spreite, may also be antler-like; thickness 1 to 7 mm. [One of the most discussed problematic fossils; originally interpreted as imprints of marine algae, later as body fossils (sponges, corals), as of inorganic origin (produced by eddy currents); as trace fossils (by ABEL, 1935; SEILACHER, 1954; LESSERTISSEUR, 1955, and others), tentatively regarded as feeding burrows made by soft-bodied wormlike animals, produced by systematic helicoid mining and foraging through sediment which shifted lobes of burrow (SEILACHER, 1967c, p. 80); other interpretation as imprints of discarded prostomial parts of sedimentary polychaetes (Sabellidae) (PLIČKA, 1962, and especially 1968, 1969) accepted by only few authors; for new interpretation as of plant origin see PLUMSTEAD (1967); "no single interpretation has yet found general acceptance" (TAYLOR, 1967, p. 11) and "much remains to be discovered" (SIMPSON, 1970, p. 505) as may be seen from many controversial discussions during recent years; for Recent "*Zoophycos* burrows" from great depth of the Pacific see SEILACHER, 1967b (cross section with lunate lamellae as in fossil *Zoophycos*, pl. 1, fig. E); complex spiral forms mostly in deep *Nereites* facies (SEILACHER, 1967b, p. 421), flat forms typical of *Zoophycos* facies, but also occasionally in neritic or even shallower marine environment (OSGOOD, 1970, p. 403); nomenclature very confused, the "cauda galli" (*Spirophyton cauda-galli* HALL, 1863) according to SIMPSON (1970, p. 506) undistinguishable from *Zoophycos*; BISCHOF (1968) proposed to restrict name to *Z. brianteus* (VILLA), for other proposals see TAYLOR (1967, p. 19); for the older history see BARSANTI (1902); (see also BISCHOF, 1968; SIMPSON, 1970; LEWIS, 1970).] *Ord.-Tert.*, cosmop. ——FIG. 75,*1a*. *Z. crassus* (HALL) ["*Spirophyton crassum*" HALL], U.Dev., USA; schem. drawing (Sarle, 1906b).——FIG. 75,*1b,c,f*. *Zoophycos; 1b*, schem. drawing, antler-shaped form, ×0.08 (Seilacher, 1959); *1c*, schem. drawing, regular spiral form, ×0.05 (Seilacher, 1959); *1f*, Tert. (probably Mungaroa Ls. = Kaiwhata Ls.), N.Z.; ×0.5 (Webby, 1969b).——FIG. 75,*1d,h*, *Z. circinnatus* (BRONGNIART), Czech. (Carpath. flysch); *1d*, Paleoc., long. sec., imprint of prostomial lobe with gill rays, ×0.3; *1h*, Eoc., spiral imprint of gill organs, ×0.25 (Plička, 1968).——FIG. 75,*1e*. *Z.* sp., Cret., Czech.(Carpath. flysch); planar imprint of an uncoiled spiral of the gill rays; ×0.27 (Plička, 1968).——FIG. 75,*1g*. *Z. brianteus* (VILLA), Eoc., Italy; ×0.4 (Massalongo, 1855). ——FIG. 75,*1i*. "*Zoophycos*," prob. up. Mio.(up. Tongaporutan beds), N.Z.(Gower R.); dextral specimen, ×0.08 (Stevens, 1968) (from Plička, M., 1970, p. 367, in: *Trace Fossils* edited by T. P. Crimes & J. C. Harper, Geol. Jour. Spec. Issue 3, Seel House Press, Liverpool).

[BRADLEY (1973, p. 118-122) has proposed that *Zoophycos* could have been produced by the feeding activities of a sea pen or similarly related animal. Such an animal would be positioned so that its calyx remained in a relatively stationary position near the sediment water interface and its tubular rhachis protruded into the sediment, free to move. The volution and accompanying lateral movement of the rhachis would account for the characteristic spiral structure of *Zoophycos*.—W. G. HAKES.]

BORINGS

Borings in shells, bones or other hard parts of invertebrates or vertebrates, in sedimentary rocks or in wood, occupy a special position among trace fossils, which entitles them to a chapter of their own. Borings are known as far back as the early Paleozoic, and may be produced by plants or by animals. Those of plant origin are made by algae, fungi, or lichens. Within the animal kingdom, boring organisms are known from the following groups: Porifera, Bryozoa, Phoronidea, Sipunculidea, Polychaeta, Turbellaria, Brachiopoda, Gastropoda, Amphineura, Bivalvia, Cephalopoda, Arthropoda (Isopoda, Amphipoda, Insecta), Cirripedia, Echinoidea, and perhaps also Foraminiferida.

In the fast few years, Recent and, especially, fossil borings have attracted much interest among paleontologists. New and important publications are by BROMLEY (1970, with many bibliographical references), BOEKSCHOTEN (1966, 1967), and CAMERON (1969b). For additional papers, one may refer to CARRIKER, SMITH, & WILCE (1969). These papers were presented at the International Symposium *Penetration of calcium carbonate substrates by lower plants and invertebrates*, which was held in Dallas in 1968. However, as the title suggests this symposium was restricted to borings and their producers only in calcareous substrates. In this symposium, CARRIKER & SMITH (1969, p. 1012) introduced the following concepts:

Calcibiocavitology. The study dealing with the hollowing out of spaces in hard, calcareous substrata by organisms.

Calcibiocavite. An organism that hollows out a space (burrow, borehole, caries) in hard, calcareous substrata (*calciphytocavite,* plant; *calcizoocavite,* animal).

Calcibiocavicole. An organism inhabiting a self-excavated space in a hard, calcareous substratum.

Calcicavicole. An organism inhabiting a space excavated by another organism or by nonbiogenic forces in a hard, calcareous substratum.

Communities of boring organisms in lithified sediments have been named *lithophocoenoses* by RADWAŃSKI (1964).

According to MARTINSSON's (1970, p. 326) suggested toponomic (stratinomic) classification of trace fossils, most borings in lithified sediments have to be placed in his Endichnia, although some can be classified as Exichnia. However, these concepts are not applicable to borings in pebbles or hard parts of organisms such as shells. If some general terms should be needed, MARTINSSON (1970, p. 328) proposed the terms Ichnidia or Endichnidia for these types of borings.

