PORIFERA

By M. W. de Laubenfels

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INTRODUCTION

Sponges are many-celled aquatic animals characterized by bulky internal skeletons and passageways for water currents produced by flagellate cells. The skeletons commonly consist of opaline silica, but calcium carbonate may occur instead, with or without other inert substances.

Sponges constitute the phylum Porifera (or Spongiaria), which is placed in the subkingdom Metazoa, in contrast to Protozoa. They belong to the branch Parazoa in contrast to the Eumetazoa or proper many-celled animals.

PORIFERA COMPARED WITH PROTOZOA

Some kinds of Protozoa aggregate to form colonies rather than remaining as completely isolated cells. The colonies may even show a sort of cell specialization in which so-called somatic cells carry on principal activities of the organism excepting reproduction, whereas others, termed germ cells, do little except carry on reproduction. Sponges may be compared to such protozoan colonies.

No agreement concerning sponge individuality exists. Living sponges may be cut into small pieces that continue to live, each fragment resembling a juvenile individual. When conspecific sponges meet as a result of growth, they fuse into a single mass. In these respects resemblance to colonies of Protozoa prevails.

Sponges may be so finely divided by cutting and grinding that completely isolated cells result. These cells, astonishingly like Protozoa, may survive for 2 to 12 days as independent organisms, thus further resembling one-celled organisms of the Protista.

Unlike Protozoa, isolated sponge cells cannot survive indefinitely. If mutually interconnected by a sort of mucous-like colloid, generally present, they reassemble through it to form co-operating aggregates that are small functioning sponges. If they do not so reassemble, they inevitably perish.

Sponges comprise not only germ cells, but at least 2 kinds of specialized somatic cells: (1) flagellate cells called **choanocytes,** each with a thin collar around the base of the single flagellum, so closely like choanoflagellate Protozoa that evolution from such ancestors is indicated; and (2) amoeboid cells that move about by pseudopods, some being divisible into categories based on appearance and function. Some germ cells are also amoeboid.

Because of lack of complete cellular independence and especially because of having 2 or more kinds of somatic cells, sponges are removed from the Protozoa.

PORIFERA COMPARED WITH EUMETAZOA

Sponges are Metazoa because many-celled, but they differ from proper Metazoa in quasi-independence of the cells and lack of distinct individuality.

Eumetazoa may contain some free-moving amoeboid cells, but (unlike sponges) these occur only in secondary roles. Eumetazoa are distinctively characterized by organs formed from layers of mutually coherent cells, which appear in embryos, there called "germ layers," although not consisting of germ cells. Examples are ectoderm and endoderm; such do not occur in sponges.

Sponge cells commonly move freely with respect to one another, as proved by microscopic observations of living animals. Such cells remain associated only because they adhere to and travel on (or through) their community skeleton. Sponge cells may cohere and co-operate, as, for example, in closing openings; when so doing they form syncytiums. A **syncytium** may be defined as a mass of protoplasm containing more than one nucleus, a sort of single cell. Those found in sponges are better described as a number of cells so intimately conjoined that no sharp boundaries remain between them.

The term "epithelium" is often employed for such membranous sponge structures as linings of canals, and the thin dermis observed in some genera. These membranes may be entirely syncytial, but invariably are at least partially syncytial and generally are replete with inanimate colloidal material. For example, sheets consisting only of horny substance (spongin) may serve as canal linings or dermis. Sponges contain no typical epithelial cells.

ONTOGENY

Sponges arise by syngamy of spermatozoa with ova, or by asexual means. There may be cleavage of a zygote, or a grouping of somatic cells to form or assist in forming the embryo.

Free-swimming sponge larvae are the rule, each comprising an ovoid organism 0.2 to 0.5 mm. in diameter. Each consists of a jelly-like matrix containing amoeboid cells, its surface more or less covered with flagellate cells. These adhere to the jelly rather than to one another and should not be regarded as ectoderm. The flagella beat in unco-ordinated manner, but propulsion is in one direction because of the absence of flagellate cells at one end of the larva.

After a few hours or as much as 3 days, the larva attaches to a comparatively solid basis; otherwise it perishes. Some sponges are specialized to grow on mud, with root-like supports, but most kinds must become fixed to rock, shells, or other rigid material.

In the newly attached sponge, the amoeboid cells move, and shape the jelly so as to form one or more cavities connected to the outside by perforations called pores, hence "Porifera." There is no infolding or invagination of layers. The flagellate cells move as individuals, in a temporarily amoeboid manner, from the outer surface to inner surfaces; a sort of positive cryptotaxis.

The flagellate cells of adult sponges occur only on the concave surfaces of chambers; when abundant they seem to form a layer, but when less abundant (as is common) it is obvious that they are not mutually coherent.

Flagellate chambers may be formed from primordial cells (archaeocytes). One such cell may undergo cleavage, yielding 32 to 64 small cells which come to occupy the same chamber, putting out their collars and flagella.

Fresh-water sponges, just before winter or a dry season, form peculiar reproductive bodies called **gemmules,** which are quiescent larvae about 300 microns in diameter, surrounded by a tough organic case that resembles chitin or spongin. Gemmules survive freezing and desiccation for as much as 6 months and they may be carried in wind-blown dust or adherent to the feet of migrating birds. They "germinate" into ordinary sponge larvae when a favorable environment again exists. Many gemmules are covered with distinctive microscleres (small spicules). It is quite possible that fossil gemmules may some day be found; if so, a fresh-water origin will be indicated. Otherwise, no sponge fossils dependably indicate fresh-water origin.

MORPHOLOGY

GENERAL FEATURES

Probably each species of sponge has its characteristic symmetry, but often this is obscured. When sponges grow near each other, or among other animals or inanimate objects, crowding may cause distortion. Sponges that grow in strong currents (3 km. or more per hour) tend to be more or less globular or incrusting, regardless of their other inherent symmetry. The overall shape may be amorphous, incrusting, globular, or cylindrical, and may have many, few, or no branches. Some are lamellate (wall-shaped) or flabellate (fan-shaped); some are tubular, and others vase-shaped. Some are stalked. Some have root-like processes below.

Some mature sponges are less than 1 cm. in greatest dimension, or may be incrustations less than 1 mm. thick. At the other extreme, cylindrical sponges are known that are more than 1 m. in diameter and nearly the same in height. Many mature sponges have about the size of a human fist or head.

Three levels of sponge architecture exist. (1) **Ascon structure** consists of a single chamber, made of jelly plus mineral skeleton and amoebocytes, with numerous choanocytes on its inner surface (Fig. 14). At one end is generally a single exit, properly called an **apopyle.** Numerous smaller inlet openings **(prosopyles)** invariably occur. Ascon chambers commonly are 50 microns in diameter but may be several mm. long. (2) **Sycon structure** consists of many ascon-type chambers grouped around an axial exhalant canal **(apochete)** (Figs. 14, 15). The numerous apopyles empty into it and its exit is the **apopore.** Sycon chambers generally are 50 microns in diameter and 100 to 500 microns long. (3) **Rhagon structure** consti-

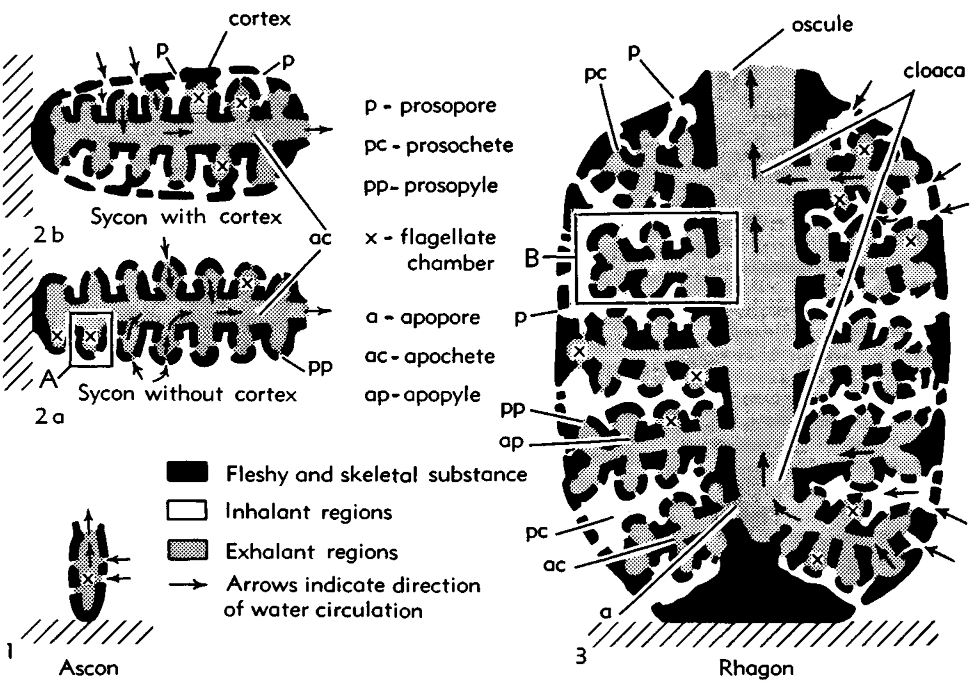

FIG. 14. Diagrammatic sagittal sections showing types of sponge architecture (68n). *1,* Ascon type, comprising a single flagellate chamber, ×2. *2,* Sycon type, composed of several flagellate chambers opening into a single excurrent passageway; *2a,* form without cortex (as in *Scyphia*), area outlined at "A" showing correspondence to ascon structure, ×5; *2b,* form with outer cortex (as in *Grantia*) and inhalant sinuses (prosochetes), ×5. *3,* Rhagon type, consisting of many sycon-like elements, as in area outlined at "B," arranged around a central excurrent passageway (cloaca), ×80.

tutes an aggregation of many sycon-like units. Their apochetes generally lead through apopores to a larger exit passageway, called a **cloaca** (Figs. 14, 15). The outlet of a cloaca may be called **oscule,** but any final exit from a sponge generally is called an oscule. Rhagon chambers are 20 to 50 microns in diameter and 30 to 100 microns long.

About 98 per cent of all sponges, Recent and fossil, considered as individuals or as species, are of rhagon type.

Among some sycons and nearly all rhagons, inhalant canals **(prosochetes)** occur. These begin with **prosopores,** branch repeatedly, and deliver to prosopyles.

Many sponges have a distinct **dermis,** 10 to 50 microns thick, over a comprehensive subdermal cavity in which pillar-like structures support the dermis. Pores (eupores) pierce the dermis, and prosopores lead inward from its floor. The dermis may attain thickness of 1 mm. or more and may be packed with skeletal structures. It is then called a **cortex.**

The interior of a sponge, called **endosome,** is set apart from outer structures **(ectosome),** such as dermis or cortex. Endosomal skeletal structures may be described as confused, reticulate, plumose, or radiate in arrangement. The cavities range from hardly visible to the naked eye (dense) through medium-size (about as large as in bread) to so large (exceeding 10 mm.) that the structure is termed cavernous.

Consistency of (Recent) sponges may be stony hard, or soft as froth, or intermediate in hardness. They vary from brittle to very elastic or "spongy." The surface may be relatively smooth, tuberculate, conulose, or hispid.

Colors of deep-sea sponges are dull, but shallow-water sponges in life are generally brightly colored; scarlet, gold, emerald, azure and royal purple, as well as snowy white to velvety black sponges abound.

SKELETON

One type of sponge skeleton consists of a soft colloid, varying from a mucous-like

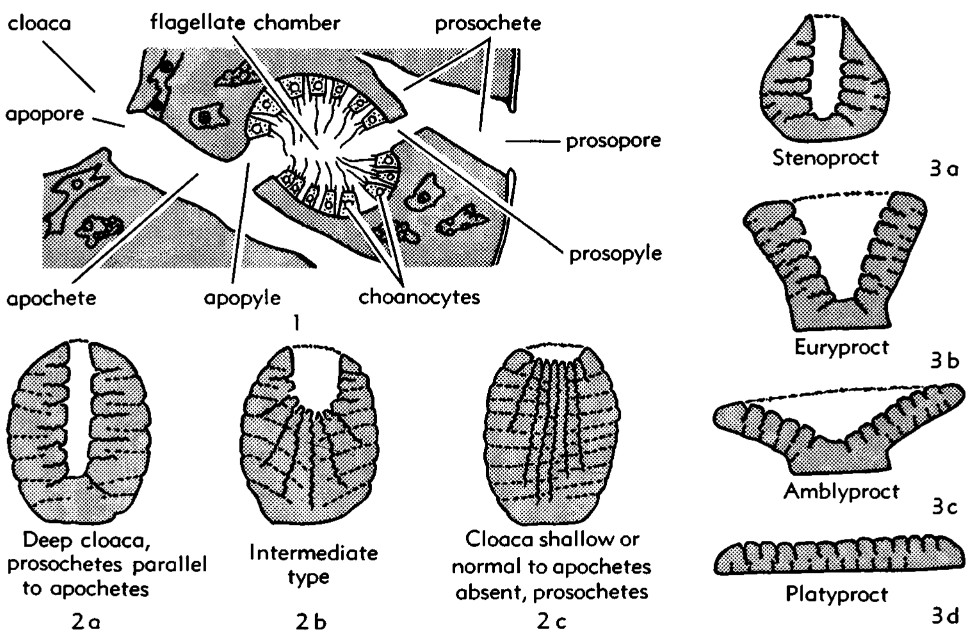

FIG. 15. Diagrammatic sections of sponges showing relationships of canals to cloacas (68n). *1,* Flagellate chamber with choanocytes; amoebocytes in surrounding jelly-like body substance; outer surface of sponge at right, ×1,000. *2,* Sagittal sections showing relations of prosochetes (dotted) to apochetes (wavy lines). *3,* Sagittal sections showing types of sponges *(3a-d)* defined by shape and relative width of the cloaca.

sol to rather stiff gel. In some species its existence is transient and small; and in a few it is the only skeleton ever present.

A second type is composed of separate mineral units called **spicules.** The mineral may be calcium carbonate (calcite) or opaline silica. No sponge ever produces both of these sorts.

A third type of sponge skeleton comprises an organic flexible but tough material called **spongin,** which is chemically related to horn and hair. It may be absent, or merely join spicule to spicule, or consist of fibers which contain spicules, or replace the spicules entirely. Only sponges of this latter sort are suitable for use as commercial sponges. The article of commerce is the completely defleshed reticulate skeleton of spongin fibers.

A considerable minority of sponge genera are sharply characterized by the fact that they can and do secure foreign debris in quantity and use this material as part of their skeleton. They take sand, bits of shell, and even the spicules of other sponge species. Thus a specimen may contain siliceous spicules of its own manufacture, and calcareous spicules from a neighbor. The occurrence of foreign spicules often renders identification extremely difficult.

A few sponges become rigid with age, uncommonly by mere interlocking of complex spicules but generally by the joining of spicules together by cement, which is silica for the siliceous spicules and calcium carbonate for calcareous spicules. Such rigid sponges constitute the vast majority of all fossil sponges. Doubtless in the past, as at present, an even greater number of sponges were of the kind that disintegrate after death.

During fossilization opaline silica may dissolve and be replaced by calcium carbonate, or vice versa, and either may be replaced by iron compounds. The original chemical nature must often be deduced by comparison with known Recent forms.

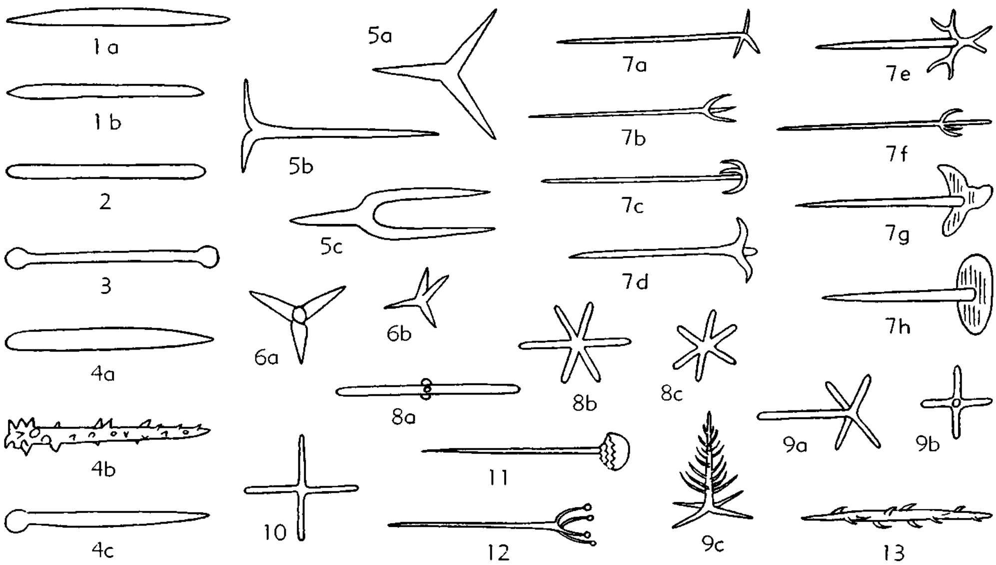

Fig. 16. Megasclere siliceous sponge spicules, approximately ×100 (68n).

1. Oxeas; *1a,* fusiform type; *1b,* hastate type.
2. Strongyle.
3. Tylote.
4. Style; *4a,* smooth type; *4b,* spiny (acanthose) type; *4c,* tylostyle.
5. Triacts; *5a,* regular type (triaxon); *5b,* sagittal type; *5c,* tuning-fork type.
6. Calthrops (tetraxon); *6a,b,* from different viewpoints.
7. Triaenes (tetraxons); *7a,* orthotriaene; *7b,* protriaene; *7c,* anatriaene; *7d,* plagiotriaene; *7e,* dichotriaene; *7f,* mesotriaene; *7g,* phyllotriaene; *7h,* discotriaene.
8. Hexacts (triaxons); *8a,* modified form resembling strongyle; *8b,c,* regular forms.
9. Pentacts (triaxons); *9a,* oblique view; *9b,* end view; *9c,* pinule.
10. Stauract.
11. Clavule.
12. Scopule.
13. Uncinate.

Spicules of sponges are divided into two categories: **megascleres** (Fig. 16) and **microscleres** (Fig. 17). The former make up the framework of the organism, but similar forms (still called megascleres) may be loose in the flesh. Microscleres, sometimes called flesh spicules, never form any part of the skeletal framework and therefore are rare in fossils. Megascleres are usually about 10 times the dimensions of the microscleres, but exceptionally large microscleres may exceed very small megascleres in size. Confusion is rare, because most microscleres are distinguished by their shapes also. Most megascleres exceed 3 microns in diameter, many are 10 microns, and some are more than 30 microns. Microscleres generally are 1 micron or less in (shaft) diameter. Megascleres mostly are more than 100 microns long, but many large forms are more than 300 microns in length, and a few attain greatest length of 1,000 microns. Microscleres typically range from 10 to 100 microns in length, but some are about 30 microns long.

In naming spicules, the roots "actine" (ray) and "axon" (axis) are often used. A triaxon spicule may have 3, 4, 5, or 6 rays, respectively describable as triactine, tetractine, pentactine, or hexactine, depending on how many rays extend from the central point. This does not mean that growth of the rays started at this point, but is purely academic. Thus with regard to monaxon

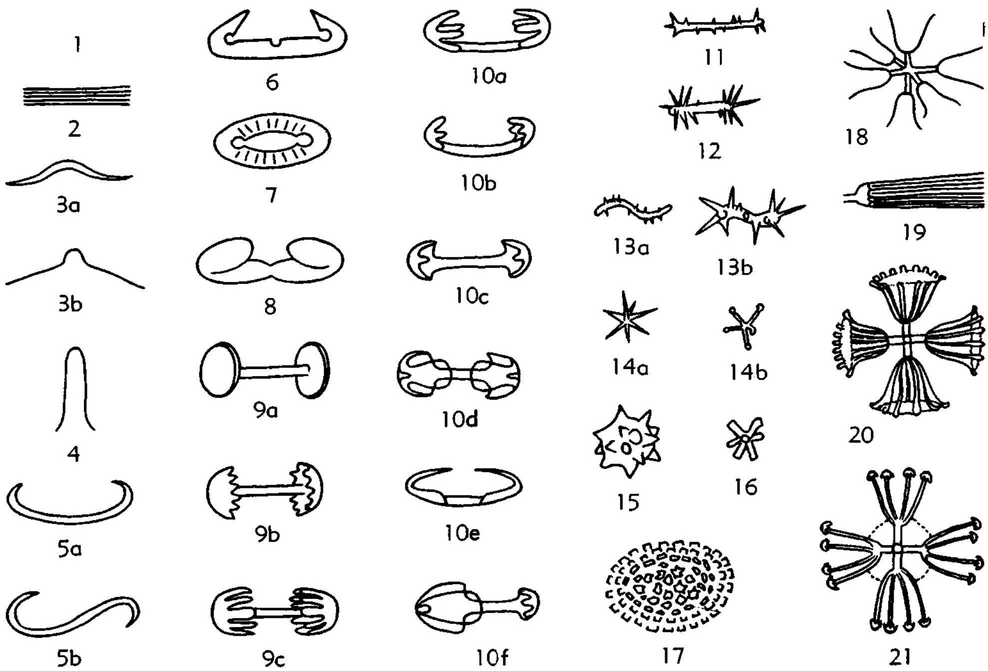

FIG. 17. Microsclere siliceous sponge spicules, approximately ×1,000 (68n).

1. Raphide (microxea).
2. Trichodragma (bundle of parallel raphides).
3. Toxas; *3a,b,* different types.
4. Forceps (may be spinose like other microscleres).
5. Sigmas; *5a,b,* different types.
6. Diancistra (rare).
7. Clavidisc (rare).
8. Placochela (rare), oblique view.
9. Amphidiscs; *9a,b,* birotulate types; *9c,* form approaching chela.
10. Chelas; *10a,* isochela of anchorate type, with shaft displaced laterally; *10b,c,* isochela of arcuate type in 2 views; *10d,e,* isochela of palmate type in 2 views; *10f,* anisochela.
11. Streptaster.
12. Amphiaster (rare).
13. Spirasters; *13a,b,* different types
14. Euasters; *14a,* oxyaster type; *14b,* tylaster type.
15. Sphaeraster.
16. Chiaster.
17. Sterraster.
18. Hexaster, oblique view.
19. Graphiohexaster, showing only one of 6 arms.
20. Floricome, with arms in line of view omitted.
21. Discohexaster, with arms in line of view omitted.

spicules, if the ends are alike, they are called diactine arbitrarily; if the ends are unlike they are called monactine. Almost invariably tetraxon spicules are also tetractine. Many terms applied to sponge spicules are explained in the glossary which follows.

It is rarely possible to identify a sponge genus, family, or order from the evidence of isolated spicules. For example, simple diactines called oxeas occur in several hundred genera of Recent sponges, including the genus *Reniera.* Fossil oxeas have been identified as *Reniera.* It would be equally logical to discover a fossil feather and identify it as belonging to the Tennessee Warbler. On the other hand, just as peacock feathers are indeed distinctive, so a few sorts of remarkable spicules may serve for generic identification.

Axial canals and other features are treated in connection with skeletal physiology.

MORPHOLOGICAL TERMINOLOGY

The literature on sponges contains very many names for soft and hard parts, as well as numerous descriptive morphological terms. A majority of these are unfamiliar to paleontologists who are not specialists in study of the sponges. Accordingly, compilation of an alphabetically arranged list that includes most of these terms or components (chiefly prefixes and suffixes) used in forming various morphological words is judged desirable. The glossary which follows gives brief explanation of the terms, together with classification in categories. The most commonly used terms are differentiated by printing in boldface type. Names referring to types of megasclere spicules and their parts are accompanied by the symbol "(M)," and similarly those referring to microsclere spicules and their parts are marked by "(m)." Names denoting placement of spicule assemblages, regardless of included types, are accompanied by "(S)." Other morphological terms are not thus restricted and these are not distinguished by a special symbol.

Glossary of Morphological Terms

acantho- (M). Prefix indicating spiny, more or less covered by spines.

amoebocyte. Cell moving by means of pseudopods.

amphiaster (m). Microsclere formed by union of 2 euasters (Fig. 17,*12*).

amphiblastula. Larva in which area without flagellate cells equals area with them.

amphidisc. (m). Rod with recurved clads at each end (Fig. 17,*9*).

amphioxea (M). Same as oxea (Fig. 16,*1*).

anatriaene (M). Triaene with clads curving back toward point of rhabd (Fig. 16,*7c*).

anchorate (m). Chela with 4 recurved clads at each end (Fig. 17,*10a*).

aniso- (m). Prefix indicating unlike; refers to ends of spicule.

anomoclad (M). Desma of sphaeroclone type.

apochete. Exhalant canal extending from apopyles to apopore (Fig. 14,*2*).

apopore. Aperture forming exit from apochete, may be equivalent to oscule (Fig. 14,*2*).

apopyle. Exhalant aperture from flagellate chamber (Figs. 14; 15,*1*).

aporrhysum. Same as apochete.

archaeo-. Prefix signifying primordial.

arcuate (m). Chela with clads in 3's, commonly flattened (Fig. 17,*10b,c*).

ascon. Sponge structure consisting of single relatively large chamber (Fig. 14,*1*).

aster (m). Rays diverging from a central focus (Fig. 17,*11-21*).

basalia. (S). Spicules protruding from lower surface of sponge.

birotule (m). Rod with disc or umbel at each end in plane normal to axis (Fig. 17,*9a,b*).

