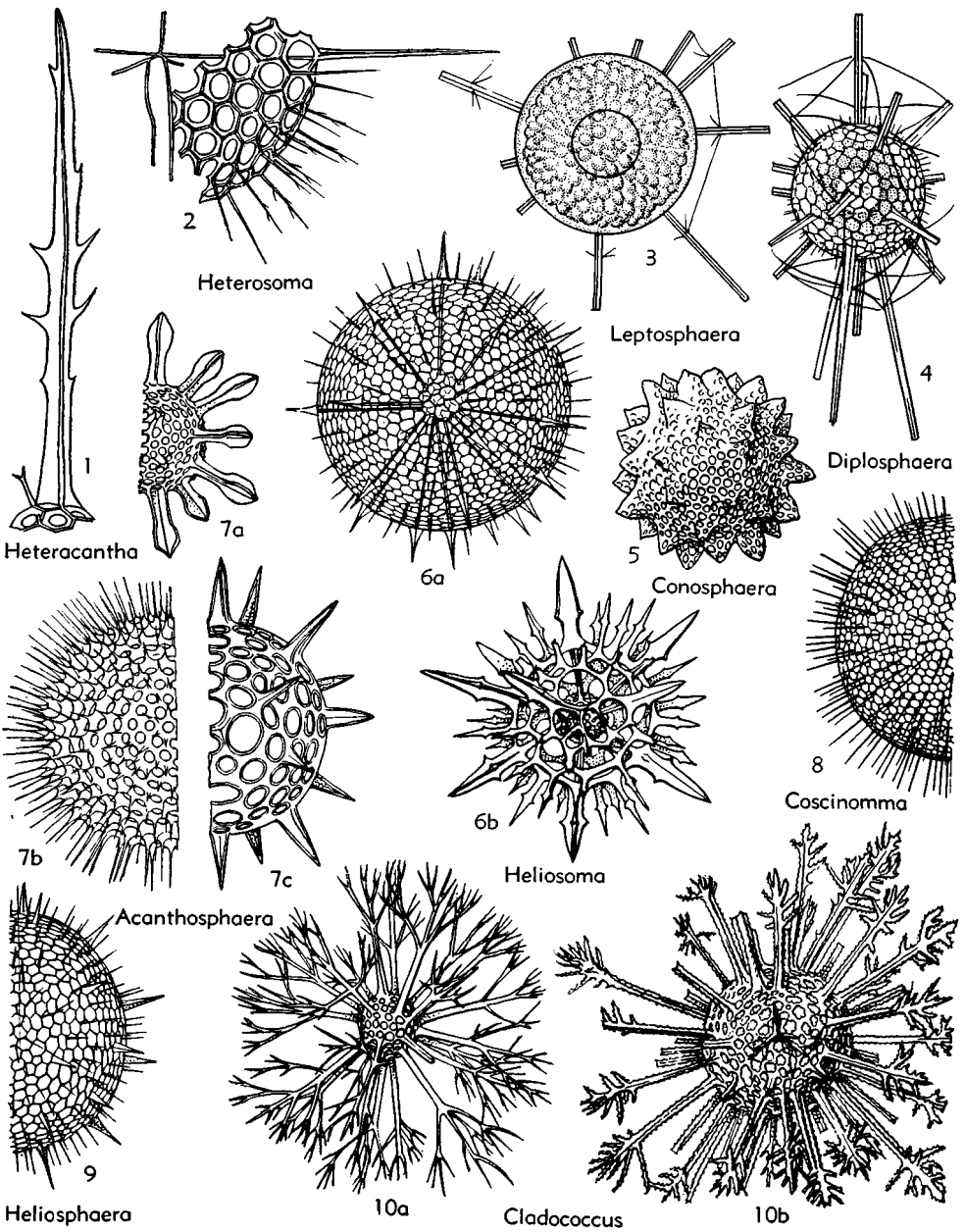

FIG. 25. Astrosphaeridae (p. D62, D63).

A. (Actinomma) [=*Actinometta* HKL., 1887 (obj.)]. Outer shell pores regular, similar; spines not covering entire surface. *Dev.-Rec.*——FIG. 26,*3a*. *A. (A.) denticulatum* HKL., Rec., ×200 (42).

A. (Actinommantha) HKL., 1887 [**A. hexagonium;* SD herein]. Outer shell pores regular, similar; spines covering entire surface. *Rec.*

A. (Actinommilla) HKL., 1887 [**A. spinigerum* STÖHR, 1880; SD herein]. Outer shell pores

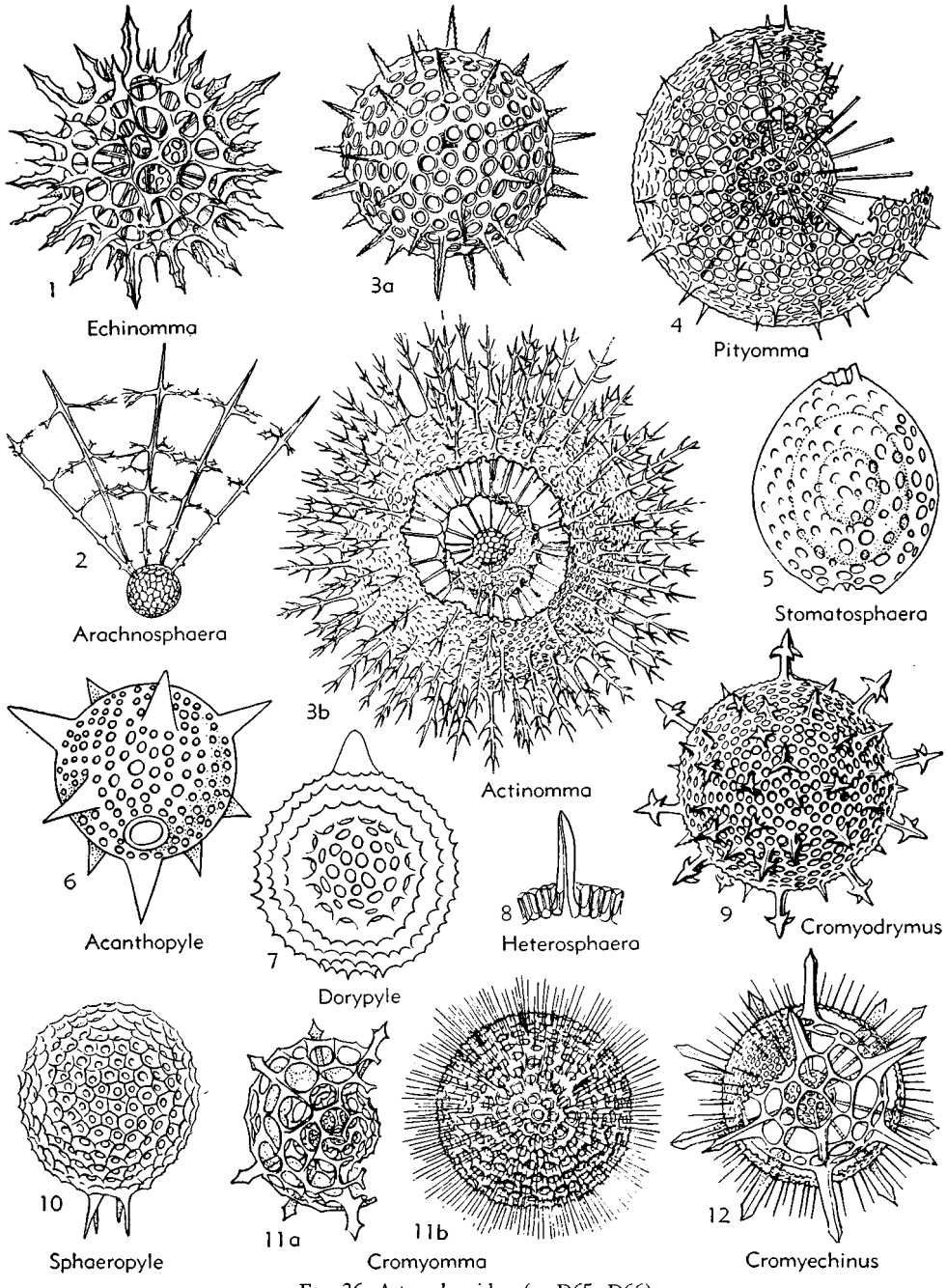

FIG. 26. Astrosphaeridae (p. D65, D66).

irregular, dissimilar; spines covering entire surface. *Eoc.-Rec.*

A. (Actinommura) HKL., 1887 [**A. capillaceum*; SD herein]. Outer shell pores irregular, dissimilar; spines not covering entire surface. *Rec.* ——FIG. 26,*3b*. **A. (A.) capillaceum*, Rec., ×150 (42).

Echinomma HKL., 1882 [**E. echinidium* HKL., 1887]. Radial spines unbranched, dissimilar in size. *Carb.-Rec.*

E. (Echinomma) [=*Echinommetta* HKL., 1887 (obj.)]. Outer shell pores regular, similar. *Rec.*

E. (Echinommura) HKL., 1887 [**E. toxopneustes* HKL., 1887; SD herein]. *Carb.-Rec.*——FIG. 26,*1*. **E. (E.) toxopneustes*, Rec., ×200 (42).

Heterosphaera MAST, 1910 [**H. tenuis*; SD herein]. Outer shell with many by-spines. *Rec.*——FIG. 26,*8*. **H. tenuis*, Rec., ×300 (47).

Pityomma HKL., 1882 [**P. scoparium* HKL., 1887]. Radial spines branched. *Carb.-Rec.*——FIG. 26, *4*. *P. drymodes* HKL., Rec., ×150 (42).

Subfamily CROMYOMMATINAE Haeckel, 1882

[as Cromyommida; emend. CAMPBELL, herein]

Four concentric lattice shells. *Cam.-Rec.*

Cromyomma HKL., 1882 [**C. villosum* HKL., 1887][=*Chromyomma* JÖRG., 1891 (obj.)]. Radial spines unbranched, all similar. *Cam.-Rec.*

C. (Cromyomma) [=*Cromyommetta* HKL., 1887 (obj.)]. Outer shell pores regular, similar. *Rec.* ——FIG. 26,*11b*. **C. villosum*, Rec., ×150 (42).

C. (Cromyommura) HKL., 1887 [**C. perspicuum*; SD herein]. Outer shell pores irregular, dissimilar. *Cam.-Rec.*——FIG. 26,*11a*. *C. (C.) mucronatum* HKL., Rec., ×100 (42).

Cromyechinus HKL., 1882 [**C. icosacanthus* HKL., 1887][=*Chromyechinus* JÖRG., 1905 (obj.)]. Radial spines unbranched, dissimilar in size. *Rec.* ——FIG. 26,*12*. **C. (C.) icosacanthus*, Rec., ×150 (42).——FIG. 40,*5*. *C.* sp., Rec., ×150 (42).

Cromyodrymus HKL., 1882 [**C. quadricuspis* HKL., 1887]. Radial spines branched. *Cret.-Rec.*—— FIG. 26,*9*. **C. quadricuspis*, Rec., ×200 (42).

Subfamily ARACHNOSPHAERINAE Haeckel, 1862

[as Arachnosphaerida; emend. CAMPBELL, herein] [=Caryommida HKL., 1887]

Five or more concentric lattice shells. *Rec.*

Arachnosphaera HKL., 1862 [**A. oligacantha*; SD herein]. Polygonal meshes.

A. (Arachnosphaera) [=*Arachnosphaerella* HKL., 1887 (obj.)]. Innermost shell pores hexagonal. ——FIG. 26,*2*. *A. (A.) hexasphaera* POP., Rec., ×150 (48).

A. (Arachnosphaeromma) HKL., 1887 [**A. tenuissima*; SD herein]. Innermost shells pores irregularly polygonal.

Arachnopila HKL., 1887 [**A. hexagonella*; SD herein]. Triangular meshes without diagonal bars between.

Caryomma HKL., 1887 [**C. regulare*; SD herein]. Like *Cromyomma* but has one more shell.

Subfamily SPHAEROPYLINAE Dreyer, 1889

[as Sphaeropylida; emend. CAMPBELL, herein]

Lattice shell single or concentrically multiple, with a pylome at one pole of outermost shell. *Dev.-Rec.*

Sphaeropyle DREYER, 1889 [**S. langi*; SD herein]. Four or more similar radial spines in 3 mutually perpendicular planes. *Dev.-Rec.*——FIG. 26,*10*. *A. mespilus* DREYER, Rec., ×250 (40).

Acanthopyle VINASSA, 1898 [**A. dreyeri*]. Single shell with large circular pylome and many similar spines. *Jur.*——FIG. 26,*6*. **A. dreyeri*, U.Jur., Italy, ×200 (55).

Dorypyle SQUIN., 1904 [**D. cretacea*]. Single shell with large pylome and one spine at pole opposite pylome. *Cret.*——FIG. 26,*7*. **D. cretacea*, Cret., Italy, ×133 (52).

Subfamily STOMATOSPHAERINAE Campbell, nov.

[=Amphistomida DREYER, 1889]

Lattice shell with 2 pylomes oppositely placed. *Rec.*

Stomatosphaera DREYER, 1889 [**S. dinoceras*; SD herein]. Single spherical shell.——FIG. 26,*5*. *S. amphistoma* DREYER, Rec., ×100 (40).

Subfamily SPONGIOMMATINAE Haeckel, 1887

[as Spongiommida; emend. CAMPBELL, herein] [=Rhizosphaerida HKL., 1882 *(partim)*; Spongosphaerinae MAST, 1910]

Spherical or polyhedral spongy shell, with or without medullary shells. *Cam.-Rec.*

Spongiomma HKL., 1887 [**Spongechinus multiaculeatus* DUNIKOWSKI, 1882; SD herein]. Solid spongy sphere with many unbranched radial spines. *Jur.-Rec.*

S. (Spongiomma) [=*Spongiommura* HKL., 1887 (obj.)]. Large and small spines. *Jur.-Rec.*

S. (Spongiommella) HKL., 1887 [**S. radiatum*; SD herein]. Spines all similar. *Rec.*

Acanthospongus MAST, 1910 [**A. minutus*]. Solid spongy sphere with branched anastomosing spines. *Rec.*

Arachnospongus MAST, 1910 [**A. varians*]. Two or more medullary shells with spongy network between outermost and next shell. *Rec.*——FIG. 27,*5*. **A. varians*, Rec., ×300 (47).

Astrospongus MAST, 1910 [**A. ramosus*; SD herein]. Like *Arachnospongus* but with spongy network outside cortical shell, and with large and small spines only on outer shell. *Rec.*——FIG. 27,*7*. **A. ramosus*, Rec., ×300 (47).

Centrocubus HKL., 1887 [**C. cladostylus*; SD herein]. Cube-shaped medullary shell with 8 main radial spines produced from corners and with or without other spines. *Rec.*——FIG. 28,*3*. **C. cladostylus*, Rec., ×50 (42).

Diplospongus MAST, 1810 [**D. dendrophorus*]. Small medullary shell and spongy network between 2 cortical shells. *Rec.*——FIG. 27,*1*. **D. dendrophorus*, Rec., ×250 (47).

Dispongia POP., 1911 [**D. velata*]. Solid spongy sphere with outer veil formed by short spines. *Rec.*——FIG. 27,*8*. **D. velata*, Rec., ×125 (48).

Exocentroconcha MAST, 1910 [**E. minor;* SD here-

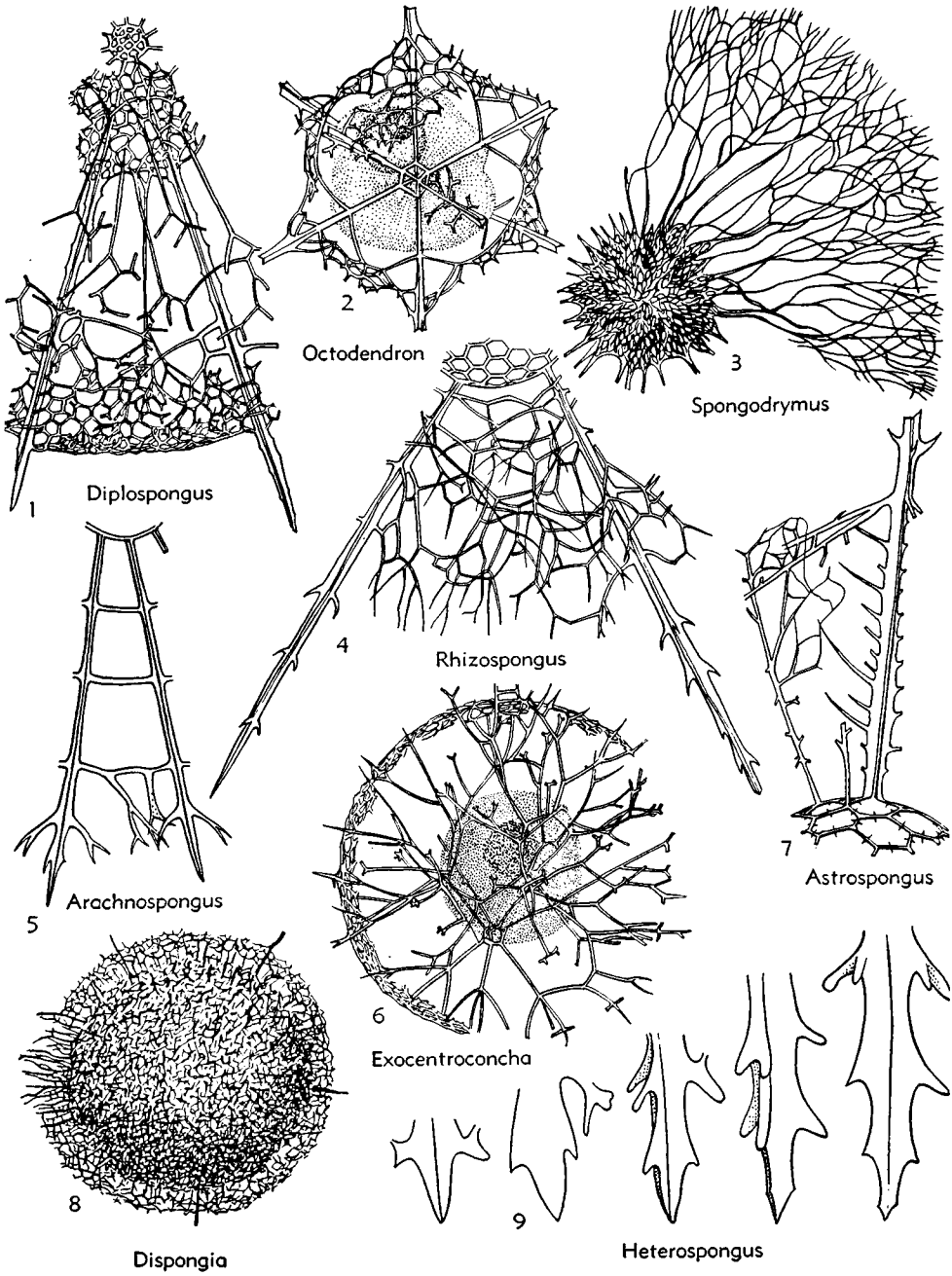

FIG. 27. Astrosphaeridae (p. D66-D68).

in]. Medullary shell strongly excentric. *Rec.*——Fig. 27,6. **E. minor*, Rec., ×250 (47).

Heterospongus Mast, 1910 [**H. varians*]. Like *Centrocubus* but 8 main spines branched. *Rec.*——Fig. 27,9. **H. varians*, Rec., ×300 (47).

Lychnosphaera Hkl., 1882 [**L. regina* Hkl., 1887]. Medullary shell with free by-spines and joined to spongy cortical by main radial spines. *Rec.*——Fig. 28,4. **L. regina*, Rec., ×75 (42).

Octodendron Hkl., 1887 [**O. cubocentron;* SD herein]. Like *Cubocentron* but latticed cortical shell surrounded by spongy network which may bear small radial spines. *Rec.*

O. (Octodendron) [=*Octodendridium* Hkl., 1887 (obj.)]. Without secondary radial spines.——Fig. 27,2. **O. (O.) cubocentron*, Rec., ×200 (42).

O. (Octodendronium) Hkl., 1887 [**O. verticellatum;* SD herein]. Secondary radial spines 24 or more. *Rec.*

Rhizoplegma Hkl., 1882 [**R. polyacanthum* Hkl., 1887] [=*Lonchosphaera* Pop., 1909]. Like *Lychnosphaera* but medullary shell lacks by-spines. *Jur.-Rec.*

R. (Rhizoplegma) [=*Rhizoplegmarium* Hkl., 1887 (obj.)]. Radial spines without branches. *Jur.-Rec.*

R. (Rhizoplegmidium) Hkl., 1887 [**R. radicatum;* SD herein]. Lateral branches on 3 edges of radial spines between shells. *Rec.*——Fig. 28,2. **R. (R.) radicatum*, Rec., ×100 (42).

Rhizosphaera Hkl., 1860 [**R. leptomitra;* SD herein]. Like *Rhizoplegma (Rhizoplegma)* but has 2 medullary shells and latticed cortical shell surrounded by spongy network. *Rec.*——Fig. 28,1. *R. serrata* Hkl., Rec., ×150 (42).

Rhizospongus Mast, 1910 [**R. arachnoideus;* SD herein]. Single lattice shell with spongy network between radial spines; no by-spines. *Rec.*——Fig. 27,4. **R. arachnoideus*, Rec., ×250 (47).

Spongechinus Hkl., 1882 [**S. setosus* Hkl., 1887]. Hollow spongy sphere with many simple, similar spines. *Rec.*

Spongioconcha Mast, 1910 [**S. inversa*]. Spongy network between medullary and cortical lattice shells; long radial spines on latter. *Rec.*

Spongodrymus Hkl., 1882 [**S. elaphococcus* Hkl., 1887]. Solid spongy sphere with many branched radial spines. *Rec.*——Fig. 27,3. **S. elaphococcus*, Rec., ×100 (42).

Spongopila Hkl., 1882 [**S. dichotoma* Hkl., 1887]. Like *Rhizospongus* but radial spines developed from surface of spongy network. *Carb.-Rec.*

Spongosphaeromma Hkl., 1887 [**Spongosphaera heliodes* Hkl., 1862; SD herein] [=*Spongosphaera* Hkl., 1887 (obj.) (*non* Ehr., 1847)]. Two medullary lattice shells surrounded by spongy cortical shell bearing many radial spines. *Cam.-Rec.*——Fig. 28,5. *S. streptacantha* (Hkl.), Rec., ×200 (42).

Spongothamnus Hkl., 1887 [**S. furcatus;* SD herein]. Like *Spongechinus* but spines branched. *Rec.*

Tetrasphaera Pop., 1911 [**T. spongiosa*]. Three concentric lattice shells joined by radial beams which by anastomosis form loose spongy network between outer shells; many short irregular spines on surface. *Rec.*——Fig. 28,6. **T. spongiosa*, Rec., ×275 (48).

Family DACTYLIOSPHAERIDAE Squinabol, 1904

Single spherical lattice shell surrounded by an elliptical latticed ring. *Cret.*

Dactyliosphaera Squin., 1904 [**D. silviae*]. Ring bears 2 opposite radial spines and numerous shorter by-spines.——Fig. 28,7. **D. silviae*, Cret., Italy, ×133 (52).

Superfamily ELLIPSIDIICAE Haeckel, 1887

[*ex* Ellipsida; emend. Campbell, herein]
[=Prunoidea Hkl., 1887]

Elliptical or cylindrical, fenestrated or spongy shell; commonly articulated by annular transverse strictures. *Cam.-Rec.*

Family ELLIPSIDIIDAE Haeckel, 1887

[as Ellipsida; emend. Campbell, herein]

Single elliptical lattice shell. *Cam.-Rec.*

Ellipsidium Hkl., 1887 [**E. datura;* SD herein]. Numerous radial spines; without polar tubules. *Dev.-Rec.*——Fig. 29,1. *E. aculeatum* Rüst, L.Carb., Harz Mts., Ger., ×100 (51).

Axellipsis Hkl., 1887 [**A. perforata;* SD herein]. Shell cavity with transverse axial rods; surface spiny. *Jur.-Rec.*——Fig. 29,2. *A. longitudinalis* Rüst, Jur., Sicily, ×150 (51).

Axoprunum Hkl., 1887 [**A. stauraxonium*]. Like *Ellipsoxiphus* but has 4 internal rods in main axis and 2 in transverse axis. *Rec.*——Fig. 29,11. **A. stauraxonium*, Rec., ×200 (42).