For the paleontologist, it is generally difficult, if not impossible, to find the creator of the boring and often it cannot be determined if a boring is of plant or animal origin. GATRALL and GOLUBIC (1970), with the help of stereoscan pictures of Jurassic and Recent material, have been the first to find characteristics that make it possible to distinguish between algal and fungal borings. In some cases, it is not even clear whether an organism found in a boring is the actual borer (e.g., borings containing shells). Even for many Recent borings, it is still unknown if they are due to chemical or mechanical processes. Likewise, it is often not certain what purpose the borings serve. Most were made as dwelling chambers, but in other cases, such as borings made by predatory snails, they were made in the search for food.

Some fossil borings have been given the names of their supposed makers (e.g., *Cliona cretacea*). I agree with BROMLEY (1970, 1972) who has emphasized that borings should not be given the name of the actual or supposed boring organisms. Especially names of Recent borers should be used only for the organisms themselves. For their borings special ichnological names are necessary, as BROMLEY (1970) showed on the example of the application of the name *Entobia* BRONN to all borings produced by sponges. Also, his new proposal (BROMLEY, 1972) is aiming in the same direction, e.g., that all pocket-shaped borings with a single opening should be named *Trypanites* MÄGDEFRAU (Fig. 76).

Recently HÖLDER (1972) published an excellent study of endozoans and epizoans on belemnite rostra. HILLMER & SCHULZ (1973) have described Upper Cretaceous polychaete borings, some of which possess secondary excavated cavities. These secondary cavities have been interpreted as brood chambers. The authors believed that the presence and absence of these cavities with relation to overall boring size is an expression of sexual dimorphism of the borings' producers (see *Ramosulichnus,* p. *W*131).

Evolution of the boring habit in Recent gastropod taxa can be traced only as far back as the Upper Cretaceous. Borings attributable to predation in pre-Upper Cretaceous and Paleozoic brachiopod and some mollusc shells do not exhibit the tapering sides and countersunk features characteristic of gastropod borings. Their origin is considered unknown. This situation has been given particular attention by CARRIKER & YOCHELSON (1968) with respect to cylindrical borings in Middle Ordovician brachiopod shells. If these and other Paleozoic borings are considered to be the work of predatory gastropods, then a boring habit for gastropods must have evolved independently long before the ancestors of the present day groups appeared in the geologic record (SOHL, 1969, p. 733).

Abeliella HÄNTZSCHEL, 1962, p. *W*228 [**A. riccioides* MÄGDEFRAU, 1937, p. 60; OD] [=*Abeliella* MÄGDEFRAU, 1937, p. 60, *nom. nud.,* estab-

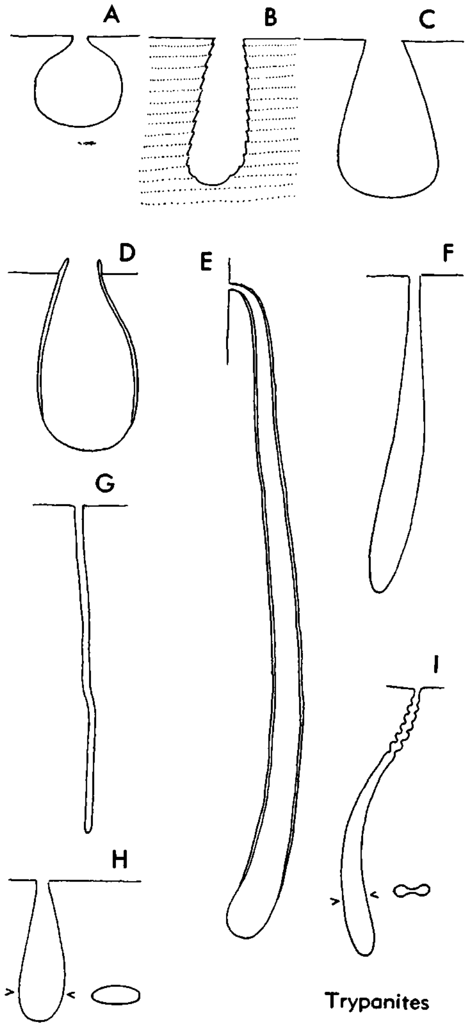

FIG. 76. Various morphologic variations of *Trypanites (A* to *I). B* shows boring in wood; *D* and *E* show calcareous lining (mod. from Bromley, 1972).

lished without designation of type species]. Dichotomously branching starlike borings in fish scales; width of individual borings 4 to 8 microns, of whole system 0.25 to 0.5 mm. [?Produced by algae or fungi.] *U.Jur.-Oligo.*, Eu. (Ger.-Eng.).——FIG. 77,*6*. **A. riccioides* MÄGDEFRAU, Oligo., Ger.; (in fish scale), ×110 (Mägdefrau, 1937).

Anobichnium LINCK, 1949, p. 185 [**A. simile*; OD]. Smooth cylindrical perforations in fossil wood, 1 to 1.5 mm. in diameter, with numerous openings to each gallery; very similar to borings of Recent beetles of genus *Anobium*. *U.Trias.*, Eu.(Ger.).——FIG. 78,*5*. **A. simile*, Keuper, Ger.; (in wood), ×0.7 (Linck, 1949a).

Bascomella MORNINGSTAR, 1922, p. 156 (*emend.* CONDRA & ELIAS, 1944, p. 538; *emend.* ELIAS, 1957, p. 390) [**B. gigantea*; OD]. First described as ctenostome parasitic, boring bryozoan characterized by large egg-shaped "vesicles" connected by narrow tubular "stolons." [CONDRA & ELIAS (1944, p. 538) doubted that interpretation, classed genus *incertae sedis* and pointed out great similarity of the "vesicles" to borings, particularly to the immature development of *Caulostrepsis* CLARKE; ELIAS (1957, p. 390) restricted diagnosis of *Bascomella* to oval to pear-shaped "vesicles" which he regarded as excavations and compared with borings made by Recent cirriped *Alcippe*; according to ELIAS (1957), "stolon"-like part of *Bascomella* should be placed in *Condranema* BASSLER, 1952; for discussion of combination of two borings of different origin see BROMLEY (1970, p. 58); see BASSLER (1953, p. G36, fig. 9,*5*).] *Penn.-Perm.*, USA(Pa.-Ohio).