-blast. Suffix denoting "that which produces."

calcareous. Containing calcium, generally $CaCO_3$.

calthrops (M). Tetraxon with equal rays arranged normal to faces of tetrahedron (Fig. 16,*6*).

canalaria. (S). Spicules in lining of canals.

centrum. Middle part of spicule, from which rays irregularly diverge.

chamber. Cavity containing operative flagellate cells (Figs. 14;15,*1*).

chela (m). Like sigma but with terminal elaborations (Fig. 17,*10*).

chiaster (m). Aster with very blunt rays (Fig. 17,*16*).

choanocyte. Flagellate cell provided with collar (Fig. 15,*1*).

clad (M). Any of 3 similar rays of triaene (Fig. 16,*7*).

cladome (M). Aggregate of clads.

clavule (M). monact with terminal toothed umbel (Fig. 16,*11*).

cleme (M). Uncinate spicule (Fig. 16,*13*).

cloaca. Large exhalant cavity adjoined by apopores Figs. 14,*3;* 15,*1,2*).

collen-. Prefix referring to jelly.

comitalia (S). Opposed to principalia.

conule. Cone-shaped surface protrusion, generally over a fiber end.

coring. Refers to spicules located well inside of a tract or fiber.

coronal. Located on rim of oscule.

cortex. Relatively thick leathery external cover (Fig. 14,*2b*).

cribriporal. Grouped pores, generally in concavities.

cysten-. Prefix meaning bladder or capsule.

dendritic. Treelike branching.

dermalia (S). Spicules in outer layer.

dermis. Skinlike external covering.

desma. (M). Irregularly shaped spicule bearing lumpy mineral deposits.

desma-. Prefix referring to fiber (ligament).

diact (M). Monaxon of 2-ray type, produced in opposite directions.

diactine (M). Having 2 rays.

diaene (M). Like triaene but having only 2 clads.

diaxon (M). Spicule with 2 axes (*see* stauract).

dicho-. Prefix meaning dividing in 2 parts.

dichotomous. Branching by forking, Y-like.

dichotriaene (M). Triaene with forked clads (Fig. 16,*7e*).

dicranoclone (M). Desma with swollen terminal couplings.

dictyonalia (S). Spicules fused into rigid framework.

diplodal. Chambers with apopore about same size as prosopore.

discohexaster (m). Aster with branching rays that terminate in umbels (Fig. 17,*21*).

discotriaene (M). Triaene with flattened clads forming a disc normal to rhabd (Fig. 16,*7h*).

echinating. Said of spicules partially protruding from a tract or fiber.

ectosome. Outer region such as cortex or dermis.

endosome. Inner portion of sponge body.

ennomoclone (M). Spicule of dicranoclone or sphaeroclone type.

epirrhysum. Prosochete.

euaster (m). Aster lacking a centrum (Fig. 17,*14*).

eulerhabd (M). Like ophirhabd but more sharply curved.

eupore. Aperture through dermis to subdermal cavity.

eurypylorus. Chamber with extremely large apopore.

eutaxiclad (M). Desma of dicranoclone type.

fiber. Column more homogeneous than a tract.

flagellum. Long projection from cell, used as propeller.

floricome (m). Like hexaster but very elaborate (Fig. 17,*20*).

forceps (m). Tongs-shaped (Fig. 17,*4*).

fusiform (M). Spicule thicker centrally than near ends (Fig. 16,*1a*).

gastral cavity. Cloaca, not at all gastric.

gastralia (S). Spicules in lining of cloaca.

gemmule. Sponge embryo in a protective capsule.

gono-. Prefix referring to sex.

graphiohexaster (m). Six-ray aster with long thin parallel branches (Fig. 17,*19*).

hastate (M). Cylindrical spicule with abruptly conical points (Fig. 16,*1b*).

hexact (M). Triaxon with 6 rays nearly normal to one another (Fig. 16,*8*).

hexactine (M). Having 6 rays.

hexaster (m). Six-ray aster with ends generally branched (Fig. 17,*18-21*).

histo-. Prefix referring to tissue.

hypo- (S). Prefix meaning partly in a membrane, partly extending into endosome.

intermedia (S). Spicules between elements of principalia or dictyonalia.

iso- (m). Prefix meaning ends alike.

keratose. Pertaining to spongin (*keras,* horn).

kyphorhabd (M). Strongyle with row of tubercles along one side.

leucon. Same as rhagon.

lipostomous. Without apertures visible to naked eye.

maltha. Mesogloea.

marginalia (S). Spicules protruding upward around an oscule.

megaclad (M). Relatively large smooth desma (syn., megaclone).

megaclone (M). Same as megaclad.

mesenchyme. Aggregate of amoeboid cells.

mesogloea. Layer of jelly.

mesotriaene (M). Triaene with rhabd projecting on both sides of cladome (Fig. 16,*7f*).

microxea (m). Like oxea but very small (Fig. 17,*1*).

monact (M). Monaxon produced in a single direction.

monactine (M). Having one ray only.

monaene (M). Like triaene but having only one clad.

monaxon (M). Spicule with a single axis.

myo-. Prefix referring to muscle.

octact (M). Spicule with 8 rays, generally 6 in one plane with others normal.

olynthus. Newly attached sponge larva.

ophirhabd (M). Oxea curved in several places.

orthotriaene (M). Triaene with clads perpendicular to rhabd (Fig. 16,*7a*).

oscule. Any comparatively large exit aperture (Fig. 14,*3*).

ostium. Eupore or prosopore.

oxea (M). Diactine monaxon with both ends pointed (syn. amphioxea) (Fig. 16,*1*).

oxyaster (m). Aster with sharp rays (Fig. 17,*14a*).

palmate (M). Chela with sheetlike or winglike elaborations (Fig. 17,*10d,e*).

paragastric. Cloacal, not at all gastric.

parenchyma. Endosome, as applied to sponges.

parenchymalia (S). Spicules in endosome, not in any lining.

parenchymula. Larva; area without flagellate cells very small.

phago-. Prefix referring to eating.

phyllotriaene (M). Triaene with clads flattened in plane normal to rhabd (Fig. 16,*7g*).

pinaco-. Prefix referring to epithelium.

pinule (M). Pentact with rhabd bearing long curved spines (Fig. 16,*9c*).

plagiotriaene (M). Like orthotriaene but clads thick, not straight (Fig. 16,*7d*).

pleuralia (S). Spicules protruding from lateral surface.

plumicome (m). Like floricome.

polyact (M). Spicule with many rays diverging from a central focus.

pore. Any small aperture.

posticum. Apopore.

principalia (S). Spicules constituting main skeletal framework.

prosochete. Inhalant canal, leading to chambers (Figs. 14;15,*1,2*).

prosopore. Aperture leading to prosochete (Figs. 14; 15,*1*).

prosopyle. Inhalant aperture of flagellate chamber (Figs. 14; 15,*1*).

prostalia (S). Spicules protruding from any surface.

protetraene (M). Tetraene with clads curving away from point of rhabd.

protriaene (M). Triaene with clads curving away from point of rhabd (Fig. 16,*7b*).

pseudopod. Temporary locomotor projection from cell.

raphide (m). Very thin microxea (Fig. 17,*1*).

regular triact (M). Spicule with 3 equal rays separated by angles of 120 degrees (Fig. 16,*5a*).

rhabd (M). Odd ray of a triaene, generally straight.

rhagon. Complex sponge structure, with many chambers (Fig. 14,*3*).

rhizoclad (M). Desma with rootlike processes (syn., rhizoclone).

rhizoclone (M). Same as rhizoclad.

rhopalostyle (M). Peculiarly lumpy spicule with bifurcate head.

rooting tuft (S). Aggregate of basalia with root function.

sagittal triact (M). Three-rayed spicule having one ray very unlike others, generally T-shaped (Fig. 16,*5b*).

sclero-. Prefix referring to skeleton.

scopule (M). Protetraene with tylote clads (Fig. 16,*12*).

selenaster (m). Like stellaster but based on a spiraster.

sigma (m). Shaped like letter C or S (Fig. 17,*5*).

siliceous. Containing silica, SiO_2 or silicate.

sphaeraster (m). Aster with globular centrum (Fig. 17,*15*).

sphaeroclone (M). Subglobular desma produced by swelling of centrum.

spicule. Unit of sponge mineral skeleton, "little spike" (Fig. 16, *4*).

spiraster (m). Spirally twisted rod-bearing spines or short rays.

spongin. Organic flexible substance, related to hair or horn.

spongocoel. Rhagon cloaca, sycon apochete, or ascon chamber.

stato-. Prefix referring to gemmule.

stauract (M). Tetractine diaxon with 4 rays in one plane (Fig. 16,*10*).

sterraster (m). Ovoid spicule with numerous radiating blunt rays (Fig. 17,*17*).

streptaster (m). Straight rod with long spines or rays (Fig. 17,*11*).

strongylaster (m). Aster with rays bluntly rounded at tips.

strongyle (M). Diactine monaxon with both ends bluntly rounded (Fig. 16,*2*).

style (M). Monactine monaxon with one end blunt and other pointed (Fig. 16,*4*).

sycon. Sponge structure comprising one layer of chambers (Fig. 14,*2a,b*).

tetraclad (M). Desma with rays bearing terminal couplings or based on a calthrops, generally both (syn., tetraclone).

tetraclone (M). Same as tetraclad.

tetractine (M). Having 4 rays.

tetraene (M). Like triaene but having 4 clads.

tetraxon (M). Spicule with 4 axes (Fig. 16,*6,7*).

theso-. Prefix referring to storage.

toko-. Prefix referring to reproduction.

tornote (M). Diactine monaxon with both ends hastate.

toxa (m). Bow-shaped spicule with 3 bends (Fig. 17,*3*).

tract. Fascicular column of spicules.

triact (M). Spicule with 3 rays (*see* regular triact, sagittal triact) (Fig. 16,*5*).

triactine (M). Having 3 rays.

triaene (M). Tetraxon with one ray differing from others (Fig. 16,*7*).

triaxon (M). Spicule with 3 axes (Fig. 16,*5,8,9*).

trichodragma (m). Aggregate of parallel raphides (Fig. 17,*2*).

tropho-. Prefix referring to nutrition.

tuning fork (M). Triact shaped like tuning fork (Fig. 16,*5c*).

tylaster (m). Aster with rays swollen at tips (Fig. 17,*14b*).

tylo- (M). Prefix referring to tip with globular swelling (Fig. 16,*4c*).

tylote (M). Diactine monaxon with both ends swollen (Fig. 16,*3*).

umbel (M). Cluster of subequal rays diverging from a common point.

uncinate (M). Fusiform oxea with thornlike spines (Fig. 16,*13*).

verticillate (M). Having spines arranged in nodes or whorls.

PHYSIOLOGY

SKELETAL SECRETION

The skeleton of sponges serves to give support and rigidity to the organism. Also, many spicule sorts are so shaped as to deter predators from eating the sponge. Sponges that lack spicules may possess chemical deterrents and even some spicule-bearing ones contain strong irritants or toxins.

Megascleres are first represented by an axial thread. This is organic, probably protoplasmic, and stains distinctively with nigrosin. Axial threads arise by longitudinal fission of pre-existing similar ones inside living sponge cells. Amoeboid cells deposit mineral material on and around an axial thread in concentric layers that alternately contain more and then less organic material. Where two or more cells collaborate in the formation of a single spicule, as is common, they unite to form a syncytium surrounding it. During growth, the spicule increases principally in diameter, but the axial thread is at once completely enclosed, with mineral layers surrounding its ends, so that the length of the spicule also increases somewhat. The axial canal, where the axial thread had been, is often visible in spicules. Spicules in water, not surrounded by flesh, may undergo slow solution. This may greatly enlarge the axial canal so that it becomes conspicuous.

Generally, no axial thread is evident in microscleres; these spicules arise inside a single cell and remain completely enclosed until fully formed.

Spicules may be anchored in place, especially within or on fibers, but often they are moved about. Many kinds arise deep within the sponge and are moved toward the surface as they mature. They may accumulate on or near the surface, or even be extruded. Accordingly, it has been suggested that to some extent they may represent a sort of physiological excretion.

The incorporation of foreign material seems to begin by adherence of it to the sponge's surface, and then amoeboid cells transport it to specific internal locations. For example, such debris may be placed inside certain vertical fibers and nowhere else.

MOTION

Motion in sponges is of three sorts: flagellate, amoeboid, and muscular.

Flagellate cells (choanocytes) are responsible for locomotion of the larva and for water currents that sweep through the adult. Each flagellum moves in a circular path with a spiral shape, thus serving like a ship's propeller. Under favorable conditions the flagellum may revolve about 10 times per second.

Amoeboid travel, by pseudopods, is characteristic of many or perhaps all cells of a sponge. Thus chambers and canals are formed, spicules are moved, and wounds are promptly repaired. Even choanocytes may be briefly amoeboid, especially in the post-larval fixation stage.

Muscular contraction can be used to close inhalant openings of all, or nearly all, sponges. In a minority of species, the larger exhalant openings can also be thus closed, with force comparable to the grip of a human hand. The sphinctrate muscular rings are syncytial. Since a syncytium is regarded by some authorities as a single cell, the statement has been made that the sponge pore is surrounded by a single cell, but this is misleading.

Reaction in sponges occurs with absolutely no nerve tissue whatsoever. The cells are sensitive, and respond to stimuli, as, for example, in closing pores and in travel to wounds; there exist thigmotaxis and chemotaxis. Transmission, however, occurs only in so far as cytolytic products diffuse or the motion of one cell physically jostles its neighbor. Activity thus spreads from a point of impact, but it extends only a few millimeters outward and disappears rapidly.

NUTRITION

Nutrition in sponges requires more study. Early research revealed pathways for elimination of colored foreign particles, but this is not related to nutrition. Some shallow-water sponges are full of symbiont plants and almost certainly derive nourishment from them. The majority of Porifera, for lack of illumination, cannot thus depend upon photosynthetic collaborators. The inlets to their flagellate chambers are so small (2 microns) that their diet must consist of very small organisms (hekistoplankton), especially bacteria. There are indications that nourishment may be transferred from cell to cell within the sponge, but no mouth, stomach, or alimentary canal exists and no structures of Porifera may properly be termed gastral.

RESPIRATION

Respiration in sponges is cell by cell, as in Protozoa. In species studied carefully, the oxygen consumption has been found to be approximately the same as in other marine invertebrates, for example, 0.15 cc. of consumed oxygen per hour per cc. of sponge, including some nonliving material (spicules). Sponges containing photosynthetic symbionts deliver carbon dioxide to them and secure oxygen in return.

EXCRETION

Excretion in sponges is cell by cell, as in Protozoa, but details are not known. Contractile vacuoles assist osmotic regulation in fresh-water sponges. Doubtless vegetable symbionts, when present, dispose of nitrogenous animal excretions.

CIRCULATION

Circulation in sponges may be represented by water currents which enter the relatively small surficial pores and proceed to the flagellate chambers. Because of the greater diameter of these chambers, the velocity temporarily decreases and action of the flagella on the slower moving water yields hydraulic efficiency. The moderately small exit passageways are progressively larger and larger; other than this, nothing so far published indicates how it happens that the current moves in only one direction. The flagellate cells have no co-ordination with one another, and unless damaged, beat continuously. The gross current becomes considerable. A sponge of 200 g. (dry) weight, in life will pass a metric ton (1,000 kg.) of water through its channels each 24-hour day.

REPRODUCTION

Reproduction in sponges certainly results sometimes from syngamy of spermatozoon with ovum, yielding a normal zygote. It is also certain that small cell aggregates, comparable to buds, may be formed asexually, and after they separate from the parent, they start new sponges. The relative abundance of the 2 methods is not known. There are reports of sperm penetrating sponge flagellate cells as a prelude to transfer into ova for syngamy (fertilization).

ECOLOGY

Sponges are eaten, in spite of spicules and toxins, by many nudibranch gastropods, by a few holothurians, and by a very few fishes. Angel fishes, especially, may take the sponge by accident while seeking worms. Sponges nearly always contain many animal, as well as plant, inhabitants, of which some, such as shrimps, are merely commensal but many others parasites. CASTER has demonstrated the occurrence of ophiuroid echinoderm inhabitants in fossil sponges, and such association is known in modern seas. Recent sponges commonly contain as many as 3 probably parasitic animals (chiefly nematodes) per cc. but almost equally abundant minute amphipod crustaceans are found. The occurrence of beneficial plant symbionts has been discussed.

Sponges frequently kill neighbors by lateral growth and smothering, and in turn they may perish similarly. Sponges of the family Clionidae excavate burrows in calcareous material by unknown means. They thus damage many mollusks, even contributing to killing them. Fossil clionids are known, but fossil excavations may be difficult to identify.

Sponges without mineral skeletons have been used by mankind for at least 4,000 years, especially for cleansing, but also for padding, pigment application, and other uses.

DISTRIBUTION

Sponges are moderately common on the ocean floor, and more abundant along shores, especially near low-tide mark. More than 10,000 Recent species have been described. Probably about half of these are synonyms, but exploration has been so incomplete that surely many undescribed species exist. More than 1,400 genera have been established for Recent sponges. Of these, about 20 occur in fresh water and another 20 are found well up in the intertidal region. All others live only where they are immersed always in sea water. Numerous genera are found in deep water. No depth seems to be too great for sponge tolerance. The entire class Hyalospongea is confined at present to such depths that light does not penetrate, and is rare at depths less than 200 m.

Sponges are largest and most abundant, both in species and in individuals, in equatorial waters, but as compared even to the coldest polar waters, only by a factor between 5 and 10. For example, nearly 400 arctic species are known, and sponges are about as common on arctic shores as along the New England coast.

PRECAMBRIAN

Sponges doubtless evolved in the Precambrian, although indubitable proof is wanting. DUNBAR (*Historical Geology*, 1949) mentions Precambrian sponge spicules in the Grand Canyon region (Arizona); this is on authority of SCHUCHERT, seemingly based on oral reports by WALCOTT. The present location of collected specimens, if they exist, is unknown. In 1951, G. W. BAIN discovered fossils in the Katanga system, presumed to be of Precambrian age, in the Belgian Congo (Africa), and he described (personal letter) them as closely resembling the Recent ascon calcisponge *Leucosolenia;* unfortunately, an accident destroyed his specimens. WALCOTT (1912, Canadian Dept. Mines, vol. 28, p. 17) described a Precambrian fossil from Canada as *Atikokania*. This has been identified variously as an inorganic concretion or a poorly preserved sponge. CAYEUX (1895, Annales Soc. géol. du Nord, p. 52-65) described Precambrian fossils from Brittany which closely resemble the spicules of calcisponges; they are lumpy and crooked, unlike the spicules of most sponges. CAYEUX's conclusion that several classes and orders of sponges are represented is here doubted. G. J. HINDE in a personal letter to CAYEUX (July 10, 1895) accepted the sponge nature of these fossils. It seems advisable to have a zoological name whereby the discovery by CAYEUX may be designated, and this is here proposed as follows: *Eospicula cayeuxi* DELAUB., gen. et sp. nov. Sponge with triact spicules, probably of the class Hyalospongea. Type specimen represented by figure 48 of plate II, Ann. Soc géol. du Nord, 1895, which is a triact with strongylote rays 15 by 20, 15 by 60 and 15 by 80 microns. Precambrian of Brittany.

PALEOZOIC AND YOUNGER

More than 1,000 genera have been established for fossil sponges. Scarcely 20 of these can be regarded with any confidence as identical with Recent sponge genera. Many sponge fossils are so poorly preserved that identification of them is extremely uncertain.

Chert may consist of more or less fused sponge spicules from the abundant kinds that disintegrate upon dying. Flints may likewise be nearly or entirely of sponge origin and in some of them whole fossil sponges appear.

The Cambrian and various succeeding periods yield fossil records which indicate abundance of sponges comparable to that of the present. The first certainly distinguishable calcisponges are Devonian, and huge assemblages of Hyalospongea flourished in Devonian time, especially in New York and Pennsylvania. An even greater sponge abundance is indicated in Lower Carboniferous rocks of Great Britain by thick strata of chert largely composed of isolated sponge spicules; in Yorkshire these chert beds are as much as 105 m. thick. Sponges seem generally to have been somewhat fewer in the Permian and Triassic periods, but in Lower Jurassic deposits of central Europe thick strata are full of isolated sponge spicules. Also, Jurassic beds of southern Germany contain numerous lithistid sponges. Hyalosponge abundance reached a climax in the Cretaceous of Europe, especially in northern Germany and France. Tertiary sponge occurrences are more like those of the Quaternary and Recent.

CLASSIFICATION

The phylum Porifera is divisible into 3 classes: Demospongea (*demos,* common), Hyalospongea (*hyalos,* glass), and Calcispongea (*calx,* lime).

Calcispongea invariably have proper skeletons of calcareous spicules, and none secrete siliceous material or spongin. Some are rhagon, some sycon, and some ascon.

All Hyalospongea have proper skeletons of siliceous spicules without associated calcareous material or spongin. The junctions of their skeletal elements tend to be at right angles. The protoplasmic structures are scanty, with relatively huge open spaces. The structure is technically rhagon, but so simple that it appears almost like sycon.

Demospongea typically have spongin as part or all of their skeleton, but there are exceptions which are referable to this class because of their significant resemblance to spongin-containing relatives. Most demosponges contain siliceous spicules, with or without spongin. A few contain only spongin, and still fewer produce neither spicules nor spongin. Skeletal structures in this class tend to meet at 120-degree angles and the flesh is compact rhagon.

Demospongea other than the Lithistida are extremely unlikely to yield recognizable fossils. Spongin fibers may leave imprints or molds, and in some fossils casts of canal systems persist. Ancient abundance is indicated by many flints, cherts, and beds of spicules.

Recent Demospongea comprise some 90 families. Members of most of these disintegrate so promptly and so completely upon dying that it does not seem advisable to describe them in a paleontologic discussion. A few paleontologists have hazarded identifications of genera from these families on the evidence of isolated spicules, but efforts of this sort are extremely unreliable.

A tabular summary of suprageneric divisions of the Porifera, showing stratigraphic distribution of recognized units, is introduced here for convenience in surveying the whole assemblage. The number of genera in each division (taking account of those mentioned in the *Treatise*) is indicated by numbers enclosed in parentheses, but it is necessary to point out that these numerical data are incomplete because very many Recent genera and not a few whole families that lack importance in paleontology are omitted. Taxonomic units containing more or less numerous unmentioned genera are distinguished by an asterisk (*).

Suprageneric Divisions of Porifera

Demospongea *(class)* (*374). *Cam.-Rec.*
- Keratosida *(order)* (*8). *Carb.-Rec.*
  - Spongiidae *(family)* (*4). *Carb.-Rec.*
  - Dysideidae (*3). *Jur.-Rec.*
  - Family uncertain (1)
- Haplosclerida *(order)* (*18). *Cam.-Rec.*
  - Spongillidae *(family)* (*3). *Jur.-Rec.*
  - Haliclonidae (*5). *L.Ord.-Rec.*

Desmacidontidae (*2). *Tert.-Rec.*
Haplistiidae (2). *M.Ord.-L.Carb.*
Wapkiidae (1). *Cam.*
Hazeliidae (1). *Cam.*
Takakkawiidae (1). *Cam.*
Family uncertain (3). *Jur.-Cret.*
Poecilosclerida *(order)* (*16). *Cam.-Rec.*
Myxillidae *(family)* (*2). *Tert.-Rec.*
Tedaniidae (*4). *Tert.-Rec.*
Cladorhizidae (*2). *Tert.-Rec.*
Amphilectidae (*2). *Tert.-Rec.*
Hamptoniidae (1). *Cam.*
Acarniidae (*2). *Cret.-Rec.*
Family uncertain (3). *Jur.-Tert.*
Hadromerida *(order)* (*15). *Cam.-Rec.*
Spirastrellidae *(family)* (*3). *Tert.-Rec.*
Suberitidae (*3). *L.Cret.-Rec.*
Piraniidae (1). *Cam.-Sil.*
Clionidae (*8). *Sil.- Rec.*
Epipolasida *(order)* (*10). *Cam.-Rec.*
Sollasellidae (*6). *Ord.-Rec.*
Corralioidae (1). *Cam.*
Choiidae (1). *M.Cam.-Sil.*
Tethyidae (*1). ?Tert., *Rec.*
Family uncertain (1). *Cam.*
Choristida *(order)* (*25). *Carb.-Rec.*
Ancorinidae *(family)* (*5). *Jur.-Rec.*
Geodiidae (*5). *Carb.-Rec.*
Craniellidae (4). *Cret.-Tert.*
Scolioraphididae (3). *Jur.-U.Cret.*
Ophiraphiditidae (*5). *Jur.-Rec.*
Family uncertain (3). *Jur.-Cret.*
Carnosida *(order)* (*11). *Carb.-Rec.*
Halinidae *(family)* (*11). *Carb.-Rec.*
Lithistida *(order)* (*286). *Cam.-Rec.*
Rhizomorina *(suborder)* (*73). *Cam.-Rec.*
Kaliapsidae *(family)* (*6). *Cret.-Rec.*
Scytaliidae (8). *Jur.-U.Cret.*
Chonellidae (8). *Jur.-Tert.*
Astroboliidae (4). *Jur.-Tert.*
Cnemidiastridae (3). *Ord.-Jur.*
Jereopsiidae (*4). *U.Jur.-Rec.*
Leiodorellidae (*12). *Jur.-Rec.*
Plinthodermatiidae (1). *U.Cret.*
Neopeltidae (*2). *Cret.-Rec.*
Scleritodermatidae (*2). *Cret.-Rec.*
Family uncertain (23). *Cam.-Mio.*
Megamorina *(suborder)* (*22). *Carb.-Rec.*
Pleromidae *(family)* (*11). *Jur.-Rec.*
Dorydermatidae (6). *Carb.-U.Cret.*
Helobrachiidae (1). *U.Cret.*
Isoraphiniidae (3). *Jur.-Cret.*
Family uncertain (1). *Cret.*
Tetracladina *(suborder)* (*97). *Ord.-Rec.*
Aulocopiidae *(family)* (12). *Ord.-Perm.*
Archaeoscyphiidae (7). *Ord.*
Chenendoporidae (12). *?Perm., Jur.-U.Cret.*
Hallirhoidae (11). *Jur.-Tert.*
Plinthosellidae (5). *?Perm., Cret.*
Astrocladiidae (4). *Cret.-Tert.*
Aulaxiniidae (2). *Cret.*
Jereidae (10). *?Perm., Cret.*
Discodermiidae (*16). *L.Cret.-Rec.*
Phymaraphiniidae (7). *Cret.-Tert.*
Family uncertain (11). *Carb.-Rec.*
Eutaxicladina *(suborder)* (*30). *Ord.-Rec.*
Astylospongiidae *(family)* (16). *Ord.-Cret.*
Gignouxiidae (*8). *Jur.-Rec.*
Chiastoclonellidae (5). *Ord.-Tert.*
Pseudoverruculinidae (1). *U.Cret.*
Anomocladina *(suborder)* (25). *Cam.-Jur.*
Cylindrophymatidae *(family)* (7). *Carb.-Jur.*
Eospongiidae (12). *Cam.-Sil.*
Mastosiidae (1). *Jur.*
Family uncertain (5). *Ord.-Cret.*
Suborder uncertain (39). *Dev.-Tert.*
Hyalospongea *(class)* (*287). *L.Cam.-Rec.*
Lyssakida *(order)* (*86). *L.Cam.-Rec.*
Hyalonematidae *(family)* (*1). *Eoc.-Rec.*
Pheronematidae (*2). *Cret.-Rec.*
Euplectellidae (*3). *U.Cret.-Rec.*
Sympagellidae (*1). *Eoc.-Rec.*
Lanuginellidae (*2). *Eoc.-Rec.*
Stauractinellidae (1). *Jur.*
Protospongiidae (9). *L.Cam.-U.Sil.*
Leptomitidae (3). *L.Cam.-Ord.*
Teganiidae (4). *Ord.*
Holasterellidae (5). *Sil.-Carb.*
Dictyospongiidae (39). *Ord.-Carb.*
Dictyospongiinae *(subfamily)* (25). *Sil.-Carb.*
Prismodictyinae (14). *Ord.-Carb.*
Uphantenidae (2). *U.Dev.-Carb.*
Brachiospongiidae (4). *Ord.-Sil.*
Multivasculatidae (1). *U.Cam.*
Vauxiidae (1). *M.Cam.*
Amphispongiidae (1). *U.Sil.*
Titusvilliidae (*4). *L.Carb.-Rec.*
Family uncertain (3). *Ord.-Carb.*
Dictyida *(order)* (*102). *M.Ord.-Rec.*
Euryplegmatidae *(family)* (*1). *?Cret., Rec.*
Hexactinellidae (*9). *Jur.-Rec.*
Eubrochididae (4). *U.Cret.*
Staurodermatidae (14). *Jur.-Mio.*
Leptophragmatidae (6). *Jur.-Tert.*
Emplocidae (1). *M.Jur.*
Polythyrididae (4). *M.Ord.-U.Cret.*
Polystigmatiidae (1). *U.Cret.*
Pleurostomatidae (10). *Jur.-Rec.*
Porospongiidae (3). *U.Jur.-U.Cret.*
Myliusiidae (*9). *Jur.-Rec.*
Botryosellidae (8). *U.Jur.-U.Cret.*
Euretidae (5). *Jur.-Tert.*
Dactylocalycidae (*10). *Cret.-Rec.*
Aphrocallistidae (*1). *Cret.-Rec.*
Wapkiosidae (*2). *Cret.-Rec.*
Family uncertain (14). *Dev.-Cret.*
Lychniskida *(order)* (*68). *?Trias., Jur.-Rec.*
Ventriculitidae *(family)* (20). *Jur.-U.Cret.*
Coeloscyphiidae (2). *Cret.*
Polyblastidiidae (2). *Jur.-Cret.*
Coeloptychiidae (2). *U.Cret.*
Camerospongiidae (7). *Jur.-Tert., ?Rec.*