Cenellipsis Rüst, 1885 [**C. jaspidea;* SD herein] [=*Ellipsis* Hkl., 1887 (obj.); *Haeckeletta* Chabakov, 1937]. Without polar tubules, spines, or internal rods. *Cam.-Rec.*

C. (Cenellipsis) [=*Cenellipsium* Hkl., 1887 (obj.)]. Network regular. *Cam.-Rec.*——Fig. 29,6b. *C. (C.) faceta* Hkl., Rec., ×200 (42).

C. (Cenellipsula) Hkl., 1887 [**C. infundibulum;* SD Frizzell 1951]. Network irregular. *Cam.-Rec.*——Fig. 29,6a. **C. (C.) infundibulum*, Rec., ×200 (42).

Ellipsostigma Hinde, 1899 [**E. australe*]. Four radial main spines; by-spines arise from shell center. *Dev.*——Fig. 29,4. **E. australe*, Dev., Austral., ×200 (44).

Ellipsostylus Hkl., 1887 [**E. psittacus;* SD herein]

[=*Ellipostylus* VINASSA (obj.)]. Two opposite dissimilar polar spines. *Jur.-Rec.*

E. (Ellipsostylus) [=*Ellipsostyletta* HKL., 1887 (obj.)]. Network regular. *Jur.-Rec.*——FIG. 29, *10. *E. (E.) psittacus,* Rec., ×268 (42).

E. (Ellipsostylissa) HKL., 1887 [**E. hirundo;* SD herein]. Network irregular. *Rec.*

Ellipsoxiphus DUNIKOWSKI, 1882 [**E. parvoforaminus;* SD herein][=*Ellipsoxiphium* HKL., 1887 (obj.)]. Two similar opposite polar spines. *Jur.-Rec.*

E. (Ellipsoxiphus) [=*Ellipsoxiphilla* HKL., 1887 (obj.)]. Network irregular. *Jur.-Rec.*——FIG. 29,*7a. E. (E.) bipolaris* HKL., Rec., ×300 (42).

E. (Ellipsoxiphetta) HKL., 1887 [**E. flosculus;* SD herein]. Network regular. *Eoc.-Rec.*——FIG. 29,*7b. E. (E.) elegans* HKL., Rec., ×200 (42).

Lithapium HKL., 1887 [**L. pyriforme;* SD herein]. Elliptical or pear-shaped; single spine on one pole. *Cam.-Rec.,*——FIG. 29,*8. *L. pyriforme,* Rec., ×200 (42).

Lithomespilus HKL., 1882 [**L. phloginus* HKL., 1887]. On one pole a cluster of spines. *Cam.-Rec.*——FIG. 29,*5. *L. phloginus,* Rec., ×300 (42).

Pipettella HKL., 1887 [**E. prismatica;* SD herein]. Two similar opposite polar, fenestrated tubules. *Jur.-Rec.*——FIG. 29,*3. *P. prismatica,* Rec., ×200 (42).

Tetracanthellipsis SQUIN., 1903 [**T. euganeus*]. Two opposite polar spines on main axis, one bifurcate. *Cret.*——FIG. 29,*9. *T. euganeus,* Cret., Italy, ×80 (52).

Family DRUPPULIDAE Haeckel, 1887

[as Druppulida; emend. CAMPBELL, herein]
[Stylosphaeridae HAECKER, 1908 *(partim)*]

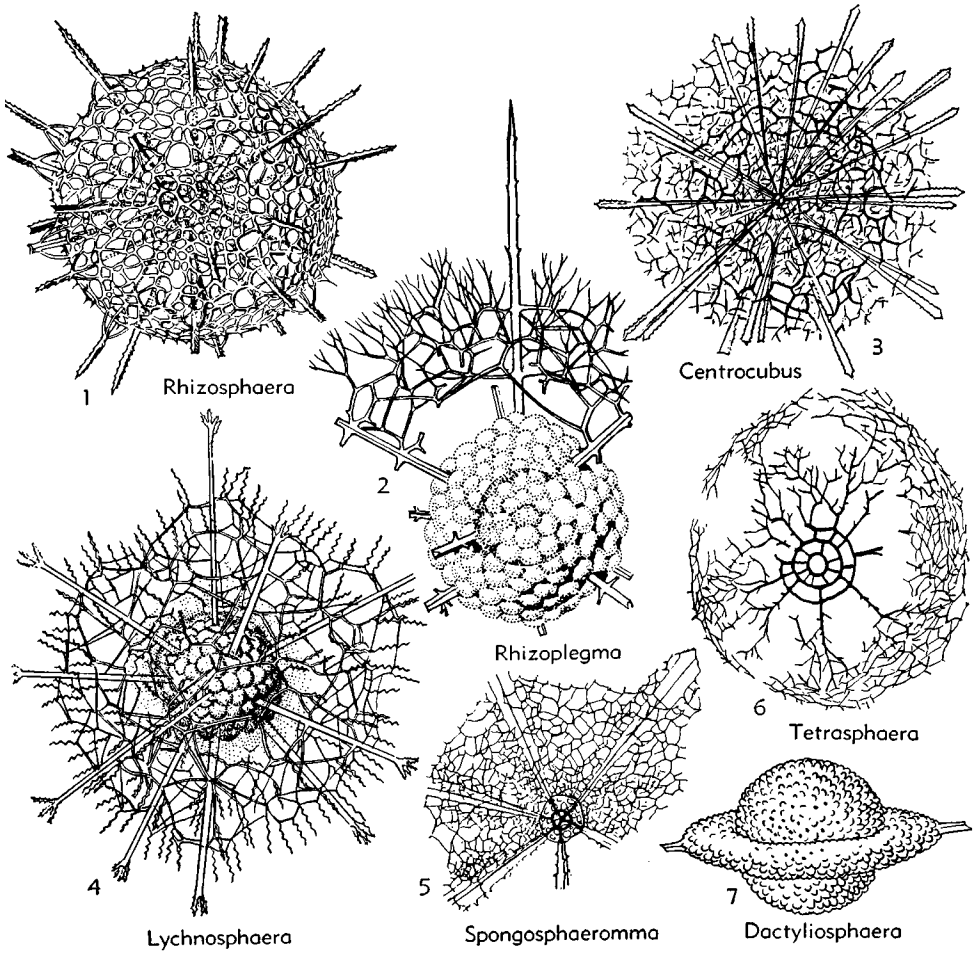

FIG. 28. Astrosphaeridae, Dactyliosphaeridae (p. D66-D68).

Two or more elliptical lattice shells. *Ord.-Rec.*

Druppula HKL., 1887 [**D. pandanus;* SD FRIZZELL, 1951][=*Coccymilium* HKL., 1887 (obj.)]. Simple double shell without polar tubules or spines. *Paleoc.-Rec.*

D. (Druppula) [=*Druppuletta* HKL., 1887 (obj.)]. Network regular. *Paleoc.-Rec.*——FIG. 30,*1.* **D. pandanus,* Rec., ×200 (42).

D. (Druppulissa) HKL., 1887 [**Haliomma ellipticum* STÖHR, 1880; SD herein]. Network irregular. *Eoc.-Rec.*

Caryodoras HKL., 1882 [**Cromyatractus tetraphractus* HKL., 1887 (=*Stylocromium tetraphractum* HKL., 1887)][=*Cromyatractus* (obj.), *Stylocromium* (obj.) HKL., 1887]. Two medullary and 2 or more cortical shells; 2 opposite similar polar spines. *Rec.*

C. (Caryodoras) [=*Cromyatractium* HKL., 1887 (obj.)].Two cortical and medullary shells.——FIG. 30,*5.* **C. (C.) tetraphractus* (HKL.), Rec., ×150 (42).

C. (Caryatractus) HKL., 1887 [**Cromyatractus cepicius;* SD herein]. Three or more cortical shells.

Cromyocarpus HKL., 1887 [**C. quadrifarius*]. Four or more concentric shells; numerous radial spines. *Rec.*

Cromyodruppa HKL., 1887 [**C. cepa;* SD herein]. Like *Cromyocarpus* but without spines. *Jur.-Rec.*

C. (Cromyodruppa) [=*Cromyodruppium* HKL., 1887 (obj.)]. Two cortical and medullary shells. *Jur.-Rec.*——FIG. 30,*3. C. (C.) prunulina* RÜST, Jur., Sicily, ×140 (51).

C. (Carpodruppula) HKL., 1887 [**C. mango;* SD herein]. Two medullary and 3 or more cortical shells. *Rec.*

Cromyodruppocarpus C.-CL., 1944 [**C. esterae*]. Several (2 or more) opposite polar spines at each main pole. *Mio.*——FIG. 30,*6.* **C. esterae,* Mio., Calif., ×150 (35).

Dorydruppa VINASSA, 1900 [**D. simonellii*]. One single polar spine; single medullary shell. *Mio.*——FIG. 30,*4.* **D. simonellii,* Mio., Italy, ×200 (55).

Druppocarpus HKL., 1887 [**D. ananassa;* SD

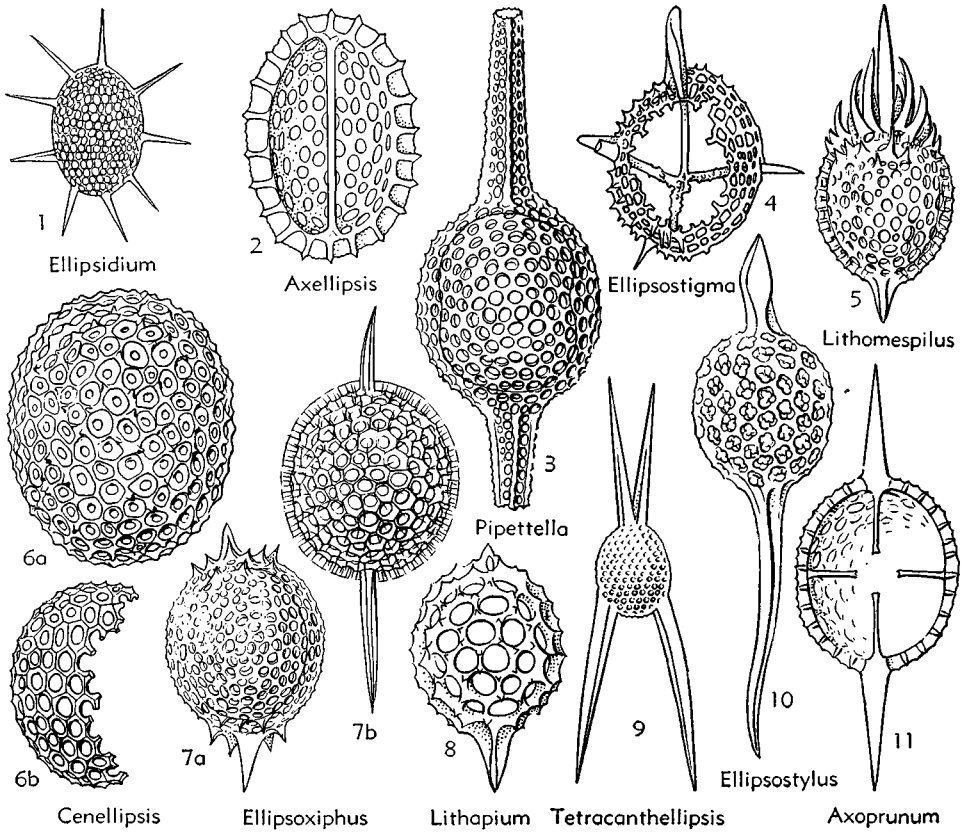

FIG. 29. Ellipsidiidae (p. D68, D69).

herein]. Double shell with numerous radial spines. *Eoc.-Rec.*

D. (Druppocarpus) [=*Druppocarpetta* HKL., 1887 (obj.)]. Network regular. *Rec.*

D. (Druppocarpissa) HKL., 1887 [**D. chamaerops;* SD herein]. Network irregular. *Eoc.-Rec.*

Druppalonche HINDE 1899 [**D. clavigera;* SD herein]. Three radial spines. *Ord.*——FIG. 30,*9*. **D. clavigera,* Ord., Eng., ×150 (44).

Druppatractus HKL., 1887 [**D. hippocampus;* SD FRIZZELL 1951][=*Drappatractus* CARNEVALE, 1908 (obj.); *Druppotractus* POP., 1911 (obj.)]. Simple medullary shell; 2 dissimilar polar spines. *Jur.-Rec.*

D. (Druppatractus) [=*Druppatractara* HKL., 1887 (obj.); *Druppatractaria* CL.-C., 1942 (obj.)]. Network regular; surface smooth. *Jur.-Rec.*——FIG. 30,*10a*. **D. (D.) hippocampus,* Rec., ×300 (42).

D. (Druppatractarium) HKL., 1887 [**D. diodon;* SD herein]. Network irregular; surface thorny or papillate. *Rec.*

D. (Druppatractoma) HKL., 1887 [**Stylosphaera laevis* EHR., 1875; SD herein]. Network irregular; surface smooth. *Rec.*

D. (Druppatractylis) HKL., 1887 [**D. ostracion;* SD herein]. Network regular; surface thorny or papillate. *Eoc.-Rec.*——FIG. 30,*10b*, **D. (D.) ostracion,* Rec., ×200 (42).

Druppastylus CAYEUX, 1897 [**D. hirsutus*][=*Doryprunum* VINASSA, 1900]. One single polar spine; double medullary shell. *Cret.-Mio.,* Belg.——FIG., 30,*2*. *D. apenninicus* (VINASSA), Mio., Italy, ×200 (55).

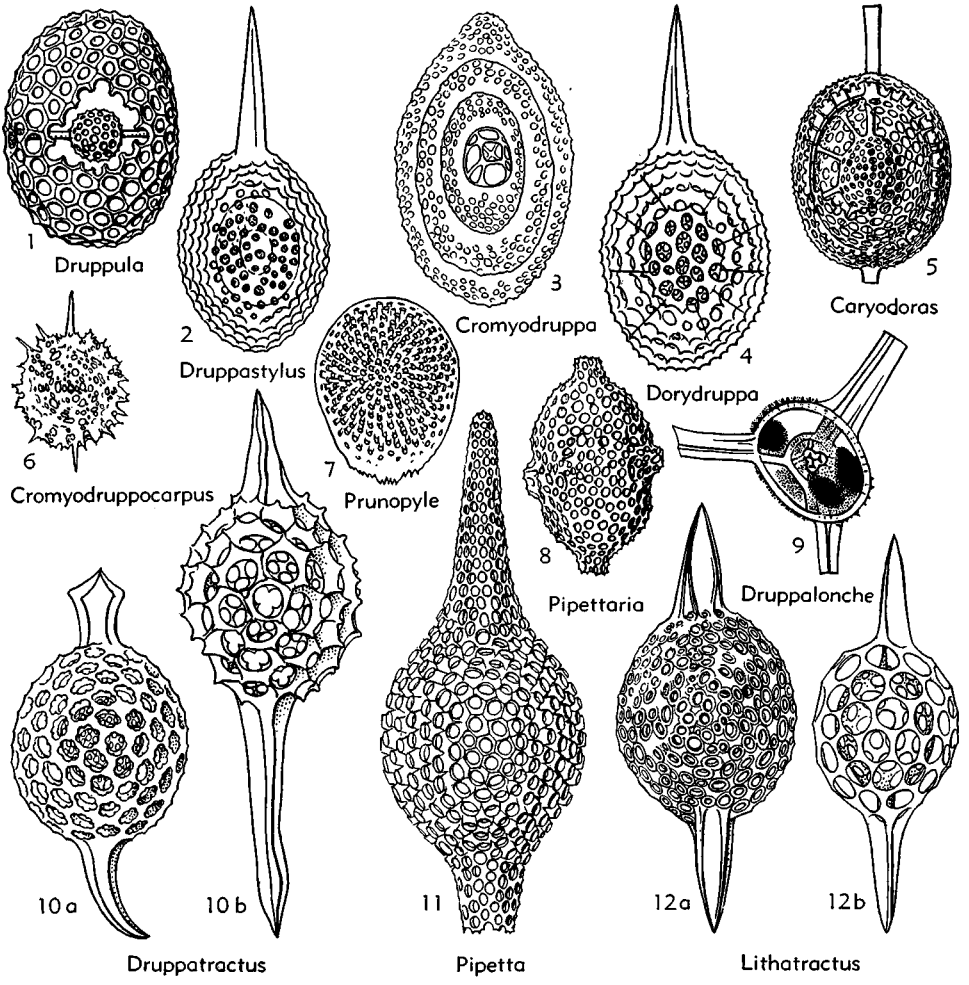

FIG. 30. Druppulidae (p. D70-D72).

Lithatractus HKL., 1887 [**L. fragilis* (=*Stylosphaera fragilis* HKL., 1887); SD herein]. Two similar polar spines; double medullary shell. *Jur.-Rec.*

L. (Lithatractus) [=*Lithatractara* HKL., 1887 (obj.)]. Network regular; surface smooth. *Jur.-Rec.*——FIG. 30,*12b*. **L. (L.) fragilis*, Rec., ×200 (42).

L. (Lithatractium) HKL., 1887 [**L. conostylus*; SD herein]. Network irregular, surface thorny or papillate. *Rec.*

L. (Lithatractona) HKL., 1887 [**L. jugatus*; SD herein]. Network irregular; surface thorny or spiny. *Rec.* ——FIG. 30,*12a*. **L. (L.) jugatus*, Rec., ×200 (42).

L. (Lithatractylis) HKL., 1887 [**L. echiniscus*; SD herein]. Network regular; surface thorny or papillate. *Eoc.-Rec.*

Pipetta HKL., 1887 [**P. fusus*; SD herein]. Single medullary shell, otherwise as *Pipettaria*. *Mio.-Rec.*, Italy.——FIG. 30,*11*. **P. fusus*, Rec., ×200 (42).

Pipettaria HKL., 1887 [**P. tubaria* (=*Cannartidium tubarium* HKL., 1887); SD herein]. Double medullary shell; hollow fenestrated tubule on each pole of main axis. *Cret.-Rec.*——FIG. 30,*8*. **P. tubaria*, Rec., ×200 (42).

Prunocarpus HKL., 1887 [**P. datura*; SD herein] [=*Artocarpium* HKL., 1887 (obj.)]. Double medullary shell; numerous radial spines and no polar tubules. *Eoc.-Rec.*

P. (Prunocarpus) [=*Prunocarpetta* HKL., 1887 (obj.)]. Network regular. *Eoc.-Rec.*

P. (Prunocarpilla) HKL., 1887 [**P. artocarpium*; SD herein]. Network irregular. *Rec.*——FIG. 31,*1*. **P. (P.) artocarpium*, Rec., ×200 (42).

Prunulum HKL., 1887 [**P. coccymelium*; SD herein] [=*Caryolithis* EHR., 1847 *(nomen vanum)*; *Coccymelium* HKL., 1887 (obj.)]. Double medullary shell; without radial spines or tubules. *Dev.-Rec.*

P. (Prunulum) [=*Prunuletta* HKL., 1887 (obj.)]. Network regular. *Dev.-Rec.*——FIG. 31,*5*. **P. (P.) coccymelium*, Rec., ×200 (42).

P. (Prunulissa) HKL., 1887 [**Actinomma fenestratum* STÖHR, 1880; SD herein]. Network irregular; pores lobate or compound in some. *Eoc.-Rec.*

Prunopyle DREYER, 1889 [**P. pyriformis*; SD herein]. Outermost shell at least has a large pylome. *Eoc.-Rec.*——FIG. 30,*7*. *P. occidentalis* CL.-C., U.Eoc., Calif., ×100 (39).

Staurodruppa HINDE, 1899 [**S. praelonga*; SD herein]. Four similar radial spines crosswise in 2 axes; pores regular. *Dev.*——FIG. 31,*3*. **S. praelonga*, Dev., Austral., ×150 (44).

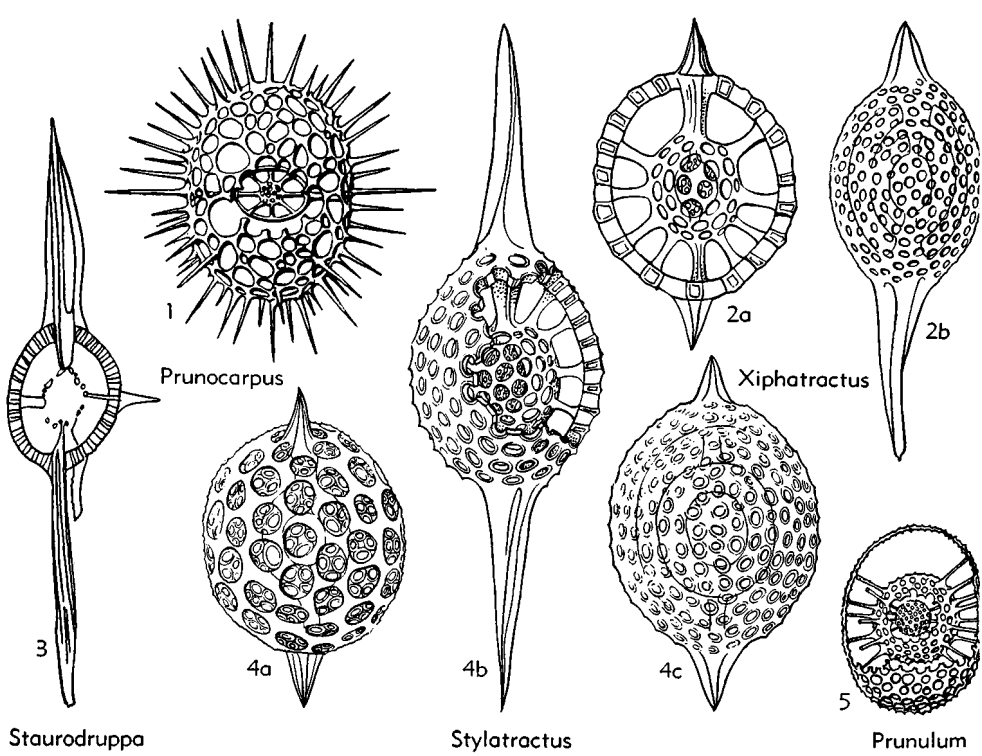

FIG. 31. Druppulidae (p. D72, D73).

Stylatractus HKL., 1887 [**S. neptunus* (=*Amphistylus neptunus* HKL., 1887); SD herein] [=*Amphistylus* HKL., 1882 *(partim)*]. Double medullary shell; 2 opposite similar polar spines. *Cret.-Rec.*

S. (Stylatractus) [=*Stylatractara* HKL., 1887 (obj.)]. Network regular; surface smooth. *Cret.-Rec.*——FIG. 31,*4c*. *S. (S.) compactus* HKL., Rec., ×200 (42).

S. (Stylatractium) HKL., 1887 [**S. papillosus;* SD herein]. Network irregular; surface thorny or papillate. *Rec.*

S. (Stylatractona) HKL., 1887 [**S. sethoporus;* SD herein]. Network irregular; surface smooth. *Rec.* ——FIG. 31,*4a*. **S. (S.) sethoporus,* Rec., ×200 (42).

S. (Stylatractylis) HKL., 1887 [**S. giganteus* (=*Amphistylus giganteus* HKL., 1887); SD herein]. Network regular; surface thorny or papillate. *Eoc.-Rec.*——FIG. 31,*4b*. **S. (S.) giganteus,* Rec., ×100 (42).

Xiphatractus HKL., 1887 [**X. armadillo;* SD herein]. Double medullary shell; 2 opposite dissimilar polar spines. *Eoc.-Rec.*

X. (Xiphatractus) [=*Xiphatractara* HKL., 1887 (obj.)]. Network regular; surface smooth. *Eoc.-Rec.*——FIG. 31,*2b*. **X. (X.) armadillo,* Rec., ×200 (42).

X. (Xiphatractium) HKL., 1887 [**X. glyptodon;* SD herein]. Network irregular; surface thorny or papillate. *Eoc.-Rec.*——FIG. 31,*2a*. **X. (X.) glyptodon,* Rec., ×200 (42).