Brachyzapfes CODEZ & DE SAINT-SEINE, 1958, p. 706 [**B. elliptica*; OD]. Short and broad borings; longitudinal cross section elliptical; depth half length; observed in belemnoids and pelecypods. [Borings of barnacles.] *L.Cret.*, Eu.(France)-Antarct.——FIG. 77,*3*. **B. elliptica*; schem. drawings, *3a-d*, long. sec., opening, tang. sec. (max.), chamber (Codez & de Saint-Seine, 1958).

Calcideletrix HÄNTZSCHEL, 1962, p. W222 [**C. flexuosa* MÄGDEFRAU, 1937, p. 57; OD] [=*Calcideletrix* MÄGDEFRAU, 1937, p. 57, *nom. nud.*, established without designation of type species]. Cavity systems in belemnoids; one or more openings, shrublike, ramified; sometimes dendritic networks of tunnels; diameter of branches 0.02 to 0.1 mm. [Probably made by algae. MARCINOWSKI (1972) interpreted this form as result of hard substrate borers in abandoned belemnite rostra.] *Jur.-U.Cret.*, Eu.(Eng.-Ger.-Pol.).——FIG. 77,*4a*. *C. breviramosa* MÄGDEFRAU; (in *Actinocamax*), ×8 (Mägdefrau, 1937).——FIG. 77,*4b*. **C. flexuosa* MÄGDEFRAU; (in *Belemnitella*), ×8 (Mägdefrau, 1937).

Calciroda MAYER, 1952, p. 455 [**C. kraichgoviae*; M]. Cylindrical boring tunnels up to 1 mm. wide; usually constructed parallel to outer surface in shells of mollusks or in stalk members of *Encrinus*; may be ramified, cutting through or crossing each other. [According to MÜLLER (1956b, p. 410) and present author, probably identical with *Trypanites* MÄGDEFRAU (p. W136).] *M.Trias.(Trochiten-Kalk)*, Eu.(Ger.).

Caulostrepsis CLARKE, 1908, p. 169 [**C. taeniola*; M] [=*Polydorites* DOUVILLÉ, 1908, p. 365 ("genus" without species name; according to BATHER (1910), not intended as an independent generic name)]. U-shaped tunnels with spreite, corresponding to tiny *Rhizocorallium*, sometimes radiating inward from commissure of brachiopods;

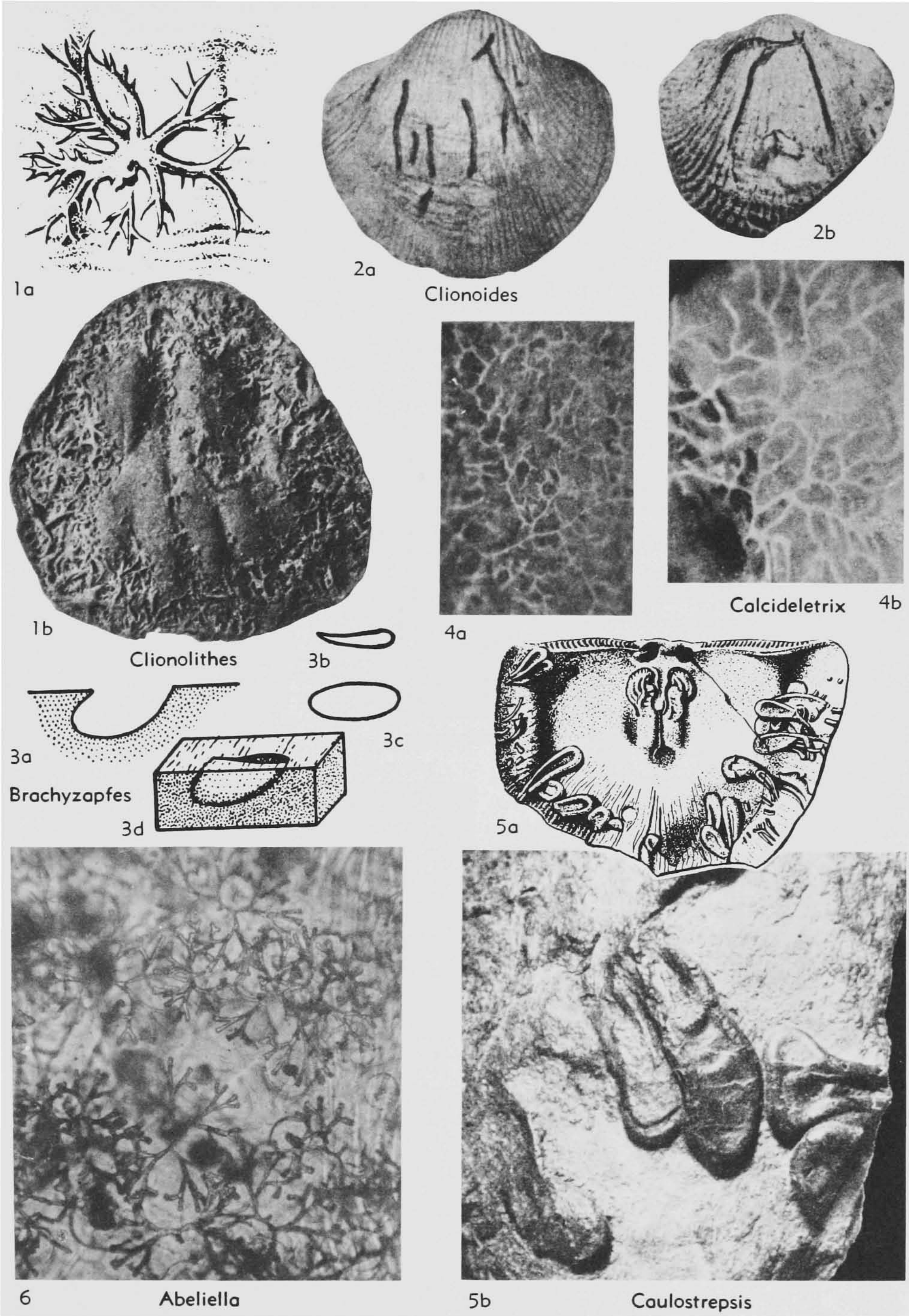

FIG. 77. Borings (p. *W*124, 126-127).