Cypelliidae (7). *Jur.-Cret.*
Oncotoechidae (1). *U.Cret.*
Callodictyidae (9). *Cret.*
Coscinoporidae (3). *U.Cret.*
Becksiidae (7). *Jur.-U.Cret.*
Calyptrellidae (5). *Jur.-U.Cret.*
Family uncertain (3). *?Trias., U.Cret.*
Heteractinida *(order)* (11). *L.Cam.-Carb.*
Chancelloriidae *(family)* (1). *M.Cam.-U.Cam.*
Astraeospongiidae (6). *M.Cam.-Carb.*
Asteractinellidae (4). *L.Cam.-Perm.*
Order uncertain (20). *M.Ord.-Cret.*
Calcispongea *(class)* (*104). *Cam.-Rec.*
Solenida *(order)* (*1). *Cam.-Rec.*
Camarocladiidae *(family)* (1). *Cam.-Ord.*
Lebetida *(order)* (*3). *L.Jur.-Rec.*
Grantiidae *(family)* (*1). *U.Jur.-Rec.*
Leuconiidae (*2). *L.Jur.-Rec.*
Pharetronida *(order)* (*67). *Perm.-Rec.*
Chalarina *(suborder)* (*36). *Perm.-Rec.*
Sestrostomellidae *(family)* (5). *Trias.-Cret.*
Stellispongiidae (11). *Trias.-Cret.*
Elasmostomatidae (3). *Jur.-Cret.*
Pharetrospongiidae (1). *L.Cret.-U.Cret.*
Lelapiidae (11). *Perm.-Eoc.*
Discocoeliidae (3). *Trias.-Cret.*
Elasmocoeliidae (2). *Jur.-Cret.*
Stereina *(suborder)* (*6). *Jur.-Rec.*
Porosphaeridae *(family)* (*5). *Cret.-Rec.*
Bactronellidae (1). *Jur.-Eoc.*
Suborder uncertain (25). *Trias.-Tert.*
Thalamida *(order)* (26). *U.Carb.-Cret.*
Sebargasiidae *(family)* (5). *U.Carb.-Cret.*
Barroisiidae (3). *Trias.-Cret.*
Cystothalamiidae (2). *Penn.-Perm.*
Celyphiidae (8). *U.Carb.-Trias.*
Cryptocoeliidae (5). *Perm.-Cret.*
Sphaerocoeliidae (1). *U.Cret.*
Family uncertain (2). *Perm.-Trias.*
Order uncertain (7). *Sil.-M.Jur.*
Class uncertain (13). *Precam.-Cret.*
Porifera total (*778). *Precam.-Rec.*
Unrecognizable supposed Porifera (269). *Cam.-Rec.*
Receptaculitidae *(family)* (11). *Ord.-Dev., ?Carb.*

SYSTEMATIC DESCRIPTIONS

Phylum PORIFERA Grant, 1872

Aquatic metazoa without germ layers, whose numerous flagellate cells draw water through many small inlets and expel it through fewer exits. *Cam.-Rec.*

Class DEMOSPONGEA Sollas, 1875

[*nom. correct.* DELAUB., herein (*ex* Demospongiae SOLLAS, 1875)]

Architecture compact rhagon. Siliceous spicules, or spongin, or (commonly) both, or (rarely) neither present. Diverse sorts of foreign inclusions occur in many. *Cam.-Rec.*

Order KERATOSIDA Grant, 1861

[*nom. correct.* DELAUB., herein (*ex* Keratosa GRANT, 1861)]

Skeleton of spongin only, except as foreign inclusions occur. *Carb.-Rec.*

Family SPONGIIDAE Gray, 1867

[*nom. correct.* DELAUB., 1936 (*ex* Spongiadae GRAY, 1867)]

Keratose sponges with small spherical flagellate chambers (not shown by fossils). *Carb.-Rec.*

Spongia Linné, 1759 [**S. officinalis*]. Fibers very spongy even when dry; chiefly clear, but a few ascending fibers contain debris. *Rec.*, cosmop.

Verongia Bow., 1845 [**Spongia fistularis* Pallas, 1766]. Fibers peculiarly pithed. *Rec.*, cosmop.——FIG. 18,*3*. **V. fistularis* (PALLAS), skeletal fiber, ×100 (68n).

Aplysinofibria Bolk., 1923 [**A. carbonicola*]. Fibroid structures like those of *Verongia.* Such have often been called aplysinoid fibers because many species of *Verongia* have been incorrectly identified as *Aplysina.*

Scyphia Oken, 1814 [**Spongia scyphiformis* ESPER, 1794; SD DELAUB., 1936]. Hollow, conical. Over 200 poorly described fossil species from many systems have been assigned incorrectly to this genus, merely because they were hollow cones, although in other respects extremely diversified. No certain fossils of this genus exist. *Rec.*

Family DYSIDEIDAE Gray, 1867

Large, sac-shaped (eurypylous) flagellate chambers (not shown by fossils). Fibers usually loaded with foreign debris. *Jur.-Rec.*

Dysidea JOHNSON, 1842 [**Spongia fragilis* MONTAGU, 1818; SD DELAUB., 1936][=*Spongelia* NARDO, 1844]. All the fibers cored with foreign debris (22). *Eoc.*(Belg.)-*Rec.*(cosmop.).

Spongelites ROTHPLETZ, 1900 [**S. fellenbergi*]. Reticulate sand-filled fibers. *Jur.*, Eu.

Spongeliomorpha DE SAPORTA, 1887 [**S. iberica*] Resembles *Spongelites. Mio.*, Sp.

Family UNCERTAIN

Felixium DELAUB. *nom. nov.* [*pro Rhizocorallium* FELIX, 1913[1] (*non* ZENKER, 1836)][**Rhizocorallium glaseli* FELIX, 1913]. Elaborately sculptured, curved cylinder 5×20 cm. *Cret.*, Ger.

[1] FELIX, J., *Ueber ein cretacische Geschiebe mit Rhizocorallium glaseli:* Sitzungsber. Natur Gesell., Leipzig, Bd. 39, p. 19-25.

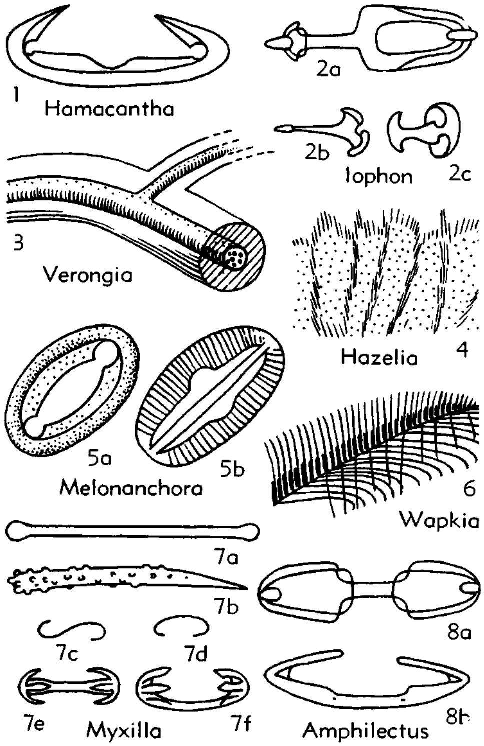

FIG. 18. Keratosida (*3*), Haplosclerida (*4, 6*), Poecilosclerida (*1, 2, 5, 7, 8*) (p. E36-E38).

Order HAPLOSCLERIDA Topsent, 1898

[*nom. correct.* DELAUB., herein (*ex* Haplosclerina TOPSENT, 1898)]

Sponges with almost no dermal specialization whatsoever. Generally reticulate with much spongin. Megasclere spicules generally of just one simple type. *Cam.-Rec.*

Family SPONGILLIDAE Gray, 1867

Fresh-water species (a few in brackish water) with gemmules. Some genera have microscleres like those of many Hyalospongea. *Jur.-Rec.*

Spongilla LAM., 1815 [**Spongia lacustris* LINNÉ, 1759; SD POTTS, 1881]. Megascleres simple oxeas, gemmules contain spiny oxeas (acanthoxeas) (22). *Jur.-Rec.*, cosmop.

Meyenia CARTER, 1881 [**M. fluviatilis;* SD DELAUB., 1936]. Gemmules contain amphidisc microscleres. Commonly reported erroneously as *Ephydatia* (=*Tupha*). *Pleisto.-Rec.*, cosmop.

Heteromeyenia POTTS, 1881 [**H. repens;* SD DELAUB., 1936]. Like *Meyenia* but amphidiscs include 2 distinct types (22). *Pleisto.-Rec.*, cosmop.

Family HALICLONIDAE de Laubenfels, 1932

Extremely simple skeletons, lacking microscleres; most typical of order. *L.Ord.-Rec.*

Haliclona GRANT, 1841 [**Spongia oculata* LINNÉ, 1759][=*Chalina* Bow., 1862]. Incrusting to ramose (14). *?Eoc., Rec.*, cosmop.

Reniera NARDO, 1847 [**R. aquaeductus* SCHMIDT, 1862; SD SCHMIDT, 1862]. Like *Haliclona* but a hollow cylinder. Many Ord.-Eoc. fossils erroneously assigned to this genus, based on presence of oxeas (22). *Rec.*

Petrosia VOSMAER, 1865 [**Reniera dura* SCHMIDT, 1862; SD DELAUB., 1932]. Differs from *Haliclona* in having 4 kinds of monaxons (8). *?Tert., Rec.*, cosmop.

Climacospongia HINDE, 1884 [**C. radiata*]. Vertical tracts of overlapping oxeas connected horizontally by single oxeas forming a reticulate skeleton; canals radiate from point at base. May be a lyssakid hyalosponge (12). *Sil.*, Tenn.

Petrosites HOWELL & LANDES, 1936 [**P. humilis*]. ?Like *Petrosia*. *L.Ord.*, Wis.

Family DESMACIDONTIDAE Gray, 1867

[*nom. correct.* DELAUB., herein (*ex* Desmacidonidae GRAY, 1867)]

Like Haliclonidae but having microscleres; flesh commonly slimy. *Tert.-Rec.*

Desmacidon Bow., 1862 [**Spongia fruticosa* MONTAGU, 1818; SD DELAUB., 1936]. Megascleres all oxeas; microscleres sigmas and arcuate isochelas; flesh very slimy (14,22). *?Tert., Rec.*, Eu.

Guitarra CARTER, 1874 [**G. fimbriata;* SD DELAUB., 1932]. Megascleres monaxons; microscleres include placochelas (14,22). *Tert.*(N.Z.)-*Rec.*(cosmop.).

Family HAPLISTIIDAE de Laubenfels, nov.

Skeleton composed chiefly of grouped simple monaxons. *M.Ord.-L.Carb.*

Haplistion Y.-Y., 1877 [**H. armstrongi*]. Rugose oval disk with many holes. *M.Ord.*(Wales)-*L.Carb.*(Scot.).

Lasiocladia HINDE, 1884 [**L. compressa*]. More vague and confused than *Haplistion*. *L.Dev.-L.Carb.*, Belg.

Family WAPKIIDAE de Laubenfels, nov.

Oxeas form close network in elongate

oval patterns or flat fronds with compact walls; spongin indicated by firm surface and crisp outlines. *Cam.*

Wapkia WALC., 1920 [**W. grandis*]. Can. (45). ——FIGS. 18,*6*; 19,*4*. **W. grandis,* part of frond showing arrangement of long spicules, ×1, ×3 (88, 88*).

Family HAZELIIDAE de Laubenfels, nov.

Simple elongate cylindrical, ramose or frondose; thin-walled, with dense dermal layer containing special fine spicules and some larger ones of the endosome; all spicules simple monaxons. *Cam.*

Hazelia WALC., 1920 [**H. palmata*]. Can. (45). ——FIG. 18,*4*. **H. palmata,* part of surface showing ascending tracts and hispid upper edge, ×2 (88).

Family TAKAKKAWIIDAE de Laubenfels, nov.

Slender thin-walled tube with longitudinal tracts of delicate oxeas, probably embedded in spongin. *Cam.*

Takakkawia WALC., 1920 [**T. lineata*]. Can. (45). ——FIG. 19,*3*. **T. lineata,* ×1 (88*).

Family UNCERTAIN

Eurydiscites SOLLAS, 1880 [**E. irregularis*]. Only a few loose spicules. *Cret.,* Eng.

Toriscodermia WISNIOWSKI, 1886 [no species]. Loose spicules. *Jur.,* Eu.

Esperites CARTER, 1871 [**E. giganteus*]. Isolated sigma. *L.Cret.,* Eu.

Order POECILOSCLERIDA Topsent, 1898

[*nom. correct.* DELAUB., herein (*ex* Poecilosclerina TOPSENT, 1898)]

Demosponges with dermal specialization or other complexities of spicules but no radiate structure or astrose microscleres; spiny spicules, spongin, or both commonly present. *Cam.-Rec.*

Family MYXILLIDAE Hentschel, 1923

Megascleres diactinal, smooth in ectosome, and monactinal, chiefly spined in endosome. *Tert.-Rec.*

Myxilla SCHMIDT, 1862 [**Halichondria rosacea* LIEBERKÜHN, 1859]. Microscleres comprise sigmas and anchorate isochelas (22). *?Tert.*(N.Z.), *Rec.* (cosmop.).——FIG. 18,*7*. **M. rosacea* (LIEBERKÜHN), Rec., cosmop.; *7a,b,* monaxon megascleres, ×100, *7a,* tylote, *7b,* acanthostyle; *7c,f,* microscleres, ×500, *7c,d,* sigmas, *7e,f,* anchorate isochela in 2 views (68n).

Iophon GRAY, 1867 [**Halichondria scandens* Bow., 1866; SD DENDY, 1924]. Microscleres include deformed anisochelas (22). *Tert.*(N.Z.)-*Rec.*(cosmop.)——FIG. 18,*2*. **I. scandens* (Bow.), Rec., N.Atl.; *2a-c,* deformed anisochelas, ×500 (58).

Family TEDANIIDAE Ridley & Dendy, 1886

[*nom. correct.* DELAUB., herein (*ex* Tedaniina RIDLEY & DENDY, 1886)]

Differs from Myxillidae in having chiefly smooth monaxons in endosome. *Tert.-Rec.*

Tedania GRAY, 1867 [**Halichondria anhelans* LIEBERKÜHN, 1859; SD DELAUB., 1936]. Microscleres exclusively faintly spined raphids. *Rec.,* cosmop.

Acarnus GRAY, 1867 [**A innominatus*]. Spicules include peculiar anatetraenes (14,22). *?Tert.* (N.Z.), *Rec.*(cosmop.).

Melonanchora CARTER, 1874 [**M. elliptica*]. Microscleres include clavidiscs (14,22). *?Tert.*(N.Z.), *Rec.*(cosmop.).——FIG. 18,*5*. **M. elliptica,* Rec., N.Atl.; *5a,b,* clavidiscs, ×400 (53).

Forcepia CARTER, 1874 [**F. colonensis*]. Microscleres include forceps (14,22). *Tert.*(N.Z.)-*Rec.* (cosmop.).

Family CLADORHIZIDAE de Laubenfels, 1936

Bizarre-shaped deep-sea sponges with peculiar chelas among microscleres. *Tert.-Rec.*

Cladorhiza SARS, 1872 [**C. abyssicola*]. Swollen anisochelas (14,22). *Tert.*(N.Z.)-*Rec.*(cosmop.).

Chondrocladia W.THOMP., 1873 [**C. vergata*]. Peculiar anchorate isochelas (14,22). *Tert.*(N.Z.)-*Rec.*(cosmop.).

Family AMPHILECTIDAE de Laubenfels, 1936

Monactinal spicules throughout, both in ectosome and endosome, none spiny. *Tert.-Rec.*

Amphilectus VOSMAER, 1880 [**Isodictya gracilis* Bow., 1866; SD DENDY, 1921]. Microscleres are all palmate isochelas (14,22). *?Tert.*(N.Z.), *Rec.* (cosmop.).——FIG. 18,*8*. **A. gracilis* (Bow.), Rec., N.Atl.; *8a,b,* front and side of palmate isochelas, ×500 (68n).

Hamacantha GRAY, 1867 [**Halichondria johnsonii* Bow., 1864]. Microscleres include diancistras (14, 22). *Tert.,*(N.Z.)-*Rec.*(cosmop.).——FIG. 18,*1*. **H. johnsonii* (Bow.), Rec., N.Atl.; diancistra, ×500 (52).

Family HAMPTONIIDAE de Laubenfels, nov.

Bladder-like globose sponges with thin loose walls; spicules consisting of oxeas and styles radially disposed about hollow center, with traces of spongin. Possibly related ro Axinellidae, which differ in having solid axial region. *Cam.*

Hamptonia WALC., 1920 [**H. bowerbanki*]. Can. (45).——FIG. 19,*1,2*. **H. bowerbanki*, M.Cam., B.C.; ×0.75, ×4.5 (88*).

Family ACARNIIDAE de Laubenfels, 1936

Spicules all spiny, mostly with confused arrangement. *Cret.-Rec.*

Acarnia GRAY, 1867 [**Hymeniacidon cliftoni* Bow., 1864]. Acanthostrongyles and acanthotylotes present. *Rec.*, SW.Pac.

Acanthoraphis HINDE, 1884 [**A. intertextus*]. All spicules are similar spiny oxeas (12). *Cret.*, Eng.

Family UNCERTAIN

Ophiodesia SCHRAM., 1936 [**O. solivaga*]. Spiny styles and smooth sinuous oxeas (40). *Jur.*, Eng.

Makiyama DELAUB., *nom. nov.* [*pro Sagarites* MAKIYAMA, 1931[1] (*non* ASHMEAD, 1900)] [**Sagarites chitanii* MAKIYAMA, 1931]. Resembles *Halichondria. Tert.*, Japan.

Oppligera DELAUB., *nom. nov.* [*pro Subularia* OPPL., 1921[2] (*non* MONTEROSATO, 1884)] [**Subularia clavaeformis* OPPL., 1921]. Small club-shaped sponge with cloaca; spicules 2-mm. long styles. *Jur.*, Eu.

Order HADROMERIDA Topsent, 1898

[*nom. correct.* DELAUB., herein (*ex* Hadromerina TOPSENT, 1898)]

Demosponges with radiate architecture, a cortex, and astrose microscleres, although one of these may be lacking; megascleres are chiefly tylostyles and include no tetraxons, spongin completely lacking. *Cam.-Rec.*

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[1] MAKIYAMA, J. (1931) *Stratigraphy of the Kakewaga Pliocene in Totomi:* Mem. Coll. Sci. Kyoto, vol. 7B, p. 5.

[2] OPPLIGER, F. (1921) *Fossil Sponges from the Jurassic:* Actes Soc. Helvet. Sci. Nat., vol. 101, p. 205.

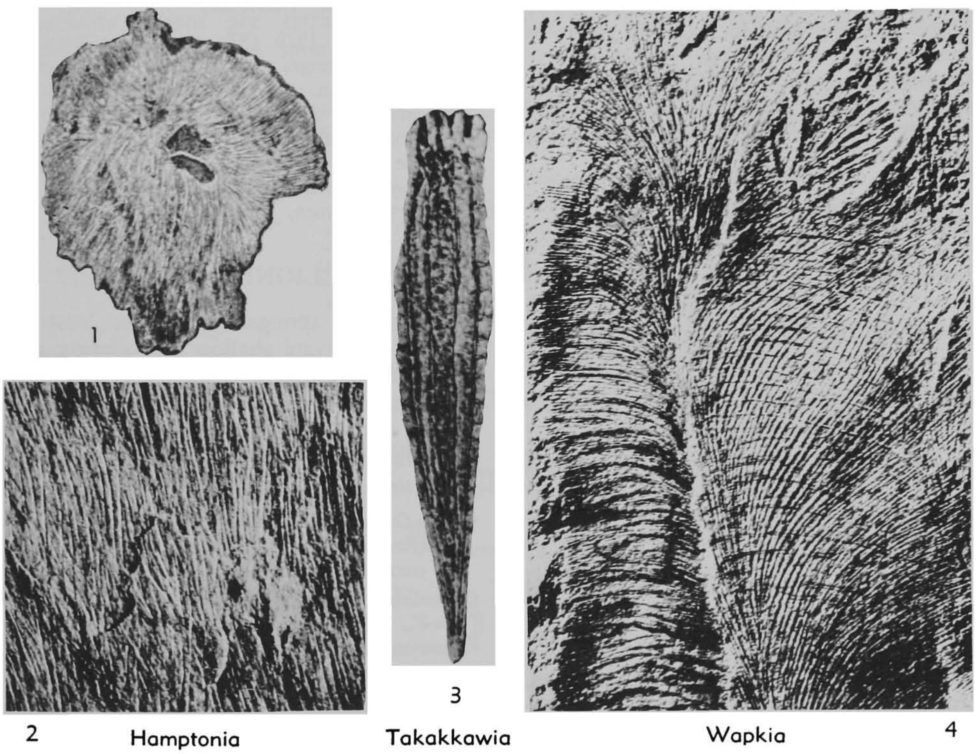


FIG. 19. Haplosclerida (*3, 4*), Poecilosclerida (*1, 2*) (p. E38-E39).

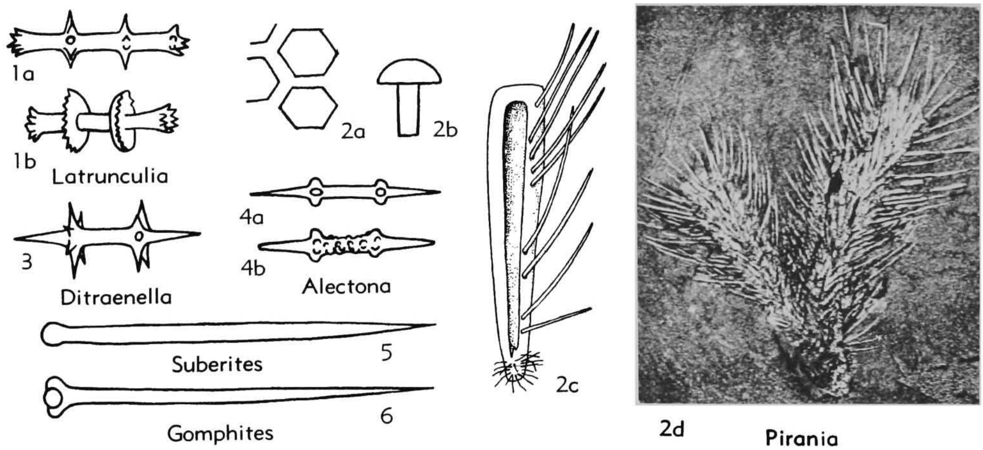


FIG. 20. Hadromerida (p. E40-E41).

Family SPIRASTRELLIDAE Hentschel, 1909

[=Choanitidae DELAUB., 1936]

Forms having astrose microscleres, not boring. *Tert.-Rec.*

Spirastrella SCHMIDT, 1868 [**S. cunctatrix*]. Megascleres comprise tylostyles only and microscleres spirasters only. *Rec.*, cosmop.

Latrunculia DE BOCAGE, 1869 [**L. cratera*]. Peculiar chessman microscleres. *Tert.* (N.Z.)-*Rec.* (14).——FIG. 20,*1*. **L. cratera; 1a,b,* chessman spicules, Rec., N.Atl., ×400 (58).

Ditraenella HINDE-H., 1892 [**D. oamaruensis*]. Verticillate spined microrhabds, like some in *Latrunculia,* which seem to be immature chessman spicules (14). *Tert.*, N.Z.——FIG. 20,*3*. **D. oamaruensis,* Tert., N.Z.; microsclere, ×400 (64).

Family SUBERITIDAE Ridley & Dendy, 1886

Like Spirastrellidae but lacking microscleres, not boring. *L.Cret.-Rec.*

Suberites NARDO, 1833 [**Alcyonium domunculum* OLIVI, 1792]. Architecture radiate, with small tylostyles in cortex and large ones in endosome (22). ?*Tert., Rec.*——FIG. 20,*5*. *S.* sp.; tylostyle, ×100 (53).

Gomphites CARTER, 1871 [**G. parfitti*]. Megascleres with heads bearing several lateral protrusions (generally 4), exactly as in *Terpios* (Rec.), from which fossils may have differed in ways not preserved (22). *L.Cret.*, Eu.——FIG. 20,*6*. **G. parfitti;* megasclere, ×100 (53).

Rhopaloconus SOLLAS, 1880 [**R. tuberculatus*]. Tylostyles extremely thick, with heads covered by many small lumps. *Cret.*, Eu.

Family PIRANIIDAE de Laubenfels, nov.

Architecture hollow, spicules consisting chiefly of tylostyles with points directed outward, but short boltlike ectosomal spicules with heads outward form a sort of surface pavement. *Cam.-Sil.*

Pirania WALC., 1920 [**P. muricata*]. Characters of family; sponges tubular, may be branched. *Cam.-Sil.*, Can.——FIG. 20,*2*. **P. muricata,* M.Cam., B.C.; *2a,* part of pavement formed by ectosomal spicules, ×2; *2b,* one of these spicules in side view, ×2; *2c,* diagrammatic outline of stem showing walls and spicules, ×3; *2d,* branched specimen, ×1.5 (88).

Family CLIONIDAE Gray, 1867

Burrowing sponges which at least in early life excavate shallow meandering galleries of subuniform diameter (commonly 1 to 6 mm.) in calcareous shells, with numerous exits of gallery-size diameter; if branches occur, they are about as large as main stem. *Sil.-Rec.*

Cliona GRANT, 1826 [**C. celata*)]. Spicules chiefly tylostyles but generally spirasters are present and less commonly oxeas (22). *Dev.-Rec.*, cosmop.

Clionolithes CLARKE, 1908 [**C. radicans;* SD FENTON-F., 1932]. Galleries about 0.5 mm. diameter, commonly radiating. *Dev.-Carb.*, U.S.A.

Clionoides FENTON-F., 1932 [**C. thomasi*]. Irregularly branched widely spaced galleries. *Dev.*, Iowa.

Filuroda SOLLE, 1938 [**Clionolithes reptans* CLARKE, 1908]. Poorly known. *Dev.*, Eu.

Thoosa HANCOCK, 1849 [**T. cactoides;* SD DELAUB., 1936]. Megascleres typically are conjoined spheres with one or more radiating shafts; microscleres commonly with verticillate spines as in *Ditraenella* (14,22). *Tert.*(N.Z.)-*Rec.*(cosmop.).

Alectona CARTER, 1879 [**A. millari;* SD DELAUB., 1936]. Like *Thoosa* but not certainly burrowing and larva seems to be choristid; some megascleres peculiarly lumpy (14,22). *Tert.*(N.Z.)-*Rec.*(cosmop.).——FIG. 20,*4*. **A. millari,* Rec., N.Atl.; *4a,b,* microscleres, ×400 (53).

?**Topsentopsis** DELAUB., *nom. nov.* [*pro Topsentia* CLARKE, 1921[1] (*non* BERG, 1899)] [**Topsentia devonica* CLARKE, 1921]. Large central galleries each with distal enlargement; so unlike any modern form that sponge affinities are doubtful. *Dev.,* U.S.A.