X. (Xiphatractona) HKL., 1887 [**S. chlamydophorus*]. Network irregular; surface smooth. *Rec.*

X. (Xiphatractylis) HKL., 1887 [**Stylosphaera spinulosa* EHR., 1875]. Network regular; surface spiny or thorny. *Eoc.-Rec.*

Family SPONGURIDAE Haeckel, 1862

[as Spongurida; emend. CAMPBELL, herein]

Spongy elliptical or cylindrical shell without equatorial strictures. *Ord.-Rec.*

Subfamily SPONGURINAE Haeckel, 1862

[as Spongurida *(partim)*; emend. CAMPBELL, herein] [=Spongellipsida HKL., 1887]

Lacking internal latticed medullary shell. *Ord.-Rec.*

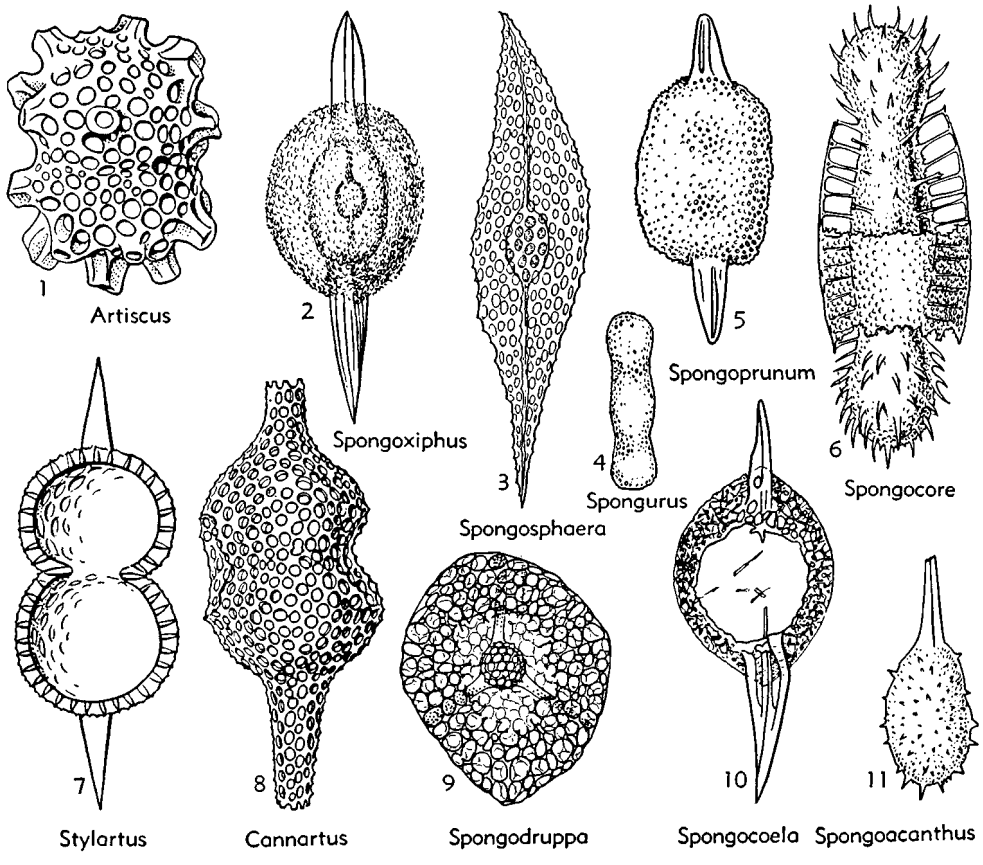

FIG. 32. Sponguridae, Artiscidae (p. D74).

Spongurus HKL., 1862 [**S. cylindricus*]. Solid spongy shell without polar spines or lattice-mantle. *Dev.-Rec.*

S. (Spongurus) [=*Spongurella* HKL., 1887 (obj.)]. Surface armed with radial spines; spongy framework everywhere similar. *Dev.-Rec.*

S. (Spongurantha) HKL., 1887 [**S. phlanga;* SD FRIZZELL 1951]. Surface without radial spines; spongy framework everywhere similar. *Paleoc.-Rec.*——FIG. 32,*4*. *S. (S.) smithi* C.-CL., Mio., ×150 (35).

S. (Sponguromma) HKL., 1887 [**S. radians;* SD herein]. Surface with radial spines, but interior framework compact. *Rec.*

Spongellipsis HKL., 1887 [**S. laevis;* SD herein]. Shell with hollow cavity but without latticed medullary shell; no polar spines. *Rec.*

S. (Spongellipsis) [=*Spongellipsarium* HKL., 1887 (obj.)]. Without radial spines.

S. (Spongellipsidium) HKL., 1887 [**S. setosa;* SD herein]. With radial spines.

Spongoacanthus SQUIN., 1903 [**S. horridus*]. Hollow shell with a single polar spine. *Cret.*——FIG. 32,*11*. **S. horridus,* Cret., Italy., ×80 (52).

Spongocoela HINDE, 1899 [**S. citreum;* SD herein]. Hollow shell with 2 opposite similar polar spines. *Dev.*——FIG. 32,*10*. **S. citreum,* Dev., Austral., ×150 (44).

Spongocore HKL., [**S. vellata;* SD herein]. Solid shell with lattice-mantle but without polar spines. *Mio.-Rec.*

S. (Spongocore) [=*Spongocorina* HKL., 1887 (obj.)]. Shell not jointed. *Rec.*

S. (Spongocorissa) HKL., 1887 [**S. puella;* SD herein]. Shell distinctly 3-jointed. *Mio.-Rec.*——FIG. 32,*6*. **S. (S.) puella,* Rec., ×200 (42).

Spongoprunum HKL., 1887 [**S. amphilonche;* SD herein]. Solid shell without lattice mantle; 2 opposite polar spines. *Ord.-Rec.*——FIG. 32,*5*. *S. markleyense,* CL.-C., U.Eoc., Calif., ×150 (39).

Subfamily SPONGODRUPPINAE Haeckel, 1887

[as Spongodruppida; emend. CAMPBELL, herein]

Latticed medullary, and spongy cortical shell. *Carb.Rec.*

Spongodruppa HKL., 1887 [**S. terebintha;* SD herein]. Simple medullary shell without polar spines. *Carb.-Rec.*

S. (Spongodruppa) [=*Spongodruppula* HKL., 1887 (obj.)]. Without radial spines. *Carb.-Rec.*——FIG. 32,*9*. *S. (S.) triradiata* RÜST, Carb., Harz Mts., Ger., ×80 (51).

S. (Spongodruppium) HKL., 1887 [**S. frangula;* SD herein]. With radial spines. *Rec.*

Spongoliva HKL., 1887 [**S. cerasina;* SD herein]. Double medullary shell; without polar spines. *Rec.*

S. (Spongoliva) [=*Spongolivetta* HKL., 1887]. Surface without radial spines.

S. (Spongolivina) HKL., 1887 [**S. opuntina;* SD herein]. Surface armed with radial spines.

Spongosphaera EHR., 1847 [**S. pachystylus* EHR., 1875][=*Spongatractus* HKL., 1887 (obj.)]. Simple medullary shell; 2 opposite polar spines. *Jur.-Rec.*——FIG. 32,*3*. *S. pleurosigma* (RÜST), Jur., Italy, ×100 (51).

Spongoxiphus HKL., 1887 [**S. prunococcus;* SD herein]. Double medullary shell; 2 opposite polar spines. *Eoc.-Rec.*——FIG. 32,*2*. **S. prunococcus,* Rec., ×150 (42).

Family ARTISCIDAE Haeckel, 1882

[as Artiscida; emend. CAMPBELL, herein]

Twin shell divided by equatorial stricture into 2 chambers; without medullary shell. *Cret.-Rec.*

Artiscus HKL., 1882 [**A. paniscus* HKL., 1887]. Without polar appendages or hollow tubules. *Cret.-Rec.*

A. (Artiscus) [=*Artiscum* HKL., 1887 (obj.)]. Surface without radial spines or solid rods. *Cret.-Rec.*

A. (Artidium) HKL., 1887 [**A. nodosus;* SD herein]. Surface with solid radial rods or spines. *Rec.*——FIG. 32,*1*. **A. (A.) nodosus,* Rec., ×300 (42).

Cannartus HKL., 1882 [**C. violina* HKL., 1887]. Two hollow fenestrated tubules on main axis. *Rec.*——FIG. 32,*8*. **C. violina,* Rec., ×200 (42).

Stylartus HKL., 1882 [**S. bipolaris* HKL., 1887]. Two solid spines or a bundle of spines on each pole of main axis. *Rec.*

S. (Stylartus) [=*Stylartella* HKL., 1887 (obj.)]. One spine on each pole.——FIG. 32,*7*. **S. (S.) bipolaris,* Rec., ×150 (42).

S. (Stylartura) HKL., 1887 [**S. palatus;* SD herein]. A bunch of spines on each pole.

Family CYPHANTIDAE Campbell, nov.

[=Cyphanida HKL., 1882]

Elliptical shell with 2 equatorial strictures; one or more medullary shells. *Dev.-Rec.*

Cyphanta HKL., 1887 [**C. colpodes;* SD herein]. Like *Cyphinus* but without polar spines or tubules. *Dev.-Rec.*

C. (Cyphanta) [=*Cyphantella* HKL., 1887 (obj.)]. Surface smooth. *Dev.-Rec.*——FIG. 33,*1*. *C. (C.) piscis* RÜST, L.Dev., Ural Mts., ×100 (51).

C. (Cyphantissa) HKL., 1887 [**C. hispida;* SD herein]. Surface spiny or thorny. *Rec.*

Astromma EHR., 1847 [**A. entomocora*][=*Cypassus* HKL., 1887 (obj.)]. Double cortical and medullary shells; without polar spines or tubules. *Eoc.-Rec.*

A. (Astromma) [=*Didymocyrtis* HKL., 1862 (obj.); *Didymophormis* HKL., 1882]. Surface spiny or thorny. *Eoc.-Rec.*——FIG. 33,*3*. *A. (A.) puella* HKL., Rec., ×200 (42).

A. (Didymospyris) HKL., 1882 [**Cypassus palliatus* HKL., 1887]. Surface smooth. *Rec.*

Cannartidium HKL., 1887 [**C. amphiconicum*; SD herein]. Simple cortical and double medullary shell; with a hollow fenestrated polar tubule on each pole. *Eoc.-Rec.*

C. (Cannartidium) [=*Cannartidella* HKL., 1887 (obj.)]. Without spines or conical tubules. *Eoc.-Rec.*——FIG. 33,*6*. *C. (C.) bicinctum* HKL., Rec., ×200 (42).

C. (Canartidissa) HKL., 1887 [**C. mammiferum*; SD herein]. Conical fenestrated protuberances. *Rec.*

Cannartiscus HKL., 1887 [**C. amphiconiscus*; SD herein]. Simple cortical and medullary shells; with a hollow fenestrated tubule at each pole. *Mio.-Rec.*——FIG. 33,*8*. **C. amphiconiscus*, Rec., ×200 (42).

Cyphanidium HKL., 1887 [**C. amphistylium*; SD herein]. Resembles *Cyphinus* but has double medullary shell. *Rec.*

C. (Cyphanidium) [=*Cyphinidoma* HKL., 1887 (obj.)]. Single polar spine or a bunch of spines on each pole.

C. (Cyphinidura) HKL., 1887 [**C. coronatum*; SD herein]. Circle of spines on each pole.

Cyphinus HKL., 1882 [**C. amphacanthus* HKL., 1887]. Simple cortical and medullary shells; 2 opposite polar spines or cluster of spines. *Cret.-Rec.*

C. (Cyphinus) [=*Cyphinoma* HKL., 1887 (obj.)]. Single polar spine on each pole. *Cret.-Rec.*

C. (Cyphinura) HKL., 1887 [**C. amphilophus*; SD herein]. Cluster of spines on each pole. *Rec.*——FIG. 33,*4*. **C. (C.) amphilophus*, Rec., ×200 (42).

Cyphocolpus HKL., 1887 [**C. virginis*; SD herein]. Triple cortical and medullary shells without polar spines or tubules. *Rec.*——FIG. 33,*2*. **C. virginis*, Rec., ×200 (42).

Diplellipsis POP., 1909 [**D. lapidosa*]. Medullary twin shell with biscuit-shaped portions. *Rec.*——FIG. 33,*7*. **D. lapidosa*, Rec., ×400 (48).

Ommatospyris EHR., 1860 [**O. apicata* EHR., 1872] [=*Cyphonium* HKL., 1887 (obj.)]. Like *Cyphanta* but has double spherical or lenticular medullary shell. *Eoc.-Rec.*

O. (Ommatospyris). Surface smooth. *Eoc.-Rec.*——FIG. 33,*5*. *O. (O.) virginea* HKL., Rec., ×200 (42).

O. (Didymocyrtis) HKL., 1882 [**Cyphonium hexagonium* HKL., 1887] [=*Ommatocyrtis* HKL., 1887 (obj.)]. Surface spiny or thorny. *Rec.*

Family PANARTIDAE Haeckel, 1887

[as Panartida; emend. CAMPBELL, herein]

External shell with 3 strictures; 2 concentric medullary shells. *Rec.*

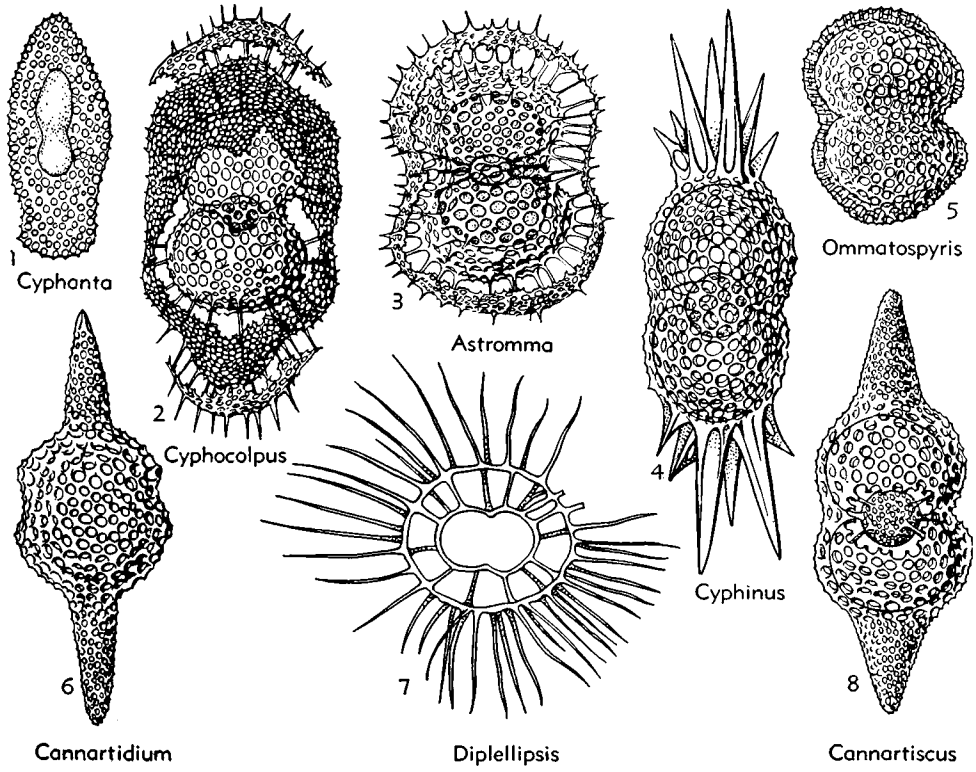

FIG. 33. Cyphantidae (p. D74, D75).

Panartus HKL., 1887 [**P. tetrathalmus;* SD herein]. Single cortical and double medullary shells; no polar spines or tubules.

P. (Panartus) [=*Panartella* HKL., 1887 (obj.)]. Surface without spines or thorns; all 4 chambers similar. FIG. 34,*1*. **P. tetrathalmus,* Rec., ×200 (42).

P. (Panartissa) HKL., 1887 [**P. diploconus;* SD herein]. Surface smooth; distal and proximal chambers dissimilar.

P. (Panartoma) HKL., 1887 [**P. quadriceps;* SD herein]. Surface thorny; 4 chambers similar.

P. (Panartura) HKL., 1887 [**P. pluteus;* SD herein]. Surface thorny; distal and proximal chambers dissimilar.

Panarium HKL., 1882 [**P. facettarium* HKL., 1887]. Like *Panartus* but has 2 polar tubules.

P. (Panarium) [=*Panarelium* HKL., 1887 (obj.)]. Surface smooth.

P. (Panaromium) HKL., 1887 [**P. tubularium;* SD herein]. Surface spiny or thorny.——FIG. 34,*4*. **P. tubularium,* Rec., ×200 (42).

Panicium HKL., 1887 [**P. amphacanthum;* SD herein]. Simple cortical shell; 2 opposite apical spines or a cluster of spines at poles of main axis.

P. (Panicium) [=*Panicidium* HKL., 1887 (obj.)]. Single spine at each pole.

P. (Panartidium) HKL., 1887 [**P. coronatum;* SD herein]. Cluster or circle of spines at each pole.——FIG. 34,*3*. **P. (P.) coronatum,* Rec., ×200 (42).

Peripanarium HKL., 1887 [**P. cenoconicum;* SD herein]. Double cortical shell; 2 opposite polar fenestrated tubules.

Peripanartus HKL., 1887 [**P. amphiconus;* SD herein]. Like *Peripanarium* but has no polar tubules or spines.

P. (Peripanartus) [=*Peripanartula* HKL., 1887 (obj.)]. Surface smooth.——FIG. 34,*2*. **P. amphiconus,* Rec., ×200 (42).

P. (Peripanartium) HKL., 1887 [**P. atractus;* SD herein]. Surface thorny or spiny.

Peripanicium HKL., 1887 [**P. amphixiphus;* SD herein]. Double cortical shell; a ring of spines, or only one spine on each pole.

P. (Peripanicium) [=*Peripanicea* HKL., 1887 (obj.)]. Single polar spine.

P. (Peripanicula) HKL., 1887 [**P. amphicorona;* SD herein]. Cluster or circle of spines at each pole.——FIG. 34,*9*. **P. (P.) amphicorona,* Rec., ×200 (42).

Family ZYGARTIDAE Haeckel, 1882

[as Zygartida; emend. CAMPBELL, herein]

External shell with 5 or more strictures; 2 or more concentric medullary shells. *Mio.-Rec.*

Subfamily ZYGARTINAE Haeckel, 1882

[as Zygartida *(partim)*; emend. CAMPBELL, herein] [=Zygocampida HKL., 1887]

Triple cortical shell. *Rec.*

Zygartus HKL., 1882 [**Z. dolium* HKL., 1887]. Hollow fenestrated polar tubule at each pole of main axis.

Zygocampe HKL., 1887 [**Z. chrysalidium* (=*Zygartus chrysalis* HKL., 1887, obj.); SD herein]. Triple or multiple cortical shell without polar tubules.——FIG. 34,*7*. **Z. chrysalidium,* Rec., ×200 (42).

Subfamily OMMATOCAMPINAE Haeckel, 1887

[as Ommatocampida; emend. CAMPBELL, herein]

Cortical shell simple. *Mio.-Rec.*

Ommatocampe EHR., 1860 [**O. polyarthra* EHR., 1872]. Without polar tubules. *Mio.-Rec.*

O. (Ommatocampe) [=*Ommatocampium* HKL., 1887 (obj.)]. Surface without thorns or spines. *Rec.*

O. (Ommatacantha) HKL., 1887 [**O. amphilonche*]. Surface smooth or spiny; 2 strong spines on each pole.

O. (Ommatocampula) HKL., 1887 [**O. nereis;* SD herein]. Surface spiny or thorny. *Mio.-Rec.* ——FIG. 34,*6*. **O. (O.) nereis,* Rec., ×200 (42).

O. (Ommatocorona) HKL., 1887 [**O. chaetopodium*]. Surface spiny; a regular circle or corona of spines on each chamber. *Rec.*

Ommatartus HKL., 1882 [**O. amphicanna* HKL., 1887]. Hollow fenestrated tubule on each pole. *Rec.*

Subfamily DESMOCAMPINAE Haeckel, 1887

[as Desmocampida; emend. CAMPBELL, herein]

Double cortical shell. *Rec.*

Desmocampe HKL., 1887 [**D. catenula;* SD herein]. Without polar spines.

Desmartus HKL., 1887 [**D. larvalis;* SD herein]. Fenestrated tubule on each pole.——FIG. 34,*5*. **D. larvalis,* Rec., ×200 (42).

Subfamily MONAXONIINAE Campbell, nov.

Triple medullary shell. *Rec.*

Monaxonium POP., 1911 [**M. perforatum*]. FIG. 34,*8*. **M. perforatum,* Rec., ×200 (48).

Superfamily CENODISCICAE Haeckel, 1887

[*ex* Cenodiscida; emend. CAMPBELL, herein] [=Discoidea HKL., 1862]

Discoidal or lenticular fenestrated or spongy shell. *Cam.-Rec.*

Subsuperfamily CENODISCILAE Haeckel, 1887

[*ex* Cenodiscida; emend. CAMPBELL, herein] [=Phacodiscaria HKL., 1887]

External lenticular latticed cortical shell. *Cam.-Rec.*

Family CENODISCIDAE Haeckel, 1887

[as Cenodiscida; emend. CAMPBELL, herein]

Without medullary shell, chambered arms or equatorial girdle. *Cam.-Rec.*

Subfamily CENODISCINAE Haeckel, 1887

[as Cenodiscida *(partim)*; emend. CAMPBELL, herein] [=Zonodiscida HKL., 1887]

Lacking peripheral radial spines. *Sil.-Rec.*

Cenodiscus HKL., 1887 [**C. phacoides;* SD herein]. Margin wthout girdle or spines. *Cam.-Rec.*—FIG. 35,*1*. **C. phacoides,* Rec., ×100 (42).

Zonodiscus HKL., 1887 [**Z. saturnalis*]. Has solid equatorial girdle, but no radial spines. *Sil.-Rec.*—FIG. 35,*4*. *Z. dentatus* RÜST, Sil., Cabrières., ×150 (51).

Subfamily TROCHODISCINAE Haeckel, 1887

[as Trochodiscida; emend. CAMPBELL, herein]

Equatorial radial spines on margin. *Cam.-Rec.*

Trochodiscus HKL., 1887 [**T. cenophacus;* SD herein]. Ten to 20 or more marginal spines on disc. *Cam.-Rec.*

T. (Trochodiscus) [=*Trochodisculus* HKL., 1887 (obj.)]. Base of radial spines free. *Cam.-Rec.*

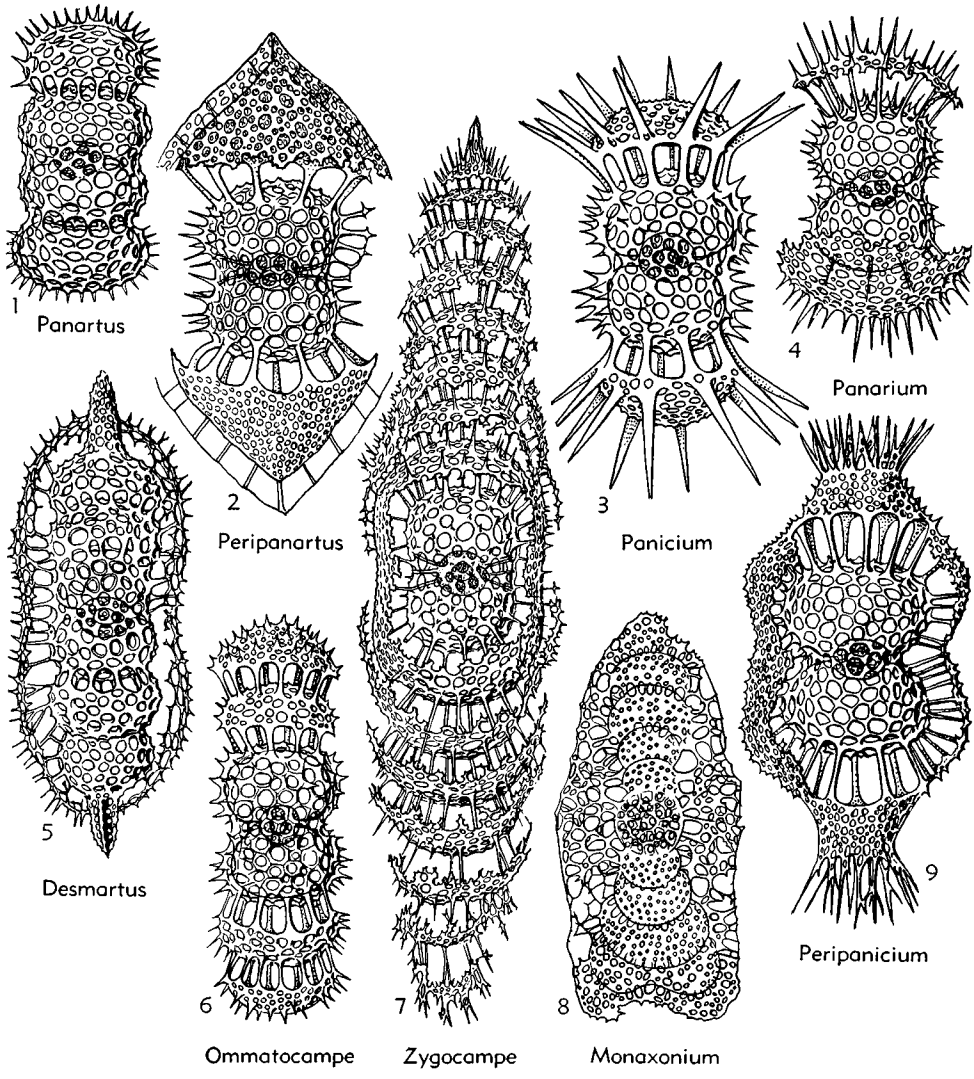

FIG. 34. Panartidae, Zygartidae (p. D76).