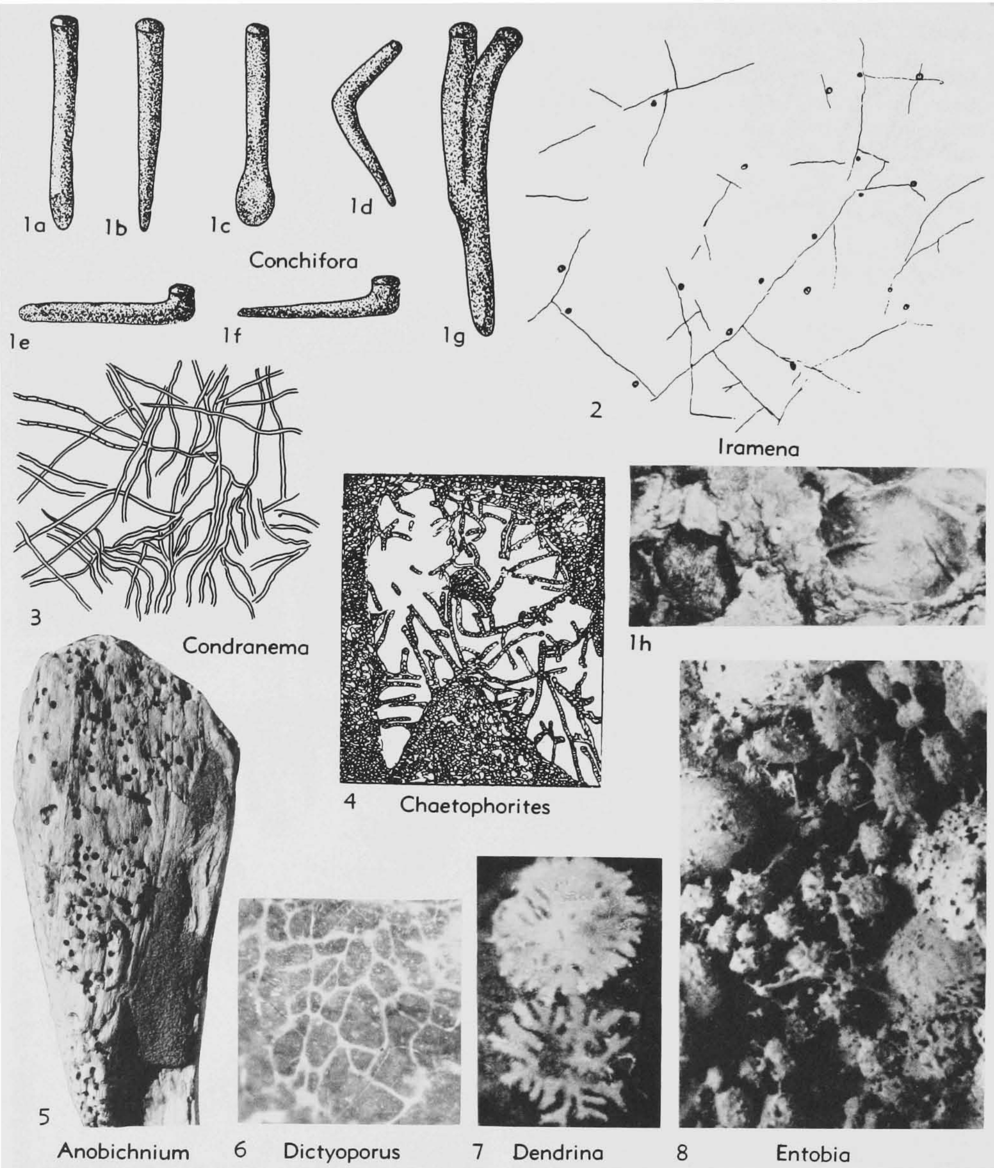

FIG. 78. Borings (p. W124, 126-127, 129).

up to 2 cm. long and 5 mm. wide; commonly found in shells of brachiopods, mollusks, and echinoids. [Interpreted tentatively as borings of worms (Spionidae) (CAMERON, 1969b); according to BROMLEY (1970, p. 50), possibly not true borings but embedment cavities; named "pseudoborings" by CONDRA & ELIAS (1944, p. 549) and thus placed in "Problematica."] *L.Dev.*, Eu. (Ger.); *Penn.-Perm.*, USA; *U.Trias.*, *?L.Jur.*, Eu. (Eng.), *Tert.*, Eu.(Port.)-Australia.——FIG. 77,5. **C. taeniola*, L.Dev., Ger.; *5a*, in shell of *Stropheodonta*, ×0.75 (Clarke, 1908); *5b*, up. Ems., Ger.(Taunus), *ca.* ×1.9 (Häusel, 1965).

Chaetophorites PRATJE, 1922, p. 301 [**C. gomontoides*; M]. Ramifying tunnels in rostra of belemnoids and shells of brachiopods and mollusks; usually straight; diameter less than 0.02 mm.; located close to surface of shell. [Probably made by algae or (as supposed by BROMLEY, 1970, p. 55) fungi; according to E. VOIGT (pers. commun., 1971), *C. cruciatus* MÄGDEFRAU, 1937, belongs to boring bryozoans.] *Jur.-Tert.(Plio.)*, Eu.——Fig. 78,*4*. **C. gomontoides,* L.Jur.(Lias δ), Ger.; (in pelecypod shell), ×106 (Pratje, 1922).