?**Palaeosabella** CLARKE, 1921 [**Vioa prisca* M'COY, 1862]. Probably a burrowing worm. *Sil.-Carb.,* U.S.A.

Order EPIPOLASIDA Sollas, 1888

[*nom. correct.* DELAUB., herein (*ex* Epipolasidae SOLLAS, 1888)]

Architecture typically radiate, with cortex, and having astrose microscleres, but one of these characters may be lacking; invariably absent are tetraxon spicules, normal tylostyles, and spongin. Principal spicules commonly are strongyles with swollen spindle-like shafts. *Cam.-Rec.*

[1] CLARKE, J.M. (1921) *Organic dependence and disease, their origin and significance;* N.Y. State Mus., Bull. 221, p. 88.

Family SOLLASELLIDAE Lendenfeld, 1888

Microscleres lacking. *Ord.-Rec.*

Sollasella LENDENFELD, 1888 [**S. digitata*]. Ramose; spicules include oxeas and strongyles in plumose arrangement. *Rec.,* SW.Pac.

Atractosella HINDE, 1887 [**A. siluriensis*]. Known only from smooth fusiform spicules. *M.Ord.-M.Sil.,* Eu.——FIG. 21,*1*. **A. siluriensis, Sil.,* Eng.; strongyle, ×30 (63).

Belemnospongia MILLER, 1889 [**B. fascicularis*]. Oxeas radiate upward and outward from pointed base (24). *Carb.,* U.S.A.

Opetionella ZITTEL, 1878 [**O. radians*]. Globular (49). *Jur.,* Eu.

Trichospongia BILL., 1865 [**T. sericea*]. Hemispherical form with diactinal spicules. *Ord.,* Can.

Rhizopsis SCHRAM., 1910 [**R. horrida*]. Like core of radiate sponge with outer parts decayed away. *U.Cret.,* Eu.

Family CORRALIOIDAE de Laubenfels, nov.

Conical forms expanding from small base in a series of fluted or lobate stages; oxeas in vertical tracts. *Cam.*

Corralio WALC., 1920 (p. 346) [*pro Corralia* WALC., 1920, p. 288 (*non* ROEWER, 1913)] [**Corralia undulata* WALC., 1920] (45). Can.

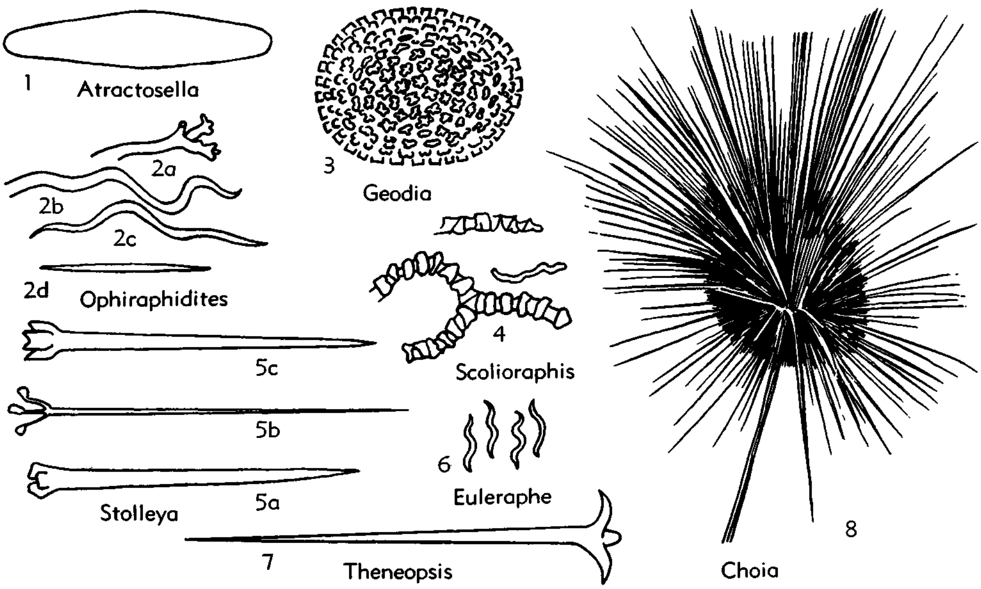


FIG. 21. Epipolasida (*1, 8*), Choristida (*2-7*) (p. E41-E43).

Family CHOIIDAE de Laubenfels, nov.

Unattached forms consisting of thin central disc with very long oxeote spicules radiating from rim in same plane. Like *Radiella* (Rec.) of the Suberitidae but lacks tylostyles. *M.Cam.-Sil.*

Choia WALC., 1920 [**C. carteri*] (45). Que.-B.C.-Utah-Wales.——FIG. 21,*8*. **C. carteri*, M.Cam., Can.; ×2 (88).

Family TETHYIDAE Gray, 1867

Spheroidal forms with warty, strongly corticate surface; microscleres include sphaerasters and euasters. *?Tert., Rec.*

Tethya LAM., 1914 [**Alcyonium aurantium* PALLAS, 1766; SD TOPSENT, 1920] (8).

Family UNCERTAIN

Sentinella WALC., 1920 [**S. draco*]. Flat, thin, poorly preserved form with tubercles and some monaxon spicules (45). Possibly close to *Tethya. Cam.,* Can.

Order CHORISTIDA Sollas, 1888

Like Epipolasida but having long-shafted triaenes and commonly other tetraxon spicules. *Carb.-Rec.*

Family ANCORINIDAE Gray, 1867

Coarse thick-shafted triaenes include dichotriaenes; presence of euasters characterizes Recent ancorinids but commonly they are lost from fossils. *Jur.-Rec.*

Ancorina SCHMIDT, 1862 [**A. cerebrum;* SD DELAUB., 1936]. Contains oxeas, anatriaenes, dichotriaenes, and 3 kinds of asters. *Rec.,* cosmop.

Theneopsis SCHRAM., 1910 [*pro Tethyopsis* ZITTEL, 1878 (*non* STEWART, 1870)] [**Tethyopsis steinmanni* ZITTEL, 1878]. Oxeas and plagiotriaeanes (38). *Cret.,* Eu.——FIG. 21,*7*. **T. steinmanni* (ZITTEL), Cret., Eu.; plagiotriaene, ×30 (93).

Stelletta SCHMIDT, 1862 [**S. grubii;* SD BURTON & RAO, 1932]. Microscleres comprise 2 types of euasters (22). *Cret.-Rec.*

Stolleya SCHRAM., 1899 [**S. microtulipa;* SD herein]. Oxeas and peculiar triaenes. *Cret.,* Eu.——FIG. 21,*5*. **S. microtulipa,* Cret., Eu.; *5a-c,* triaenes, ×20 (82).

Discispongia KOLB, 1909 [**D. unica*]. Cup-shaped form with oxeas and dichotriaenes (20). *Jur.,* Eu.

Family GEODIIDAE Gray, 1867

Like ancorinids but with dermal armor of distinctive large microscleres termed sterrasters. *Carb.-Rec.*

Geodia LAM., 1815 [**G. gibberosa*] [=*Cydonium* FLEMING, 1828] (22). *Cret.-Rec.*——FIG. 21,*3*. **G. gibberosa,* Rec.; sterraster, ×400 (68n).

Erylus GRAY, 1867 [**Stelletta mammillaris* SCHMIDT, 1862]. Like *Geodia* but with flattened sterrasters (14,22). *Tert.*(N.Z.)-*Rec.*(cosmop.).

Geodiopsis SCHRAM., 1910 [**Geodia cretacea* SCHRAM., 1899]. Like *Geodia* but with large smooth spheres which may represent sterrasters (38). *Cret.,* Eu.

Geodites CARTER, 1871 [**G. haldonensis;* SD DELAUB., herein]. Like *Geodiopsis* but with rays (clads) of triaenes blunted at ends. *Carb.-Tert.,* cosmop.

Rhaxella HINDE, 1890 [**R. perforata*]. Only sterrasters known. *U.Jur.,* Eng.

Family CRANIELLIDAE de Laubenfels, 1936

Sigmoid spiny microscleres characterize Recent forms but they are absent from fossils; otherwise members of the family are distinguished by lack of coarse triaenes. *Cret.-Tert.*

Craniella SCHMIDT, 1870 [**Alcyonium cranium* MÜLLER, 1876] (14). *Tert.-Rec.,* N.Z.

Megaloraphium SCHRAM., 1910 [**M. auriforme*]. Ear-shaped form with thin oxeas and protriaenes and some sinuous spicules (38). *U.Cret.,* Eu.

Polytretia SCHRAM., 1910 [**P. seriatopora*]. Like *Megaloraphium* but with large pores on outer surface and oscular groups on inside (38). *U.Cret.,* Eu.

Tetillopsis SCHRAM., 1910 [**T. dorinzi*]. Only thin oxeas and protriaenes present. Belongs among tetillids if microscleres lacking originally (38). *U.Cret.,* Eu.

Family SCOLIORAPHIDIDAE Zittel, 1879

[*nom. correct.* DELAUB., herein (*ex* Scolioraphidae ZITTEL, 1879)]

Some spicules strikingly annulate, like those found in the lithistid family Thamnospongiidae. *Jur.-U.Cret.*

Scolioraphis ZITTEL, 1878 [**S. cerebriformis;* SD DELAUB., herein]. Meandriform leaves or irregular shapes containing dense masses of lumpy spicules (48). *U.Cret.,* Eu.——FIG. 21,*4*. **S. cerebriformis,* spicules, ×25 (93).

Helminthophyllum SCHRAM., 1936 [**H. feifeli*]. Lumpy spicules with ornament not quite encircling rays are associated with smooth spicules (40). *Jur.,* Ger.

Condylacanthus FISCHER, 1867 [**C. gaudryi*]. Like *Scolioraphis* but less well known. *Cret.*, Fr.

Family OPHIRAPHIDITIDAE Schrammen, 1903

[*nom. correct.* DELAUB., herein (*ex* Ophiraphididae SCHRAM., 1903)]

Lithistid-like sponges characterized by peculiarly sinuous or contorted spicules, some having well-defined triaenes; evident tetraxons lacking in most. *Jur.-Rec.*

Ophiraphidites CARTER, 1876 [**O. tortuosus*]. Contorted spicules only. Type species (Rec.) represented by macerated fragments encrusting deep-sea sponge (22). *Cret.-Tert.*(Eu.)-*Rec.*(cosmop.).——FIGS. 21,*2*; 22. *O. infundibuliformis* SCHRAM., Cret., Fr.; 21,*2a*, triaene, ×16; 21,*2b,c*, ophirhabds, ×16; 21,*2d*, oxea, ×16 (21,*2*, 82); 22, spicular skeleton, ×20 (72*).

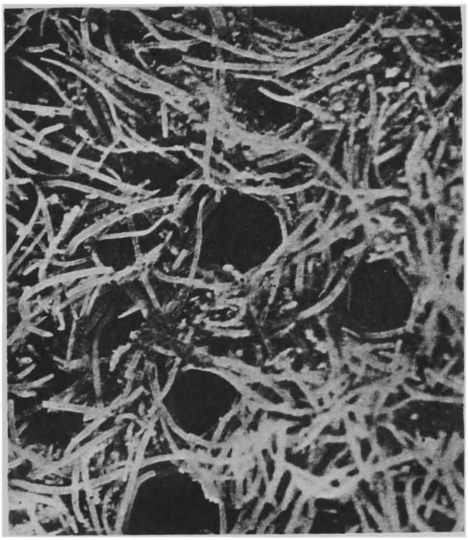


FIG. 22. *Ophiraphidites infundibuliformis* SCHRAM., Cret., Fr. (p. E43).

Heteroraphidites SCHRAM., 1901 [**H. spongiosus*] [=*Alloioraphium* SCHRAM., 1910]. Some spicules have swollen knoblike terminations (tylote) (36). *U.Cret.-Tert.*, cosmop.

Rhabdospongia SOLLAS, 1873 [**R. communis*]. Spicules are sinuous oxeas (42). *L.Cret.*, Eu.

Ophiodesia SCHRAM., 1936 [**O. solivaga*]. Spicules are sinuous ophirhabds and lumpy styles (40). *Jur.*, Eu.

Euleraphe SCHRAM., 1936 [**E. incrustans*]. Thin crust on other sponges; short sinuous spicules called eulerhabds. Strikingly similar spicules of *Megaloraphium* and *Polytreta* (Choristida) probably are convergent (40). *Jur.*, Ger.——FIG. 21,*6*. **E. incrustans;* eulerhabds, ×50 (82).

Family UNCERTAIN

Arthaberia SIEMIRADZKI, 1915 [**A. balinensis*]. Semilithistid. *Jur.*, Eu.

Cephaloraphidites SCHRAM., 1899 [**C. cavernous;* SD DELAUB., herein]. May comprise assembled spicules of diverse sponges. *Cret.*, Eu.

Fusiferella DELAUB., *nom. nov.* [*pro Atractophora* SCHRAM., 1924 (ref. 39, p. 76) (*non* STAL, 1853)] [**Atractophora armata* SCHRAM., 1924] (39). *Cret.*, Ger.

Order CARNOSIDA Carter, 1875

[*nom. correct.* DELAUB., herein (*ex* Carnosa CARTER, 1875)]

Fleshy demosponges lacking radiate structure and long-shafted triaenes and with little or no cortex. Most forms have small tetraxons with all rays nearly equal (calthrops), astrose microscleres, or both, but some lack spicules entirely, being distinguished from keratose sponges by absence of spongin. *Carb.-Rec.*

Family HALINIDAE de Laubenfels, 1936

Calthrops present and generally microscleres also. *Carb.-Rec.*

Halina BOW., 1858 [**H. bucklandi;* SD DELAUB., 1936] [=*Dercitus* GRAY, 1867]. Small calthrops common, associated with 2 types of microscleres (streptasters, toxas) (22). *Cret.-Rec.*——FIG. 23,*1*. **H. bucklandi*, Rec., Eu.; *1a*, calthrops, ×100; *1b*, streptaster, ×300; *1c*, toxa, ×300 (68n).

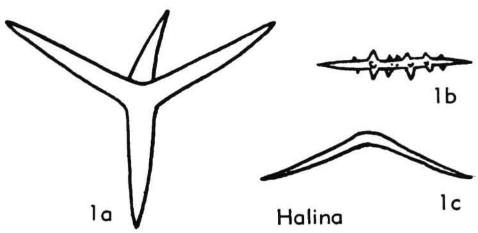


FIG. 23. *Halina bucklandi* BOW., Rec., Eu. (p. E43).

Calthropella SOLLAS, 1888 [**C. simplex;* SD LENDENFELD, 1903]. Calthrops and euasters (22). *Cret.-Rec.*, cosmop.

Triptolemma DELAUB., *nom. nov.* [*pro Triptolemus* SOLLAS, 1888[1] (*non* PECKAM, 1885)] [**Triptolemus cladosus* SOLLAS, 1888]. Calthrops, oxeas, streptasters (14,22). ?*Tert.*(N.Z.), *Rec.*(cosmop.)

Pachastrella SCHMIDT, 1868 [**P. monilifera;* SD

[1] SOLLAS, W. J. (1888) *Report on the Tetractinellida collected by H.M.S. Challenger during the years 1873-76:* Edinburgh, vol. 25, p. 93.

DELAUB., 1936]. Oxeas, calthrops, smooth microxeas, spirasters (22). *Carb.-Rec.,* cosmop.

Propachastrella SCHRAM., 1910 [**Pachastrella primaeva* ZITTEL, 1878]. Calthrops with deformities, some with extra branching as in dichotriaenes (38). *U.Cret.,* Eu.

Paropsites POČTA, 1884 [**P. hindei*]. Oxeas, small spheres, clathrops with tips of rays finely branched (30). *Cret.,* Eu.

Corticium SCHMIDT, 1862 [**C. candelabrum*]. Calthrops, some lumpy and with ray tips finely branched (14,22). *Tert.*(N.Z.)-*Rec.*(cosmop.).

Plakina SCHULZE, 1880 [**P. monolopha;* SD DELAUB., herein]. Oxeas and calthrops, some with one or more rays branched at tips but not lumpy (22). *Cret.-Rec.,* cosmop.

Youngella DELAUB., *nom. nov.* [*pro Chlamys* Y.-Y., 1877[1] (*non* Knoch, 1801)]. Resembles *Corticium* but poorly known. *Carb.,* Scot.

Acanthastrella SCHRAM., 1924 [**A. penniculosa*]. Spiny calthrops (39). *Jur.-Cret.,* Eu.

Acanthophora SOLLAS, 1873 [**A. hartogii*]. Poorly known (42). *L. Cret.,* Eu.

Order LITHISTIDA Schmidt, 1870

[*nom. correct.* ZITTEL, 1877 (*ex* Lithistidae Schmidt, 1870)]

Sponges characterized by lumpy spicules called desmas, and these generally so interlocked or cemented that rigid frameworks result. *Cam.-Rec.*

In nearly all lithistid sponges some spicules are comparatively simple and regular in form; typical microscleres also occur, but these are almost invariably lost from fossils. The desmas seem to be such megascleres as occur in other orders of Demospongea, but with increments of silica (Fig. 24). The microscleres indicate that most Lithistida are related to Choristida, but some are close to other orders. The group is judged to be polyphyletic, therefore, but it must be retained for two reasons. First, the general lack of microscleres preclude other allocation. Second, the sharp characterization and importance of these sponges warrant distinctive appellation.

Lithistids are represented in the Cambrian but are more abundant in the Ordovician and subsequent systems; they are most abundant in Cretaceous rocks. Doubtless in the past, as now, other orders were much more common, but lithistids are most apt to be recognizable fossils. Modern lithistids occur chiefly below the zone of penetration of light, and are world-wide in distribution.

The Lithistida are divisible into 5 suborders on the basis of desma type.

Suborder RHIZOMORINA Zittel, 1878

Desmas typically of rhizoclone type, small (commonly with rays about 0.2 mm. long,

[1] YOUNG, J., & YOUNG, J. (1877) *On a Carboniferous Hyalonema and other sponges from Ayrshire:* Ann. Mag. Nat. Hist. (4), vol. 20, p. 425.

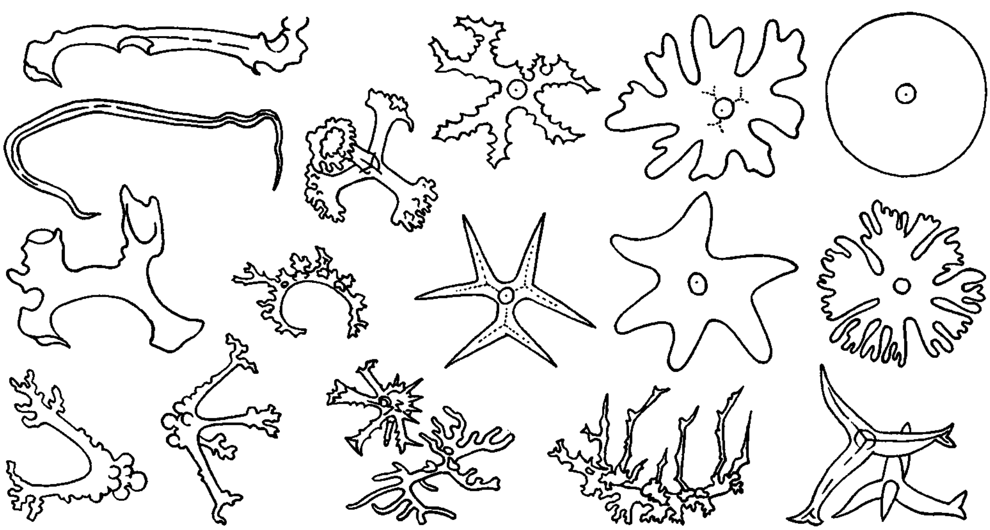


FIG. 24. Types of lithistid desmas, approximately ×25 (68n).

rarely as much as 0.5 mm.), mostly not joined together at tips of rays. *Cam.-Rec.*

None of the rhizomorine (signifying piece of root) or rhizocladine desmas are clearly based on an original tetraxonid framework, but commonly they show development from a single straight or crooked initial rod (primordium). If 4 main rays are produced, the desma has a superficial tetraclad appearance; such spicules occur in the suborder but are rare. The common sort of desma, consisting of highly irregular rugose rhizoclones, is often termed monocrepid. Skeletons formed by union of these spicules may be classed as (1) confused when the desmas are joined together in quite irregular manner, and as (2) fibroid when the united desmas form elongate columnar tracts which may exhibit coarse reticulation. Because various genera (as *Scytalia, Chonella,* and others) have been interpreted divergently by different authors and because intermediate structures of dubious nature exist, both types of skeletons may be included in a given family.

Many sponges assigned to the Rhizomorina have smooth spicules, as well as rhizoclone desmas. These smooth spicules generally resemble typical choristid types, but they may correspond to sorts characteristic of other orders, indicating possible relationship to them. On the basis of external appearance, each of the 6 families in this suborder may be compared with some family of the Tetracladina.

Representatives of the Rhizomorina are found in nearly every system, beginning with the Cambrian, but Paleozoic fossils are mostly not well preserved. Greatest abundance of forms belonging to the suborder occurs in Cretaceous rocks.

Family KALIAPSIDAE de Laubenfels, 1936

Typical rhizomorine sponges. *Cret.-Rec.*

Kaliapsis Bow., 1869 [**K. cidaris*]. Phyllotriaenes, rhizoclad desmas, and acanthostyles. *Rec.,* Ind.O.-Pac.O.

Corallistes SCHMIDT, 1870 [**C. typus*]. Amorphous or polymorphic lithistids with monocrepid desmas, associated in some individuals with megacladine and dicranocladine types; smooth oxeas and dichotriaenes present. Recent species are characterized by streptaster microscleres. Skeleton divergently defined as fibroid (48) or confused (22,26). *Tert.-Rec.,* cosmop.

Procorallistes SCHRAM., 1901 [**P. polymorphus;* SD herein]. Like *Corallistes* but has few or no smooth spicules (36). *Cret.-Mio.,* Ger.-Fr.

Laosciadia POMEL, 1872 [**L. fungiformis* (?=*Spongia plana* PHILL., 1829)] [=*Trachydictya* POMEL, 1872; *Seliscothon* ZITTEL, 1878 (**Spongia plana* PHILL., 1829; SD DELAUB., herein)]. Vase or funnel shape, skeleton radiate-lamellate (31, 49). *Cret.,* Eu.——FIG. 25,*5*. *L. cylindricum* (MORET), Cret., Fr.; skeleton white, ×25 (72).

Histiodia POMEL, 1872 [**H. undulata;* SD DELAUB., herein]. [=*Histodia* MORET, 1924 *(nom. null.)*]. Vase- or funnel-shaped. Fascicles of confluent and intercrossing canals in cortex (25, 31). *Cret.-Tert.* Fr.-Alg.——FIG. 25,*1*. *H. cylindrica* (MORET), Cret., Fr.; desmas, ×30 (72).

Pseudoseliscothon MORET, 1926 [**P. cazioti*]. Like *Histiodia* but desmas have extremely long roots (26). *U.Cret., Fr.*——FIG. 25,*2*. **P. cazioti;* desmas, ×25 (72).

Family SCYTALIIDAE de Laubenfels, nov.

Like Kaliapsidae but large cloaca gives tubular sponge, as in the tetracladine family Chenendoporidae. *Jur.-U.Cret.*

Scytalia ZITTEL, 1878 [**Jerea turbinata* RÖMER, 1864; SD SCHRAM., 1924]. Tubes commonly branched (49). *Jur.-Cret.,* Eu.

Coelocorypha ZITTEL, 1878 [**Siphonocoelia nidulifera* RÖMER, 1864; SD herein]. Differs from *Scytalia* in narrowness of cloacal tube; skeleton fibroid (49). *Cret.,* Eu.——FIG. 25,*4*. *C. subglobosa* ZITTEL, Ger.; spicules, ×64 (93).

Stachyspongia ZITTEL, 1878 [**Siphonocoelia spica* RÖMER, 1864; SD DELAUB., herein]. Like *Coelocorypha* but with large conical protrusions, especially near distal end; skeleton fibroid-confused (49). *U.Cret.,* Eu.——FIG. 25,*7*. *S. tuberculosa* RÖMER, U.Cret., Fr.; side view of sponge, ×1.2 (72).

Yrrhiza DELAUB., *nom. nov.* [*pro Rhizinia* KOLB, 1910 (ref. 20, p. 242) (*non* HAMMERSCHMIDT, 1838)] [**Rhizinia immunuta* KOLB, 1910]. Resembles *Coelocorypha. Jur.,* Eu.

Chondriophyllum SCHRAM., 1924 [**Verruculina tenuis* RÖMER, 1864]. Thin-walled cup or leaf (39). *U.Cret.,* Eu.

Aulosoma SCHRAM., 1924 [**Spongia radiciformis* PHILL., 1835]. Slender cylinder with surface pattern of narrow canals (39). *U.Cret.,* Ger.

Rhabdotum SCHRAM., 1924 [**R. columna*]. Like *Aulosoma* but with porous surface (39). *Cret.,* Eu.

Polyrhizophora LINCK, 1883 [**P. jurassica*]. Resembles *Coelocorypha* but poorly known. *Jur.,* Eu.

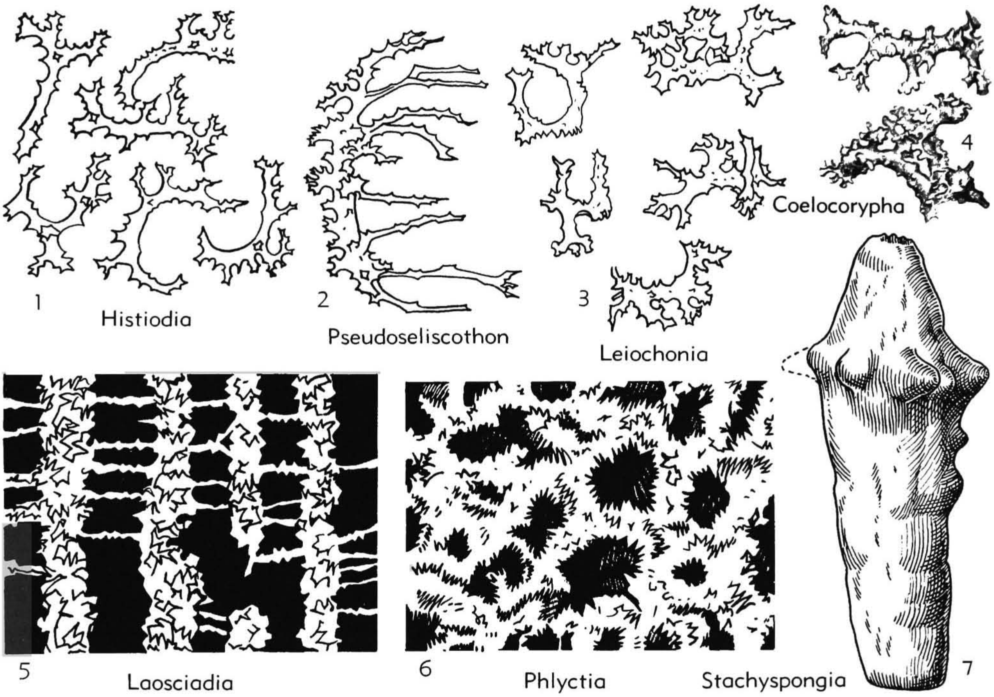


FIG. 25. Lithistida (Rhizomorina): Kaliapsidae, Scytaliidae, Chonellidae, Astroboliidae (p. E45-E47).