——Fig. 35,*3a*. *T. (T.) maximus* Squin., Cret., Italy, ×80 (52).

T. (Pristodiscus) Hkl., 1887 [**T. stellaris*; SD herein]. Bases of radial spines connected by solid equatorial girdle. *Rec.*——Fig. 35,*3b*. **T. (P.) stellaris*, Rec., ×100 (42).

Crucidiscus Hkl., 1887 [**C. endostaurus*; SD herein]. Four crossed radial spines on margin. *Cam.-Rec.*

C. (Crucidiscus) [=*Staurentodiscus* Hkl., 1887 (obj.)]. Internal centripetal rods. *Cam.-Rec.*——Fig. 35,*6*. **C. (C.) endostaurus*, Rec., ×100 (42).

C. (Staurexodiscus) Hkl., 1887 [**C. cuspidatus*; SD herein]. Without centripetal rods. *Rec.*

Dactyliodiscus Squin., 1903 [**D. cayeuxi*]. Circular hole in center; 8 marginal spines. *Cret.*——Fig. 35,*2*. **D. cayeuxi*, Rec., ×80 (52).

Theodiscus Hkl., 1887 [**T. divinus*; SD herein]. Three marginal radial spines. *Cam.-Rec.*

T. (Theodiscus) [=*Theodiscoma* Hkl., 1887 (obj.)]. Spines equidistant. *Cam.-Rec.*——Fig. 35,*5*. *T. (T.) brachyacanthus* Rüst, L.Carb., Ger., ×75 (51).

T. (Theodiscura) Hkl., 1887 [**T. vanitatis*; SD herein]. Spines not equidistant. *Rec.*

Stylodiscus Hkl., 1887 [**S. endostylus*; SD herein]. Two solid radial spines opposite in one axis. *Rec.*

S. (Stylodiscus) [=*Stylentodiscus* Hkl., 1887 (obj.)]. Cavity with centripetal rods.——Fig. 35,*7*. **S. (S.) endostylus*, Rec., ×150 (42).

S. (Stylexodiscus) Hkl., 1887 [**S. amphistylus*; SD herein]. Without centripetal rods.

Family PHACODISCIDAE Haeckel, 1882

[as Phacodiscida; emend. Campbell, herein]

Single lenticular latticed cortical shell and single or double medullary shell; without chambered equatorial girdles. *Cam.-Rec.*

Subfamily PHACODISCINAE Haeckel, 1882

[as Phacodiscida *(partim)*; emend. Campbell, herein] [=Sethodiscida Hkl., 1882]

Margin of disc without radial spines. *Eoc.-Rec.*

Phacodiscus Hkl., 1882 [**P. rotula* Hkl., 1887]. Double medullary shell; margin without girdle. *Eoc.-Rec.*

P. (Phacodiscus) [=*Phacodiscinus* Hkl., 1887 (obj.)]. Surface smooth. *Eoc.-Rec.*——Fig. 35,*8a*. **P. (P.) rotula*, Rec., ×200 (42).

P. (Phacodisculus) Hkl., 1887 [**P. clypeus*]. Surface with elevated ribs or spines. *Rec.*——Fig. 35,*8b*. **P. clypeus*, Rec., ×200 (42).

Periphaena Ehr., 1873 [**P. decora* Ehr., 1875]. Simple medullary shell; margin with hyaline girdle. *Eoc.-Rec.*——Fig. 35,*12*. *P. cincta* Hkl., Rec., ×200 (42).

Perizona Hkl., 1882 [**P. scutella* Hkl., 1887]. Double medullary shell; solid equatorial girdle. *Rec.*——Fig. 35,*9*. *P. pterygota* Hkl., Rec., ×320 (42).

Phacopyle Dreyer, 1889 [**P. stomatopora*]. Single pylome at one pole of lenticular shell. *Rec.*——Fig. 35,*11*. **P. stomatopora*, Rec., ×100 (40).

Sethodiscinus Hkl., 1887 [*non Sethodiscus* Hkl., 1882] [**Sethodiscus lenticula* Hkl., 1882; SD herein]. Simple medullary shell; neither girdle nor spines. *Eoc.-Rec.*

S. (Sethodiscinus). Surface smooth. *Rec.*——Fig. 35,*10*. **S. (S.) lenticula*, Rec., ×150 (42).

S. (Sethodisculus) Hkl., 1887 [**Haliomma radians* Ehr., 1854; SD herein]. Surface with elevated ribs or spines. *Eoc.-Rec.*

Subfamily DORYDISCINAE Campbell, nov.

[=Heliosestrida Carnevale, 1908 *(partim)*]

Single radial spine at one pole. *Mio.*

Dorydiscus Carnevale, 1908 [**D. bergontianus*]. Single medullary shell.——Fig. 36,*4*. **D. bergontianus*, Mio., Italy, ×110 (36).

Doryphacus Carnevale, 1908 [**D. poroacanthus*; SD herein]. Two concentric medullary shells.——Fig. 36,*3*. **D. poroacanthus*, Mio., Italy, ×110 (36).

Subfamily HELIOSESTRINAE Haeckel, 1887

[as Heliosestrida; emend. Campbell, herein]

Margin of disc with 2 to 8 or more radial spines; more or less regularly disposed. *Dev.-Rec.*

Heliosestrum Hkl., 1882 [**H. medusinum* Hkl., 1887] [=*Heliodiscus medusinus* Hkl., 1887]. Radial spines 8; simple medullary shell. *Dev.-Rec.*

H. (Heliosestrum) [=*Heliosestantha* Hkl., 1887 (obj.)]. Surface smooth; bases of radial spines without connecting girdle. *Dev.-Rec.*——Fig. 36,*1b*. **H. (H.) medusinum*, Rec., ×150 (42).

H. (Heliosestilla) Hkl., 1887 [**H. octonum*; SD herein]. Surface armed with spines; no girdle. *Rec.*——Fig. 36,*1a*. **H. (H.) octonum*, Rec., ×150 (42).

H. (Heliosestomma) Hkl., 1887 [**H. octangulum*; SD herein]. Surface smooth; solid equatorial girdle. *Rec.*

Astrosestrum Hkl., 1882 [**A. ephyra* Hkl., 1887]. Double medullary shell; 8 (7-9) radial spines. *Eoc.-Rec.*

A. (Astrosestrum) [=*Astrosestantha* Hkl., 1887 (obj.)]. Surface smooth; bases of spines not connected by girdle. *Rec.*——Fig. 36,*9*. **A. (A.) ephyra*, Rec., ×150 (42).

A. (Astrosestilla) Hkl., 1887 [**A. acanthastrum*; SD herein]. Surface spiny; bases of spines without girdle. *Eoc.-Rec.*

A. (Astrosestomma) Hkl., 1887 [**A. pelagicum*; SD herein]. Surface smooth; solid girdle. *Rec.*

Distriactis Hkl., 1887 [**D. lirianthus*; SD herein].

Radial spines 6; simple medullary shell. *Dev.-Rec.*——Fig. 36,2. *D. vetusa* Hinde, Dev., Austral., ×200 (44).

Heliosestarium C.-Cl., 1944 [**H. cretaceum*]. Like *Distriactis* but has subequal radial spines; double medullary shell. *Cret.*——Fig. 36,6. **H. cretaceum,* Cret., Calif., ×150 (35).

Heterosestrum Cl.-C., 1945 [**Stylodictya sexispinata* Cl.-C., 1942]. Six similar radial spines; double medullary shell. *Eoc.*——Fig. 36,5. **H. sexispinatum,* U.Eoc., Calif., ×150 (39).

Phacotriactis Sutton, 1896 [**P. triangula*]. Three short radial spines; triangular disc. *Eoc.*——Fig. 36,10. **P. triangula,* U.Eoc., Barbados, ×150 (54).

Phacostaurus Hkl., 1882 [**P. oceanidus* Hkl., 1887]. Four crossed radial spines; double medullary shell. *Rec.*

P. (Phacostaurus) [=*Phacostaurium* Hkl., 1887 (obj.)]. Margin simple.——Fig. 36,8a. **P. (P.) oceanidus* Hkl., Rec., ×150 (42).

P. (Astrostaurus) Hkl., 1887 [**P. magnificus;* SD

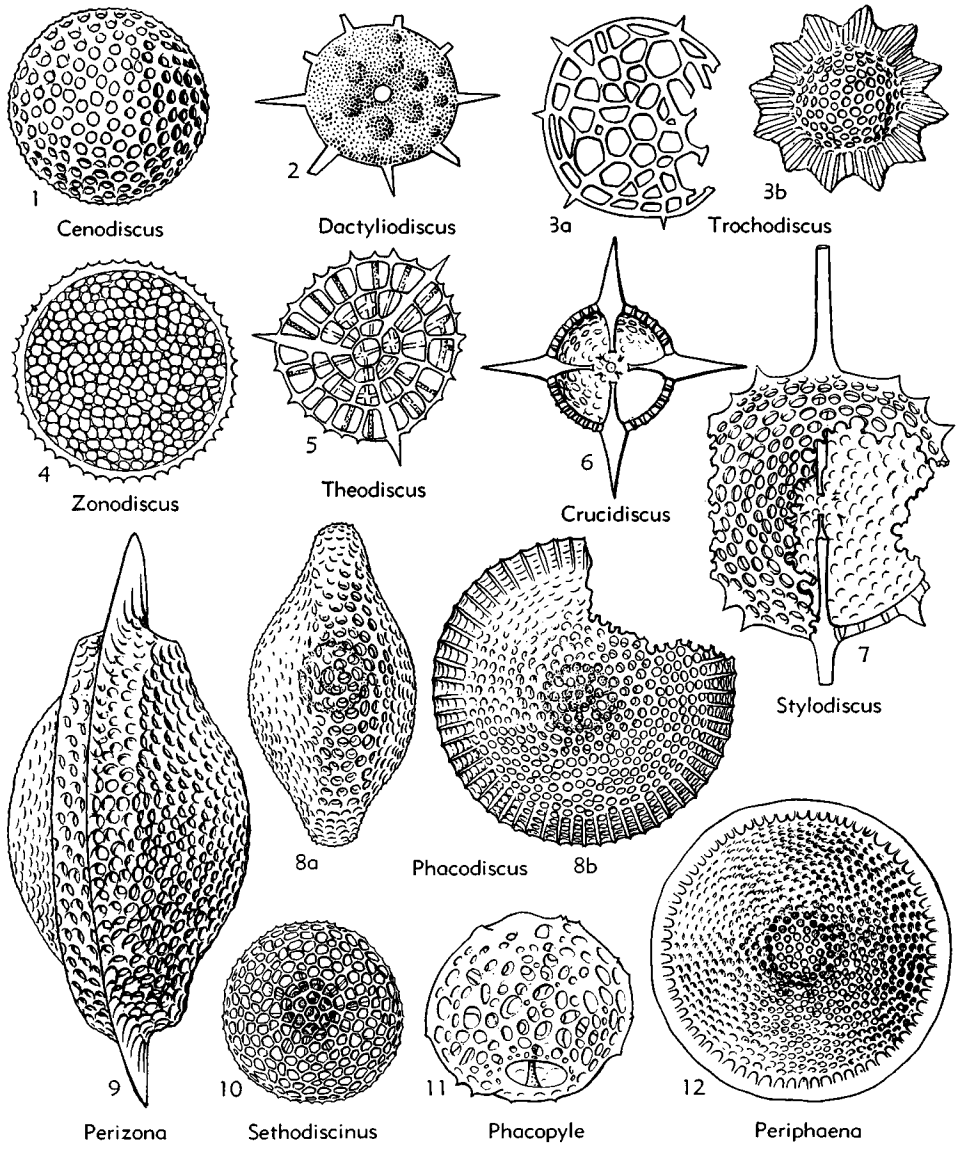

Fig. 35. Cenodiscidae, Phacodiscidae (p. D77, D78).

herein]. Margin with solid girdle, or a corona of spines.——Fig. 36,*8b*. **P. (A.) magnificus*, Rec., ×200 (42).

Phacostylus* Hkl., 1882 [P. amphistylus* Hkl., 1887]. Two opposite radial spines; double medullary shell. *Eoc.-Rec.*

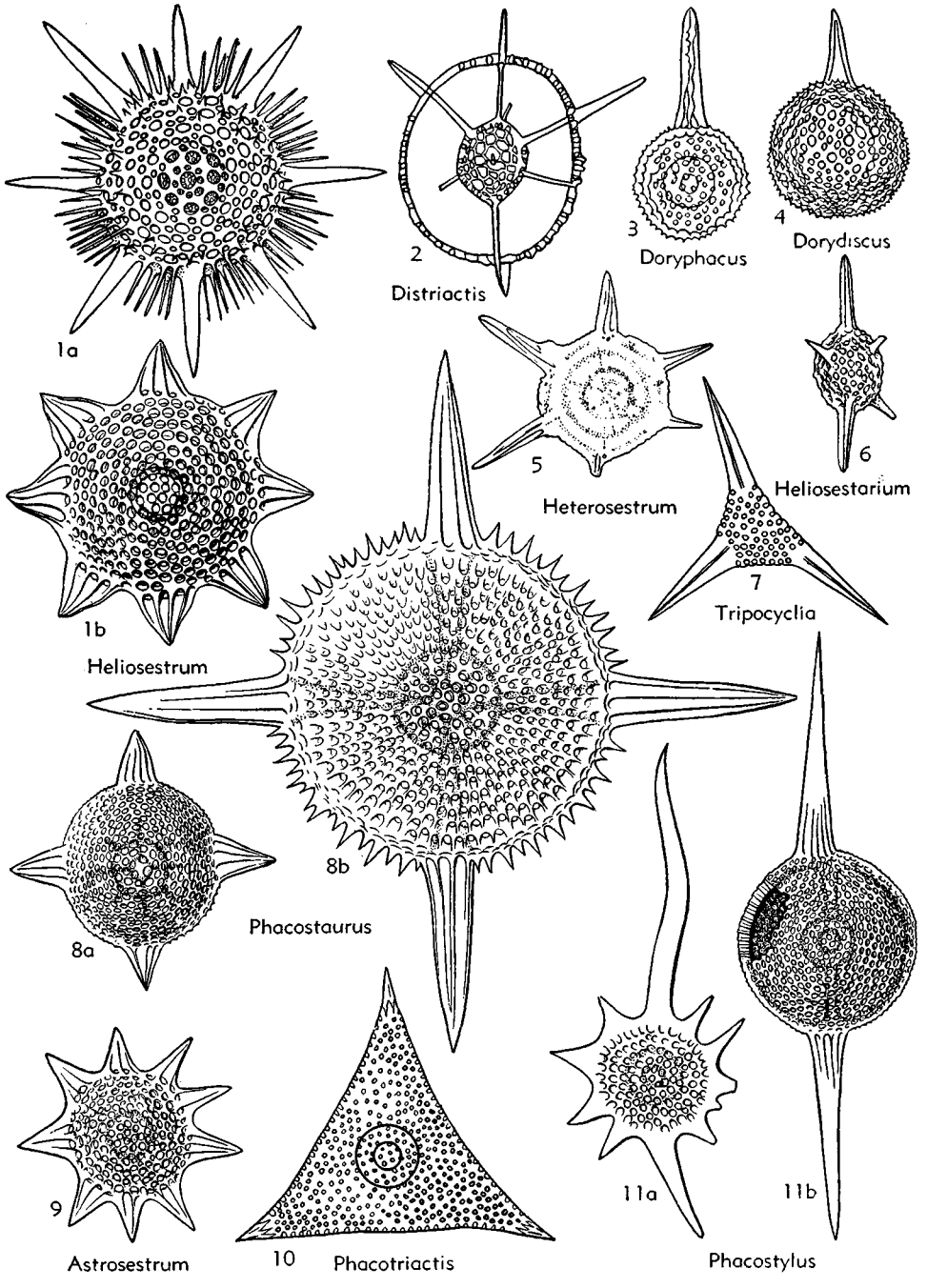

Fig. 36. Phacodiscidae (p. D78-D82).

P. (Phacostylus) [=*Phacostylium* Hkl., 1887 (obj.)]. Margin simple. *Rec.*——Fig. 36,*11b*. **P. amphistylus*, Rec., ×150 (42).

P. (Astrostylus) Hkl., 1887 [**P. caudatus*; SD herein]. Margin with solid equatorial girdle or corona of spines. *Eoc.-Rec.*——Fig. 36,*11a*. **P. (A.) caudatus*, Rec., ×150 (42).

Sethostaurus Hkl., 1882 [**S. orthostaurus* Hkl., 1887]. Like *Phacostaurus* but has simple medullary shell. *Cam.-Rec.*

S. (Sethostaurus) [=*Sethostaurium* Hkl., 1887 (obj.)]. Margin simple. *Cam.-Rec.*——Fig. 37,*2a*. *S. (S.) rhombostaurus* Hkl., Rec., ×300 (42).

S. (Heliostaurus) Hkl., 1887 [**S. cruciatus* (=*Heliostaurus cruciatus* Hkl., 1887); SD herein]. Margin with solid equatorial girdle. *Rec.*——Fig. 37,*2b*. **S. (H.) cruciatus*, Rec., ×150 (42).

Sethostylus Hkl., 1881 [**S. distyliscus* Hkl., 1887]. Two opposite radial spines; simple medullary shell. *Eoc.-Rec.*

S. (Sethostylus) [=*Sethostylium* Hkl., 1887 (obj.)]. Margin simple. *Rec.*——Fig. 37,*4b*. **S. (S.) distyliscus*, Rec., ×200 (42).

S. (Heliostylus) Hkl., 1887 [**S. dentatus*; SD herein]. Margin with girdle or corona of spines. *Eoc.-Rec.*——Fig. 37,*4a*. **S. (H.) dentatus*, Rec., ×150 (42).

Triactis Hkl., 1882 [**Triactoma titonianum* Rüst, 1885][=*Triactoma* Rüst, 1885 (obj.); *Triactiscus* Hkl., 1887 (obj.)]. Three marginal spines; simple medullary shell. *Jur.-Rec.*——Fig. 37,*3*. *T. tripyramis* Hkl., Rec., ×200 (42).

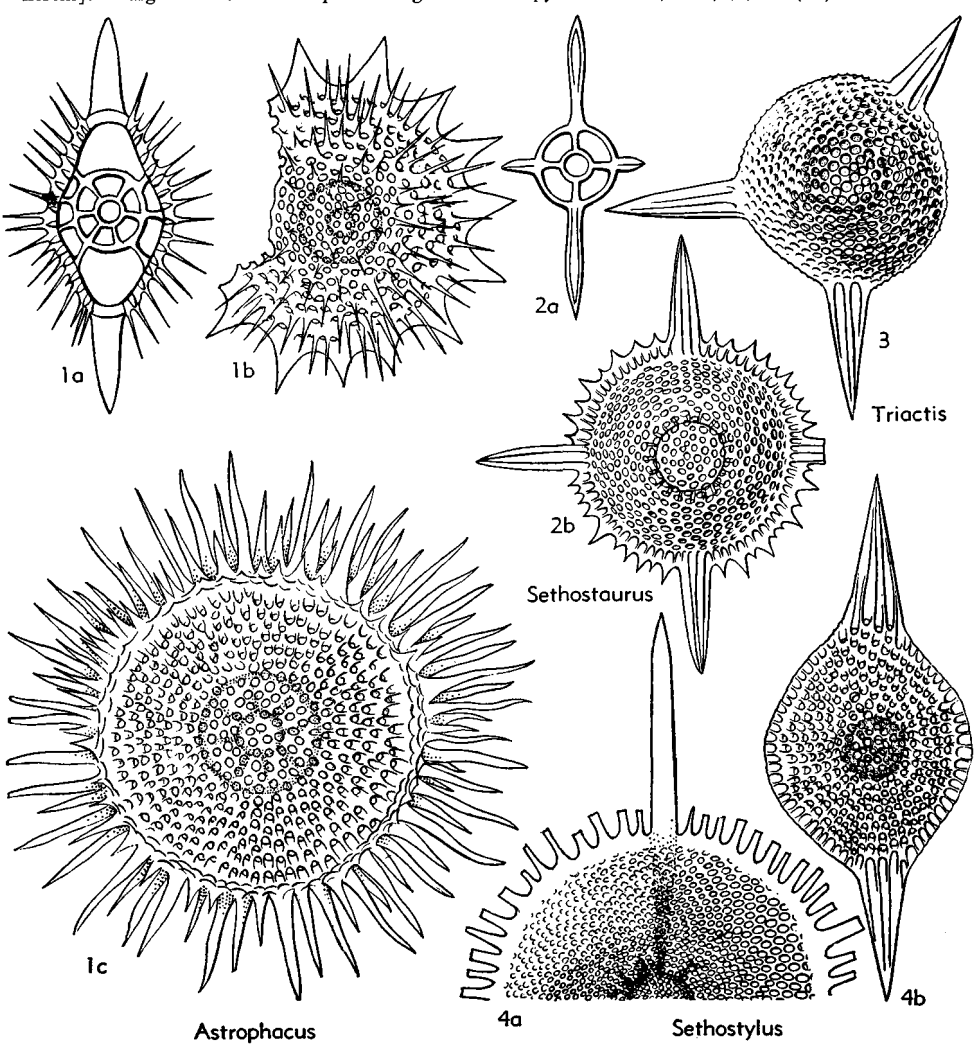

Fig. 37. Phacodiscidae (p. D81, D82).

Tripocyclia HKL., 1882 [**T. trigonum* RÜST, 1885]. Flat triangular disc; 3 strong spines; surface with minute pores. *Jur.* (cosmopol.).——FIG. 36,*7*. **T. trigonum*, Jur., Switz., ×120 (51).

Subfamily HELIODISCINAE Haeckel, 1882

[as Heliodiscida; emend. CAMPBELL, herein]
[=Eliodiscida CARNEVALE, 1908]

Variable number of radial spines (commonly 10 to 20 or more), mostly disposed irregularly. *Cam.-Rec.*

Heliodiscus HKL., 1882 [**H. inchoatus* RÜST, 1885]. Radial spines unbranched; medullary shell simple. *Cam.-Rec.*

H. (Heliodiscus) [=*Heliodiscetta* HKL., 1887 (obj.)]. Surface smooth; no girdle. *Cam.-Rec.* ——FIG. 38,*2c*. *H. (H.) asteriscus* HKL., Rec., ×150 (42).

H. (Heliodiscilla) HKL., 1887 [**H. pertusus* (=*Heliosestrum pertusum* HKL., 1887); SD herein]. Surface spiny; no girdle. *Rec.*——FIG. 38,*2a*. **H. (H.) pertusus*, Rec., ×200 (42).

H. (Heliodiscomma) HKL., 1887 [**H. cingulum*; SD herein]. Surface smooth; solid marginal girdle. *Rec.*——FIG. 38,*2b*. **H. (H.) cingulum*, Rec., ×150 (42).

H. (Heliodiscura) HKL., 1887 [**H. apollonis*; SD herein]. Surface spiny; solid marginal girdle. *Rec.*

Astrophacus HKL., 1882 [**A. asteriscus* HKL., 1887] [=*Chilomma* EHR., 1838 *(nomen vanum)*]. Like *Heliodiscus* but has double medullary shell. *Dev.-Rec.*

A. (Astrophacus) [=*Astrophacetta* HKL., 1887 (obj.)]. Surface smooth; no girdle. *Dev.-Rec.* ——FIG. 37,*1c*. *A. (A.) solaris* HKL., Rec., ×150 (42).

A. (Astrophacilla) HKL., 1887 [**A. phacodiscus*]. Surface spiny; no girdle. *Rec.*——FIG. 37,*1a*. **A. (A.) phacodiscus*, Rec., ×150 (42).

A. (Astrophacomma) HKL., 1887 [**A. cingulum*; SD herein]. Surface smooth; solid girdle. *Eoc.-Rec.*

A. (Astrophacura) HKL., 1887 [**A. apollinis*]. Surface spiny; solid girdle. *Rec.*——FIG. 37,*1b*. **A. apollinis*, Rec., ×150 (42).

Heliocladus HKL., 1882 [**H. dendrocyclus* HKL., 1887 (=*Heliodrymus dendrocyclus* HKL., 1887)] [=*Heliodrymus* HKL., 1882 (obj.)]. Ten to 20 branched radial spines; simple medullary shell. *Eoc.-Rec.*

H. (Heliocladus). Surface smooth; no spines. *Eoc.-Rec.*——FIG. 38,*1b*. **H. (H.) dendrocyclus*, Rec. ×150 (42).

H. (Heliodendrum) HKL., 1887 [**Heliodrymus ramosus*; SD herein]. Armed with simple or branched spines. *Rec.*——FIG. 38,*1a*. **H. (H.) ramosus*, Rec., ×200 (42).