Clionoides Fenton & Fenton, 1932, p. 47 [**C. thomasi*; OD]. Tubular borings, widely spaced, somewhat flexuous or straight, irregularly branched; 0.5 to 1.5 mm. in diameter; round perforations extending throughout length of tubes. Generally excavated in brachial valves of thick-shelled specimens of *Atrypa.* [Origin by sponges related to Recent *Cliona* has been suggested; regarded by Jux (1964) as produced presumably by polychaetes living in commensalism with brachiopods; according to Elias (1957, p. 381), *Clionoides* is possibly junior synonym of the bryozoan genus *Vinella* Ulrich, 1890 (Bassler, 1953, p. *G*35).] *U.Dev.,* Eu.(Ger.)-USA(Iowa).——Fig. 77,*2*. **C. thomasi,* Dev., Iowa; upon the brachial valve of *Atrypa waterlooensis* Webster; *2a,* tubes, *2b,* tubes and perforations, ?×1 (Fenton & Fenton, 1932).

Clionolithes Clarke, 1908, p. 168 [**C. radicans*; SD Fenton & Fenton, 1932, p. 43] [=*Pyritonema? gigas* Fritsch, 1908, p. 10 (*non* M'Coy, 1850); *Olkenbachia* Solle, 1938, p. 156 (type, *O. hirsuta*); for discussion see Teichert, 1945, p. 202]. Bent or cracked borings, generally radiating in one plane to all sides from very small central cavity; commonly branching dichotomously; diameter several mm.; always etched into shell or some host animal. [Made by sponges (e.g., *C. querens* Ruedemann, 1925, p. 38), algae, or worms; according to Jordan (1969), certain astrorhizae of Stromatoporoidea (M.Dev.,Ger.) are morphologically identical to *C. radicans* and might be made by parasitic boring organisms; nomenclature of the "species" not yet resolved; *C. reptans* Clarke, 1908, and similar forms may be placed in the "genus" *Filuroda* Solle, 1938; see also de Laubenfels, 1955, p. *E*40.] *Ord.,* Eu.(Czech.); *Dev.-Carb.,* Eu.(Ger.)-USA-China.——Fig. 77,*1*. **C. radicans,* U.Dev.(Chemung Ss.), USA; *1a,* in *Atrypa* shell, ×6; *1b,* in shell of *Dalmanella superstes,* ×0.5 (Clarke, 1921).

Conchifora Gisela Müller, 1968, p. 68 [**C. zylindriformis zylindriformis*; OD]. Variously shaped straight or slightly sinuous tunnels in shells of brachiopods, seldom in pelecypods or gastropods; not branched; walls smooth; commonly with 1 or rarely 2 openings; sometimes with enlarged ends or conical; ends rounded or somewhat acute; 1 to 30 mm. long, diameter 0.1 to 1.4 mm., diameter of openings 0.2 to 0.5 mm.; seven "varieties" named, but these names are unavailable (*Code,* Art. 15). [?Made by polychaetes.] *L.Dev.(mid.Siegen.-low.Ems.),* Eu.(W. Ger.).——Fig. 78,*1*. **C. zylindriformis; 1a-h,* infillings of seven "varieties"; *1a-c,* ×7; *1d,* ×5; *1e,f,* ×4.7; *1g,* ×9.5; *1h,* ×1.3 (Gisela Müller, 1968).

Conchotrema Teichert, 1945, p. 203 [**C. tubulosa*; OD]. Narrow tubular borings in shells (diameter about 0.2 mm), communicating with surface, but buried completely in shell of host; straight or gently curved; branching. [Probably made by worms; according to Teichert (1945), *Clionolithes canna* Price, 1916, may also be placed in this "genus."] *U.Dev.,* USA(N.Y.); *L.Carb.,* Eu.(Scot.); *Miss.-Penn.,* USA(Ark.-W. Va.); *Perm.,* W.Australia; *?U.Cret.,* Eu.(Eng.).——Fig. 79,*7*. **C. tubulosa,* Perm. (Wandagee F.), W.Australia; in *Taeniothaerus* valve, ×2 (Teichert, 1945).

Condranema Bassler, 1952, p. 381 [**Heteronema capillare* Ulrich & Bassler, 1904, p. 278; OD] [=*Heteronema* Ulrich & Bassler, 1904, p. 278 (type, *H. capillare*) (*non* Dujardin, 1841)]. Straight or somewhat curved cylindrical borings in shells, immersed tunnels very close to surface of shell; zooecial scars present. [Interpreted as creeping stolons of ctenostome bryozoan; see Bassler, 1953, p. *G*35.] *Ord.-Perm.,* Eu.(Swed.)-USA.——Fig. 78,*3*. **C. capillare* (Ulrich & Bassler), Sil., Gotl.; ×10 (Ulrich & Bassler, 1904).

Dendrina Quenstedt, 1848, p. 470 (published without species name) [**Talpina dendrina* Morris, 1851, p. 87 (=*Dendrina belemniticola* Mägdefrau, 1937, p. 55); SD Häntzschel, 1965, p. 30]. Borings just below surface in brachiopods and in rostra of belemnoids; without aperture; forming rosettes 1.5 to 6 mm. in diameter; ramifying intensely and irregularly; diameter of borings about 0.05 mm. [?Made by algae. Radwański (1972) interpreted *Dendrina* as result of hard substrate borers on abandoned belemnite rostra.] *Ord.,* (Pleist. drift), Eu.(Ger.); *M.Trias.(low. Muschelkalk),* Eu.(Ger.); *U.Cret.,* Eu.(Eng.-France-Ger.-Pol.).——Fig. 78,*7*. *D. belemniticola* Mägdefrau, U.Cret., Ger.; in *Belemnitella,* ×5 (Mägdefrau, 1937).

Dictyoporus Mägdefrau, 1937, p. 55 [**D. nodosus*; M]. Borings in rostra of belemnoids; without exterior aperture; distinctly netlike; canals about 0.07 mm. wide. [Producer unknown.] *?L.Jur.,* Eu.(S.Ger.); *M.Jur.,* Eu.(Pol.); *U.Cret.,* Eu.(Eng.-Ger.-Pol.).——Fig. 78,*6*. **D. nodosus,* U.Cret., Ger.; in *Belemnitella,* ×5 (Mägdefrau, 1937).