Family CHONELLIDAE Schrammen, 1924

Thin-walled, generally vase- or cup-shaped sponges; entire surface marked by pattern of fine pores with jagged outlines owing to lumpy desmas around them; smooth spicules few or lacking. *Jur.-Tert.*

Chonella ZITTEL, 1878 [**Cupulospongia tenuis* RÖMER, 1861]. Ear-shaped; skeleton fibroid-confused (49). *Cret.-Mio.*, Eu.-N.Afr.

Platychonia ZITTEL, 1878 [**Spongites vagans* QUENST., 1858; SD DELAUB., herein]. Like *Chonella* but skeleton extremely confused (49). *U.Jur.-Tert.*, Eu.

Discostroma ZITTEL, 1878 [**Tragos intricatum* QUENST., 1878]. Discoid, with shallow concavity at top; skeleton confused (49). *Jur.*, Eu.

Patanophyma OPPL., 1915 [**P. polyporum*]. Thin-walled vase (28). *Jur.*, Eu.

Leiochonia SCHRAM., 1901 [**L. cryptoporosa;* SD DELAUB., herein]. Moderately thick-walled cup, saucer, or plate; skeleton confused (36). *Cret.*, Eu.——FIG. 25,*3*. **L. cryptoporosa;* spicules, ×25 (72).

Amphichondrium SCHRAM., 1924 [**Verruculina convoluta* QUENST.]. Thin-walled cup (39). *U.Cret.*, Eu.

Pseudoscytalia SCHRAM., 1924 [**Spongia terebrata* PHILL., 1835]. Like *Amphichondrium* but with definite cortex (39). *U.Cret.*, Eu.

Chonellopsis SCHRAM., 1936 [**C. striata;* SD DELAUB., herein]. Small ear- or leaf-shaped form (40). *Jur.*, Eu.

Family ASTROBOLIIDAE de Laubenfels, nov.

Oscules set in shallow depressions sur-

FIG. 26. *Pliobolia fragilis* (SCHRAM.), U. Cret. (Santon.) (p. E47).

rounded by stellate pattern of radiating grooves, which in life probably were covered by dermis and functioned as apochetes; smooth spicules few or absent. Corresponds to tetracladine family Astrocladiidae. *Jur.-Tert.*

Astrobolia ZITTEL, 1878 [**Cnemidium conglobatum* REUSS, 1846; SD DELAUB., herein]. Asymmetrical, with many small pores; skeleton ?fibroid (49). *Cret.*, Eu.

Phlyctia POMEL, 1872 [**P. expansa;* SD DELAUB., herein]. Distinctive skeleton, no canals (31). *Tert.*, N.Afr.——FIG. 25,6. *P.* sp.; conjoined desmas (white), ×30 (72).

Pliobolia POMEL, 1872 [**P. vermiculata*] [=*Coscinostoma* SCHRAM., 1910]. Funnel-shaped; skeleton confused (31). *U.Cret.*(Ger.)-*Mio.*(N.Afr.). ——FIG. 26. *P. fragilis* (SCHRAM.), U.Cret.(Santon.), Fr.; ×1 (72*).

Cytoracia POMEL, 1872 [**Stellispongia grandis* RÖMER, 1864; SD DELAUB., herein]. Globular lobate; skeleton confused (31). *Jur.-Cret.*, Eu.

Family CNEMIDIASTRIDAE Schrammen, 1936

Massive to cylindrical, lateral surfaces bearing vertical ridges and grooves which commonly form radiate pattern on summit; smooth spicules rare or absent. Corresponds to tetracladine family Aulaxiniidae. *Ord.-Jur.*

Cnemidiastrum ZITTEL, 1878 [**Cnemidium stellatum* GOLDF., 1833; SD DELAUB., herein] [=*Lithostrobilus* SCHRAM., 1936]. Cylindrical or top-shaped, with deep central cloaca; prosopores in grooves between ridges; skeleton confused. *Ord.-U.Jur.*, Eu.(49).——FIG. 27,2. **C. stellatum* (GOLDF.), *U.Jur.*, Ger.; *2a*, specimen, ×0.5; *2b*, vert. tang. sec., showing radial canals in clefts, ×1; *2c*, desma, ×60 (94).

Proseliscothon SIEMIRADZKI, 1915 [**P. cracoviense*]. Wider than high, cloaca lacking. *Jur.*, Eu.

Cnemispongia QUENST., 1878 [**C. goldfussii;* SD DELAUB., herein]. Externally like *Cnemidiastrum* but skeleton unknown (32). *?Mesoz.*, Ger.

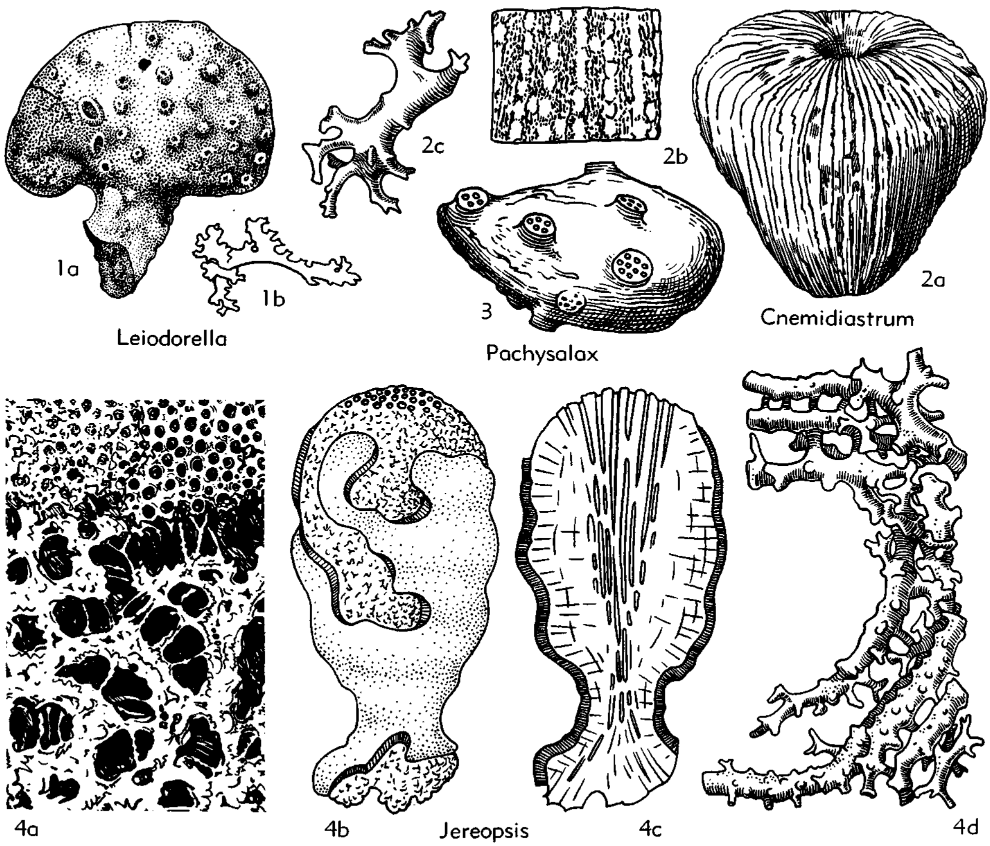


FIG. 27. Lithistida (Rhizomorina): Cnemidiastridae, Jereopsiidae, Leiodorellidae (p. E47-E48).

Family JEREOPSIIDAE de Laubenfels, nov.

Cylindrical to massive, summit rather flat, bearing oscules of several deep narrow vertical cloacas; sides finely porous, with prosochetes intersecting cloacas at right angles; smooth spicules rare. Corresponds to tetraclad family Jereiidae. *U.Jur.-Rec.*

Jereopsis POMEL, 1872 [**J. inaequalis;* SD DELAUB., herein] [=*Jereopsidea* POMEL, 1872 (**Jereopsis aberrans* POMEL, 1872; SD DELAUB., herein); *Jereica* ZITTEL, 1878]. Skeleton fibroid (25, 49). *Cret.-Tert.,* Eu.-Alg.——FIG. 27,*4a. J. punctata* (GOLDF.), Cret., Fr.; part of skeleton, cortex with pores at right, naked endoskeleton at left, ×18 (72).——FIG. 27,*4b-d. J. polystoma* (RÖMER), Cret., Fr.; *4b,c,* side view and vert. sect., ×0.5; *4d,* rhizoclone desmas, ×60 (93).

Hyalotragos ZITTEL, 1878 [**Tragos patella* GOLDF., 1833; SD DELAUB., herein]. Commonly wider than high, shallow concavity at top (49). *U.Jur.,* Eu.

Pachysalax SCHRAM., 1910 [**P. processifer*]. Fig- or potato-shaped, with about 10 raised areas, each resembling an individual of *Hyalotragos* or *Jereopsis* (38). *U.Cret.,* Eu.——FIG. 27,*3.* **P. processifer;* side view, ×0.5 (82).

Pomelia ZITTEL, 1878 [**P. schmidti*]. Resembles *Jereopsis* (49). *?Mio.*(N.Afr.),*Rec.*(Fla.).

Family LEIODORELLIDAE Schrammen, 1924

Form diverse but having smooth corticate surface with abundant small oscules surrounded by circular raised rim which has rounded (not sharp) upper edge. *Jur.-Rec.*

Leiodorella ZITTEL, 1878 [**L. expansa;* SD herein] [=*Amphisyringium* SCHRAM., 1924]. Ear- or plate-shaped, possibly encrusting, both sides corticate; skeleton confused (49). *Jur.,* Eu.——FIG. 27,*1.* **L. expansa; 1a,* specimen, ×0.5; *1b,* desma, ×50 (93).

Amphistomium SCHRAM., 1924 [**A. aequabile*]. Like *Leiodorella* but cup-shaped (39). *Cret.,* Eu.

Epistomella ZITTEL, 1878 [**Spongites clivosa* QUENST., 1843]. Like *Leiodorella* but oscules on one side only (49). *Jur.,* Eu.

Pyrgochonia ZITTEL, 1878 [**Tragos acetabulum* GOLDF., 1833]. Like *Leiodorella* but desmas differ (49). *U.Jur.,* Eu.

Verruculina ZITTEL, 1878 [**Manon micrommata* RÖMER, 1841; SD DELAUB., herein]. Funnel- or leaf-shaped; skeleton fibroid, some smooth spicules (49). *M.Cret.-Tert.,* Eu.——FIG. 28,*1. Verruculina,* various species from Cret., Eu.; *1a, V. auriformis* RÖMER, ×0.7 (94); *1b, V. astraea* HINDE; *1c, V. seriatopora* RÖMER; *1d, V. cupula* SCHRAM.; *1e, V. miliaris* REUSS; *1b-e,* ×0.7 (72).

Scythophymia POMEL 1872 [**S. crassa;* SD DELAUB., herein]. MORET (26) says "most spp. = *Verruculina*" (31). *Tert.,* Alg.

Pleurophymia POMEL 1872 [**P. cotyle;* SD DELAUB., herein]. MORET (26) says "most spp. =*Verruculina*" (31). *Tert.,* Alg.

Amphithelion ZITTEL, 1878 [**Manon macrommata* RÖMER, 1841; SD SCHRAM., 1924]. Like *Verruculina* but both oscules and pores have round raised rims. *Cret.,* Eu.

Hyalospongia SIEMIRADZKI, 1915 [**Tragos infrajugum* QUENST., 1878]. Plate- or disk-shaped, top like *Leiodorella,* base with radiating rounded ridges. *Jur.,* Eu.

Bothrolemma SCHRAM., 1936 [**Platychonia osculifera* KOLB, 1910]. Encrusting on other sponges (40). *Jur.,* **Eu.**

Stichophyma POMEL, 1872 [**Manon turbinatum* RÖMER, 1841; SD RAUFF, 1893] [=*Marisca* POMEL, 1872; *Meta* POMEL, 1872 (*non* LAPORTE, 1849); *Stychophyma* VOSMAER, 1885 *(nom. null.)*; *Sticophyma* MORET, 1924 *(nom. null.)*]. Like *Leiodorella* but with serial annulate swellings; skeleton fibroid (31). *Cret.-Mio.,* Eu.-N.Afr.

Macandrewia GRAY, 1859 [**M. azorica*]. Like *Stichophyma* but lacks annulate swellings and oscules confined to nearly level summit. *Cret.-Rec.*

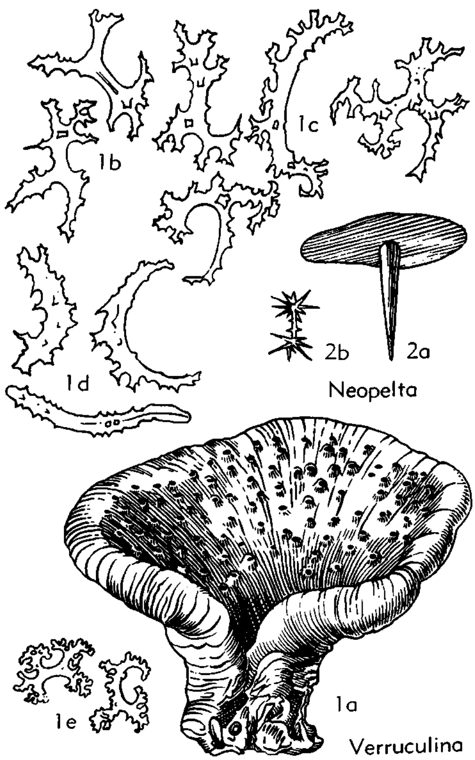


FIG. 28. Lithistida (Rhizomorina): Leiodorellidae, Neopeltidae (p. E48-E49).

Family PLINTHODERMATIIDAE de Laubenfels, nov.

Extremely thin leaflike, probably plate- or vase-shaped when complete, with one side smooth and the other rough like shark skin; without evident pores, oscules, or canals. *U.Cret.*

Plinthodermatium SCHRAM., 1910 [**P. exile*] (38). *U.Cret.,* Ger.

Family NEOPELTIDAE Sollas, 1888

Dermal armor of discotriaenes present. Corresponds to tetracladine family Discodermiidae. *Cret.-Rec.*

Neopelta SCHMIDT, 1880 [**N. imperfecta*]. Endosome packed with desmas and containing some smooth oxeas and amphiasters. *Cret.-Rec.,* cosmop. ——FIG. 28,*2*. **N. imperfecta,* Rec., N.Atl.; *2a,* discotriaene, ×50; *2b,* amphiaster, ×500 (81).

Trachynoton DELAUB., *nom. nov.* [*pro Trachynotus* SCHRAM., 1924 (ref. 39, p. 76) (*non* BELL, 1862)]. [**Coscinostoma auricula* SCHRAM., 1912]. Desmas and dermal siliceous plates (?discotriaenes lacking inward-pointing rhabds). *U.Cret.,* Ger.

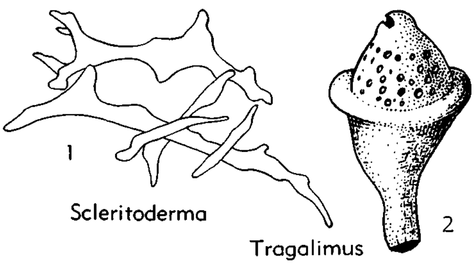


FIG. 29. Lithistida (Rhizomorina): Scleritodermatidae, Uncertain family (p. E49).

Family SCLERITODERMATIDAE Sollas, 1888

[*nom. correct.* DELAUB., herein (*ex* Scleritodermidae SOLLAS, 1888)]

Rhizocladine sponges which seem closely related to the order Epipolasida in lacking tetraxon spicules, whereas other rhizocladine families show relationship to the order Choristida. *Cret.-Rec.*

Scleritoderma SCHMIDT, 1879 [**S. paccardi*]. Strongyles and monocrepid (monaxonid) desmas. In Recent species, microscleres include sigmas and sigma-like spirasters (22). *Cret.-Rec.,* cosmop.—— FIG. 29,*1*. *S. paccardi,* Rec., Gulf Mexico; spicules, ×100 (81).

Azorica CARTER, 1873 [**A. pfeifferae*]. Smooth oxeas and monocrepid desmas; skeleton fibroid (8). *Cret.-Rec.,* cosmop.

Family UNCERTAIN

Pemmatites DUNIKOWSKI, 1885 [**P. verrucosa;* SD DELAUB., herein]. Mass of rhizoclones with some strands of monaxons. *Carb.-Perm.,* Eu.

Nipterella HINDE, 1889 [**Calathium paradoxicum* BILL., 1865]. Subcylindrical, top convex. *Cam.-Ord.,* E.Can.

Bolidium ZITTEL, 1878 [**Amorphispongia palmata* RÖMER, 1864]. Many small pores but no evident oscules or canals; desmas with peculiarly rounded lumps (49). *Cret.,* Eu.

Tragalimus POMEL, 1872 [**Dimorpha balanus* COURT., 1861; SD DELAUB., herein]. Distinctive annulated pear shape, spicules poorly known. *Cret.,* Fr.——FIG. 29,*2*. **T. balanus* (COURT.); side view, ×0.2 (56).

Elasmalimus POMEL, 1872 [**Dimorpha prolifera* COURT., 1861; SD DELAUB., herein]. Contorted; possibly same as *Tragalimus. Cret.,* Fr.

Dimorpha COURT., 1872 [**D. cornuta;* SD DELAUB., herein]. Like *Tragalimus* but with incomplete belt and 2 conspicuous oscules at top. *Cret.,* Fr.

Urnacristata DELAUB., *nom. nov.* [*pro Lophiophora* SCHRAM., 1924 (ref. 39, p. 110) (*non* ZRYK, 1915)] [**Lophiophora sulcata* SCHRAM., 1924] (39). *Cret.,* Ger.

Orecyta DELAUB., *nom. nov.* [*pro Cytorea* POMEL, 1872 (ref. 31, p. 225) (*non* LAPORTE, 1849)] [**Limnorea nobilis* RÖMER, 1864] (31). *Cret.,* Eu.

Oncodona DELAUB., *nom. nov.* [*pro Oncophora* SCHRAM., 1924 (ref. 39, p. 112) (*non* DIESING, 1851)] [**Oncophora maeandrina* SCHRAM., 1924] (39). *U.Cret.,* Ger.

Multipocula DELAUB., *nom. nov.* [*pro Polypora* SCHRAM., 1901 (ref. 36, p. 16) (*non* M'COY, 1842)] [**Polypora reticulata* SCHRAM., 1901] (38). *Cret.,* Ger.

Verrucospongia ORB., 1849 [**Manon sparsum* REUSS, 1829; SD DELAUB., herein] (29). *U.Cret.,* Eu.

Microrhizophora KOLB, 1910 [**M. pentagona*]. Very small (20). *Jur.,* Eu.

Oncocladia KOLB., 1910 [**O. sulcata*] (20). *Jur.,* Eu.

Allomera POMEL, 1872 [**A. obovata;* SD DELAUB., herein] (31). *Mio.,* N.Afr.

Perimera POMEL, 1872 [**Polystoma boletiformis* COURT., 1861] (31). *Cret.,* Eu.

Pleuromera POMEL, 1872 [**P. inaequalis*] (31). *Mio.,* N.Afr.

Plococonia POMEL, 1872 [**Spongia contortolobata* MICH., 1847] (31). *Cret.,* Eu.

Pocillospongia COURT., 1861 [**P. pyriformis;* SD DELAUB., herein] [=*Poecilospongia* POMEL, 1872] (6). *Cret.,* Eu.

Heterothelion SCHRAM., 1924 [**Verruculina cupula*] (39). *Cret.,* Ger.

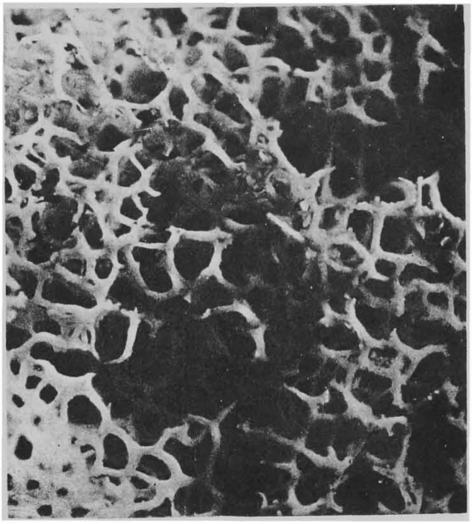


FIG. 30. *Propleroma regnardi* MORET, U.Cret., Fr. (p. E50).

Cryptothelion SCHRAM., 1924 [**C. geminum*] (39). *Cret.*, Ger.

Sporadothelion SCHRAM., 1924 [**S. dissipatum*] (39). *Cret.*, Ger.

Coelosphaeroma SCHRAM., 1910 [**C. appendiculata*] (38). *U.Cret.*, Ger.

Macrobrochus SCHRAM., 1910 [**M. emscheris;* SD DELAUB., herein] (38). *U.Cret.*, Ger.

Suborder MEGAMORINA Zittel, 1878

Desmas of megaclone type, relatively large (length commonly more than 1 mm.), with rays mostly smooth except for rounded lumps. Vertical canals representing large apochetes or narrow cloacas lead to several oscules on upper surface, and numerous small prosopores on sides are inhalant openings of subhorizontal or curved narrow prosochetes. Architecture resembles that of the rhizocladine Jereopsiidae and tetracladine Jereidae. *Carb.-Rec.*

Family PLEROMIDAE Sollas, 1888

Mostly subcylindrical sponges, unbranched, symmetrical. *Jur.-Rec.*

Pleroma SOLLAS, 1888 [**P. turbinatum*]. Desmas smooth except at ends of clads; microscleres raphids and spirasters. *Rec.*, E.Ind.——FIG. 31,*3*. **P. turbinatum; 3a,b,* megascleres, ×45 (72).

Nematinion HINDE, 1884 [**N. calyculum*]. Elongate cylindrical (commonly more than 25 cm. high), with somewhat concave summit (12). *Cret.*, Eu.——FIG. 31,2. **N. calyculum;* side, ×0.3 (63).

Carterella ZITTEL, 1878 [**Jerea cylindrica* GÜMBEL, 1861; SD DELAUB., herein]. Like *Nematinion* but with convex summit (49). *Cret.*, Eu.

Propleroma MORET, 1926 [**P. regnardi*]. Resembles *Carterella* (27). *U.Cret.*, Fr.——FIGS. 30,31,*1*. **P. regnardi;* 30, skeleton, ×20 (72*); 31,*1a-e,* desmas, ×40 (72).

Inodia MORET, 1926 [**I. elizabethae*]. Like *Carterella* but spicules very long (26). *U.Cret.*, Fr. ——FIG. 31,*5*. **I. elizabethae;* desmas, ×20 (72).

Pachypoterion HINDE, 1884 [**P. robustum;* SD DELAUB., herein]. Like *Nematinion* but expanded upward in goblet form (12). *U.Cret.*, Eu.

Holodictyon HINDE, 1884 [**H. capitatum*]. Like *Pachypoterion* but canal system obscure. *Cret.*, Eu.——FIG. 31,*6*. **H. capitatum; 6a,* side view of specimen, ×0.3; *6b,* conjoined spicules, ×25 (63).

Heterostinia ZITTEL, 1878 [**H. cyathiformis*]. Polymorphic, commonly like *Holodictyon* or *Pachypoterion* (49). *Cret.*, Eu.——FIG. 31,*7*. *H. obliqua* BENNETT; spicules, ×10 (63).

Anomorphites KOLB, 1910 [**A. plicatus;* SD DELAUB., herein] [=*Anomorphistes* FERRER HERNANDEZ *(nom. null.)*]. Cup- or saucer-shaped (20). *Jur.*, Eu.

Lyidium SCHMIDT, 1870 [**L. torquilla*]. *Eoc.-Rec.*, Eu.

Megalithista ZITTEL, 1878 [**M. foraminosa*]. Summit so concave as to produce cup shape (49). *U.Jur.*, Ger.

Family DORYDERMATIDAE Moret, 1926

[*nom. correct.* DELAUB., herein (*ex* Dorydermidae MORET, 1926)]

Like Pleromidae but cylinders branched, or growth massive with many distinct oscular areas, each resembling the summit of *Pleroma*. *Carb.-U.Cret.*

Doryderma ZITTEL, 1878 [**D. roemeri* HINDE, 1883 (*pro Polyjerea dichotoma* RÖMER, 1861)]. Branches shorter than wide (49). *Carb.-U.Cret.*, Eu.——FIG. 31,*8*. **D. roemeri* HINDE, U.Cret., Eng.; *8a,* side view of specimen, ×1; *8b,* dermal layer, ×2; *8c,* spicules, ×10; *8d,* spicules, showing some triaenes, ×30; *8e,* transverse section, showing prosochetes containing smooth spicules, ×20 (*8a-d*,92; *8e*,72).

Brochodora SCHRAM., 1910 [**B. ramusculus;* SD DELAUB., herein]. Resembles *Doryderma* (38). *Cret.*, Eu.

Homalodora SCHRAM., 1910 [**Spongia ramosa* MANTELL, 1822; SD DELAUB., herein]. Like *Doryderma* but has longer branches (38). *U.Cret.*, Eu.

Valhalla DELAUB., *nom. nov.* [*pro Asteroderma* SCHRAM., 1901 (ref. 36, p. 13) (*non* PERRIER, 1888)] [**Asteroderma expansa* SCHRAM., 1901] (36). *Cret.*, Eu.

Placonella HINDE, 1883 [**P. perforata;* SD DELAUB., herein]. Mass with several concave round oscular areas. *Jur.,* Eu.

Amphilectella SCHRAM., 1901 [**A. piriformis;* SD DELAUB., herein]. Pear-shaped (36). *U.Cret.,* Ger.

Family HELOBRACHIIDAE Schrammen, 1910

Besides typical megaclone desmas, contains peculiar spicules having an axial sphere from which strongly curved rays (commonly 3) diverge, the rays as much as 1 mm. long. *U.Cret.*

Helobrachium SCHRAM., 1910 [**H. consecatum*]. Incrusting, with or without lobes; oxeas present (38). *U.Cret.,* Ger.——FIG. 31,*4*. **H. consecatum;* peculiar threadlike spicules, ×12 (82).