Family COCCODISCIDAE Haeckel, 1862

[as Coccodiscida; emend. CAMPBELL, herein]

One or more chambered equatorial girdles. *Dev.-Rec.*

Subfamily COCCODISCINAE Haeckel, 1862

[as Coccodiscida *(partim)*; emend. CAMPBELL, herein]
[=Lithocyclida HKL., 1882]

Circular disc without solid radial spines or chambered arms. *Dev.-Rec.*

Coccodiscus HKL., 1862 [**C. darwinii*]. Double medullary shell. *Cret.-Rec.*——FIG. 39,*2*. *C. goethei* HKL., Rec., ×200 (42).

Lithocyclia EHR., 1847 [**L. ocellus* EHR., 1854] [=*Stephanopyxis* HKL., 1887 (obj.)]. Single medullary shell. *Dev.-Rec.*——FIG. 39,*1*. *L. lenticula* HKL., Rec., ×200 (42).

Subfamily STYLOCYCLIINAE Haeckel, 1882

[as Stylocyclida; emend. CAMPBELL, herein]

Solid radial spines; no chambered arms. *Jur.-Rec.*

Stylocyclia EHR., 1847 [**S. dimidiata* EHR., 1875]. Two solid radial spines; simple medullary shell. *Eoc.-Rec.*——FIG. 39,*4*. *S. prionacantha* HKL., Rec., ×200 (42).

Amphicyclia HKL., 1882 [**A. chronometra* HKL., 1887]. Like *Stylocyclia* but has double medullary shell. *Eoc.-Rec.*——FIG. 39,*5*. **A. chronometra*, Rec., ×200 (42).

Astrocyclia HKL., 1882 [**A. solaster* HKL., 1887]. Numerous (5 to 60) solid radial spines; simple medullary shell. *Eoc.-Rec.*——FIG. 39,*3*. **A. solaster*, Rec., ×200 (42).

Coccocyclia HKL., 1882 [**C. liriantha* HKL., 1887]. Like *Astrocyclia* but has double medullary shell. *Eoc.-Rec.*——FIG. 40,*9*. *C. heliantha* HKL., Rec., ×200 (42).

Staurocyclia HKL., 1882 [**S. cruciata* HKL., 1887] [=*Coccostaurus* HKL., 1882 (obj.); *Phacostaurus* HKL., 1887 (obj.)]. Four crossed radial spines; simple medullary shell. *Eoc.-Rec.*——FIG. 39.*7*. **S. cruciata*, Rec., ×200 (42).

Trigonocyclia HKL., 1882 [**T. triangularis* HKL., 1887]. Three solid radial spines; simple medullary shell. *Jur.-Rec.*——FIG. 39,*6*. **T. triangularis*, Rec., ×200 (42).

Subfamily ASTRACTURINAE Haeckel, 1882

[as Astracturida; emend CAMPBELL, herein]

Several (2 to 4 or more) chambered arms with or without connecting patagium. *Trias.-Rec.*

Astractura HKL., 1882 [**A. ordinata* HKL., 1887]. Four crossed chambered arms; no patagium; simple medullary shell. *Eoc.-Rec.*

A. (Astractura) [=*Astracturium* HKL., 1887

(obj.)]. Distally blunt or truncate arms without terminal spine. *Eoc.-Rec.*

A. (Astractinium) HKL., 1887 [**Astromma aristotelis* EHR., 1856; SD herein]. *Eoc.-Rec.*

Amphiactura HKL., 1882 [**A. amphibrachia* HKL., 1887]. Two opposite chambered arms connected by patagium. *Rec.*——FIG. 40,*8*. **A. amphibrachia,* Rec., ×150 (42).

Astrococcus SUTTON, 1896 [**A. concinna*]. Like *Astractura* but has double medullary shell. *Eoc.*——FIG. 40.7. **A. concinna,* Eoc., Barbados, ×150 (54).

Dicoccura CARTER, 1896 [**D. brevibrachia*]. Like *Amphiactura* but without patagium and has double medullary shell. *Eoc.*——FIG. 40,*4*. **D. brevibrachia,* Eoc., Barbados, ×100 (37).

Diplactura HKL., 1882 [**D. longa* RÜST, 1885]. Like *Dicoccura* but has single medullary shell and no patagium. *Trias.-Rec.*

D. (Diplactura) [=*Diplacturium* HKL., 1887 (obj.)]. Arms blunt or truncate, without terminal spine. *Trias.-Rec.*

D. (Diplactinium) HKL., 1887 [**D. diploconus* (=*Amphiactura diploconus* HKL., 1887)]. Arms with distal spine. *Rec.*——FIG. 40,*10*. **D. (D.) diploconus,* Rec., ×150 (42).

Echinactura HKL., 1887 [**E. culcita;* SD herein]. Five chambered arms connected by patagium; disc circular or pentagonal. *Rec.*

Hymenactura HKL., 1882 [**H. archimedes* HKL., 1887]. Three chambered arms connected by patagium; circular or triangular disc. *Eoc.-Rec.*

H. (Hymenactura) [=*Hymenacturium* HKL., 1887 (obj.)]. Arms blunt or truncate; no terminal spine. *Eoc.-Rec.*——FIG. 40,*1b*. **H. (H.) archimedes,* Rec., ×150 (42).

H. (Hymenactinium) HKL., 1887 [**H. copernici;* SD herein]. Distal end of each arm with terminal spine. *Eoc.-Rec.*——FIG. 40,*1a*. **H. (H.) copernici,* Rec., ×150 (42).

Pentactura HKL., 1882 [**Astromma pentactis* EHR., 1875]. Like *Echinactura* but without patagium. *Eoc.-Rec.*——FIG. 40,*2*. **P. pentactis* (EHR.), Eoc., Barbados, ×200 (42).

Stauractura HKL., 1882 [**S. octogena* HKL., 1887]. Like *Astractura* but with patagium. *Rec.*

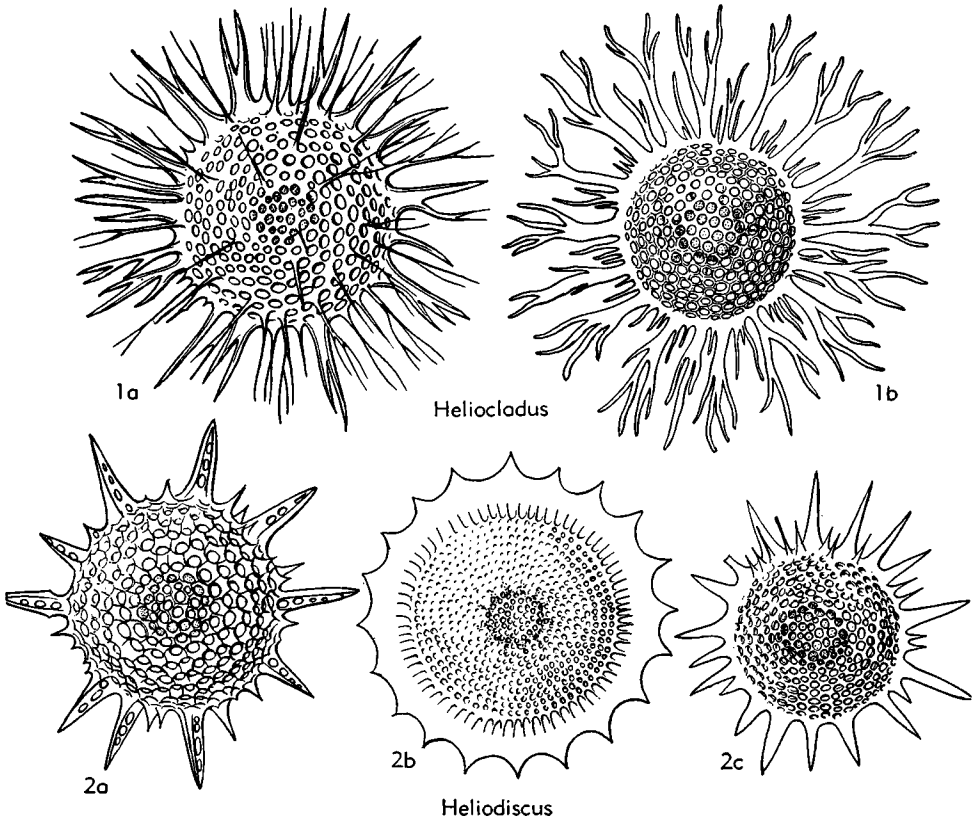

FIG. 38. Phacodiscidae (p. D82).

S. (Stauractra) [=*Stauracturium* HKL., 1887 (obj.)]. Arms distally blunt or truncate, without terminal spine.

S. (Stauractinium) HKL., 1887 [**S. medusina;* SD herein]. Arms with distal spine.

Staurococcura CARTER, 1896 [**S. quaternarium*]. Like *Astractura* but has patagium and double medullary shell. *Eoc.*——FIG. 40,*3*. **S. quaternaria,* Eoc., Barbados, ×133 (37).

Trigonactura HKL., 1882 [**T. weissmannii* RÜST, 1885]. Like *Hymenactura* but has patagium. *Trias.-Rec.*

T. (Trigonactra) [=*Trigonacturium* HKL., 1887 (obj.)]. Arms distally blunt or truncate; without terminal spine. *Trias.-Rec.*

T. (Trigonactinium) HKL., 1887 [**T. triacantha;* SD herein]. Arms distally with radial spine. *Eoc.-Rec.*——FIG. 40,*6*. **T. (T.) triacantha,* Rec., ×150 (42).

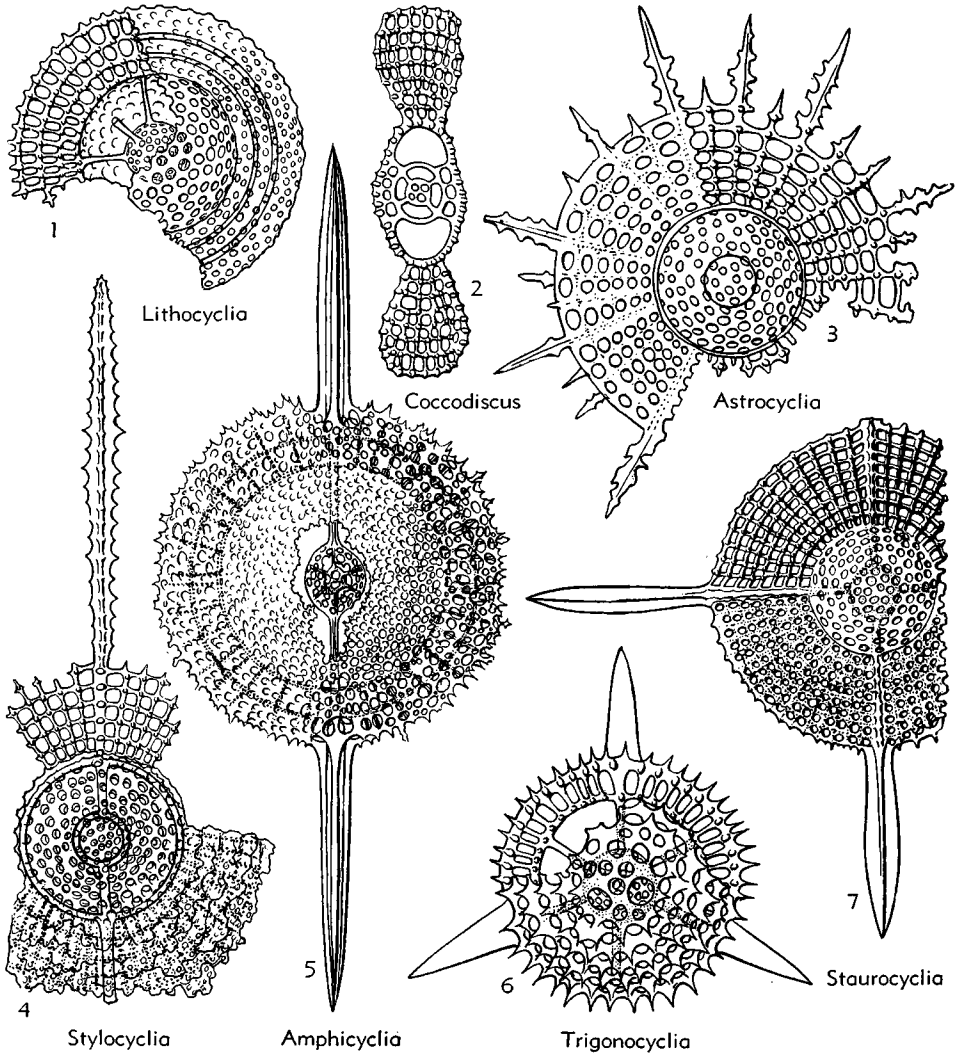

FIG. 39. Coccodiscidae (p. D82).

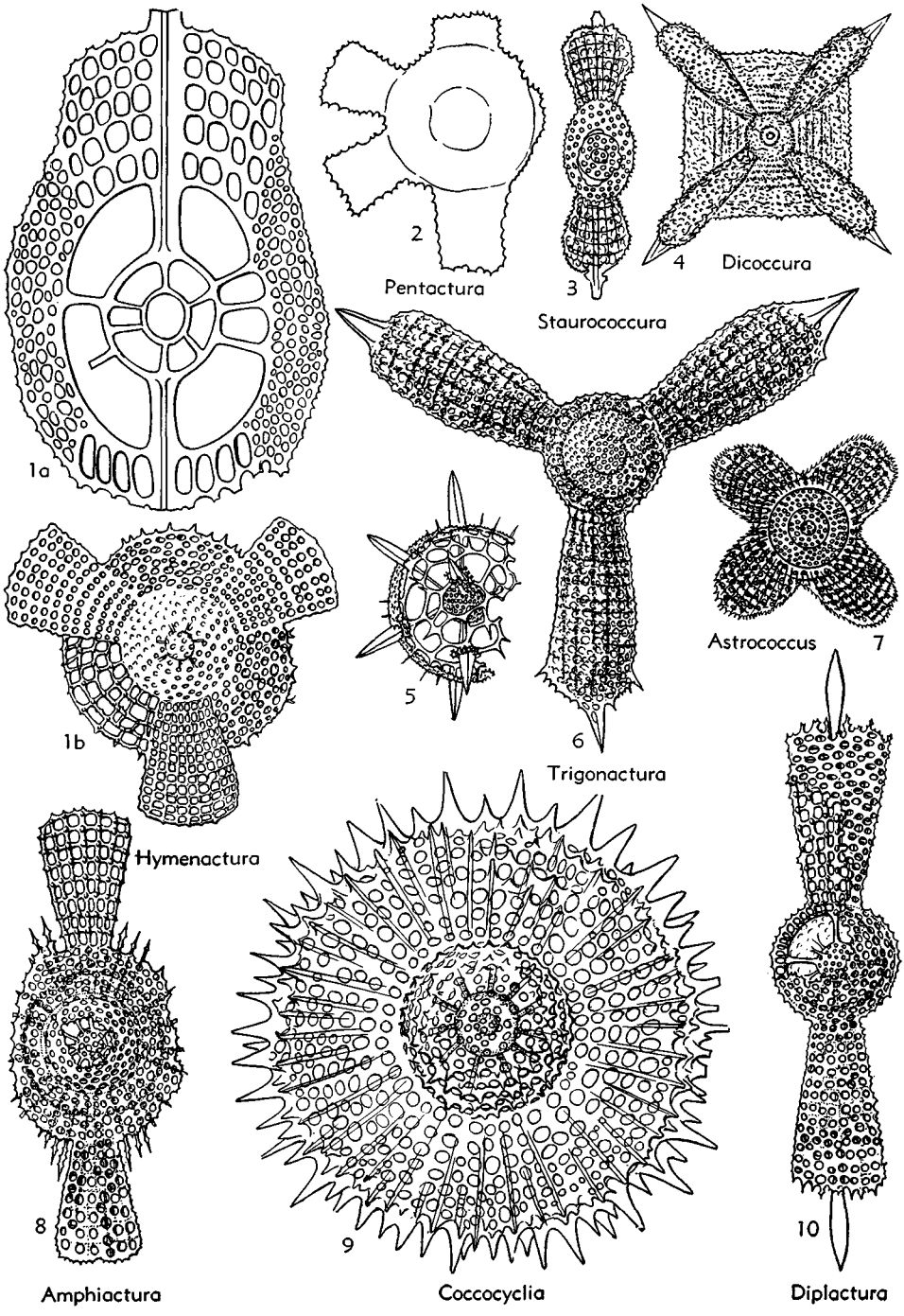

FIG. 40. Coccodiscidae (p. D82-D84). FIG. 40,*5* is *Cromyechinus* sp. (p. D66).

Subsuperfamily EUCHITONIILAE Haeckel, 1887

[*ex* Euchitonida; emend. CAMPBELL, herein] [=Cyclodiscaria HKL., 1887]

Lenticular latticed shell wanting. *Cam.-Rec.*

Family EUCHITONIIDAE Haeckel, 1887

[as Euchitonida; emend. CAMPBELL, herein] [=Calidictya EHR., 1847 *(partim);* Trematodiscida HKL. 1862; Discospirida HKL., 1882; Porodiscida HKL., 1887; Trematodiscidae FRIZZELL, 1951]

Flat disc-shaped shell with a simple central chamber surrounded by concentric rings which are divided by radial beams; porous sieve-plate covers disc. *Cam.-Rec.*

Subfamily EUCHITONIINAE Haeckel, 1887

[as Euchitonida *(partim);* emend. CAMPBELL, herein]

Two to 4 (rarely 5 or 6) chambered or spongy arms in equatorial plane; with or without patagium. *Dev.-Rec.*

Euchitonia EHR., 1860 [**E. furcata* EHR., 1872]. Three undivided chambered arms; with a patagium; shell bilateral. *Cret.-Rec.*

E. (Euchitonia) [=*Stylactis* EHR., 1872 (obj.); *Styla* Stechow, 1921]. Arms blunt, without distal spine. *Cret.-Rec.*——FIG. 41,*2a. E. (E.) lanceolata* HKL., Rec., ×100 (42).

E. (Pteractis) EHR., 1872 [**Pteractis elegans*]. Arms distally with spine. *Rec.*——FIG. 41,*2b. E. (P.) carina* HKL., Rec., ×200 (42).

Amphibrachium HKL., 1882 [**A. diminutum* RÜST, 1885]. Two undivided opposite arms; no patagium. *Dev.-Rec.*

A. (Amphibrachium) [=*Amphibrachella* HKL., 1887 (obj.)]. Arms similar, distally blunt; no terminal spine. *Dev.-Rec.*

A. (Amphibrachidium) HKL., 1887 [**A. amphilonche;* SD herein]. Arms similar; with terminal spine. *Rec.*——FIG. 41,*5. A. (A.) dilatatum* HKL., Rec., ×50 (42).

A. (Amphibrachoma) HKL., 1887 [**A. indicum*]. Arms dissimilar; no terminal spine. *Rec.*

A. (Amphibrachura) HKL., 1887 [**A. clavula*]. Arms dissimilar; with terminal spine. *Rec.*

Amphicraspedium HKL., 1882 [**A. maclaganium* HKL., 1887]. Two forked opposite arms; with patagium. *Rec.*

A. (Amphicraspedium) [=*Amphicraspedon* HKL. 1887 (obj.)]. Arms similar; no terminal spine. ——FIG. 42,*1. *A. (A.) maclaganium,* Rec., ×100 (42).

A. (Amphicraspedina) HKL., 1887 [**A. wyvilleanum*]. Arms dissimilar; no terminal spine.

A. (Amphicraspedula) HKL., 1887 [**A. murrayanum* (=*Amphimenium murrayanum* HKL., 1887)]. Arms dissimilar; with terminal spine.

Amphimenium HKL., 1882 [**A. zygartus* HKL., 1887]. Like *Ommatogramma* but patagium incomplete. *Eoc.-Rec.*——FIG. 41,*9. *A. zygartus,* Rec., ×200 (42).

Amphirrhopalum HKL., 1887 [**A. ximorphum*] [=*Amphirhopalum* HKL., 1882 (obj.)]. Like *Amphibrachium* but has one or more distally forked arms; without patagium. *Rec.*

A. (Amphirrhopalum) [=*Amphirrhopalium* HKL., 1887]. Without terminal spine.

A. (Amphirrhopella) HKL., 1887 [**A. echinatum;* SD herein]. With terminal spine.——FIG. 42,*3. *A. (A.) echinatum,* Rec., ×200 (42).

Chitonastrum HKL., 1882 [**S. triglochin* HKL., 1887]. Three distally forked arms; no patagium. *Cret.-Rec.*

C. (Chitonastrum) [=*Chitonastrella* HKL., 1887 (obj.)]. Arms similar. *Cret.-Rec.*

C. (Chitonastromma) HKL., 1887 [**C. jugatum;* SD herein (=*Dictyastrum jugatum* HKL., 1887)]. *Rec.*——FIG. 43,*4. C. (C.) lyra* HKL., Rec., ×100 (42).

Cyclastrum RÜST, 1898 [**C. infundibuliforme*]. Like *Chitonastrum* but has patagium. *Cret.*—— FIG. 41,*10. *C. infundibuliforme.* Cret., Cittiglio., ×300 (51).

Dicranastrum HKL., 1882 [**D. furcatum* HKL., 1887] [=*Ceratastrum* HKL., 1882]. Four bifurcate crossed arms; square shell. *Cret.-Rec.*

D. (Dicranastrum) [=*Dicranaster* HKL., 1887 (obj.)]. Each cross arm with 2 simple branches. *Cret.-Rec.*

D. (Tetracranastrum) HKL., 1887 [**D. bifurcatum*]. Cross arms with 4 terminal branches. *Rec.*——FIG. 42,*6. *D. (T.) bifurcatum,* Rec., ×100 (42).

D. (Tricranastrum) HKL., 1882 [**D. wyvillei* (=*Tricranastrum wyvillei* HKL., 1887)]. Each cross arm with 3 terminal branches. *Rec.*

Dictyastrum EHR., 1860 [**D. angulatum* EHR., 1872]. Three undivided arms; without patagium; shell triangular. *Jur.-Rec.*

D. (Dictyastrum) [=*Dictyastrella* HKL., 1887 (obj.)]. Arms blunt; no terminal spine.—— FIG. 41,*7. D. (D.) hexagonum* HKL., Rec., ×100 (42).

D. (Dictyastromma) HKL., 1887 [**D. trispinosum;* SD herein (=*Rhopalastrum trispinosum* HKL., 1887)]. Arms with terminal spine. *Rec.*

Hagiastrum HKL., 1882 [**H. plenum* RÜST, 1885]. Four crossed undivided arms; with patagium; shell quadrangular. *Jur.-Rec.*

H. (Hagiastrum) [=*Hagiastrella* HKL., 1887 (obj.)]. Both longitudinal arms similar. *Jur.-Rec.*

H. (Hagiastromma) HKL., 1887 [**H. mosis;* SD herein]. Longitudinal arms dissimilar. *Rec.*—— FIG. 41,*12. *H. (H.) mosis,* Rec., ×100 (42).

Hexactura HKL., 1882 [**Hexalastrum palmanthum* HKL., 1887] [=*Hexalastrum* HKL., 1887 (obj.)]. Six simple arms; no patagium. *Jur.-Rec.*

H. (Hexactura). Arms similar. *Jur.-Rec.*

H. (Hexalastromma) HKL., 1887 [**H. orchidacea*

HKL., 1887 (=*Hexalastrum orchidaceum* HKL., 1887)]. Arms dissimilar. *Rec.*——FIG. 41,*8*. **H. (H.) orchidacea,* Rec., ×50 (42).