Electra Lamouroux, 1816 (see Bassler, 1953, p. *G*157) [Borings of this Recent cheilostome bryozoan have been observed in bivalve and gastropod shells from Pliocene of Belgium (Boekschoten, 1966, p. 366; 1967, p. 322); Recent species *Electra monostachys* (Busk) lives in brackish environments and tidal flats.]

Entobia Bronn, 1838, p. 691 [**E. cretacea* Portlock, 1843, p. 360; SD Häntzschel, 1962, p. *W*230]. Borings consisting of globular chambers (max. diam. about 1 cm.), mostly crowded, connected by very short slender canals (diam. 0.1-1.0 mm.); walls of chambers with few small surface

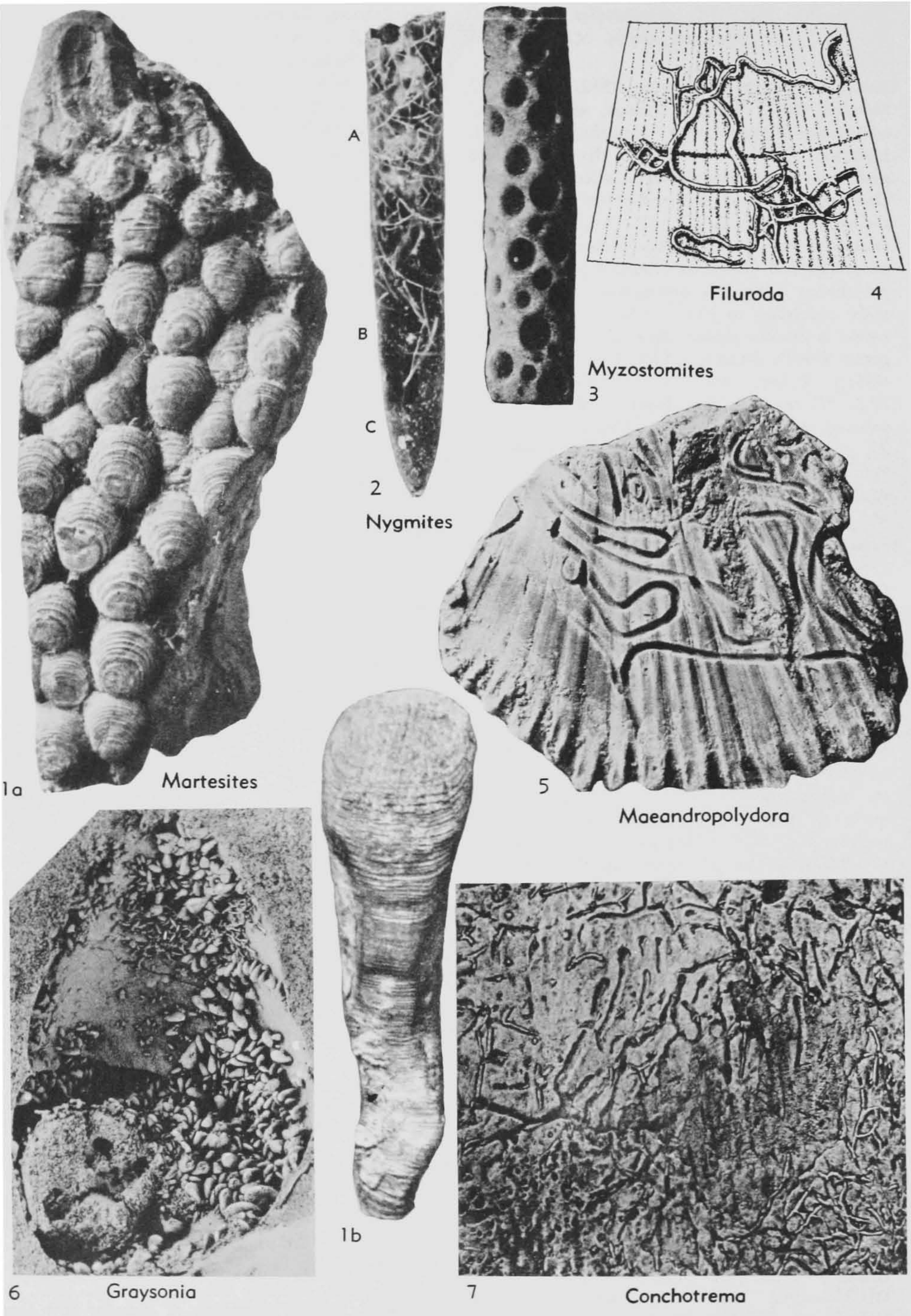

Fig. 79. Borings (p. W127, 129-131).

pores and penetrated by canals and by more slender holes, in steinkern preservation appearing as spines radiating from chambers; occurring in brachiopods, pelecypods (particularly *Inoceramus*), ammonites, and belemnites. [Made by sponges of family Clionidae; for selected synonymy of the type species (known as *Cliona cretacea* since 1854), see BROMLEY, 1970, p. 78; borings in trilobites of Silurian age also placed in this genus by PORTLOCK, 1843 *(E. antiqua)*.] *?Sil.,* Eu.(Ire.); *U.Jur.(low.Tithon.)-Tert.,* Eu.(Ire.-Eng.-France-Ger.-Pol.).——FIG. 78,*8*. **E. cretacea* PORTLOCK, Cret.(Chalk Rock, Turon.), Eng. (Herts.), ×2.7 (Bromley, R. G., 1970, p. 81, in Trace Fossils edited by T. P. Crimes & J. C. Harper, Geol. Jour. Spec. Issue 3, Seel House Press, Liverpool).

Filuroda SOLLE, 1938, p. 158 [**Clinolithes reptans* CLARKE, 1908; OD] [=*Clionolithes* CLARKE, 1908, p. 168 *(partim)* (type, *C. radicans*); for discussion see TEICHERT, 1945]. Threadlike, strongly curved borings in shells, running closely below surface of shell. [Possibly made by boring sponges; see also DE LAUBENFELS, 1955, p. *E*40.] *L.Dev.-M.Dev.,* N.Am.(USA)-Eu.(Ger.)——FIG. 79,*4*. **F. reptans* (CLARKE), L.Dev.(Oriskany Ss.), USA; in *Leptostrophia, ca.* ×2 (Clarke, 1908).