Family ISORAPHINIIDAE Schrammen, 1924

Unusually large megaclone desmas nearly or quite unbranched; may be grouped in bundles and generally are joined at their extremities to form a network. *Jur.-Cret.*

Isoraphinia ZITTEL, 1878 [**Siphonocoelia texta*

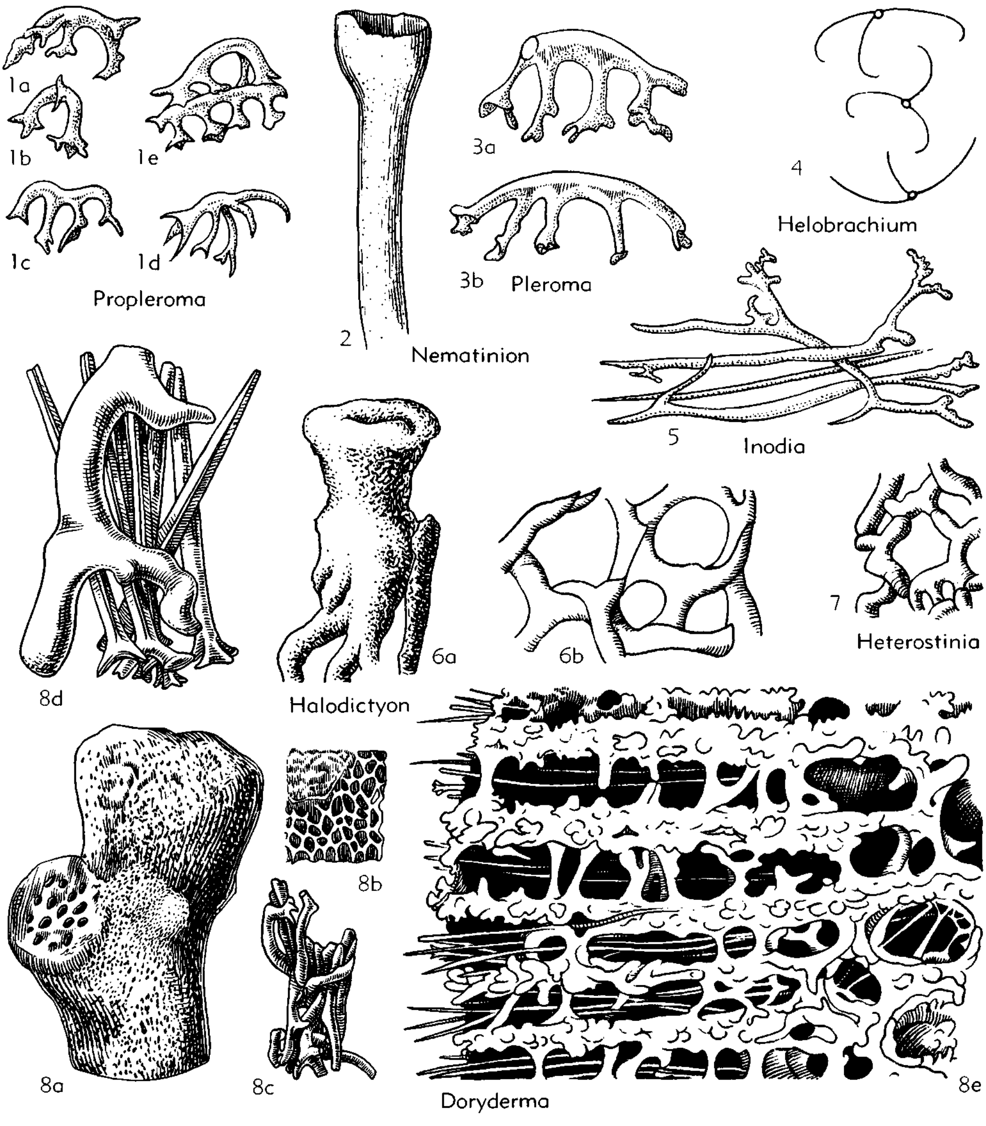


FIG. 31. Lithistida (Megamorina): Pleromidae, Dorydermatidae, Helobrachiidae (p. E50-E51).

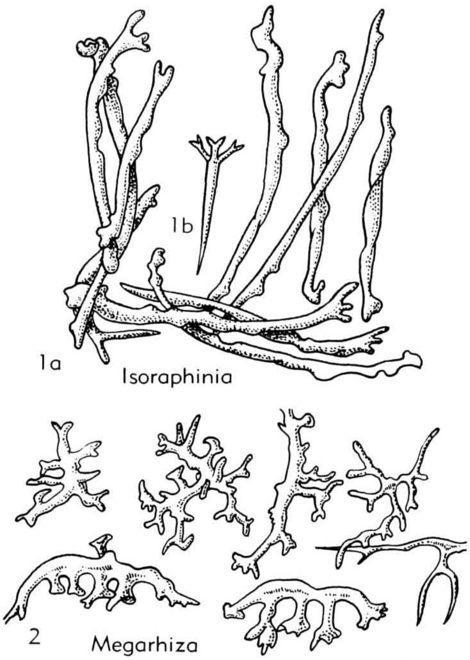


FIG. 32. Lithistida (Megamorina): Isoraphiniidae, Uncertain family (p. E52).

RÖMER, 1864]. Cylindrical, with wide, deep cloaca; contains choristid-type spicules (49). *Cret.*, Eu. ——FIG. 32,*1*. **I. texta* (RÖMER); *1a*, spicules of principal skeleton, ×30; *1b*, dermal dichotriaene, ×15 (72).

Heloraphinia SCHRAM., 1936 [**H. arborescens*]. Like *Isoraphinia* but with warty branches (40). *Jur.*, Ger.

Pachycothon SCHRAM., 1901 [**P. giganteum;* SD DELAUB., herein]. Skeleton as in *Isoraphinia* but canal system unknown (36). *Jur.-Cret.*, Eu.

Family UNCERTAIN

Megarhiza SCHRAM., 1901 [**M. dubia;* SD DELAUB., herein]. Desmas intermediate between rhizocladine and megacladine types (36). *Cret.*, Eu.——FIG. 32,*2*. *M. colungensis* MORET, Cret., Fr.; spicules, ×30 (72).

Suborder TETRACLADINA Zittel, 1878

Desmas of tetraclone type, mostly with rays smooth except at tips but some covered with lumps or spines; union of desmas commonly at contacts of elaborately sculptured ray extremities, forming a rigid fine-meshed reticulation. *Ord.-Rec.*

The desmas of this suborder, based on a tetraxonid framework, generally are intermediate in size between those of the Rhizocladina and Megacladina, but many are as small as the former and a few as large as the latter. If the tetraxonid nature of the spicules is evident, sponges containing them ordinarily are assignable to the Tetracladina whether tip-to-tip reticulation exists or not. The term tetracrepid frequently is applied to these desmas.

Tetracladine sponges predominate over other types in known fossils of Ordovician age and they are common in many younger formations. Greatest abundance is observed in Cretaceous deposits. Only a few are recorded from Tertiary rocks and the group is nearly lacking in modern faunas.

Family AULOCOPIIDAE de Laubenfels, nov.

Rounded to amorphous sponges having typically a set of prosochetes parallel to the surface and apochetes approximately normal to the surface, but this pattern may be vague; most ancient and generalized family of the suborder. *Ord.-Perm.*

Aulocopium OSWALD, 1847 [**A. aurantium* OSWALD, 1850; SD RAUFF, 1893]. Subglobular short-stalked form, underside with wrinkled dense dermis; canal system typical of family. *Ord.-Sil.*, Eu.-Ill.——FIG. 34,*1*. **A. aurantium*, Sil., Ger.; *1a*, side view of sponge, partly dissected, ×0.5; *1b*, network of spicules, ×60 (94).

Dendroclonella RAUFF, 1895 [**D. rugosa*]. Like upper part of *Aulocopium*. *U.Sil.*, Tenn.

Allosaccus RAY.-O., 1940 [**A. prolixus*]. Resembles *Dendroclonella* (34). *Ord.*, Tenn.-Va.

Exochopora RAY.-O., 1940 [**Calathium canadense* BILL., 1865] (34). *Ord.*, Can.-Ill.

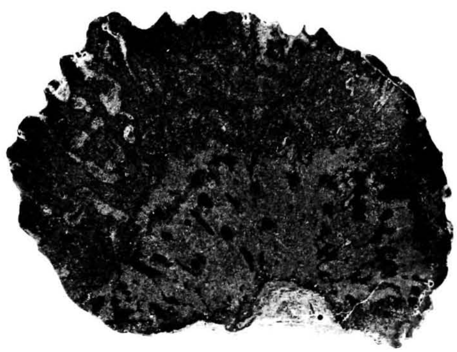


FIG. 33. *Defordia defuncta* R. H. KING, L.Perm., Tex. (p. E53).

Hudsonospongia RAY.-O., 1940 [**H. cyclostoma*]. Pear-shaped, top gently concave (34). *M.Ord.,* Tenn.-N.Y.-Vt.-Can.

Psarodictyon RAY.-O., 1940 [**P. magnificum*]. Discoid (34). *Ord.,* N.Y.

Rhopalocoelia RAY.-O., 1940 [**R. clarkii*]. Cylindrical (34). *Ord.,* N.Y.-Tenn.

Aulocopina BILL., 1874 [**A. granti*]. Resembles *Aulocopium*. *Sil.,* Can.

Aulocopella RAUFF, 1895 [**A. winnipegensis*]. Much like *Aulocopium*. *Ord.,* Can.

Protachilleum ZITTEL, 1877 [**P. kayseri*] (40). *Sil.,* Arg.

?**Defordia** KING, 1943 [**D. defuncta*]. Hemispherical, rough-surfaced like bath sponge, with large canals normal to the surface and branching near it and with slender canals parallel to surface (22), *Perm.,* Tex.——FIG. 33. **D. defuncta;* long. sec., ×1 (66).

?**Pseudovirgula** GIRTY, 1908 [**P. tenuis*]. Cylindrical, with oscules on side (8). *Perm.,* Tex.

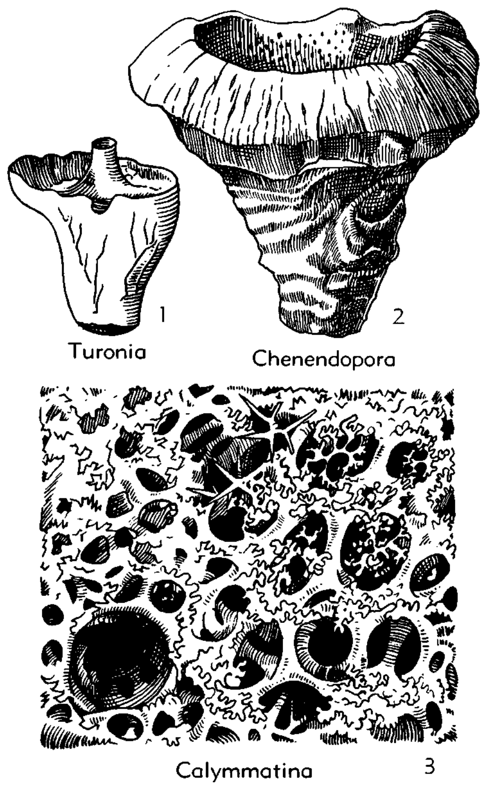


FIG. 35. Lithistida (Tetracladina): Chenendoporidae (p. E54-E55).

Family ARCHAEOSCYPHIIDAE Rauff, 1894

Highly organized vase-shaped sponges, moderately large (10 to 20 cm. high and nearly as wide), with rather smooth walls 1 to 2 cm. thick marked by vertical rows of apopores betwen dense radiate ridges; outer side profusely porous, commonly with rounded elevations 1 or 2 cm. high or with annular rings of similar height. *Ord.*

Archaeoscyphia HINDE, 1889 [**Archaeocyathus minganensis* BILL., 1859]. Curved horn-shaped,

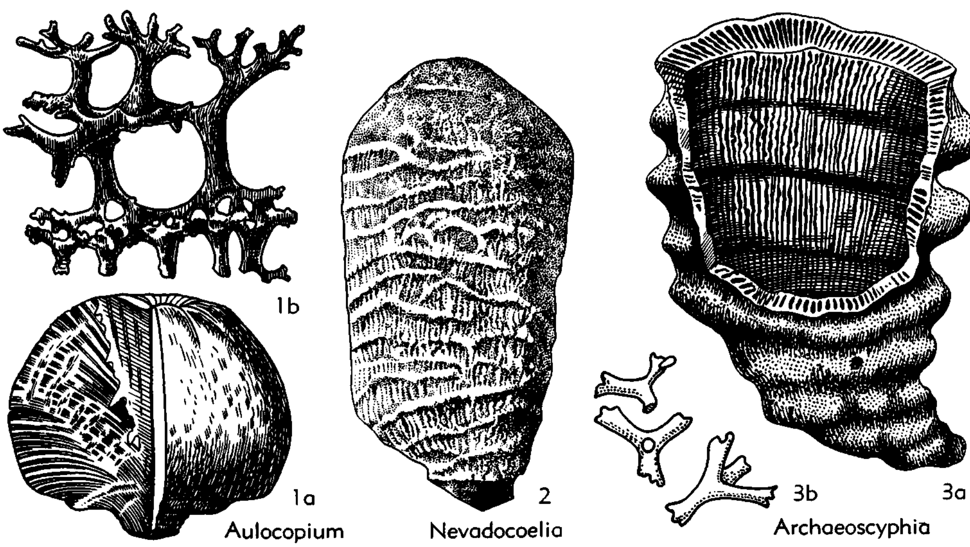


FIG. 34. Lithistida (Tetracladina): Aulocopiidae, Archaeoscyphiidae (p. E52-E54).

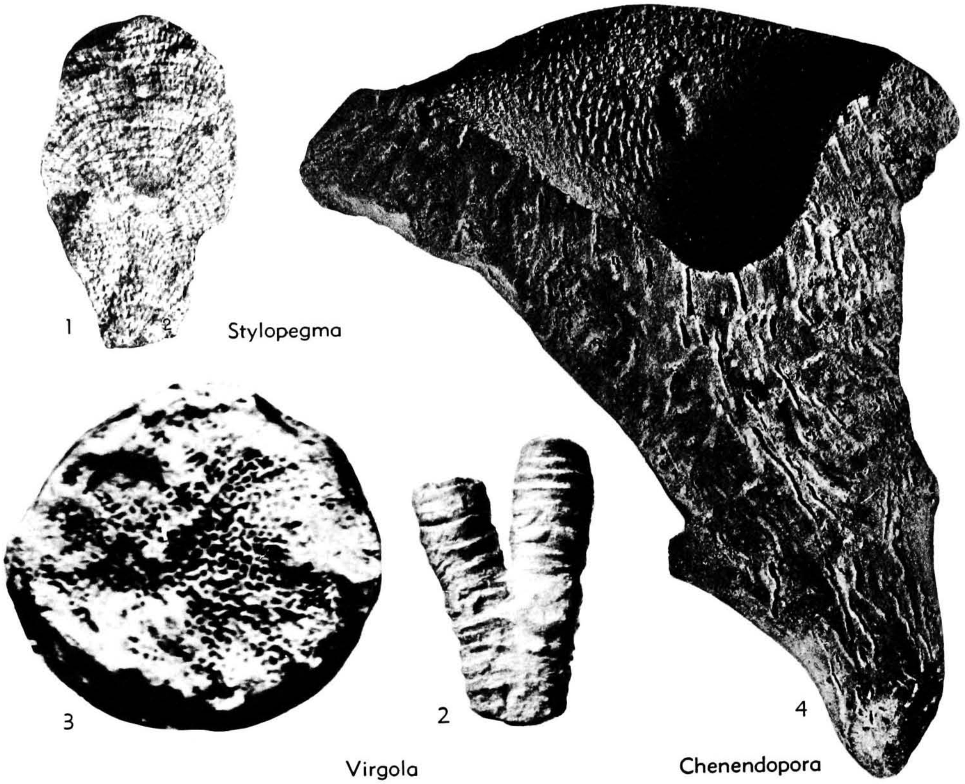


FIG. 36. Lithistida (Tetracladina): Chenendoporidae (p. E54-E55).

central cavity very deep and wide. *Ord.*, Can. (13).——FIG. 34,*3*. **A. minganensis* (BILL.); *3a,* side view of specimen, part of wall removed, ×0.3; *3b,* spicules, ×35 (63).

Nevadocoelia BASSLER, 1927 [**N. wistae*]. Simple, erect, stalked, with cloaca extending full length; outer surface ridged transversely (1). *M.Ord.*, Nev.——FIG. 34,*2*. **N. wistae,* side view of specimen, ×6 (84).

Patellispongia BASSLER, 1927 [**P. oculata*]. Lamellate, possibly comprising fragments of vase; convex side smooth, with cortex containing canals; concave side with large ?apopore openings (1). *M.Ord.*, Nev.

Hesperocoelia BASSLER, 1927 [**H. typicalis*]. Like *Patellispongia* but flat (1). *M.Ord.*, Nev.

Lissocoelia BASSLER, 1927 [**L. ramosa*]. Hollow cylinders (1). *M.Ord.*, Nev.

Calycocoelia BASSLER, 1927 [**C. typicalis*]. Cup-shaped (1). *M.Ord.*, Nev.

Ozarkocoelia CULLISON, 1944 [**O. irregularis*]. *Ord.*, U.S.A.

Family CHENENDOPORIDAE Schrammen, 1910

Like Archaeoscyphiidae but structure much simpler. Corresponds to the rhizocladine family Scytaliidae. *?Perm., Jur.-U.Cret.*

Chenendopora LAMX., 1821 [**C. fungiformis*] [=*Chenendropora* FROM., 1860]. Many slender apochetes open into cloaca (21). *U.Cret.*, Eu.——FIG. 35,*2*. **C. fungiformis,* side view of specimen, ×0.3 (94).——FIG. 36,*4*. *C. gratiosa* COURT., Fr.; ×1 (72*).

Trachysycon ZITTEL, 1878 [**Plocoscyphia muricata.* RÖMER, 1864]. Fig- or egg-shaped, cloaca very large (49). *Cret.*, Eu.

Protetraclis STEINM., 1881 [**P. linki*]. Elongate vase-shaped. *Jur.*, Ger.

Rhizotetraclis KOLB., 1910 [**R. plana*] (28). *Jur.*, Ger.

Tretoechus OPPL., 1915 [**T. coniformis*]. Like *Protetraclis;* thick-walled (29). *Jur.*, Ger.

Turonia MICH., 1849 [**T. variabilis*] [=*Turonifungia* FROM., 1860]. Expanding upward to sharp-rimmed crater containing central cone with oscule (but interpreted by author with reverse orientation). *U.Cret.*, Eu.——FIG. 35,*1*. **T. variabilis;* side view, ×0.5 (59).

Calymmatina ZITTEL, 1878 [**C. rimosa;* SD DE-LAUB., herein]. Long tubes, some branched; dense cortex (49). *U.Cret.*, Eu.——FIG. 35,*3*. *C. niciensis* MORET; surface showing main skeletal framework and scattered dermal spicules, with large opening of a prosopore, ×25 (72).

Pachycalymma SCHRAM., 1901 [**P. subglobosa;* SD DELAUB., herein]. Like *Calymmatina* but thicker (36). *Cret.*, Eu.

Kalpinella HINDE, 1884 [**K. pateraeformis;* SD DELAUB., herein]. Stalked cup with large pores on outside and similar exhalant openings on inside. Resembles *Marginospongia* but approaches the Hallirhoidae. *U.Cret.*, Eng.

Marginospongia ORB., 1849 [**Alcyonium infundibulum* LAMX., 1821] [=*Marginoierea* FROM., 1860]. Like *Kalpinella* but pores minute (29). *Cret.*, Eu.

?**Virgola** DELAUB., *nom. nov.* [*pro Virgula* GIRTY, 1908 (ref. 8, p. 73) (*non* SIMPSON, 1900)] [**Virgula neptunia* GIRTY, 1908]. Cylindrical, commonly branched, some with deep cloaca, all with conspicuous rectangular-mesh reticulation (8). *Perm.*, Tex.——FIG., 36,*3*. **V. neptunia* (GIRTY), Capitan; transv. sec., ×5 (60).——FIG. 36,*2*. *V. rigida* (GIRTY), Capitan, ×1 (60*).

?**Stylopegma** KING, 1943 [**S. dulce*]. Like *Virgola* (19). *Perm.*, Tex.——FIG. 36,*1*. *S. conica* KING, L.Perm., W.Tex.; nat. oblique long. sec., ×1 (66*).

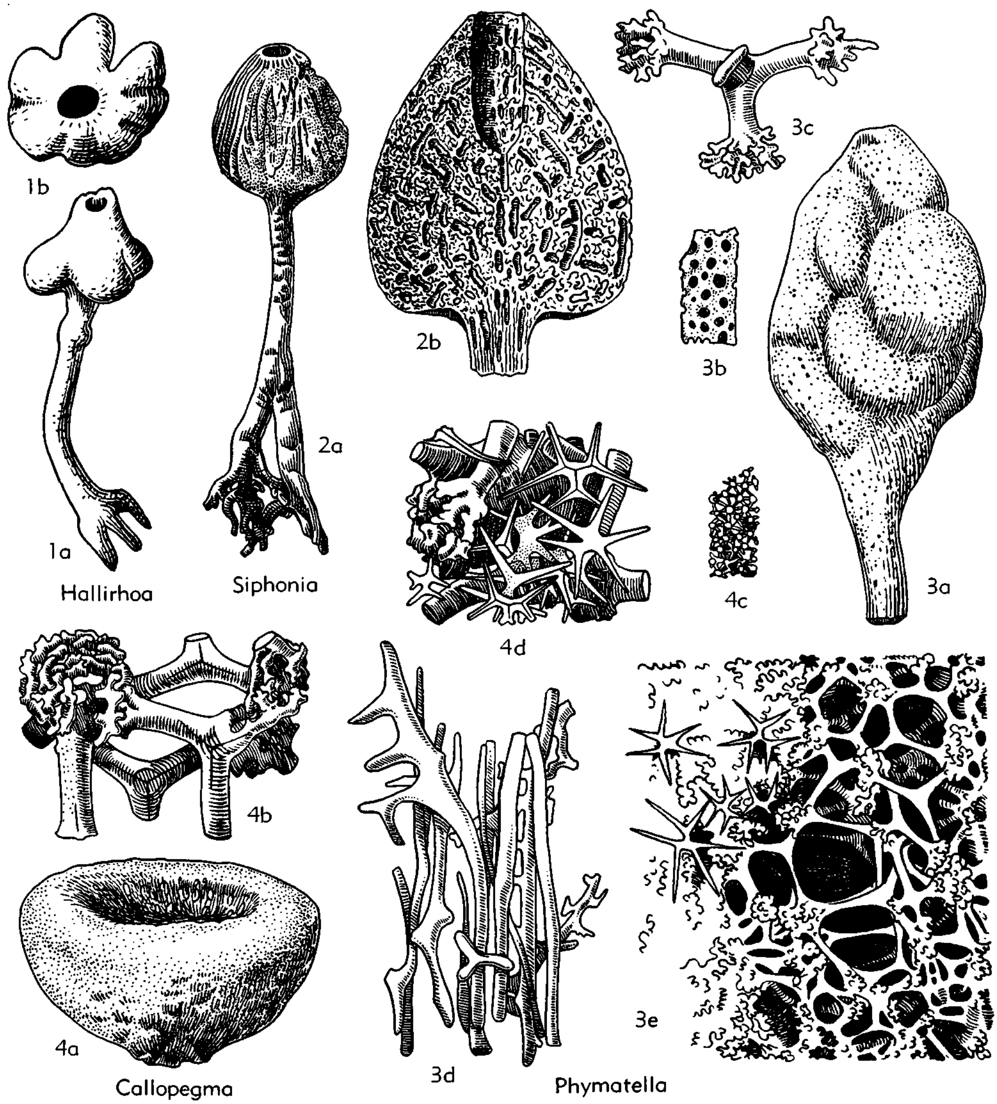


FIG. 37. Lithistida (Tetracladina): Hallirhoidae (p. E56).

Family HALLIRHOIDAE de Laubenfels, nov.

Mostly stalked (some with very long stalks), commonly with lobate lateral protrusions; surface rather smooth, with only minute pores; apochetes generally parallel to surface, with apopores in rows within cloaca; prosochetes invariably slender, subnormal to surface. *Jur.-Tert.*

Hallirhoa LAMX., 1821 [**H. costata*]. Lobate body shorter than root-bearing stalk (21). *U.Cret.*, Eu.——FIG. 37,*1*. **H. costata; 1a*, side view; *1b*, top view of another specimen; both ×0.4 (72).

Siphonia PARKINSON, 1822 [**Choanites konigii* MANTELL, 1822; SD HINDE, 1887] [=*Siphoneudea* FROM., 1860]. Nonlobate body on long stem with large roots; well-developed canal system typical of family. *M.Cret.-Tert.*, Eu.——FIG. 37,*2*. *S. tulipa* ZITTEL, U.Cret., Eng.; *2a*, side view, ×0.5; *2a*, side view, ×0.5; *2b*, sagittal sec., ×1 (94).

Phymatella ZITTEL, 1878 [**Eudea intumescens* RÖMER, 1864; SD DELAUB., herein]. Body irregularly lobate, longer than stem; cloaca very small (49). *U.Cret.*, Eu.——FIG. 37,*3*. *P. tuberosa* QUENST.; *3a*, side view, ×0.5; *3b*, portion of surface showing prosopores, ×1; *3c*, desma of articulated main skeleton, ×5; *3d*, spicules from stalk, ×50 (94).——FIG. 37,*3e*. *P. nodosa* HINDE; part of reticulate main skeleton (below) and cortex with dichotriaenes (above), ×30 (72).

Bathotheca OPPL., 1915 [**Batotheca ovata* OPPL., 1915 (pl. 9, fig. 4); SD DELAUB., herein] [=*Batotheca* OPPL., 1915, p. 59 (*non* ENDERLEIN, 1905)]. Like *Siphonia* but pores coarser and lacks cloaca (28). *Jur.*, Eu.

Carterella SCHRAM., 1901 [**C. tuberosa;* SD DELAUB., herein]. Funnel-shaped (36). *U.Cret.*, Eu.

Callopegma ZITTEL, 1878 [**C. acaule;* SD DELAUB., herein]. Funnel-shaped, with very short stem (49). *U.Cret.*, Ger.-Belg.——FIG. 37,*4*. **C. acaule*, Ger.; *4a*, side view, ×0.75; *4b*, united desmas, ×40; *4c,d*, part of lateral surface, ×2, ×40 (94).

Sontheimia KOLB., 1910 [**S. parasitica;* SD DELAUB., herein]. Globular, very short-stemmed, with or without cloaca (20). *Jur.*, Ger.

Asterocalyx MORET, 1926 [**A. beaussetensis*]. Horn-shaped, stemmed; apopores in cloaca grouped, with radiating ridges (26). *U.Cret.*, Fr.

Bolospongia HINDE, 1884 [**B. globata;* SD DELAUB., herein]. Globular, commonly lobate as in *Phymatella* (12). *Jur.-Cret.*, Eu.

Thecosiphonia ZITTEL, 1878 [**Lymnorea nobilis* RÖMER; SD herein]. Top-shaped, dense cortex, with cloaca (49). *U.Cret.-Tert.*, Eu.

Pseudoplocoscyphia SCHRAM., 1901 [**P. moeandrina*] (36). *U.Cret.*, Ger.

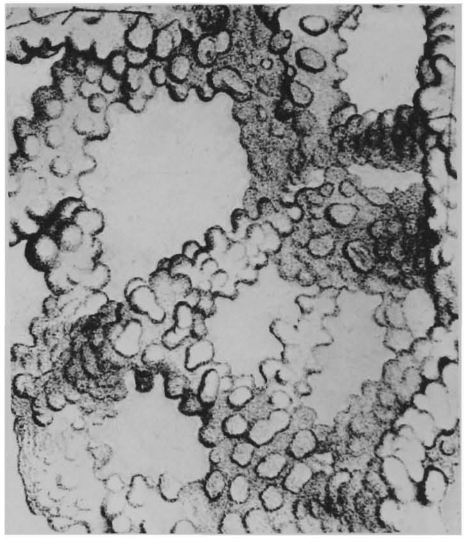


FIG. 38. *Plinthosella squamosa* ZITTEL, Cret., Ger. (p. E56).