Hexinastrum HKL., 1882 [**H. geryonidum* HKL., 1887]. Like *Hexactura* but has patagium. *Rec.*

Histiastrum EHR., 1847. [**H. quaternarium* EHR., 1875]. Like *Stauralastrum* but has patagium. *Cret.-Rec.*

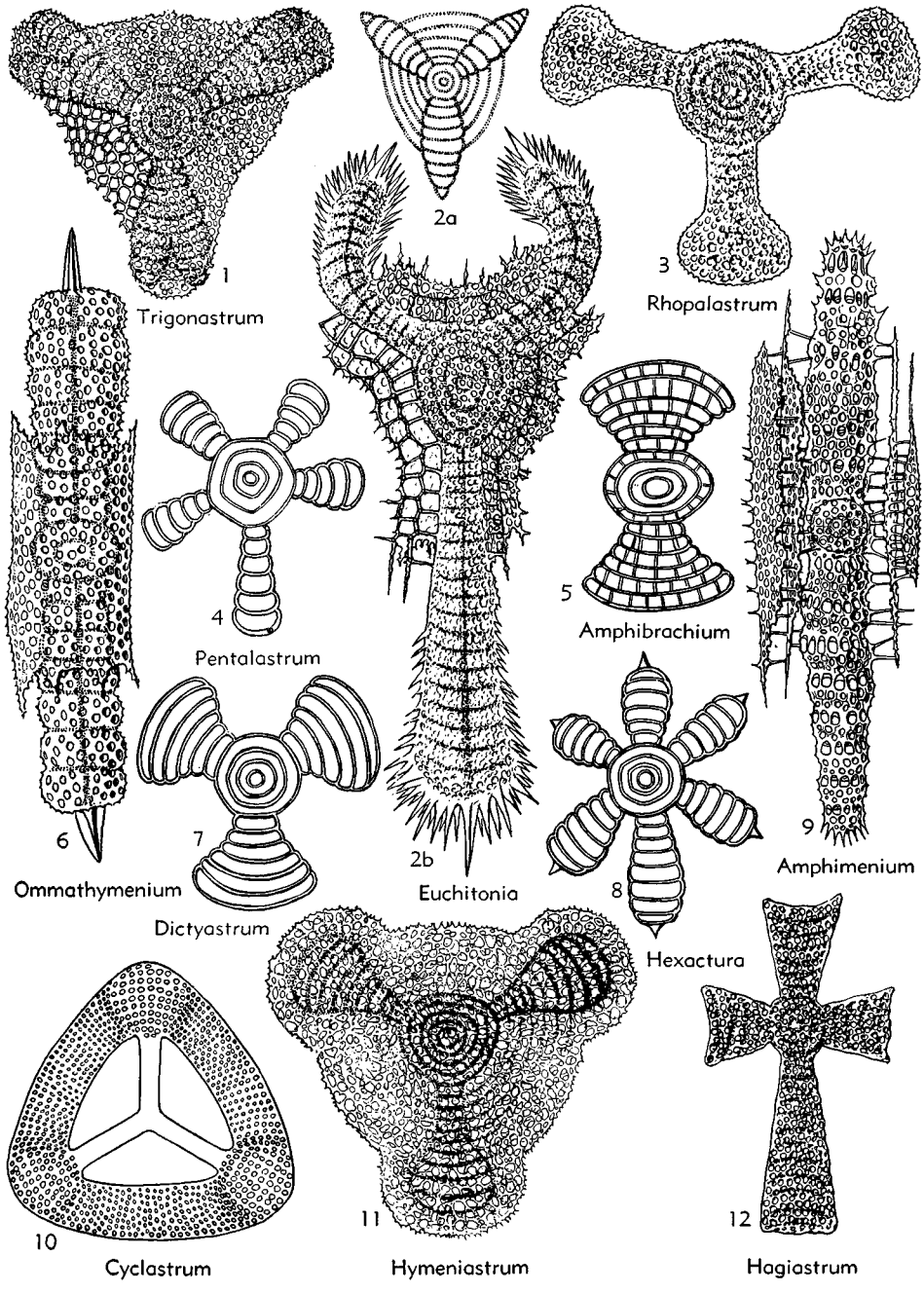

FIG. 41. Euchitoniidae (p. D86-D88).

H. (Histiastrum) [=*Histiastromma* HKL., 1887 (obj.)]. Arms distally spiny. *Cret.-Rec.*——FIG. 43,*5b*. *H. (H.) boseanum* HKL., 1887, Rec., ×200 (42).

H. (Histiastrella) HKL., 1887 [**H. quadrigatum;* SD herein]. Arms distally blunt. *Eoc.-Rec.*——FIG. 43,*5a*. *H. (H.) velastum* HKL., Rec., ×100 (42).

Hymeniastrum EHR., 1847 [**H. pythagorae*]. Like *Euchitonia* but has regular triangular shell. *Jur.-Rec.*

H. (Hymeniastrum) [=*Hymeniastrella* HKL., 1887 (obj.)]. Arms blunted. *Jur.-Rec.*——FIG. 41,*11*. *H. (H.) euclidis* HKL., Rec., ×150 (42).

H. (Hymeniastromma) HKL., 1887 [**Histiastrum ternarium* EHR., 1875]. Arms with distal radial spines. *Eoc.-Rec.*

Myelastrum HKL., 1882 [**M. medullare* HKL., 1887]. Like *D. (Tricranastrum)* but has 2-fold differentiation of arms. *Cret.-Rec.*

M. (Myelastrum) [=*Myelastrella* HKL., 1887 (obj.)]. Anterior arms lobate or cleft. *Cret.-Rec.*

M. (Myelastromma) HKL., 1887 [**M. octocorne;* SD herein]. All 4 arms lobate or cleft. *Rec.*——FIG. 42,*5*. **M. octocorne,* Rec., ×50 (42).

Ommathymenium HKL., 1887 [**Amphimenium amphistylium;* SD herein]. Two opposite similar arms distally with terminal spine; incomplete patagium. *Rec.*——FIG. 41,*6*. **O. amphistylium,* Rec., ×200 (42).

Ommatogramma EHR., 1860 [**O. naviculare* EHR., 1872]. Like *Ommathymenium* but patagium complete. *Rec.*——FIG. 42,*4*. **O. naviculare,* Rec., ×200 (41).

Pentalastrum HKL., 1882 [**P. asteracanthion* HKL., 1887]. Five undivided arms; no patagium. *Jur.-Rec.*

P. (Pentalastrum) [=*Pentalastrella* HKL., 1887 (obj.)]. All arms similar. *?Carb., Jur.-Rec.*

P. (Pentalastromma) HKL., 1887 [**P. ophidiaster;* SD herein]. Arms dissimilar. *Rec.*——FIG. 41,*4*. **P. (P.) ophidiaster,* Rec., ×100 (42).

Pentinastrum HKL., 1882 [**P. asteriscus* HKL., 1887]. Like *Pentalastrum* but has patagium. *Rec.*——FIG. 43,*6*. **P. asteriscus,* Rec., ×200 (42).

Pentophiastrum HKL., 1887 [**P. dicranastrum;* SD herein]. Like *Pentinastrum* but arms ramified. *Rec.*

P. (Pentophiastrum). Arms similar.

P. (Pentophiastromma) HKL., 1887 [**P. caudatum;* SD herein]. Arms dissimilar.——FIG. 42,*7*. **P. (P.) caudatum,* Rec., ×50 (42).

Rhopalastrum EHR., 1847 [**R. lagenosum*]. Like *Dictyastrum* but bilateral. *Jur.-Rec.*

R. (Rhopalastrum) [=*Rhopalastrella* HKL., 1887 (obj.)]. Arms blunt. *Jur.-Rec.*——FIG. 41,*3*. **R. (R.) malleus* HKL., Rec., ×100 (42).

R. (Rhopalastromma) HKL., 1887 [**R. triceros;* SD herein]. Arms spiny. *Rec.*

Stauralastrum HKL., 1887 [**S. cruciforme;* SD herein]. Four undivided arms; no patagium; shell quadrangular. *Eoc.-Rec.*

S. (Stauralastrum) [=*Stauralastrella* HKL., 1887 (obj.)]. Arms blunt. *Rec.*

S. (Stauralastromma) HKL., 1887 [**S. rhopalophorum;* SD herein (=*Hagiastrum rhopalophorum* HKL., 1887)]. Arms spiny. *Eoc-Rec.*——FIG. 43,*2*. **S. rhopalophorum* Rec., ×150 (42).

Stephanastrum EHR., 1847 [**S. rhombus* EHR., 1854]. Four undivided arms; patagium with 4 large interbrachial openings (patagial girdles). *Eoc.-Rec.*

S. (Stephanastrum) [=*Stephanastromma* HKL., 1887 (obj.)]. Arms all similar. *Eoc.-Rec.*

S. (Stephanastrella) HKL., 1887 [**S. quadratum;* SD herein]. Two opposite arms larger than 2 cross arms. *Rec.*——FIG. 42,*2*. **S. (S.) quadratum* Rec., ×100 (42).

Tessarastrum HKL., 1887 [**T. straussii;* SD herein]. Like *Histiastrum* but symmetrically bilateral. *Cret.-Rec.*

T. (Tessarastrum) [=*Tessarastrella* HKL., 1887 (obj.)]. Principal arms similar. *Cret.-Rec.*——FIG. 43,*1*. **T. (T.) straussii,* Rec., ×200 (42).

T. (Tessarastromma) HKL., 1887 [**T. democriti*]. Principal arms dissimilar. *Rec.*

Trigonastrum HKL., 1887 [**T. regulare;* SD herein]. Like *Chitonastrum* but has 3 forked arms and a patagium. *Rec.*

T. (Trigonastrum) [=*Trigonastrella* HKL., 1887 (obj.)]. Arms similar.——FIG. 41,*1*. **T. (T.) regulare,* Rec., ×100 (42).

T. (Trigonastromma) HKL., 1887 [**T. gegenbauri;* SD herein]. One arm different in size or form.

Subfamily ARCHIDISCINAE Haeckel, 1887

[as Archidiscida; emend. CAMPBELL, herein]

Single chambered girdle surrounds central chamber. *Jur.-Rec.*

Archidiscus HKL., 1887 [**A. dioniscus;* SD herein]. Shell margin smooth. *Jur.-Rec.*

A. (Archidiscus) [=*Dioniscus* HKL., 1887 (obj.)]. Ring with 2 chambers. *Jur.-Rec.*

A. (Hexoniscus) HKL., 1887 [**A. hexoniscus;* SD herein]. Ring with 6 chambers. *Rec.*

A. (Pentoniscus) HKL., 1887 [**A. pentoniscus*]. Ring with 5 chambers. *Rec.*

A. (Tetroniscus) HKL., 1887 [**A. stauroniscus;* SD herein]. Ring with 4 chambers. *Rec.*——FIG. 43,*3*. **A. stauroniscus,* Rec., ×400 (42).

A. (Trioniscus) HKL., 1887 [**A. trioniscus;* SD herein]. Ring with 3 chambers. *Rec.*

Axodiscus HKL., 1887 [**A. stylophorus;* SD herein]. Like *Archidiscus* but margin armed with spines. *Rec.*

Subfamily FLUSTRELLINAE Campbell, nom. nov.

[*pro* Trematodiscida HKL., 1862]

Central chamber has 2 or more (com-

monly 3 to 6) concentric chambered rings; shell margin without radial appendages. *Cam.-Rec.*

Flustrella EHR., 1838 [*non* GRAY, 1848, *nec* D'ORB., 1852][**F. concentrica*][=*Porodiscus* HKL., 1882 (obj.)]. Shell margin simple; without equatorial girdle. *Cam.-Rec.*

F. (Flustrella) [=*Trematodiscus* HKL., 1860 (obj.)]. Rings all concentric. *Cam.-Rec.*——FIG. 44,*2c*. *F. (F.) flustrella* HKL., Rec., ×200 (42).

F. (Atactodiscus) HKL., 1882 [**Atactodiscus liasicus* RÜST, 1885][=*Perispongidium* HKL., 1882 (obj.)]. Rings more or less irregular. *Jur.-Rec.*——FIG. 44,*2a*. *F. (A.) irregularis* HKL., Rec., ×200 (42).

F. (Centrospira) HKL., 1882 [**Porodiscus centrospira* HKL., 1887]. Inner rings spiral; outer ones

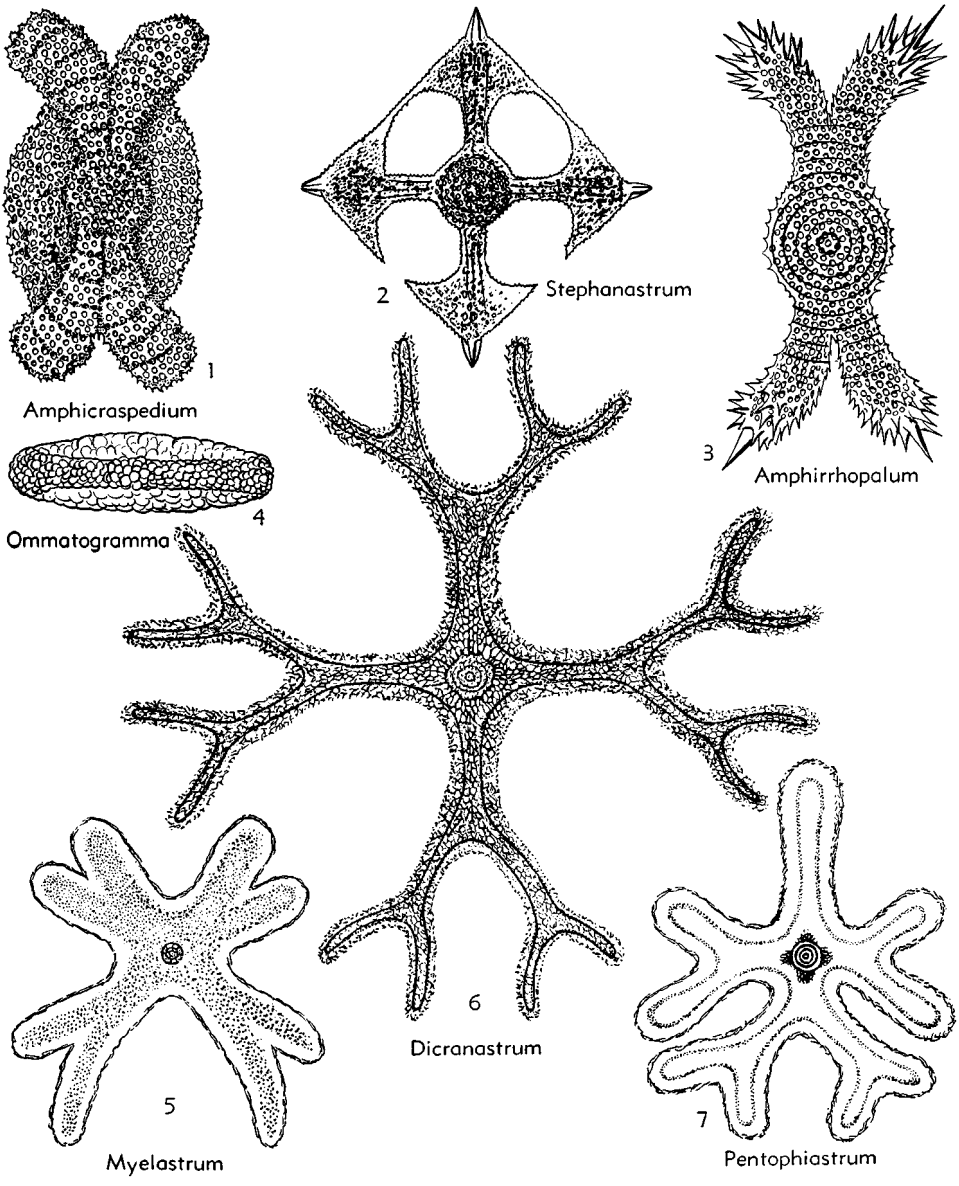

FIG. 42. Euchitoniidae (p. D86-D88).

concentric. *Rec.*——Fig. 44,*2b*. **F. (C.) centrospira*, Rec., ×200 (42).

F. (Discospira) Hkl., 1862 [**Discospira helicoides*; SD herein]. All rings spiral. *Eoc.-Rec.* ——Fig. 44,*2e*. *F. (D.) semispiralis* Hkl., Rec., ×200 (42).

F. (Perispira) Hkl., 1882 [**Porodiscus perispira* Hkl., 1887 (=*Perispira perispira* Hkl., 1887)]. Inner rings concentric; outer ones spiral. *Rec.* ——Fig. 44,*2d*. **F. (P.) perispira*, Rec., ×200 (42).

Perichlamydium Ehr., 1847 [**P. praetextum*].

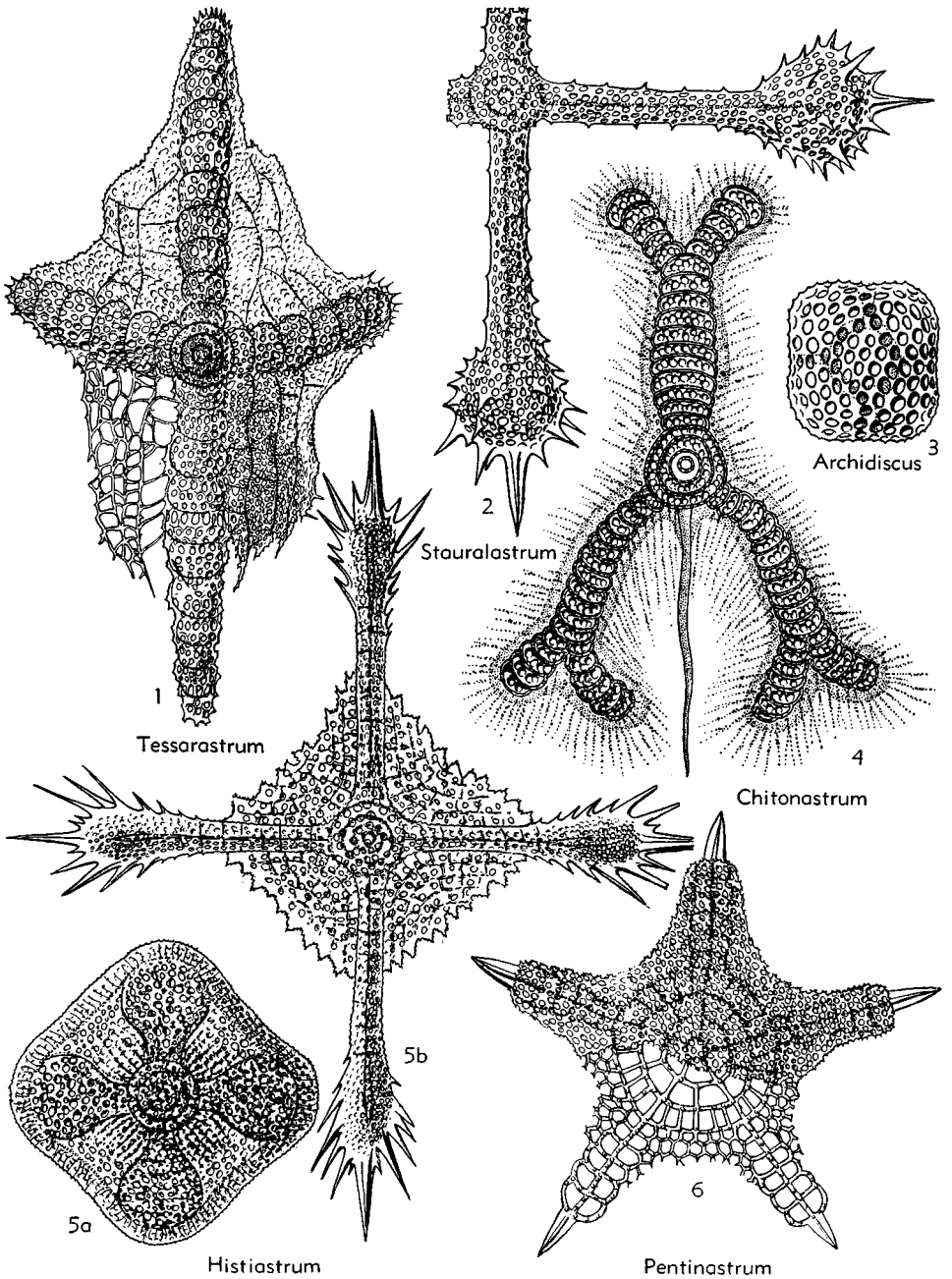

Fig. 43. Euchitoniidae (p. D86-D88).

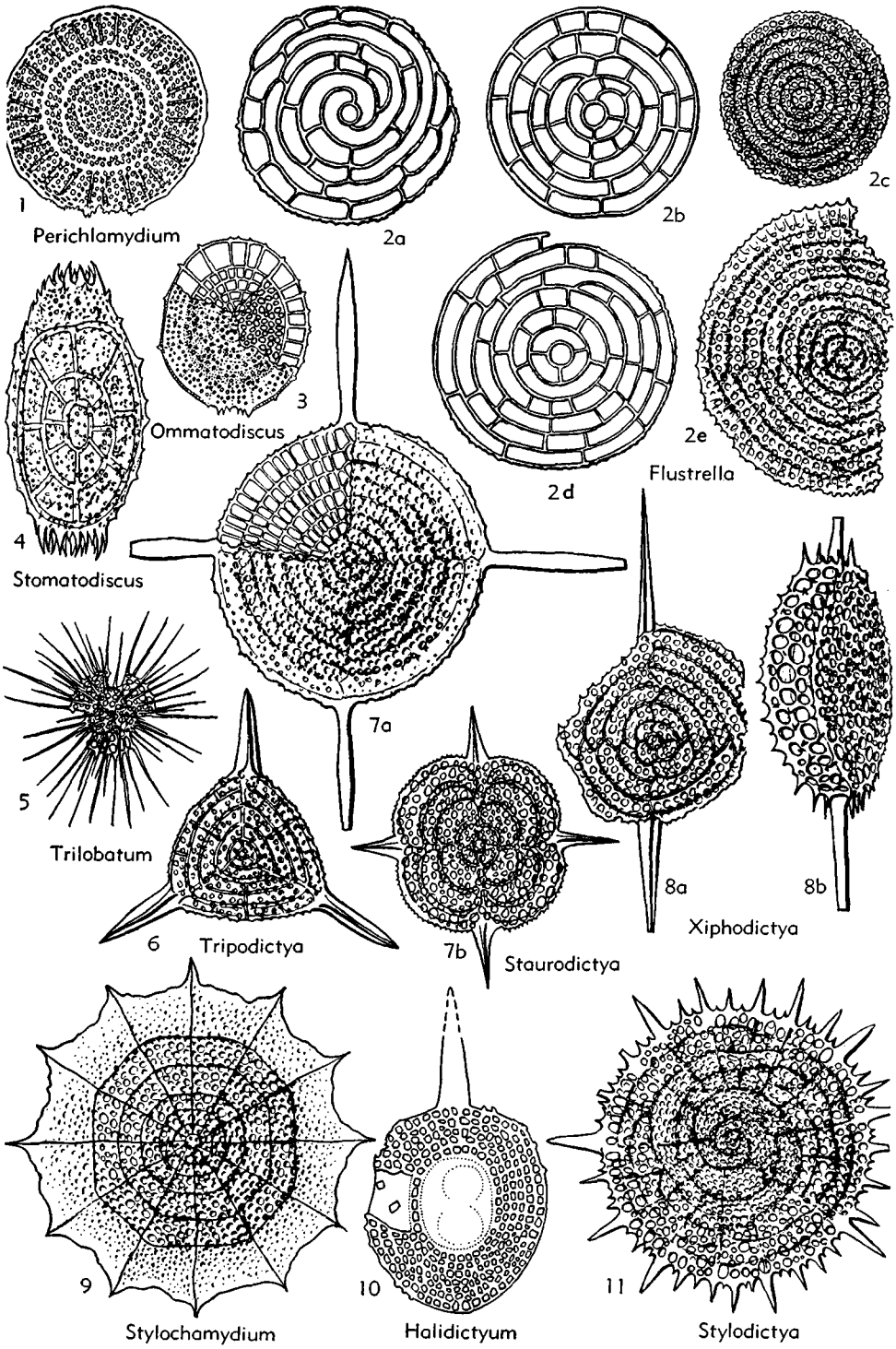

FIG. 44. Euchitoniidae (p. D89-D92).

Smooth shell margin with thin porous equatorial girdle. *Eoc.-Rec.*——Fig. 44,*1*. *P. scutaeforme* C.-Cl., Mio., Calif., ×150 (35).

Subfamily OMMATODISCINAE Stöhr, 1880

[as Ommatodiscida; emend. Campbell, herein]

Shell margin without chambered arms; with 1 or 2 large pylomes each armed with a spiny corona. *Paleoc.-Rec.*

Ommatodiscus Stöhr, 1880 [**O. haeckeli*; SD Frizzell, 1951]. Disc with 2 pylomes. *Paleoc.-Eoc.-Rec.*

O. (Ommatodiscus) [=*Ommatodisculus* Hkl., 1887 (obj.)]. Disc elliptical. *Eoc.-Rec.*——Fig. 44,*3*. *O. (O.) fragilis* Stöhr, Mio., Sicily, ×150 (53).

O. (Ommatodiscinus) Hkl., 1887 [**O. decipiens* Stöhr, 1880; SD herein]. Disc circular. *Eoc.-Rec.*

Stomatodiscus Hkl., 1887 [**S. osculatus*; SD Frizzell, 1951]. Disc with 2 pylomes. *Paleoc.-Rec.*——Fig. 44,*4*. **S. osculatus*, Rec., ×300 (42).