Graysonia STEPHENSON, 1952, p. 52 [**G. bergquisti*; OD]. Borings in shells of pelecypods and gastropods, preferentially in thicker shells; "zoarium" consisting of a compound system of "tubular stolons" and "vesicles (internodes)"; "stolons" rather irregularly distributed, forming connected series of little arches which may form complicated meshworks, "vesicles" irregularly subovate, ranging in size from microscopic to 4.5 mm., often crowded together but also widely scattered, intermingled with the "stolons." [Interpreted as a boring bryozoan of the family Vinellidae, perhaps living commensally rather than parasitically; regarded by BROMLEY (1970, p. 58) as a compound genus ("mixture of acrothoracican borings and thread borings") appearing to include worm borings or embedment traces; according to E. VOIGT (pers. commun. 1971), certainly no boring bryozoan; *Graysonia anglica* CASEY (1961, p. 573) from the Aptian of England represents only the "stolon"-like part of the fossil.] *L.Cret.(Apt.),* Eu.(Eng.); *U.Cret.(Cenoman., Woodbine F.),* USA(Texas).——FIG. 79,*6*. **G. bergquisti,* Cenoman.(Woodbine F.), Texas; holotype, in *Gymnentome valida* (gastropod), ×1.5 (Stephenson, 1952).

Iramena BOEKSCHOTEN, 1970, p. 45 [**I. danica*; OD] [=?*Terebripora antillarum* FISCHER, 1866, p. 300; for discussion see BOEKSCHOTEN, 1970, p. 45]. Diminutive borings of *"Penetrantia"*-type in oyster shells, gastropods *(Buccinum)*, and coral branches producing irregular network of long stolon tunnels 3 microns wide; reniform or circular apertures with diameters of 0.03 to 1.0 mm., situated in alternating positions laterally and at distance of 0.01 to 0.1 mm. from stolon tunnels; apertures spaced 0.5 to 2.5 mm. from each other. [Probably made by ctenostome bryozoans.] *L. Tert.(mid.Dan.),* Eu.(Denm.); *U.Tert.(Plio.),* Eu.(Belg.); *Rec.*(Neth.-France-Ire.).——FIG. 78,*2*. **I. danica,* Dan., Denm.; camera lucida tracings of the type zoarium borings of *Iramena,* ×11 (Boekschoten, G. J., 1970, p. 46, in: *Trace Fossils* edited by T. P. Crimes & J. C. Harper, Geol. Jour. Spec. Issue 3, Seel House Press, Liverpool).

Maeandropolydora VOIGT, 1965, p. 204 [**M. decipiens*; OD]. Long, meandering furrows sunk into outer or inner side of Cretaceous oysters and pectinids; width 0.5 to 1.2 mm.; resembling U-shaped tubes of *Polydora* but without spreite. [Probably made post-mortem by polychaete worms of family Spionidae.] *U.Cret.,* Eu.(Ger.-Neth.-Swed.).——FIG. 79,*5*. *M. sulcans* VOIGT, U.Cret. (L.Santon.), W.Ger(Gross Bülten); in *Neithea quinquecostata* (SOWERBY), ×1.8 (Voigt, 1965).

Martesites VITÁLIS, 1961, p 6, 16 [**M. vadaszi*; M]. Very closely crowded borings of pelecypods (probably *Martesia* sp.) in driftwood, lying approx. 45° oblique to the annual rings; clayey fillings of borings with circular rills produced by animal's boring activity; 5 to 7 cm. in length, diameter of opening of boring 1.0 to 1.5 cm. *L.Tert.(low.Mio.-mid.Mio., low.Helvet.),* Eu.(N. Hung.).——FIG. 79,*1*. *M.* sp., low.Mio., Hung.; *1a,* in wood (concentric stripes on steinkerns of boreholes correspond to given rings of the wood), ×0.4; *1b,* in wood, steinkern of a borehole, ×1 (Abel, 1935).

Mycelites ROUX, 1887, p. 246 [**M. ossifragus*; M]. General ecologic name for various irregularly branching tunnels about 2 to 6 microns wide in hard parts (shells, bones, teeth, scales) of invertebrates and vertebrates. [According to BERNHAUSER, 1953, 1962, made by green algae; interpreted by W. J. SCHMIDT, 1954, as borings of fungi; for detailed discussion, see PEYER, 1945; for similar borings in Paleozoic fossils from freshwater sediments, BYSTROW, 1956, used name *Paleomycelites*.] *?Sil., Carb.-Rec.,* cosmop.——FIG. 80,*3*. *M. conchifragus* SCHINDEWOLF; *3a,* U.Jur.(up.Volg.), USSR (Moscow); hyphae of fungi in the dissolved shell of *Craspedites* sp. *cf. C. okensis* (D'ORBIGNY), ×30 (Schindewolf, 1963); *3b,* L.Jur., Ger.; in *Coroniceras rotiforme* (SOWERBY), schem. reconstr. [*a,* horizontal borings parallel to overlying layer; *b,* layer containing cavities almost perpendicular to overlying layer; *c,* horizontal borings parallel to underlying layer] (Schindewolf, 1962).