Family PLINTHOSELLIDAE Schrammen, 1910

Shape various, commonly small (diameter 1 cm. or less), with surface openings (pores, ?oscules) consisting of jagged interstices between rough skeletal elements. Somewhat resemble Chonellidae. *?Perm., Cret.*

Plinthosella ZITTEL, 1878 [**P. squamosa;* SD HINDE, 1884] [=*Phintosella* POČTA, 1883]. Globular, free or short-stemmed, with large oscules; at least some desmas very lumpy (49). *Cret.*, Eu.——FIG. 38. **P. squamosa*, Ger.; skeletal structure, ×64 (93*).

Pycnodesma SCHRAM., 1910 [**P. globosum*]. Minute, stalked, without cloaca (38). *U.Cret.*, Eu. ——FIG. 39,*1*. **P. globosum;* part of surface, ×15 (72).

Phymaplectia HINDE, 1884 [**P. irregularis;* SD DELAUB., herein]. Platelike, dermal desmas triradiate, very lumpy (12). *U.Cret.*, Eng.

Zitteleus DELAUB., *nom. nov.* [*pro Spongodiscus* ZITTEL, 1878 (ref. 49, p. 153) (*non* EHR., 1854)]. [**Turonia radiata* COURT., 1861]. Like *Phymaplectia* (49). *Cret.*, Fr.

?Monarchopemmatites DELAUB., 1947 [*pro Pseudopemmatites* KING, 1943 (*non* FRAIPOUNT, 1911)] [**Pseudopemmatites skinneri* KING, 1943]. Surface with many pores but no dermis, large canals, or oscules (19). *Perm.*, Tex.

Family ASTROCLADIIDAE Schrammen, 1910

Scattered oscules numerous, each surrounded by stellate pattern of radiating grooves. Corresponds to rhizocladine family Astroboliidae. *Cret.-Tert.*

Astrocladia ZITTEL, 1878 [**Asterospongia laevis* RÖMER, 1861; SD DELAUB., herein]. Ramose; cortex contains desmas resembling rhizoclones (49). *U.Cret.-Tert.,* Eu.——FIG. 39,*2*. *A. ramosa* (MICH.), *Cret.,* Fr.; side view of specimen, ×0.5 (72).

Microdendron SCHRAM., 1901 [**M. ramulosum*]. Cylindrical or ramose, with incomplete dermis. Similar gross structure is seen in *Cystispongia* (Camerospongiidae) (36). *U.Cret.,* Ger.

Ingentilotus DELAUB., *nom. nov.* [*pro Dactylotus* SCHRAM., 1910 (ref. 38, p. 115) (*non* SCHOENHERR, 1884)] [**Dactylotus micropelta* SCHRAM., 1910]. Bushy, with flat branches; desmas resemble rhizoclones (38). *U.Cret.,* Ger.

Myrmeciophytum SCHRAM., 1910 [**Stellispongia verrucosa* RÖMER, 1864]. Oscules on wartlike elevations (38). *U.Cret.,* Ger.

Family AULAXINIIDAE de Laubenfels, nov.

Mostly subcylindrical, invariably marked by parallel longitudinal furrows on surface, which probably represent large subdermal canals in the living sponge. Corresponds to rhizocladine family Cnemidiastridae. *Cret.*

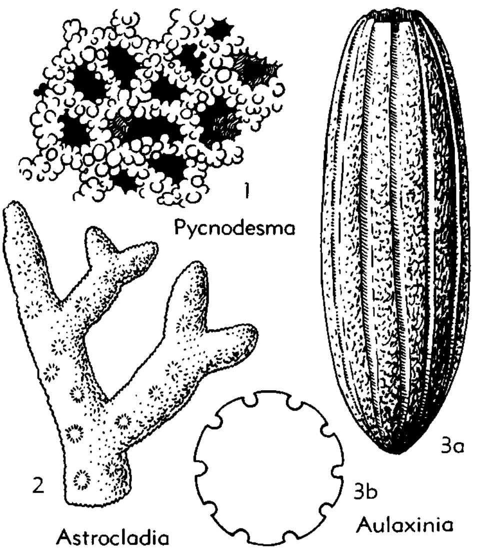


FIG. 39. Lithistida (Tetracladina): Hallirhoidae, Astrocladiidae, Aulaxiniidae (p. E56-E57).

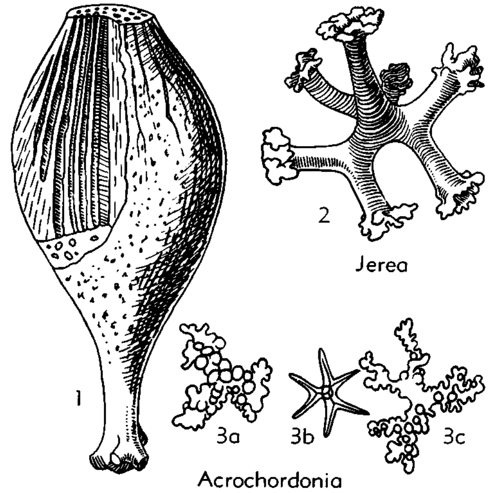


FIG. 40. Lithistida (Tetracladina): Jereidae (p. E57-E58).

Aulaxinia ZITTEL, 1878 [**Siphonocoelia sulcifera* RÖMER, 1864]. Cylindrical, with deep to shallow cloaca; desmas very large (49). *U.Cret.,* Ger.-Eng. ——FIG. 39,*3*. **A. sulcifera* RÖMER; *3a,b,* side view and transv. sec. ×0.3 (63).

Rhopalospongia HINDE, 1884 [*Polypothecia gregaris* BENNETT, 1831; SD DELAUB., herein]. Elongate club-shaped, with roots; many conspicuous pores (12). *L.Cret.,* Eng.

Family JEREIDAE de Laubenfels, nov.

Relatively large vertical apochetes open into a round, flat or gently concave area at summit of sponge; slender prosochetes, which may be obscure, are nearly normal to lateral surface and to ascending canals. Corresponds to rhizocladine family Jereicidae. *?Perm., Cret.*

Jerea LAMX., 1821 [**J. pyriformis*] [=*Ierea* FROM., 1860]. Ovoid, stalked (24). *Cret.,* Eu.——FIG. 40,*1*. **J. pyriformis,* Ger.; side partly dissected, ×0.5 (50).——FIG. 40,*2*. *J. quenstedti* ZITTEL, Ger.; desma, ×40 (94).

Polyierea FROM., 1860 [**Jerea gregaria* MICH., 1847] [=*Polyjerea* POMEL, 1872]. Like compound *Jerea* and may be merely a growth form of this genus (7). *Cret.,* Eu.

Dichojerea POMEL, 1872 [**Polyjerea dichotoma* RÖMER, 1864; SD RAUFF, 1893]. Like *Polyierea* (31). *Cret.,* Eu.

Bolojerea RAUFF, 1933 [**B. glebula*]. Resembles *Jerea. U.Cret.,* Eu.

Jereomorpha MORET, 1925 [**J. cenomanensis*]. Like *Jerea. U.Cret.,* Fr.

Placoscytus SCHRAM., 1910 [*pro Sollasella* SCHRAM., 1901 (*non* LENDENFELD, 1887)] [**Sollasella jer-*

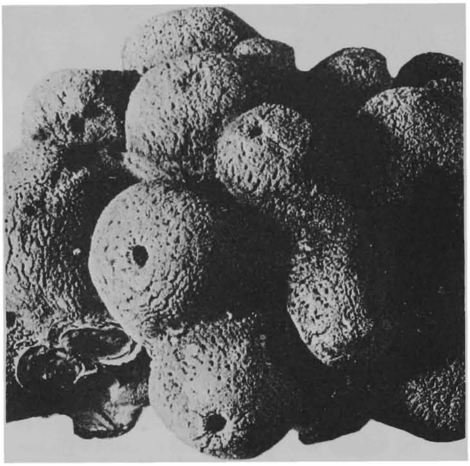


FIG. 41. *Discodermia galloprovincialis* MORET, U. Cret. (Santon.), Fr. (p. E58).

eaeformis SCHRAM., 1910]. Like *Polyierea* on stalk, possibly a growth form of *Jerea* (38). *U.Cret.*, Ger.

Nelumbia POMEL, 1872 [**Polystoma cupula* COURT., 1861; SD DELAUB., herein]. Like *Jerea* with roots (31). *U.Cret.*, Eu.

?**Anthracosycon** GIRTY, 1908 [**A. fiscus*]. Much like *Jerea*. *Perm.*, Tex.

?**Laubenfelsia** KING, 1943 [**L. regularis*]. Like *Jerea* but spicules much as in *Stromatidium* (22). *Perm.*, Tex.

Acrochordonia SCHRAM., 1901 [**A. ramosa*]. Like *Jerea* but stalkless and with very lumpy tetraclones (36). *U.Cret.*, Ger.——FIG. 40,*3*. **A. ramosa; 3a,c,* lumpy tetraclones, ×30; *3b,* dermal smooth dichotriaene, ×30 (72).

Family DISCODERMIIDAE Schrammen, 1910

Dermal armor of discotriaenes or phyllotriaenes. Corresponds to rhizocladine family Neopeltidae. *L.Cret.-Rec.*

Discodermia BOCAGE, 1869 [**D. polydiscus*]. Polymorphic; discotriaenes grading toward phyllotriaenes (8). *Cret.-Rec.*, cosmop.——FIG. 41. *D. galloprovincialis* MORET, U.Cret.(Santon.), Fr.; ×0.8 (72*).

Racodiscula ZITTEL, 1878 [**Corallistes asteroides* CARTER, 1873; SD DELAUB., herein]. Phyllotriaenes common (49). *Cret.-Rec.*, cosmop.——FIG. 42,*2*. **R. asteroides,* Cret., Eu.; phyllotriaene from side facing sponge interior, ×50 (93).

Theonella GRAY, 1868 [**T. swinhoei*]. Somewhat radiate architecture (22). *Tert.-Rec.*, cosmop.

Ragadinia ZITTEL, 1878 [**Cupulospongia rimosa* RÖMER, 1864]. Saucer-shaped, with canals opening on conspicuous branched furrows on both surfaces (49). *U.Cret.*, Ger.——FIG. 42,*4*. **R. rimosa* (RÖMER); *4a,* specimen, ×0.7; *4b,* desmas; *4c,* dermal phyllotriaene; *4d,* other dermal spicules; *4b-d,* ×40 (94).

Phyllodermia SCHRAM., 1924 [**P. spinosa;* SD DELAUB., herein]. Expanding upward from one or more short stalklike parts; top concave (38). *U.Cret.*, Ger.——FIG. 42,*7*. **P. spinosa; 7a,* top views of 3 specimens; *7b,* sagittal sec. of same ×0.2 (38).

Pseudojerea MORET, 1926 [**P. massiliensis;* SD DELAUB., herein]. Shape like *Jerea,* with cortex as in *Discodermia* (26). *U.Cret.*, Fr.——FIG. 43,*2*. **P. massiliensis,* Santon.; ×15 (72*).

Lerouxia MORET, 1926 [**L. galloprovincialis*]. Ramose (26). *U.Cret.*, Fr.——FIG. 43,*1*. **L. galloprovincialis,* Santon.; ×15 (72*).

Dactylocalycites CARTER, 1871 [**D. callodiscus;* SD DELAUB., herein]. Loose thin discoid spicules, which seem to be distinctively modified phyllotriaenes or discotriaenes. *L.Cret.*(Eng.)-*Tert.* (N.Z.).——FIG. 42,*1a*. **D. callodiscus,* Tert., Austral.; spicules, ×150; 42,*1b,* same from L.Cret., Eng., ×150 (53).

Stellettites CARTER, 1871 [**S. haldonensis*]. Resembles *Dactylocalycites*. *L.Cret.*, Eu.

Eustrobilus SCHRAM., 1910 [**E. callosus*]. Cylindrical, cloaca large; some peculiar fusiform spicules (38). *U.Cret.*, Ger.——FIG. 42,*6*. **E. callosus; 6a,* tetraclones of main skeleton, with associated smooth spicules, ×30; *6b,* dermal phyllotriaenes, ×30 (72).

Cladodermia SCHRAM., 1924 [**Discodermia colossia* SCHRAM., 1912]. Rooted, cloaca deep (38). *U.Cret.*, Eu.

Leiophyllum SCHRAM., 1924 [**L. panniculosum*]. Large, like man's arm, with network of subdermal canals; has cortex and roots (39). *U.Cret.*, Eu.

Polyrhipidium SCHRAM., 1924 [**P. cristagalli*]. Stalked (30). *U.Cret.*, Ger.

Colossolacis SCHRAM., 1910 [**C. plicata*]. Plates and cylinders radiating from central mass; dermal spicules very large (38). *U.Cret.*, Ger.

Rhoptrum SCHRAM., 1910 [**R. scytaliforme*]. Short wide cylinder, cloaca deep (38). *U.Cret.*, Ger.

?**Pachycorynea** POČTA, 1907 [**P. erecta*]. Cylindrical, cloaca opening at side; large monaxons in cortex. *U.Cret.*, Eu.

Family PHYMARAPHINIIDAE Schrammen, 1910

[*nom. transl. et correct.* DELAUB., herein (*ex* Phymaraphininae SCHRAM., 1910)]

Distinguished from Discodermiidae by peculiar spicules, desmas of main skeleton with annular enlargements of rays. Corresponds to the choristid family Scolioraphididae. *Cret.-Tert.*

Thamnospongia HINDE, 1884 [**T. glabra;* SD DELAUB., herein]. Cylindrical, ramose, with longitudinal canals ?apochetes; spicules of main skeleton small and oddly swollen, those of dermis phyllotriaene-like (12). *U.Cret.-Tert.,* Eu.——FIG. 42,*5*. **T. glabra,* U.Cret., Eng.; *5a,* specimen, ×0.3; *5b,* endosomal spicules, ×50; *5c,* dermal spicules, ×50; (63).

Pholidocladia HINDE, 1884 [**P. dichotoma;* SD DELAUB., herein]. Horn-shaped, may be branched; desmas distinct from those of *Thamnospongia* (12). *Cret.,* Eu.——FIG. 42,*3*. **P. dichotoma,* network or tetraclone spicules, ×20 (63).

Phymaraphinia SCHRAM., 1901 [**P. infundibuliformis;* SD DELAUB., herein]. Resembles *Pholidocladia* (36). *U.Cret.,* Ger.

Prokaliapsis SCHRAM., 1901 [**P. cylindrica;* SD DELAUB., herein]. Like *Pholidocladia* (36). *Cret.,* Ger.

Cycloclema SCHRAM., 1910 [**Rhagadinia compressa* HINDE, 1883]. Like *Pholidocladia* (38). *U.Cret.,* Eu.

Lopadophorus SCHRAM., 1910 [**Oculispongia janus* RÖMER, 1864; SD DELAUB., herein] (38). *U.Cret.,* Ger.

Phymaplectia HINDE, 1884 [**P. irregularis;* SD DELAUB., herein]. Saucer- to funnel-shaped, with dermal triaenes but no phyllotriaenes (12). *Cret.,* Eng.

Family UNCERTAIN

Vermiculissimum DELAUB., *nom. nov.* [*pro Stelidium* SCHRAM., 1924 (ref. 39, p. 55) (*non* ROBERTSON, 1903)] [**Stelidium vermiculare* SCHRAM., 1924]. Wormlike, very small pores. *Cret.,* Ger.

Compsaspis SOLLAS, 1880 [**C. cretacea*]. Spicules. *Cret.,* Eu.

Sulcastrella SCHMIDT, 1879 [**S. clausa*]. *Cret.-Rec.,* Eu.

Stuckenbergia TSCHERN., 1898 [**Kazania ufensis*]. *?Carb.-?Perm.,* Eu.

Pseudoguettardia MORET, 1926 [**Guettardia thiolati* D'ARCHIAC, 1842] (26). *Cret.,* Eu.

Moretia HÉRENGER, 1944 [**M. elegans*]. *Cret.,* Sp.

Mortieria KON., 1842 [**M. vertebralis*]. *Carb.-Perm.,* Eu.

Chalaropegma SCHRAM., 1910 [**C. cerebriforme*] (38). *U.Cret.,* Ger.

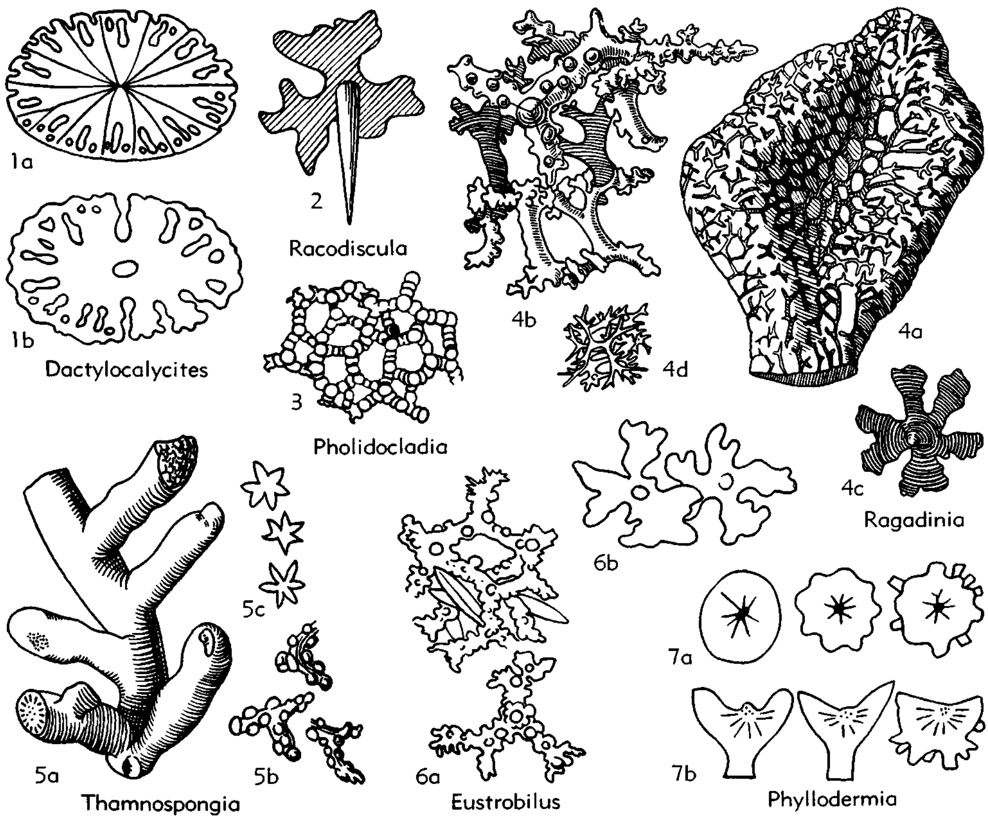


FIG. 42. Lithistida (Tetracladina): Discodermiidae, Phymaraphiniidae (p. E58-E59).

Astrolemma Schram., 1924 [**A. semiglobosum*] (39). *U.Cret.*, Ger.

Mastophorus Schram., 1924 [**M. arboreus*] (39). *U.Cret.*, Ger.

Paraspelaeum Schram., 1924 [**P. obductum;* SD herein] (39). *U.Cret.*, Ger.

Suborder EUTAXICLADINA Rauff, 1893

Rigid skeleton composed of desmas termed dicranoclones, characterized by 3 or 4 (rarely 5 or more) rays diverging from a point; union of desmas mostly between ray tip of one spicule and center or apex of another, rather than by junction of terminal parts of rays (clads) belonging to different spicules; lumpy swelling commonly present at the desma junctions. *Ord.-Rec.*

The term ennomoclone, employed by some workers, is applicable to the type of desmas found in the Eutaxicladina and Anomocladina, but it seems preferable to distinguish the dominantly tripod or tetrapod forms classed as dicranoclones from those having a strongly swollen, subglobular centrum, which are called sphaeroclones; the latter characterize anomocladine sponges. Except in the family Chiastoclonellidae, the clads of these desmas are all on one side of the globular centrum. The Eutaxicladina superficially resemble tetracladine sponges, but structure of the skeleton, as defined by nature and union of the desmas, is essentially different. Differentiation of the Eutaxicladina and Anomocladina, especially in case preservation of fossils is poor, may be difficult, because enlargement of junctions of spicular elements is noteworthy in both.

Family ASTYLOSPONGIIDAE Rauff, 1893

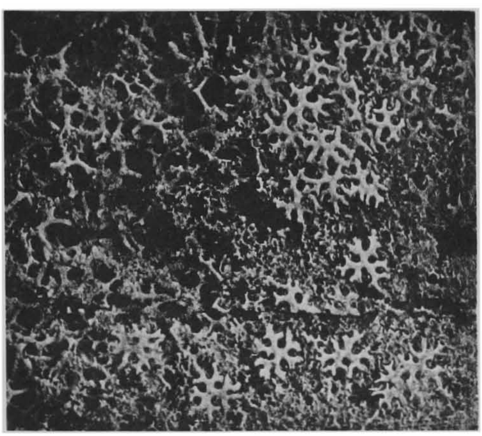
Subglobular or hemispherical sponges traversed by large apochetes which converge from all sides to a small or large apical cloaca. *Ord.-Cret.*

Astylospongia Römer, 1860 [**Siphonia praemorsa* Goldf., 1826; SD Pomel, 1872]. Spheroidal unattached bodies with external ridges and grooves running longitudinally as in the Cnemidiastridae and Aulaxiniidae, desmas commonly with 5 or 6 rays. *Ord.-Sil.*, cosmop.——Fig. 44,*1*. **A. praemorsa* (Goldf.), Sil., Ger.; *1a*, partly dissected specimen from side, ×1; *1b,c*, united desmas, ×12, ×100 (94).

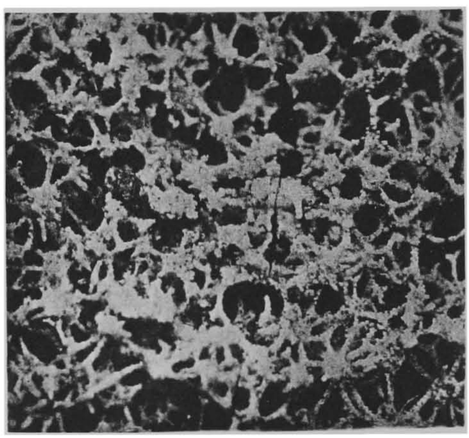
Astylomanon Rauff, 1894 [*Palaeomanon cratera* Römer, 1860; SD deLaub., herein]. Like *Astylospongia* but lacks external sculpture (33). *Sil.*, Tenn.——Fig. 44,*4*. **A. cratera* (Römer), sagittal sections of 3 specimens, ×0.3 (78).

Palaeomanon Römer, 1860 [**Siphonia cratera* C. F. Römer, 1848]. Like *Astylomanon* but decidedly more bowl-shaped. *Sil.*, Tenn.

Microspongia Miller-D., 1878 [**M. gregaria*] [=*Hindia* Duncan, 1879]. Globular, all evident canals radially disposed around a central point; desmas symmetrical, distinctive. *Ord.-Perm.*, cosmop.——Fig. 44,*2*. **M. gregaria*, Sil., U.S., dicranoclone, ×200 (94).——Fig. 45. *M. fibrosa* Römer, M.Sil., Tenn.; *1*, mold, infilled channels appearing as tuberculate rods, ×8; *2*, section showing radial spicules, ×1; *3*, spicular skeleton, ×50 (63*).



1 Lerouxia



2 Pseudojerea

Fig. 43. Lithistida (Tetracladina): Discodermiidae (p. E58).

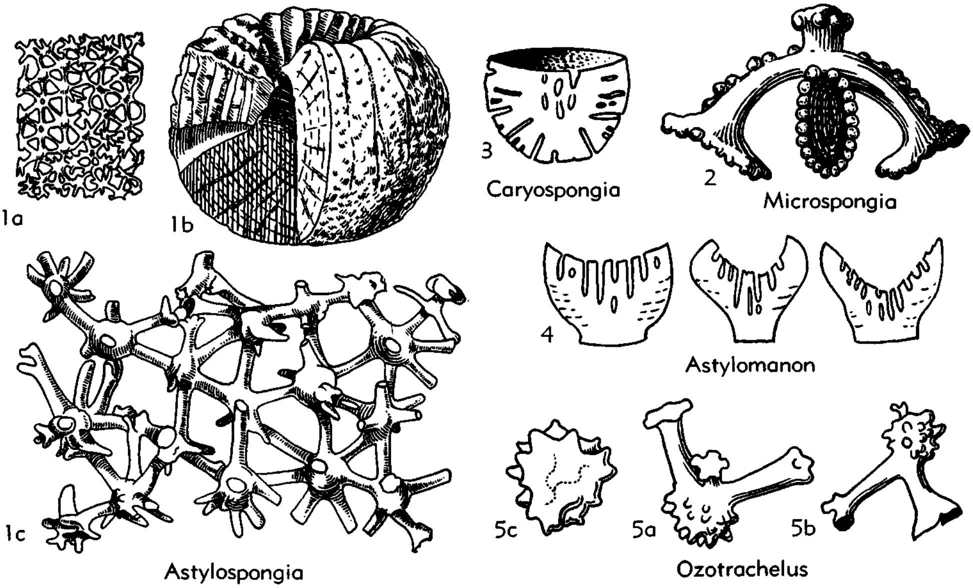


FIG. 44. Lithistida (Eutaxicladina): Astylospongiidae (p. E60-E61).

Neohindia SCHRAM., 1901 [**N. cylindrica*]. Like *Microspongia* but stalked and with distinct cloaca (36). *U.Cret.*, Ger.

Ozotrachelus DELAUB., *nom. nov.* [*pro Pachytrachelus* SCHRAM., 1910 (ref. 38, p. 170) (*non* CHAUDOIR, 1852)] [**Pachytrachelus expectatus* SCHRAM., 1910]. Resembles *Microspongia* but desmas have serpentine axial canal and sphaeroclones present (38). *U.Cret.*, Ger.——FIG. 44,*5*. **O. expectatus* (SCHRAM.); *5a,b*, dicranoclones, ×35; *5c*, sphaeroclone, ×35 (82).

Caryomanon RAUFF, 1894 [**C. glandulosum;* SD DELAUB., herein] [=*Carpomanon* HOWELL, 1937]. Like *Astylomanon* but exterior more lumpy (33). *Sil.*, Tenn.

Caryospongia RAUFF, 1894 [**Siphonia juglans* QUENST., 1878; SD DELAUB., herein] [=*Carpospongia* RAUFF, 1894]. Like *Astylomanon* but with canals normal to all parts of surface (33). *Ord.-Sil.*, cosmop.——FIG. 44,*3*. **C. juglans* (QUENST.), Sil. Eu.; sagittal section, ×0.3 (33).

Steliella HINDE, 1889 [**S. billingsi;* SD DELAUB., herein]. Subcylindrical, resembles *Astylospongia* (16). *M.Ord.*, Can.

Cyathospongia HALL, 1882 [**C. excrescens;* SD MILLER, 1889]. Somewhat like *Palaeomanon*. *Sil.*, N.Y.

Rhytidoderma SCHRAM., 1936 [**R. berckhemeri*]. Lumpy, with dermal net (40). *Jur.*, Ger.

?**Mastophyma** GERTH, 1927 [**M. jonkeri*]. *Perm.*, E.Ind.

?**Palaeojerea** GERTH, 1927 [**P. molengraaffi*]. *Perm.*, E.Ind.

?**Palaeophyma** GERTH, 1927 [**P. cucumeriformis*]. *Perm.*, E.Ind.

?**Phacellopegma** GERTH, 1927 [**P. campanum*]. *Perm.*, E.Ind.