Subfamily STYLODICTYINAE Haeckel, 1882

[as Stylodictyida; emend. Campbell, herein]

Solid radial spines on shell margin. *Permo-Trias.-Rec.*

Stylodictya Ehr., 1847 [**S. gracilis* Ehr., 1854]. Five or more radial spines. *Jur.-Rec.*

S. (Stylodictya) [=*Stylodictyon* Hkl., 1862 (obj.)]. All rings concentric. *Jur.-Rec.*

S. (Stylodictula) Hkl., 1887 [**S. perispira*; SD herein]. Rings partly concentric and partly spiral or interrupted. *Eoc.-Rec.*——Fig. 44,*11*. *S. (S.) centrospira* Hkl., Rec., ×200 (42).

S. (Stylospira) Hkl., 1862 [**S. dujardinii*]. All rings convoluted in simple or double spiral. *Eoc.-Rec.*

Halidictyum Ichikawa, 1950 [**H. haeckeli*]. One single radial spine. *Permo-Trias.*——Fig. 44,*10*. **H. haeckeli*, Permo-Trias., Japan, ×75 (45).

Staurodictya Hkl., 1882 [**S. beneckei* Rüst, 1885]. Four crossed radial spines. *Jur.-Rec.*

S. (Staurodictya) [=*Staurodictyon* Hkl., 1887 (obj.)]. All rings concentric. *Jur.-Rec.*——Fig. 44,*7b*. *S. (S.) medusa* Hkl., 1887, Rec., ×200 (42).

S. (Staurospira) Hkl., 1887 [**S. cruciata*; SD herein]. Rings partly concentric; partly spiral. *Eoc.-Rec.*——Fig. 44,*7a*. **S. (S.) cruciata*, Rec., ×200 (42).

Stylochamydium Hkl., 1882 [**S. asteriscus* Hkl., 1887 (=*Perichlamydium asteriscus* Hkl., 1887)]. Like *Stylodictya* but has thin porous equatorial girdle. *Eoc.-Rec.*

S. (Stylochlamydium) [=*Stylochlamys* Hkl., 1887 (obj.)]. Rings all concentric. *Eoc.-Rec.*——Fig. 44,*9*. **S. (S.) asteriscus*, Rec., ×200 (42).

S. (Stylochlamyum) Hkl., 1887 [**S. perispirale*; SD herein]. Rings partly concentric; partly spiral. *Eoc.-Rec.*

Trilobatum Pop., 1911 [**T. tribrachium*; SD herein]. Central chamber tripartate-lobular. Rec.——Fig. 44,*5*. **T. tribrachium*, Rec., ×200 (45).

Tripodictya Hkl., 1882 [**T. trigonaria* Hkl., 1887]. Three equatorial radial spines. *Rec.*——44,*6*. **T. trigonaria*, Rec., ×200 (42).

Xiphodictya Hkl., 1882 [**X. teretispinosa* Rüst, 1885]. Two opposite radial spines. *Jur.-Rec.*

X. (Xiphodictya) [=*Xiphodictyon* Hkl., 1887 (obj.)]. All rings concentric. *Jur.-Rec.*——Fig. 44,*8b*. *X. (X.) amphibelone* Hkl., Rec., ×200 (42).

X. (Xiphospira) Hkl., 1887 [**X. staurospira*; SD herein]. All rings partly or completely spiral. *Rec.*——Fig. 44,*8a*. **X. (X.) staurospira*, Rec., ×200 (42).

Family PYLODISCIDAE Haeckel, 1887

[as Pylodiscida; emend. Campbell, herein] [=Pylonida Hkl., 1882 *(partim)*]

Simple spherical central chamber surrounded by 1 or 2 concentric triradial girdles; each girdle with 3 gates separated by 3 simple arm-chambers; surface with 3 gates. *Eoc.-Rec.*

Subfamily PYLODISCINAE Haeckel, 1887

[as Pylodiscida *(partim)*; emend. Campbell, herein] [=Pylomorphida Hkl., 1882 *(partim)*; Hexapylida Hkl., 1887]

Six gates between 3 double arm-chambers; no chambered marginal girdle. *Rec.*

Pylodiscus Hkl., 1887 [**P. triangularis*; SD herein]. Both faces of 3 outer gates; latticed equatorial girdle.——Fig. 45,*3*. **P. triangularis*, Rec., ×200 (42).

Hexapyle Hkl., 1882 [**H. triangula* Hkl., 1887]. Like *Pylodiscus* but both faces of 3 outer gates simple.——Fig. 45,*1*. *H. dodecantha* Hkl., Rec., ×150 (42).

Pyolena Hkl., 1887 [**P. armata*; SD herein]. Three outer gates open.——Fig. 45,*2*. **P. armata*, Rec., ×200 (42).

Subfamily TRIOPYLINAE Haeckel, 1887

[as Triopylida; emend. Campbell, herein]

Three gates between 3 single arms. *Rec.*

Triopyle Hkl., 1882 [**T. circulus* Hkl., 1887]. Three gates barred by latticed equatorial girdle; gate-faces simple.——Fig. 45,*6*. *T. hexagona* Hkl., Rec., ×400 (42).

Triodiscus Hkl., 1887 [**T. spinosus*; SD herein]. Like *Triopyle* but gate-faces latticed.——Fig. 45.*7*. **T. spinosus*, Rec., ×400 (42).

Triolena Hkl., 1887 [**T. primordialis*; SD herein]. Like *Triopyle* but gates open.——Fig. 45,*5*. **T. primordialis*, Rec., ×600 (42).

Subfamily DISCOPYLINAE Haeckel, 1887
[as Discopylida; emend. CAMPBELL, herein]

Six gates between 3 double arm-chambers; chambered marginal girdle. *Eoc.-Rec.*

Discopyle HKL., 1887 [**D. osculata;* SD herein]. With pylome. *Eoc.-Rec.*——FIG. 45,*4*. *D. elliptica* HKL., Rec., ×200 (42).

Discozonium HKL., 1887 [**D. hexagonium;* SD herein]. Without pylome. *Rec.*——FIG. 45,*8*. **D. hexagonium,* Rec., ×200 (42).

Family SPONGODISCIDAE Haeckel, 1882

[as Spongodiscida; emend. CAMPBELL, herein]

Simple central chamber surrounded by spongy framework; without porous sieve-plate. *Ord.-Rec.*

Subfamily SPONGODISCINAE Haeckel, 1882
[as Spongodiscida *(partim)*; emend. CAMPBELL, herein]
[=Spongophacida HKL., 1882]

Simple circular disc without radial spines or chamberd arms. *Dev.-Rec.*

Spongodiscus EHR., 1845 [*non* ZITTEL, 1878] [**S. resurgens*]. Circular disc without equatorial girdle. *Dev.-Rec.*

S. (Spongodiscus) [=*Spongodisculus* HKL., 1887 (obj.)]. Spongy framework lacks spiral convolutions or rings. *Dev.-Rec.*

S. (Annulatospira) CL.-C., 1945 [**S. pulcher*]. Inner part spiral, outer part annular. *Eoc.*

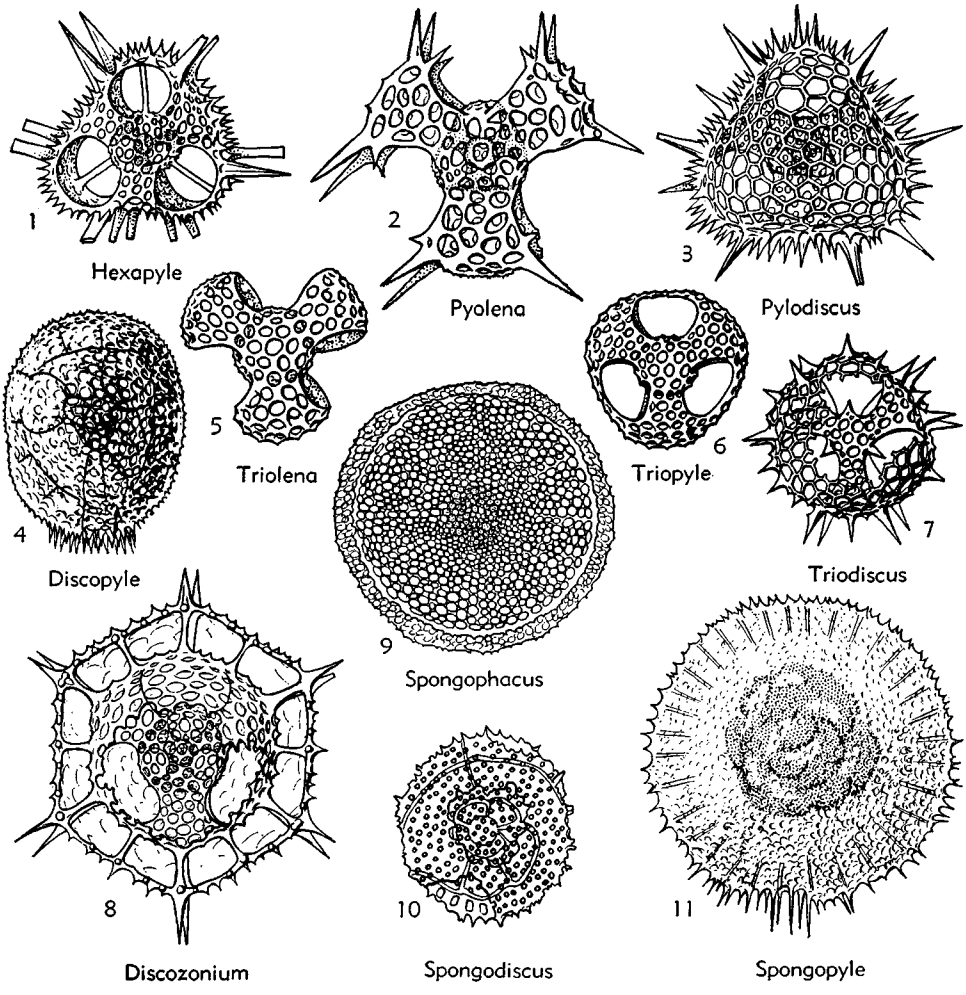

FIG. 45. Pylodiscidae, Spongodiscidae (p. D92-D94).

S. (Spongocyclia) HKL., 1862 [**S. cycloides;* SD FRIZZELL, 1951]. Inner part with concentric rings, outer part irregular. *Eoc.-Rec.*

S. (Spongospira) STÖHR, 1880 [**S. florealis*]. Inner part spiral, outer part irregular. *Eoc.-Rec.* ——FIG. 45,*10*. **S. (S.) florealis,* Mio., Sicily, ×150 (53).

Spongophacus HKL., 1882 [**S. periphaena* HKL., 1887]. Spongy disc with solid or porous equatorial girdle. *Trias.-Rec.*——FIG. 45,*9*. *S. hantkeni* RÜST, Trias., Hungary, ×150 (51).

Subfamily SPONGOPYLINAE Dreyer, 1889
[as Spongopylida; emend. CAMPBELL, herein]

One or more pylomes. *Eoc.-Rec.*

Spongopyle DREYER, 1889 [**S. setosa;* SD herein]. One pylome. *Eoc.-Rec.*

S. (Spongopyle) [=*Spongopylarium* DREYER, 1889 (obj.)]. Shell generally circular. *Eoc.-Rec.* ——FIG. 45,*11*. **S. setosa,* Rec., ×250 (40).

S. (Spongopylidium) DREYER, 1889 [**S. ovata;* SD herein]. Shell elliptical or oval. *Rec.*

Subfamily SPONGOTROCHINAE Haeckel, 1882
[as Spongotrochida; emend. CAMPBELL, herein]

Spongy disc with radial spines. *Ord.-Rec.*

Spongotrochus HKL., 1860 [**S. brevispinus* HKL., 1862]. Five or more (commonly 10) solid equatorial radial spines. *Ord.-Rec.*

S. (Spongotrochus) [=*Spongotrochiscus* HKL., 1862 (obj.)]. Spongy framework everywhere irregular. *Ord.-Rec.*

S. (Stylospongidium) HKL., 1882 [**S. scutella* HKL., 1887]. Inner part with concentric rings, outer part irregular. *Eoc.-Rec.*——FIG. 46,*1*. *S. (S.) echinodiscus* CL.-C., U.Eoc., Calif., ×120 (39).

Dispongotripus SQUIN., 1903. [**D. acutispina*]. Triangular shell with 6 radial spines. *Cret.*—— FIG. 46,*5*. **D. acutispina,* Cret., Italy, ×80 (52).

Spongolonche HKL., 1882 [*non Spongolonchis* HKL., 1887][**S. conostyla* HKL., 1887]. Two opposite radial spines. *Dev.-Rec.*——FIG. 46,*7*. *S. lens* HINDE, Dev., Austral., ×150 (44).

Spongostaurus HKL., 1882 [**S. cruciatus* HKL., 1887]. Four crossed radial spines. *Jur.-Rec.*—— FIG. 46,*2*. *S. circulus* RÜST., L.Jur., Ilsede., ×100 (51).

Spongotripus HKL., 1882 [**S. regularis* HKL., 1887]. Three radial spines. *Dev.-Rec.*

S. (Spongotripus) [=*Spongotripodiscus* HKL., 1887 (obj.)]. Radial spines similar. *Dev.-Rec.* ——FIG. 46,*4*. *S. (S.) morenoensis* C.-CL., Cret., Calif., ×150 (35).

S. (Spongopodium) HKL., 1887 [**S. ypsilon;* SD herein]. Radial spines dissimilar in size or distance. *Rec.*

Stylospongia HKL., 1862 [**S. huxleyi*][=*Stylotrochus* HKL., 1862 (obj.), *non idem* SEGUENZA, 1876, *nec* FROMENTEL, 1887]. Like *Spongotrochus* but spines limited to shell margin. *Dev.-Rec.*

S. (Stylospongia). Inner part with concentric rings or spirals. *Cret.-Rec.*——FIG. 46,*3*. *S. (S.) polygonata* C.-CL., Cret., Calif., ×150 (35).

S. (Stylotrochiscus) HKL., 1887 [**Spongotrochus arachnius* HKL., 1862]. Spongy framework everywhere irregular. *Dev.-Rec.*

Subfamily SPONGOBRACHIINAE Haeckel, 1882
[as Spongobrachida; emend. CAMPBELL, herein]

Spongy disc with spongy radial arms. *Jur.-Rec.*

Spongobrachium HKL., 1882 [**Spongodiscus ellipticus* HKL., 1860]. Two spongy arms; with patagium. *Cret.-Rec.*——FIG. 46,*11*. *S. divergens* RÜST, Cret., Zilli., ×200 (51).

Dictyocoryne EHR., 1860 [**D. profunda* EHR., 1872]. Three spongy arms; with patagium. *Jur.-Rec.*

D. (Dictyocoryne) [=*Dictyocorynula* HKL., 1887 (obj.)]. Arms similar. *Jur.-Rec.*——FIG. 46,*6*. *D. (D.) heimi* RÜST, Jur., Urshlau., ×150 (51).

D. (Dictyocorynium) HKL., 1887 [**Spongodiscus charybdaeus* HKL., 1860]. Arms dissimilar. *Eoc.-Rec.*

Rhopalodictyum EHR., 1860 [**R. abyssorum* EHR., 1872; SD HKL., 1887]. Like *Dictyocoryne* but lacks patagium. *Trias.-Rec.*

R. (Rhopalodictyum) [=*Rhopalodictya* HKL., 1887 (obj.)]. Three similar arms. *Eoc.-Rec.*—— FIG. 46,*8*. *R. (R.) irvinense* C.-CL., Mio., Calif., ×150 (35).

R. (Triactinosphaera) DUNIKOWSKI, 1882 [**T. zittelii*]. Three arms dissimilar in size or distance. *Trias.-Rec.*

Spongolena HKL., 1887 [**S. rhopalura;* SD herein] [=*Spongolene* CL.-C., 1942 (obj.)]. Like *Spongobrachium* but lacks patagium. *Cret.-Rec.*——FIG. 46,*9*. *S. lataformis* CL.-C., U.Eoc., Calif., ×120 (39).

Spongaster EHR., 1860 [**S. tetras* EHR., 1872]. Four spongy arms; with patagium. *Cret.-Rec.*

S. (Spongaster) [=*Spongastrella* HKL., 1887 (obj.)]. Cross of 4 arms regular. *Cret.-Rec.*—— FIG. 46,*12*. **S. (S.) tetras,* Rec., ×200 (41).

S. (Spongastromma) HKL., 1887 [**S. orthogona;* SD herein]. Cross of 4 arms bilateral or irregular. *Rec.*

Spongasteriscus HKL., 1862 [**S. quadricornis;* SD herein]. Like *Spongaster* but lacks patagium. *Jur.-Rec.*

S. (Spongasteriscus) [=*Spongastericulus* HKL., 1887 (obj.)]. Cross of 4 arms bilateral or irregular. *Rec.*

S. (Spongasteriscinus) HKL., 1887 [**S. ovatus;* SD herein]. Cross of 4 arms regular. *Jur.-Rec.* ——FIG. 46,*10*. *S. (S.) cruciferus* CL.-C., U.Eoc., Calif., ×120 (39).

Superfamily LARACARIICAE Haeckel, 1887

[*ex* Laracarida; emend. CAMPBELL, herein] [=Larcoidea HKL., 1887]

Lentelliptical fenestrated or spongy shell resulting from unequal growth in 3 axes. *Cam.-Rec.*

Family LARACARIIDAE Haeckel, 1887

[as Laracarida; emend. CAMPBELL, herein]

Shell without gates, domes or annular constrictions. *Eoc.-Rec.*

Subfamily LARACARIINAE Haeckel, 1887

[as Laracarida *(partim)*; emend. CAMPBELL, herein] [=Cenolarcida HKL., 1887]

Cortical shell only. *Rec.*

Laracarium HKL., 1887 [**L. amphistylum;* SD herein]. Surface with radial spines.

Cenolarchus HKL., 1887 [**C. primordialis;* SD herein]. Surface without spines.——FIG. 47,*2*. **C. primordialis,* Rec., ×200 (42).

Subfamily COCCOLARCINAE Haeckel, 1887

[as Coccolarcida; emend. CAMPBELL, herein]

Single medullary shell. *Eoc.-Rec.*

Coccolarcus HKL., 1887 [**C. lentellipsis;* SD herein]. Surface smooth. *Eoc.-Rec.*——FIG. 47,*1*. *C. oviformis* CL.-C., U.Eoc., Calif., ×150 (39).

Larcidium HKL., 1887 [**L. dodecanthum;* SD herein]. Surface with radial spines. *Eoc.-Rec.*——FIG. 47,*4*. **L. dodecanthum,* Rec., ×200 (42).

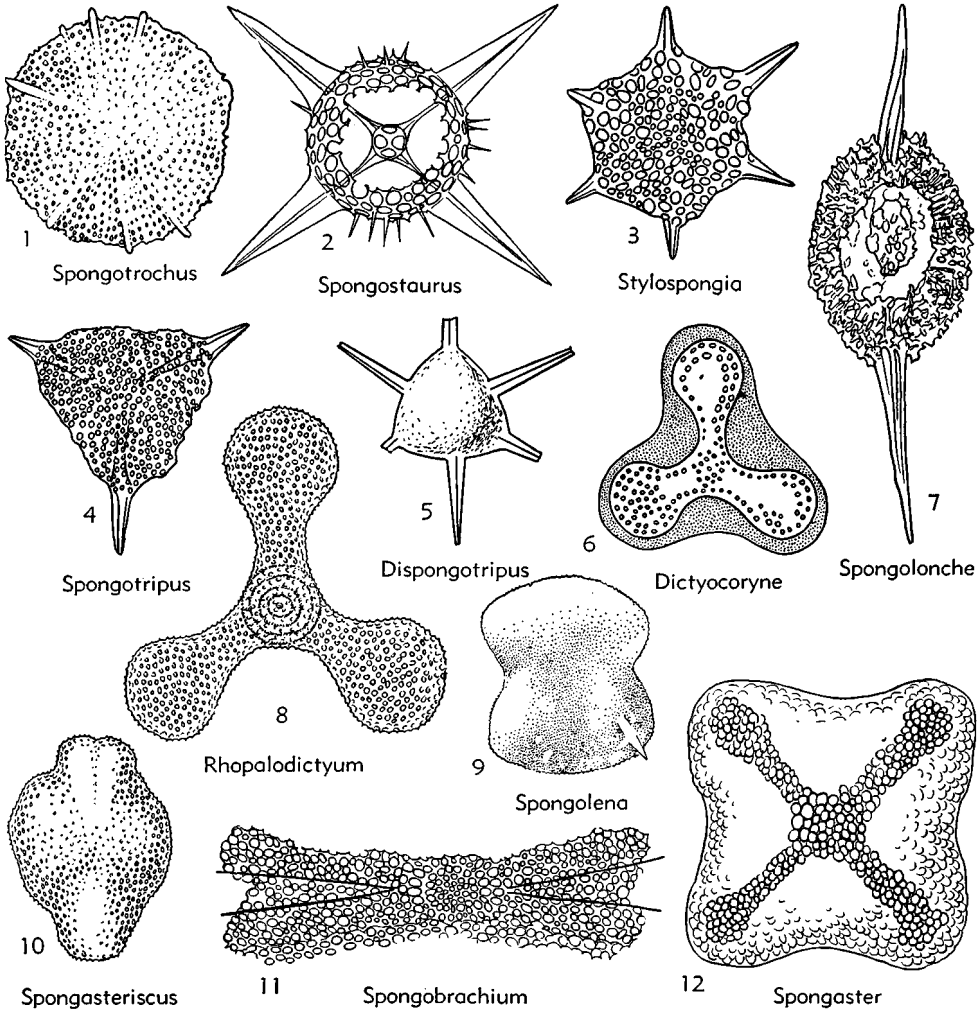

FIG. 46. Spongodiscidae (p. D94).

Subfamily SPONGOLARCINAE Haeckel, 1887
[as Spongolarcida; emend. CAMPBELL, herein]

Shell spongy. *Rec.*

Spongolarcus HKL., 1887 [**S. lentellipsis;* SD herein]. With internal cavity.
Stypolarcus HKL., 1887 [**S. spongiosus*]. Solid shell.

Subfamily LARCOPYLINAE Dreyer, 1889
[as Larcopylida; emend. CAMPBELL, herein]

With pylome. *Rec.*

Larcopyle DREYER, 1889 [**L. bütschlii*].——FIG. 47,*3*. **L. bütschlii*, Rec., ×250 (40).

Family LARNACILLIDAE Haeckel, 1887
[as Larnacillida; emend. CAMPBELL, herein]
[=Larnacida HKL., 1887]

Shell with open gates or annular constrictions; medullary shell trizonal. *Paleoc.-Rec.*

Subfamily LARNACILLINAE Haeckel, 1887
[as Larnacillida *(partim)*; emend. CAMPBELL, herein]

Medullary shell single. *Rec.*

Larnacilla HKL., 1887 [**L. typus*]. Surface smooth.——FIG. 47,*7*. **L. typus*, Rec., ×200 (42).
Larnacidium HKL., 1887 [**L. staurobelonium;* SD herein]. Surface spiny.

Subfamily LARNACALPIDINAE Haeckel, 1887
[as Larnacalpida; emend. CAMPBELL, herein]

Medullary shell double. *Paleoc.-Rec.*

Larnacalpis HKL., 1887 [**L. lentellipsis;* SD FRIZZELL, 1951]. Surface smooth. *Paleoc.-Rec.*——FIG. 47,*6*. **L. lentellipsis*, Rec., ×200 (42).
Larnacantha HKL., 1887 [**L. hexacantha;* SD herein]. Shell spiny. *Mio.-Rec.*——FIG. 47,*5*. **L. hexacantha*, Rec., ×200 (42).
Larnacoma HKL., 1887 [**L. lentellipticum;* SD herein]. Double cortical shell smooth. *Rec.*
Laracospongus HKL., 1887 [**L. larnacillifer;* SD herein]. Spongy cortical shell without spines. *Rec.*
Larnacostupa HKL., 1887 [**L. octacantha;* SD herein]. Spongy cortical shell with spines. *Rec.*

Subfamily CENOLARCOPYLINAE Campbell, nov.

One single pylome. *Plio.*

Cenolarcopyle TAN, 1931 [**C. fragilis*]. *Plio.*, Rotti.