?**Pycnospongia** GERTH, 1927 [**P. timorensis*]. *Perm.*, E.Ind.

Family GIGNOUXIIDAE de Laubenfels, nov.

Skeleton as in Astylospongiidae but shape more vaselike or hornlike. *Jur.-Rec.*

Gignouxia MORET, 1926 [**G. niciensis,* SD DELAUB., herein]. Skeleton an extremely symmetrical reticulation formed of triclad desmas; dichotriaenes also present (26). *U.Cret.*, Fr.——FIG. 46,*5*. **G. niciensis;* part of skeleton, perspective view, ×25 (72).

Iouea DELAUB., *nom. nov.* [*pro Phalangium* SCHRAM., 1910 (ref. 38, p. 170) (*non* LINNÉ, 1758)] [**Phalangium cylindratum* SCHRAM., 1910]. Cylindrical, skeletal network less regular than in *Gignouxia*. *Cret.*, Ger.——FIG. 46,*1*. *I. cylindratum* (SCHRAM.); section normal to surface, showing dicranoclones of main skeleton and arrangement of different kinds of dermal spicules, the latter commonly lost during fossilization, ×20 (72).

Phrissospongia MORET, 1926 [**P. glandiformis*]. Differs from *Gignouxia* in peculiarly shaped dermal spicules (26). *U.Cret.*, Fr.——FIG. 46,*2*. **P. glandiformis; 2a,b,* dermal spicules, ×40 (72).

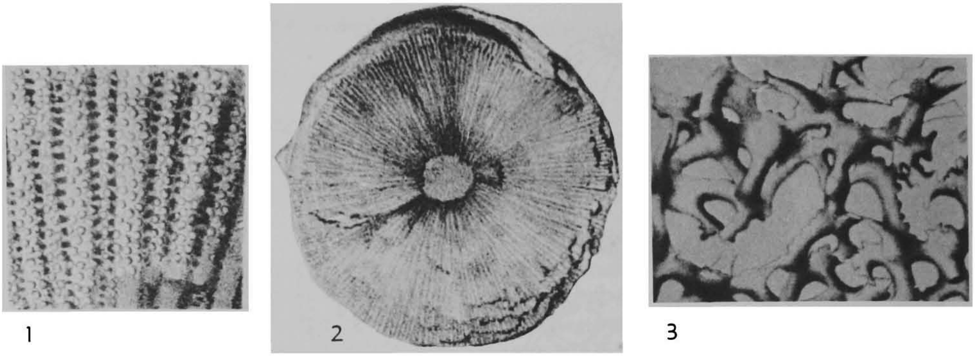


FIG. 45. *Microspongia fibrosa* RÖMER, M.Sil., Tenn.; *1*, mold, canals appearing as tuberculate rods, ×8; *2*, section showing radially arranged spicules, ×1; *3*, skeleton, ×50 (63*) (p. E60).

Dicranoclonella SCHRAM., 1936 [**D. praecursor;* SD DELAUB., herein]. Like *Gignouxia* but ear-shaped; pores resemble oscules (40). *Jur.*, Ger.

Leiocarenus SCHRAM., 1936 [**L. papillosus;* SD DELAUB., herein]. Differs from *Dicranoclonella* in having some dermal siliceous plates (40). *Jur.*, Ger.

Kyphoclonella KOLB, 1910 [**K. multiformis*] [=*Cyphoclonella* OPPL., 1925]. Polymorphic, somewhat like *Gignouxia* (20). *Jur.*, Eu.

Pachynion ZITTEL, 1878 [**Jerea scripta* RÖMER, 1864; SD DELAUB., herein]. Elongate vase-shaped (49). *Cret.*, Ger.

Coscinospongia Bow., 1869 [**C. heteroformis*]. Skeletal network vague; dichotriaenes with crooked rhabd occur in Recent species. *Cret.-Rec.*, cosmop.

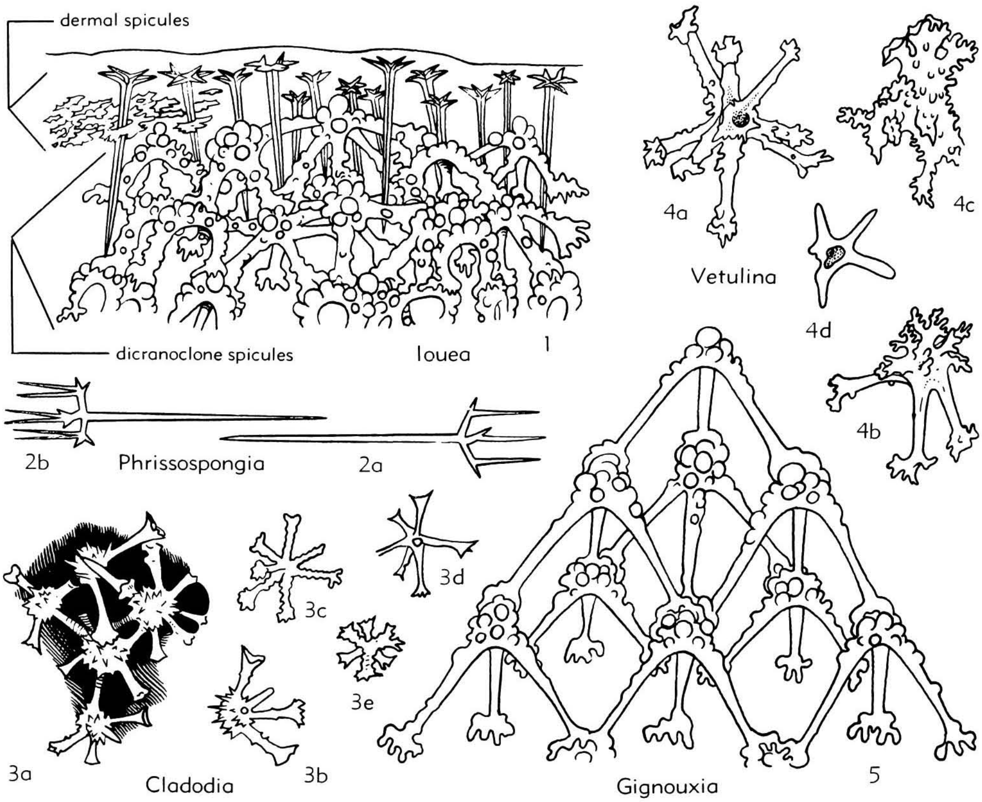


FIG. 46. Lithistida (Eutaxicladina): Gignouxiidae, Chiastoclonellidae (p. E61-E63).

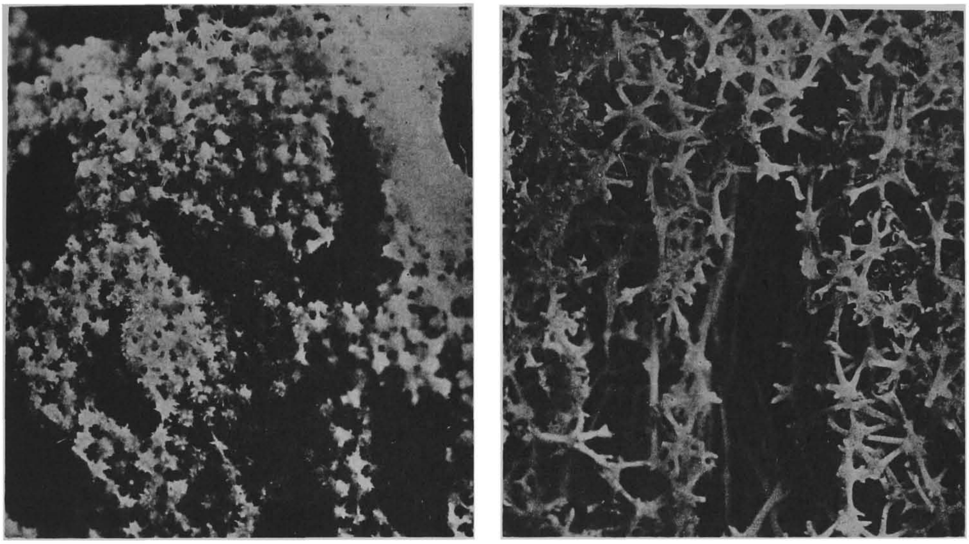


FIG. 47. Lithistida (Eutaxicladina): Chiastoclonellidae (p. E63).

Family CHIASTOCLONELLIDAE de Laubenfels, nov.

Some desmas typical of Eutaxicladina, but others have clads on more than one side of the globular centrum, thus resembling the sphaeroclones of the Anomocladina. *Ord.-Tert.*

Chiastoclonella RAUFF, 1894 [**C. headi*]. Spheroidal, composed of concentric shells of interlocked desmas separated by relatively open zones (33). *Ord.-Sil.*, Eu.

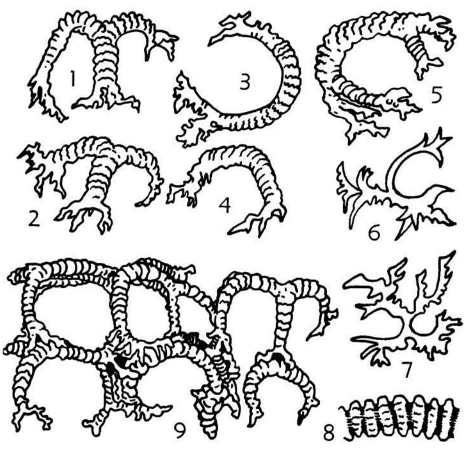


FIG. 48. *Pseudoverruculina niciensis* MORET, U.Cret. Fr. (p. E63).

Cladodia MORET, 1925 [**C. kiliani*]. Cylindrical (26). *Cret.*, Fr.——FIG. 46,*3*. **C. kiliani; 3a,* skeletal network; *3b,* normal sphaeroclone; *3c-e,* distinctive sphaeroclones from surface region; *3a-c,* ×50 (72).

Exodictydia MORET, 1926 [**E. canalifera;* SD DE-LAUB., herein]. Like *Cladodia* but massive or cup-shaped (26). *Cret.*, Fr.——FIG. 47,*1*. *E. cyathiformis* MORET, Santon.; ×35 (72*).

Regnardia MORET, 1926 [**R. lapparenti*]. Like *Cladodia* but ramose (26). *U.Cret.*, Fr.——FIG. 47,*2*. **R. lapparenti,* Cenom.; ×20 (72*).

Vetulina SCHMIDT, 1879 [**V. stalactites*]. Chiefly known from spicules only. *Tert.-Rec.*, Eu.——FIG. 46,*4*. *V. stalactites,* Rec., W.Ind. *4a,b,* typical sphaeroclones; *4c,* abnormal desma; *4d,* juvenile desma showing granular core around which spherical swelling develops; *a-c,* ×30 (85).

Family PSEUDOVERRUCULINIDAE de Laubenfels, nov.

Spicules chiefly dicranoclads with rays bearing distinctive subannulate elevations on one side; some smooth desmas (megarhizoclones) present. *U.Cret.*

Pseudoverruculina MORET, 1926 [**P. niciensis*]. Lamellate (26). *U.Cret.*, Fr.——FIG. 48. **P. niciensis; 1,2,* tripod desmas; *3-5,* dicranoclones; *6,7,* megarhizoid desmas; *8,* part of desma, ×30; *9,* articulated desmas; *1-7, 9,* ×20 (72).

Suborder ANOMOCLADINA Zittel, 1878

Lithistid sponges of tetracladine type, with reticulate skeleton formed by coalescence of desmas at points where extremities of their rays meet one another, but distinguished by the strongly swollen centrum of the desmas which gives rise to the subglobular spicules termed sphaeroclones. The rays (clads) of these spicules, ranging from 3 to mostly 5 or more in number, are disposed in radially subequal manner, instead of directionally grouped as in typical dicranoclones which characterize eutaxicladine lithistids; superficially the latter may resemble Anomocladina, but their swellings are at junctions of the spicules (tips of the clads), not at centrums. *Cam.-Jur.*

Family CYLINDROPHYMATIDAE Schrammen, 1936

[*nom. correct.* deLaub., herein (*ex* Cylindrophymidae Schram., 1936)]

Skeleton typically anomocladine, shape of sponge generally tubular. *Carb.-Jur.*

Cylindrophyma Zittel, 1878 [**Scyphia milleporata* Goldf., 1833, SD deLaub., herein]. Cylindrical, thick-walled (49). *Jur.*, Eu.——Fig. 49,*1*. **C. milleporata* (Goldf.), U.Jur., Ger.; *1a*, part of skeleton, ×30; *1b*, specimen from side, ×0.5 (94).

Melonella Zittel, 1878 [**Siphonia radiata* Quenst., 1858]. Like *Cylindrophyma* but globular, with deep cloaca; may be stalked (49). *M.Jur.-U.Jur.*, Ger.-Eng.

Didymosphaera Linck, 1883 [**D. steinmanni*]. Like *Cylindrophyma* but some desmas resemble rhizoclones. *Jur.*, Ger.

Heliospongia Girty, 1908 [**H. ramosa;* SD King, 1943]. Like much-enlarged *Cylindrophyma* (diameter 12 cm.) (8). *Carb.-Perm.*, Kan.

Coelocladia Girty, 1908 [**C. spinosa*]. Resembles *Cylindrophyma* (8). *Carb.*, Kan.

Linochone Schram., 1936 [**L. rimosa*]. Thick-walled cup (40). *Jur.*, Ger.

Coscinodiscus Schram., 1936 [**C. suevicus*]. Like *Linochone* (40). *Jur.*, Ger.

Family EOSPONGIIDAE de Laubenfels, nov.

Lithistids with very unsymmetrical desmas, generally resembling anomocladine forms but difficult to classify; mostly preserved poorly. *Cam.-Sil.*

Eospongia Bill., 1861 [**E. roemeri;* SD Miller, 1889]. Flat-topped cone with conspicuous vertical canals, cloaca at summit. *M.Ord.*, Can.——Fig. 49,*2*. **E. roemeri*, specimen from side ×1 (84).

Calathium Bill., 1865 [**C. formosum;* SD Miller, 1889]. Like *Eospongia*, with special cortex lining conical cloaca (24). *Cam.-Ord.*, Can.-E.Asia.

Trachyum Bill., 1865 [**T. cyathiforme;* SD Miller, 1889]. Structure denser, finer-grained than *Eospongia* (24). *Cam.-Sil.*, Can.

Edriospongia Miller, 1889 [**E. basalis* Ulr., 1889]. Massive, sides indented (24). *Ord.*, Ill.

Anthaspidella Miller, 1889 [**A. mammulata*]. Saucer- to funnel-shaped (24). *Cam.Ord.*, Ill.-E.Asia.

Zittelella Miller, 1889 [**Z. typicalis* Ulr., 1889]. Funnel-shaped, with horizontal canals relatively prominent (24). *M.Ord.*, Can.——Fig. 49,*3*. **Z. typicalis;* specimen from side, ×1 (84).

Dystactospongia Miller, 1883 [**D. insolens;* SD Miller, 1889]. Subcylindrical, with shallow cloaca (24). *Ord.-Sil.*, Ohio.

Strotospongia Miller, 1889 [**S. masculosa* Ulr., 1890]. Funnel-shaped, with intertwined vertical leaves radially arranged around cloaca (24). *Ord.*, U.S.A.

Heterospongia Ulr., 1889 [**H. subramosa*]. Like *Dystactospongia*, sublobate. *L.Sil.*, Ohio-Ky.

Saccospongia Ulr., 1889 [**S. rudis*]. Subcylindrical, deep cloaca. *Ord.-Sil.*, Ky.

Pycnopegma Rauff, 1895 [**P. pileum;* SD deLaub., herein]. Globose, stalked, without cloaca. *Ord.-Sil.*, U.S.A.

Anomoclonella Rauff, 1895 [**A. zitteli;* SD deLaub., herein]. *Ord.-Sil.*, U.S.A.

Family MASTOSIIDAE de Laubenfels, nov.

Subhemispherical lithistids with somewhat elongate rounded processes, resembling an inverted udder with teats; surface smooth, without oscules; no canals evident. Skeleton composed of sphaeroclones, oxeas, triaenes, and globular spicules resembling sterrasters of *Geodia*. *Jur.*

Mastosia Zittel, 1878 [**M. wetzleri*] (49). *Jur.*, Ger.

Family UNCERTAIN

Corallidium Zittel, 1878 [**Cnemidium diceratinum* Quenst., 1852] (49). *U.Jur.*, Ger.

Lecanella Zittel, 1878 [**L. pateraeformis;* SD deLaub., herein] (49). *Jur.*, Ger.

Streptospongia Ulr., 1889 [**S. labyrinthica*]. *Ord.*, U.S.A.

Streptosolen Miller, 1889 [**S. obconicus* Ulr., 1889] (24). *Ord.*, U.S.A.

Poterionella Počta, 1903 [**P. trunciformis*]. Like *Lecanella*. *Cret.*, Eu.

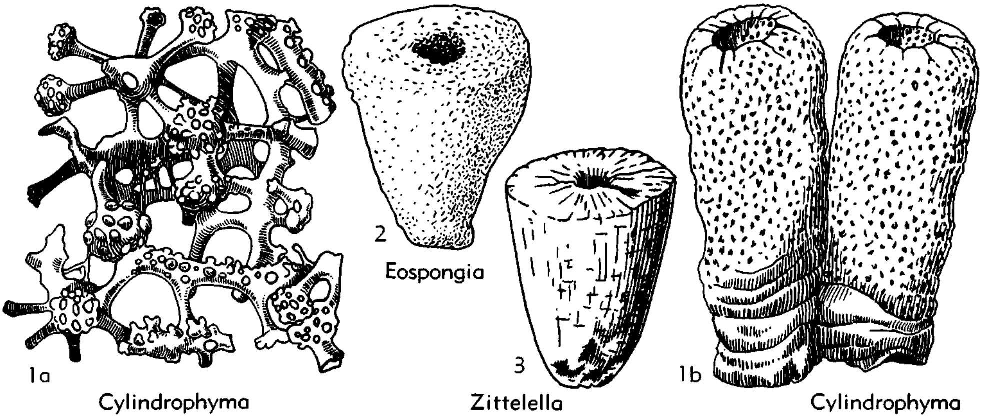


FIG. 49. Lithistida (Anomocladina): Cylindrophymatidae, Eospongiidae (p. E64).

Suborder UNCERTAIN

Hippalimus LAMX., 1821 [**H. fungoides*] [=*Hippalimeudia* FROM., 1860]. Mushroom-shaped, with apical oscule (21). *U.Cret.*, Eu.

Polysiphoneudea FROM., 1860 [**Siphonia arbuscula* MICH., 1847] [=*Polysiphonia* POMEL, 1872 (obj.)] (7). *U.Cret.*, Eu.

Siphonocoelia FROM., 1860 [**Scyphia elegans* GOLDF., 1833] (7). *U.Jur.*, Eu.

Cupulina COURT., 1861 [**C. pocillum;* SD DELAUB., herein] (5). *U.Cret.*, Fr.

Platispongia COURT., 1861 [**P. speculum;* SD DELAUB., herein] (5). *U.Cret.*, Fr.

Polystoma COURT., 1861 [**P. irregulare;* SD DELAUB., herein] (5). *U.Cret.*, Fr.

Asterospongia RÖMER, 1864 [**A. laevis;* SD DELAUB., herein] (35). *Cret.*, Ger.

Discodermites SOLLAS, 1880 [**D. cretaceus*]. *Cret.*, Eu.

Macandrewites SOLLAS, 1880 [**Dactylocalycites vicaryi* CARTER, 1871]. *Cret.*, Eng.

Podapsis SOLLAS 1880 [**P. cretacea;* SD DELAUB., herein]. *Cret.*, Eu.

Hyaloderma OPPL., 1921 [**H. porata*]. *Jur.*, Eu.

Ocellaria DE CARBONNIÈRE, 1801 [**O. nuda;* SD POMEL, 1872]. *U.Cret.*, Eu.

Olkenbachia SOLLE, 1938 [**O. hirsuta*]. *Dev.*, Eu.

Ortmannispongia SCHRAM., 1936 [*pro Ortmannia* SCHRAM., 1924 (*non* RATHBUN, 1902)] [**Ortmannia colligens* SCHRAM., 1924; SD DELAUB., herein]. *Cret.*, Eu.

Sphaeropegma SCHRAM., 1936 [**S. nuda*] (40). *Cret.*, Eu.

Stromatidium GIRTY, 1908 [**S. typicale*] (8). *Perm.*, Tex.

Timidella DELAUB., *nom. nov.* [*pro Timorella* GERTH, 1909[1] (*non* BERGH, 1905)] [**Timorella permica* GERTH, 1909]. *Perm.*, E.Ind.

[1] GERTH, H. (1909) *Timorella permica, n.g., n. sp., eine neue Lithistide aus dem Perm von Timor:* Centralbl. Mineral., vol. 22, p. 695.

Adrianella PARONA, 1933 [**A. distefanoi*]. *Perm.*, Eu.

Arbuscula PARONA, 1933 [**A. contortiplicata*]. *Perm.*, Eu.

Bothrochlaenia POMEL, 1872 [**B. pavonia*] (31). *U.Jur.*, ?Eu.

Cladolithosia POMEL, 1872 [no species] (31). *Cret.*, Eu.

Cymbochlaenia POMEL, 1872 [**Chenendopora complanata* ORB., 1850; SD DELAUB., herein (31). *Cret.*, Eu.

Diacyparia POMEL, 1872 [**Chenendopora rugosa* ORB., 1849; SD DELAUB., herein] (31). *Cret.*, Eu.

Elasmolimus POMEL, 1872 [**Dimorpha prolifera* COURT., 1861; SD DELAUB., herein] (31). *Cret.*, Eu.

Hypothyra POMEL, 1872 [**Scyphia trilobata* MICH., 1847] (31). *Cret.*, Eu.

Ischadia POMEL, 1872 [**I. typica*] (31). *Tert.*, N.Afr.

Orosphecion POMEL, 1872 [**Manon pulvinarium* GOLDF., 1833] (31). *Cret.*, Eu.

Pachypsechia POMEL, 1872 [**P. subannulata*] (31). *Jur.*, N.Afr.

Physocalpia POMEL, 1872 [**Scyphia mamillata* COURT., 1861] (31). *Cret.*, Fr.

Placojerea POMEL, 1872 [**Jerea desnoyersii* MICH., 1847] (31). *Cret.*, Fr.

Plethosiphonia POMEL, 1872 [**P. oroides*]. [=*Pliobunia* POMEL, 1872] (31). *Tert.*, N.Afr.

Polythyra POMEL, 1872 [**Scyphia perforata* COURT., 1861] (31). *Cret.*, Eu.

Pterocalpia POMEL, 1872 [**Scyphia alata* COURT., 1861] [=*Petrocalpia* RAUFF, 1893 *(nom. null.)*]. *Cret.*, Eu.

Rhagosphecion POMEL, 1872 [**Cnemidium conglobatum* REUSS, 1841] (31). *Cret.*, Eu.

Rhizostele POMEL, 1872 [**Rhizospongia clavata* COURT., 1861] (31). *Cret.*, Eu.

Scythophyma Pomel, 1872 [**C. crassa;* SD deLaub., herein] (31). *Tert.,* N.Afr.

Trachycinclis Pomel, 1872 [**Spongia ramosa* Mantell, 1822] (31). ?Age, ?loc.

Tragalimus Pomel, 1872 [**Dimorpha balanus* Court., 1861] [=*Glyphalimus* Pomel, 1872] (31). *Cret.,* Eu.

Class HYALOSPONGEA Vosmaer, 1886

[*nom. correct.* deLaub., herein (*ex* Hyalospongiae Vosmaer, 1886)] [=Hexactinellida Sollas, 1887]

Skeletal structure siliceous, very open, generally with large central cloaca as in sycons; flesh of simple rhagon type but much less compact than in Demospongea. Some Paleozoic forms may have been ascon. *?Precam., L.Cam.-Rec.*

The rays of hyalosponge spicules typically form a right angle where they diverge from one another, whereas spicules of demosponges tend to have rays separated by angles of 60 or 120 degrees. A very common type of spicule in the Hyalospongea is a tetraxon with all 4 rays in the same plane; these are termed stauracts. Spicules with 5 rays (pentacts) or 6 rays (hexacts) are like stauracts with extra rays meeting the others perpendicularly. Octactinal and so-called polyactinal spicules (with more than 8 rays) also occur. The name Hexactinellida, which has been used for the class, is inappropriate because spicules other than hexacts are prevalent in some genera and because Hexactinellida is almost identical with the family name Hexactinellidae.

Living Hyalospongea invariably contain, among other spicules, microscleres which are either a rod with disclike expansions at each end (amphidisc) or a spicule with many rays diverging from a center (aster). None has both amphidiscs and asters. Accordingly, the class has been divided in two orders: Amphidiscophora (with amphi-

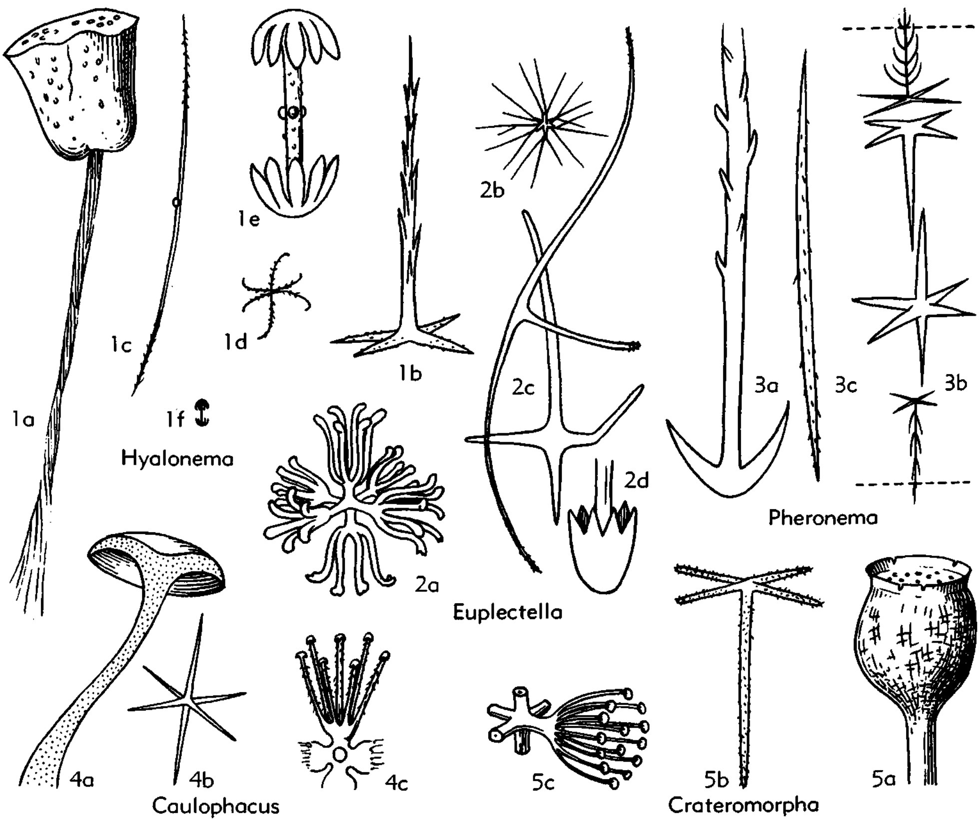


Fig. 50. Lyssakida: Hyalonematidae, Pheronematidae, Euplectellidae, Sympagellidae, Lanuginellidae (p. E67-E68).