Family PYLONIIDAE Haeckel, 1882
[as Pylonida; emend. CAMPBELL, herein]

Cortical shell latticed; with 2 to 4 or more symmetrically disposed gates. *Jur.-Rec.*

Subfamily PYLONIINAE Haeckel, 1882
[as Pylonida *(partim)*; emend. CAMPBELL, herein]
[=Diplozonaria HKL., 1887]

Two systems of concentric girdles. *Rec.*

Pylonium HKL., 1882 [**P. circozonium* HKL., 1887]. Cortical shell with 3 perfect girdles.
P. (Pylonium) [=*Pylonissa* HKL., 1887 (obj.)]. Shell without large symmetrically disposed spines.
P. (Pylonura) HKL., 1887 [**P. quadricorne;* SD herein]. Shell arms with large spines.——FIG. 47,*14*. **P. (P.) quadricorne*, Rec., ×200 (42).
Amphipyle HKL., 1882 [**A. aceros* HKL., 1887]. Shell with only one perfect girdle.
A. (Amphipyle) [=*Amphipylissa* HKL., 1887 (obj.)]. Shell without large symmetrically disposed spines.
A. (Amphipylura) HKL., 1887 [**A. tetraceros;* SD herein]. Shell armed with large spines.——FIG. 47,*16*. **A. (A.) tetraceros*, Rec., ×200 (42).
Octopyle HKL., 1882 [**O. ovulina* HKL., 1887]. Shell with 2 perfect girdles; 4 gates bisected by sagittal septum.
O. (Octopyle) [=*Octopylissa* HKL., 1887 (obj.)]. Shell without large symmetrically disposed spines.
O. (Octopylura) HKL., 1887 [**O. stenozona;* SD herein]. Shell armed with large spines.——FIG. 47,*13*. *O. (O.) sexangulata* HKL., Rec., ×150 (42).
Tetrapyle MÜLLER, 1858 [**T. octacantha*][=*Schizomma* EHR., 1860 (obj.)]. Like *Octopyle* but gates simple.
T. (Tetrapyle) [=*Tetrapylura* HKL., 1887 (obj.)]. Shell armed with large symmetrically disposed spines.
T. (Tetrapylissa) HKL., 1887 [**T. circularis;* SD herein]. Shell without large spines.——FIG. 47,*15*. **T. (T.) circularis*, Rec., ×200 (42).

Subfamily MONOZONIINAE Campbell, nov.
[=Haplozonaria HKL., 1887]

One perfect system of girdles. *Jur.-Rec.*

Monozonium HKL., 1887 [**M. primordiale;* SD herein]. One transverse girdle. *Rec.*
M. (Monozonium) [=*Monozonaris* HKL., 1887 (obj.)]. Shell smooth.——FIG. 47,*9*. *M. (M.) alatum* HKL., Rec., ×300 (42).
M. (Monozonites) HKL., 1887 [**M. pleurostylum;* SD herein]. Shell with large spines.
Dizonium HKL., 1887 [**D. circulare;* SD herein]. Two crossed latticed girdles. *Jur.-Rec.*
D. (Dizonium) [=*Dizonaris* HKL., 1887 (obj.)]. Shell smooth. *Jur.-Rec.*
D. (Dizonites) HKL., 1887 [**D. pleuracanthum;* SD herein]. Shell with large spines. *Rec.*——FIG. 47,*11*. **D. (D.) pleuracanthum*, Rec., ×300 (42).
Echinosphaera HERTWIG, 1879 [**E. datura*][=*Trizonium* HKL., 1887 (obj.)]. Three girdles. *Rec.*
E. (Echinosphaera) [=*Trizonites* HKL., 1887 (obj.)]. Shell with large symmetrically disposed spines.
E. (Trizonaris) HKL., 1887 [**Trizonium tricinc-*

tum; SD herein]. Shell without large spines. ——Fig. 47,*8*. **E. (T.) tricincta,* Rec., ×300 (42).

Subfamily TETRAPYLONIINAE Campbell, nov.
[=Triplozonaria Hkl., 1887]

Three concentric systems of fenestrated girdles. *Jur.-Rec.*

Tetrapylonium Hkl., 1887 [**T. pantellipticum;* SD herein]. Outer cortical shell with 3 perfect girdles. *Jur.-Rec.*——Fig. 47,*10*. *T. quadrangulare* Hkl., Rec., ×150 (42).

Amphipylonium Hkl., 1882 [**A. semilunare* Hkl., 1887]. One perfect girdle. *Rec.*

Pylozonium Hkl., 1887 [**P. octacanthum;* SD herein]. Three perfect girdles. *Rec.*——Fig. 47,*12*. **P. octacanthum,* Rec., ×150 (42).

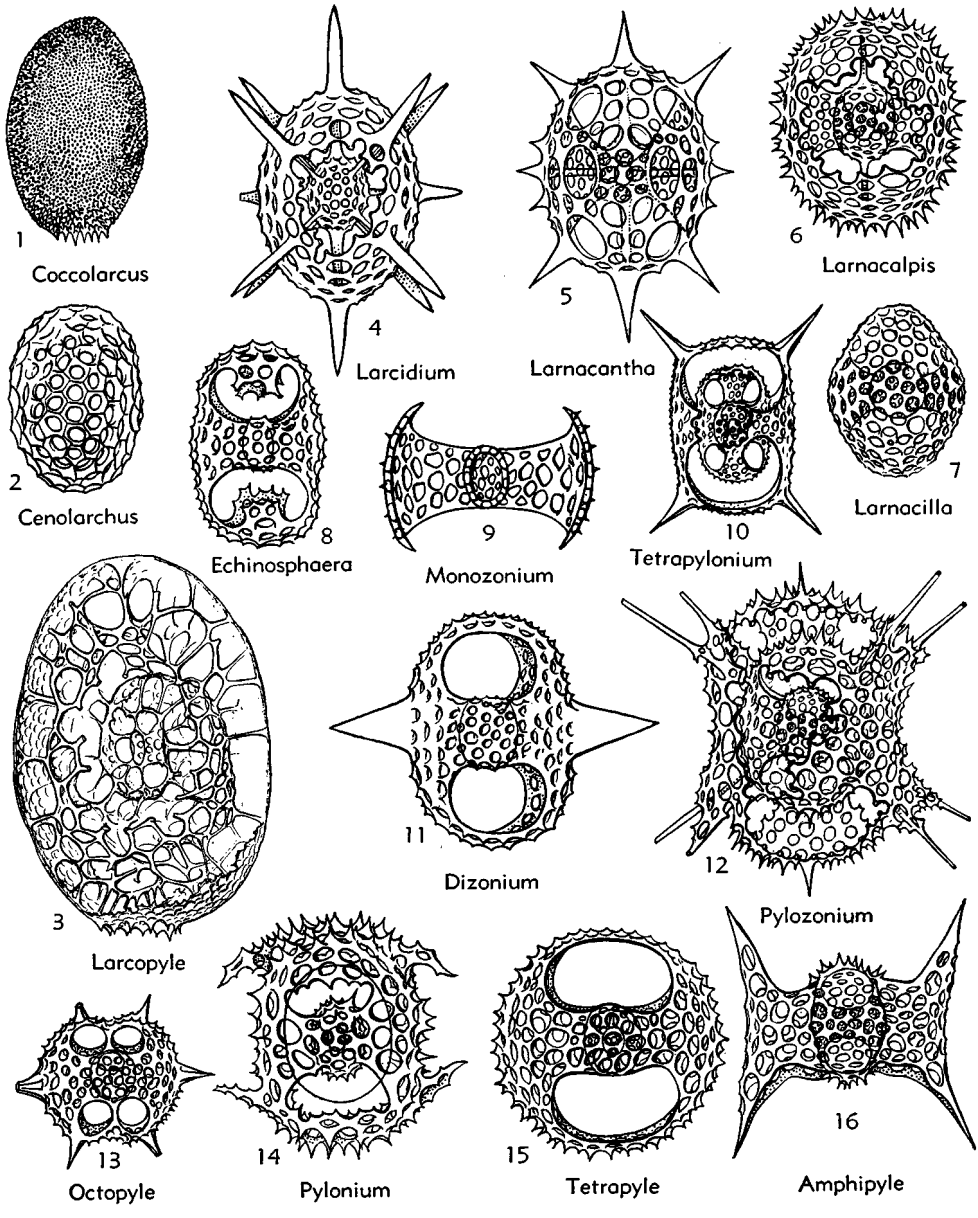

Fig. 47. Laracariidae, Pyloniidae (p. D95, D96).

Family THOLONIIDAE Haeckel, 1887

[as Tholonida; emend. CAMPBELL, herein]

Cortical shell with 2 to 4 or more annular constrictions separated by 3 to 6 or more cupolas; constrictions in diagonal planes, cupolas in dimensive axes. *Rec.*

Subfamily THOLONIINAE Haeckel, 1887

[as Tholonida *(partim);* emend. CAMPBELL, herein] [=Cubotholida HKL., 1887]

Cupolas developed in direction of 3 axes. *Rec.*

Tholonium HKL., 1887 [**T. bicubicum;* SD herein]. Like *Tholocubus* but has 6 double cupolas.

T. (Tholonium) [=*Tholonetta* HKL., 1887 (obj.)]. Without radial spines or thorns.

T. (Tholonilla) HKL., 1887 [**T. hexonium;* SD herein]. With radial spines or thorns.——FIG. 48,*1*. **T. (T.) hexonium,* Rec., ×200 (42).

Cubotholus HKL., 1887 [**C. regularis;* SD herein]. Central chamber with medullary shell; 6 simple cupolas.

C. (Cubotholus) [=*Cubotholissa* HKL., 1887 (obj.)]. Without spines or thorns.——FIG. 48,*3*. **C. (C.) regularis,* Rec., ×200 (42).

C. (Cubotholura) HKL., 1887 [**C. octoceras*]. With radial spines or thorns.

Cubotholonium HKL., 1887 [**C. ellipsoides*] [=*Tholothauma* HKL., 1887 (obj.)]. Like *Cubotholus* but has 6 double cupolas.——FIG. 48,*4*. **C. ellipsoides,* Rec., ×150 (42).

Tholocubus HKL., 1887 [**T. tesselatus;* SD herein]. Without medullary shell; 6 simple cupolas.

T. (Tholocubus) [=*Tholocubulus* HKL., 1887 (obj.)]. Without radial spines or thorns.——FIG. 48,*2*. *T. (T.) tessellatus,* Rec., ×200 (42).

T. (Tholocubitus) HKL., 1887 [**T. tessaralis*]. With radial spines or thorns.

Subfamily AMPHITHOLINAE Haeckel, 1887

[as Amphitholida; emend. CAMPBELL, herein]

Cupolas developed only in direction of a single axis. *Rec.*

Amphitholus HKL., 1887 [**A. artiscus;* SD herein]. Central chamber with medullary shell; 2 simple cupolas.

A. (Amphitholus) [=*Amphitholissa* HKL., 1887 (obj.)]. Without radial spines or thorns.——FIG. 48,*9*. **A. (A.) artiscus,* Rec., ×200 (42).

A. (Amphitholura) HKL., 1887 [**A. acanthometra;* SD herein]. With radial spines or thorns.

Amphitholonium HKL., 1887 [**A. tricolonium;* SD herein]. Like *Amphitholus* but has 2 double cupolas.——FIG. 48,*6*. **A. tricolonium,* Rec., ×150 (42).

Tholartus HKL., 1887 [**T. tricolus;* SD herein]. Central chamber without medullary shell; 2 simple cupolas.

T. (Tholartus) [=*Tholartella* HKL., 1887 (obj.)]. Without radial spines.——FIG. 48,*7*. **T. (T.) tricolus,* Rec., ×200 (42).

T. (Tholartissa) HKL., 1887 [**T. tripanis;* SD herein]. With radial spines or thorns.

Tholodes HKL., 1887 [**T. cupola*]. Like *Tholartus* but has 2 double cupolas.——FIG. 48,*10*. **T. cupola,* Rec., ×250 (42).

Subfamily STAUROTHOLINAE Haeckel, 1887

[as Staurotholida; emend. CAMPBELL, herein]

Cupolas developed in direction of 2 axes. *Rec.*

Staurotholus HKL., 1887 [**S. quadratus;* SD herein]. Central chamber with medullary shell; 4 simple cupolas.

S. (Staurotholus) [=*Staurotholissa* HKL., 1887 (obj.)]. Without radial spines.

S. (Staurotholura) HKL., 1887 [**S. tetrastylus;* SD herein]. With radial spines.——FIG. 48,*8*. **S. (S.) tetrastylus,* Rec., ×200 (42).

Staurotholonium HKL., 1887 [**S. biquadratum;* SD herein]. Like *Staurotholus* but has 4 double cupolas.

S. (Staurotholonium) [=*Staurotholodes* HKL., 1887 (obj.)]. Without radial spines.

S. (Staurotholoma) HKL., 1887 [**S. octodoronium;* SD herein]. Surface spiny or thorny.——FIG. 48,*12*. **S. (S.) octodoronium,* Rec., ×150 (42).

Tholoma HKL., 1887 [**T. quadrigeminum;* SD herein]. Like *Tholostaurus* but has 4 double cupolas.

T. (Tholoma) [=*Tholomantha* HKL., 1887 (obj.)]. Without radial spines.——FIG. 48,*5*. **T. (T.) quadrigeminum,* Rec., ×200 (42).

T. (Tholomura) HKL., 1887 [**T. metallasson*]. With radial spines.

Tholostaurus HKL., 1887 [**T. quadrigatus;* SD herein]. Central chamber without medullary shell; 4 simple cupolas.

T. (Tholostaurus) [=*Tholostaurantha* HKL., 1887 (obj.)]. Without radial spines.

T. (Tholostauroma) HKL., 1887 [**T. tetrabelonis;* SD herein]. With radial spines or thorns.

Family ZONARIIDAE Haeckel, 1887

[as Zonarida; emend. CAMPBELL, herein]

Annular constrictions in dimensive axes 2 or more; cupolas in diagonal axes. *Rec.*

Zonarium HKL., 1887 [**Z. octangulum;* SD herein]. Two rings; 4 cupolas.—— FIG. 48,*11*. **Z. octangulum,* Rec., ×200 (42).

Zonidium HKL., 1887 [**Z. octotholium;* SD herein]. Four rings; 8 cupolas.——FIG. 48,*13*. **Z. octotholium,* Rec., ×200 (42).

Zoniscus HKL., 1887 [**Z. tetracanthus;* SD herein]. Three rings; 6 cupolas.——FIG. 48,*14*. **Z. tetracanthus,* Rec., ×200 (42).

Family LITHELIIDAE Haeckel, 1862

[as Lithelida; emend. CAMPBELL, herein]

Planispiral cortical shell. *Dev.-Rec.*

Subfamily LITHELIINAE Haeckel, 1862

[as Lithelida *(partim);* emend. CAMPBELL, herein] [=Spireuma HKL., 1882; Spiremida HKL., 1887]

Medullary shell simple. *Dev.-Rec.*

Lithelius HKL., 1862 [**L. spiralis;* SD herein]. Branched or unbranched radial spines. *Dev.-Rec.*

L. (Lithelius) [=*Lithospira* HKL., 1887 (obj.)]. Simple spiral. *Dev.-Rec.*

L. (Drymospira) HKL., 1882 [**L. solaris* HKL., 1887]. Spiral double. *Rec.*——FIG. 49,*3*. *L. (D.) solaris*, Rec., ×200 (42).

Spireuma HKL., 1882 [**Spirema lentellipsis* HKL., 1887][=*Spirema* HKL., 1887 (obj.)]. Surface smooth or thorny; without radial spines. *Rec.*

S. (Spireuma) [=*Spiremarium* HKL., 1887 (obj.)]. Simple spiral.——FIG. 49,*1*. *S. (S.) melonia* HKL., Rec., ×200 (42).

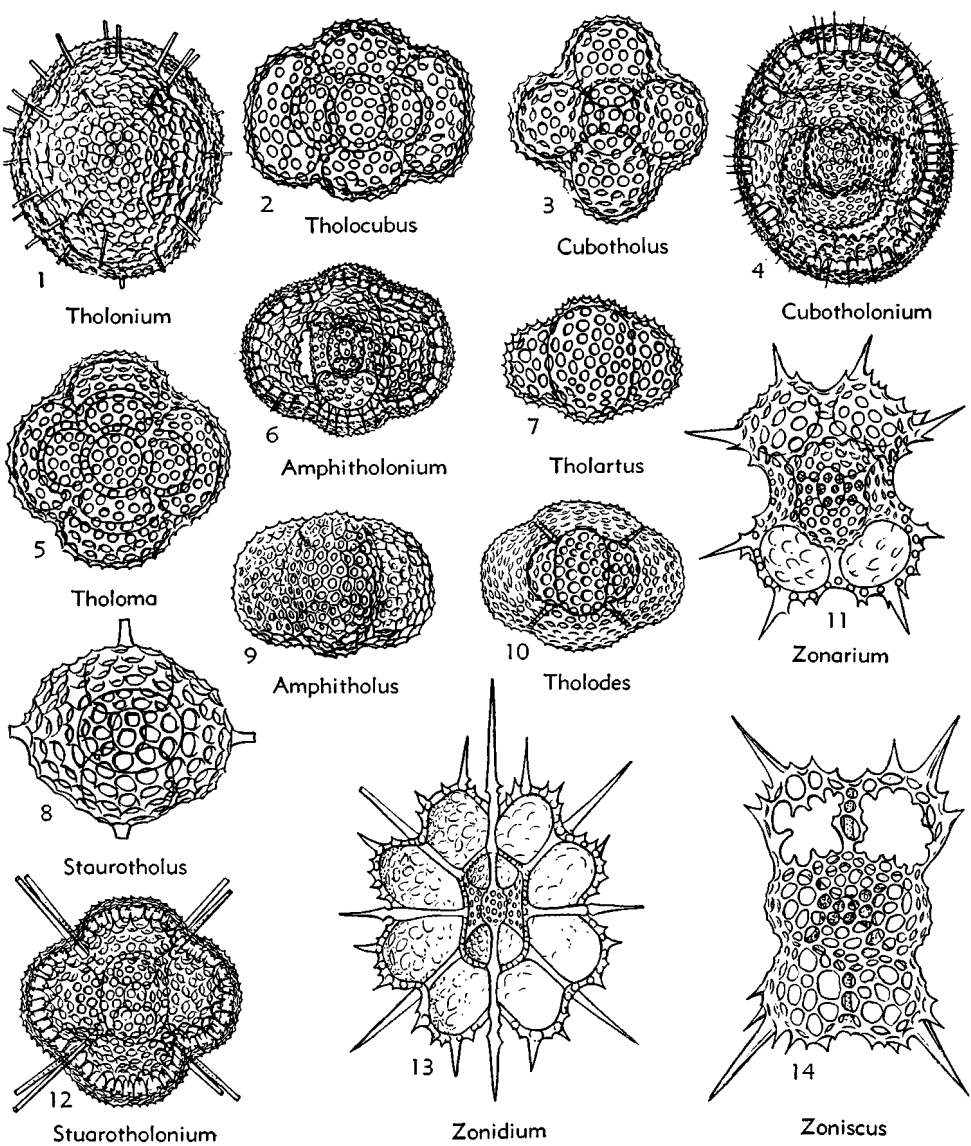

FIG. 48. Tholoniidae, Zonariidae (p. D98).

S. (Spiremidium) HKL., 1887 [**S. diplospira;* SD herein]. Spiral double.

Subfamily LARCOSPIRINAE Haeckel, 1887

[as Larcospirida; emend. CAMPBELL, herein]

Medullary shell double. *Dev.-Rec.*

Larcospira HKL., 1887 [**L. quadrangula;* SD herein]. Transverse girdle turns around principal axis. *Rec.*

L. (Larcospira) [=*Larcospirema* HKL., 1887 (obj.)]. Spiral turns single.——FIG. 49,*2*. **L. quadrangula,* Rec., ×200 (42).

L. (Larcospironium) HKL., 1887 [**L. oliva*]. Spiral turns double.

Pylospira HKL., 1887 [**P. octopyle;* SD herein]. Lateral girdle turns around sagittal axis. *Rec.*

P. (Pylospira) [=*Pylospirema* HKL., 1887 (obj.)]. Spiral turns single.——FIG. 49,*10*. **P. (P.) octopyle,* Rec., ×300 (42).

P. (Pylospironium) HKL., 1887 [**P. cymbium*]. Spiral turns double.

Spironium HKL., 1887 [**S. octonium;* SD herein]. Both wings of transverse girdle turn around principal axis in an opposite diagonal direction. *Dev.-Rec.*

S. (Spironium) [=*Spironetta* HKL., 1887 obj.)]. Surface without radial spines; smooth or rough surface.——FIG. 49,*5*. **S. (S.) octonium,* Rec., ×150 (42).

S. (Spironilla) HKL., 1887 [**S. spinosum;* SD herein]. Surface covered by branched or unbranched radial spines.

Tholospira HKL., 1887 [**T. dendrophora* 1887; SD herein]. Sagittal girdle turns around transverse axis. *Rec.*

T. (Tholospira) [=*Tholospirema* HKL., 1887 (obj.)]. Spiral turns simple.——FIG. 49,*4*. **T. (T.) dendrophora,* Rec., ×150 (42).

T. (Tholospironium) HKL., 1887 [**T. crevicornis;* SD herein]. Spiral turns double.

Family STREBLONIIDAE Haeckel, 1887

[as Streblonida; emend. CAMPBELL, herein]
[=Streblemida HKL., 1887]

Cortical shell helicoidal. *Rec.*

Subfamily STREBLONIINAE Haeckel, 1887

[as Streblonida *(partim)*; emend. CAMPBELL, herein]
[=Streblacanthida HKL., 1887]

Primary chamber simple. *Rec.*

Streblonia HKL., 1887 [**S. globigerna;* SD herein]. Shell without radial spines.

Streblacantha HKL., 1887 [**S. siderolina;* SD herein]. Shell with radial spines.——FIG. 49,*11*. **S. siderolina,* Rec., ×200 (42).

Subfamily STREBLOPYLINAE Haeckel, 1887

[as Streblopylida; emend. CAMPBELL, herein]

Primary shell composed of 3 elliptical girdles surrounding single central chamber. *Rec.*

Streblopyle HKL., 1887 [**S. helicina;* SD herein]. Without radial spines.——FIG. 49,*12*. **S. helicina,* Rec., ×150 (42).

Family PHORTICIDAE Haeckel, 1882

[as Phorticida; emend. CAMPBELL, herein]

Cortical shell with single irregular chamber. *Cam.-Rec.*

Phorticum HKL., 1882 [**P. pylonium* HKL., 1887]. Cortical shell latticed. *Cam.-Rec.*

P. (Phorticum) [=*Phortopyle* HKL., 1887 (obj.)]. Lattice with large gates. *Cam.-Rec.*——FIG. 49,*7*. **P. (P.) pylonium,* Rec., ×150 (42).

P. (Phortolarcus) HKL., 1887 [**P. deforme;* SD herein]. Lattice complete. *Rec.*

Spongophortis HKL., 1882 [**S. spongiosa* HKL., 1887]. Spongy cortical shell. *Rec.*

S. (Spongophortis) [=*Stylophorticum* HKL., 1887 (obj.)]. Spongy shell immediately enclosing medullary shell.——FIG. 49,*6*. **S. (S.) larnacilla* HKL., Rec., ×200 (42).

S. (Spongophorticum) HKL., 1887 [**S. radiosa;* SD herein]. Spongy shell separated from medullary shell.

Family SOREUMATIDAE Haeckel, 1882

[as Soreumida; emend. CAMPBELL, herein]

Cortical shell composed of irregularly grouped chambers. *Rec.*

Soreuma HKL., 1882 [**S. irregulare* HKL., 1887]. Simple primary chamber.

S. (Soreuma) [=*Soreumium* HKL., 1887 (obj.)]. Without radial spines.——FIG. 49,*8*. **S. (S.) irregulare,* Rec., ×100 (42).

S. (Soreumidium) HKL., 1882 [**S. spinosum* HKL., 1887]. With radial spines.

Sorolarcus HKL., 1887 [**S. larnacillifer;* SD herein]. Primary chamber has elliptical girdle.

S. (Sorolarcus) [=*Sorolarcium* HKL., 1887 (obj.)]. Without radial spines.——FIG. 49,*9*. **S. (S.) larnacillifer,* Rec., ×150 (42).

S. (Sorolarcidium) HKL., 1887 [**S. terminalis*]. With radial spines.

Order OSCULOSIDA Haeckel, 1887

[as Osculosa; emend. CAMPBELL, herein]
[=Merotrypasta HKL., 1887]

Pores restricted to one pole or to tubular openings in the central capsule. *Cam.-Rec.*

Suborder NASSELLINA Ehrenberg, 1875

[as Nassellaria; emend. CAMPBELL, herein]
[=Monopylea HERTWIG, 1879; Cricoidea BÜTSCHLI, 1882; Monopylaria HKL., 1882; Polycystina DREYER, 1913 (*non* EHRENBERG, 1838) *(partim)*]

Central capsule perforated only at one pole; with a single membrane; skeleton a tripod, ring, or lattice shell; opposite poles