Myzostomites CLARKE, 1921, p. 58 (published without species) [**M. clarkei*; SD HOWELL, 1962, p. *W*167]. Gall-like protuberances on crinoid stems, with a central perforation. [Compared with modern worm *Myzostomum* causing similar

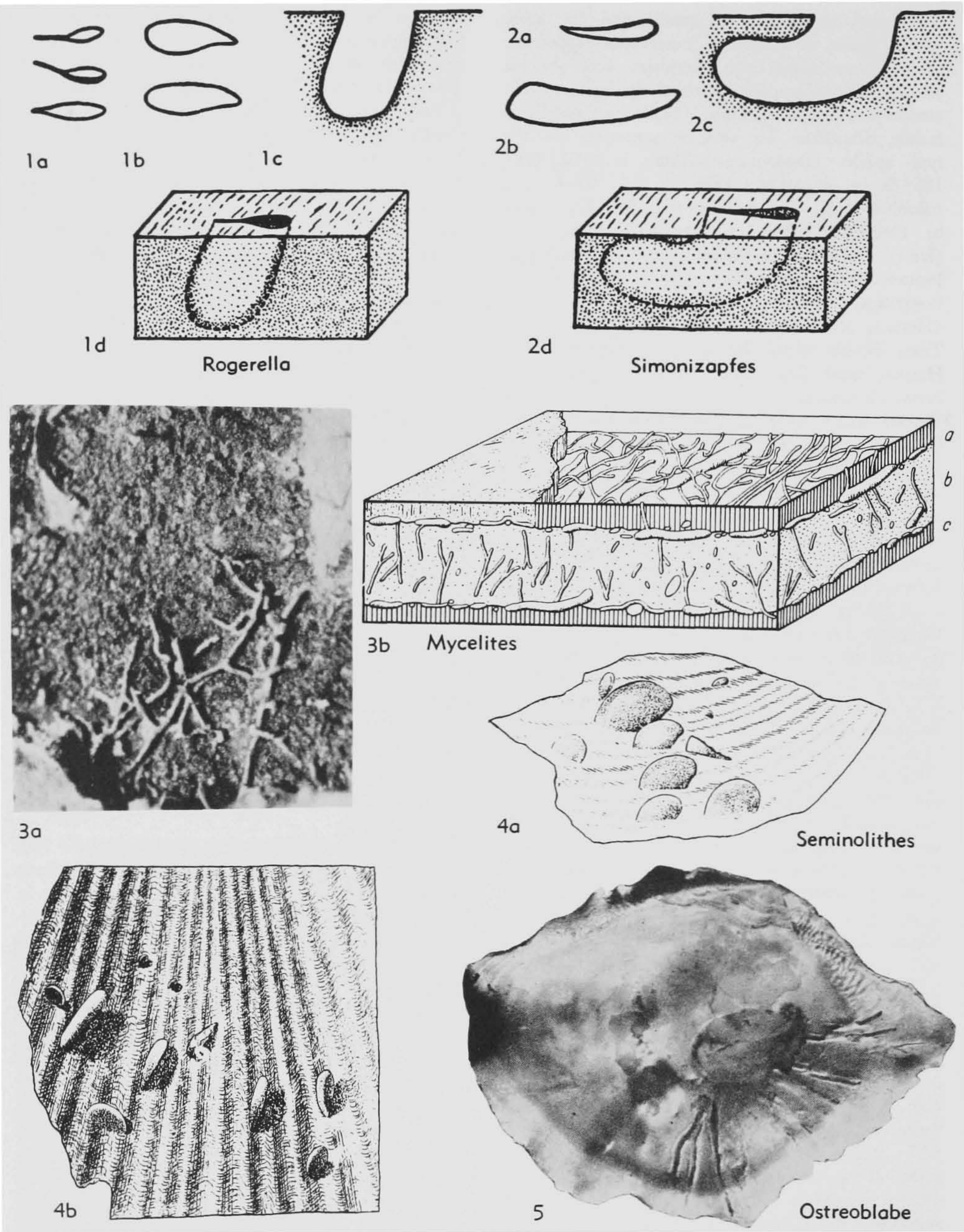

FIG. 80. Borings (p. W129, 131, 133).

cysts or swelling on its host; see HOWELL (1962), p. W167.] *Ord.-Perm.*, USA. [According to HOWELL (1962, p. W167), also found in Trias.-Jur. and cosmop.]——FIG. 79,3. *M.* sp. CLARKE, Carb., loc. unknown; x1 (Clarke, 1921).

Nygmites HÄNTZSCHEL, 1962, p. W230 [**Talpina solitaria* VON HAGENOW, 1840; OD] [=*Talpina* VON HAGENOW, 1840 *(partim)* (type, *T. ramosa*; SD HÄNTZSCHEL, 1962, p. W231); *Nygmites* MÄGDEFRAU, 1937, p. 56, *nom. nud.*, established without designation of type species]. Simple, unbranched tunnels in rostra of belemnoids; oblique to surface, open to exterior, leading from outside inward. [Type species perhaps made by algae or fungi; according to E. VOIGT (pers. commun., 1971), *Nygmites pungens* (QUENSTEDT) (=*Talpina pungens* QUENSTEDT) probably identical with boring bryozoan *Spathipora prima* VOIGT, 1962.] *L.Jur.*, Eu.(Ger.); *U.Cret.*, Eu.(France-Ger.-Pol.-USSR).——FIG. 79,*2*. **N. solitarius* (VON HAGENOW), U.Cret., Ger.; in *Belemnitella mucronata; A, Talpina cf. T. ramosa* VON HAGENOW; *B, N. solitarius; C, Terebripora pungens* (QUENSTEDT), ×0.87 (Voigt, 1972b).

Ostreoblabe VOIGT, 1965, p. 200 [**O. perforans*; OD]. Tubes in shells of Cretaceous oysters, sunk into shell material; straight or slightly curved; directed centripetally toward muscle scar, proceeding from round external opening perforating shell; resembling mud blisters of Recent oysters; [Obviously made by parasitic polychaete worms and representing *intra vitam* deformation of shell.] *U.Cret.(Turon.-Santon.)*, Eu.(W.Ger.). ——FIG. 80,*5*. **O. perforans*, mid.Turon., W. Ger.; in *Lopha semiplana* SOWERBY, ×1.4 (Voigt, 1965).

Palaeachlya DUNCAN, 1876, p. 210 [**P. perforans*; M]. Small tubes, average diameter 0.2 mm., usually straight, rarely flexuous; running inward in all directions to surface or parallel to it; sometimes branching. [Interpreted as made by parasitic algae; observed particularly in corals.] *Sil.-Dev.; Tert.*; Eu.-N.Am.(Can.)-Australia.

Palaeosabella CLARKE, 1921. p. 91 [**Vioa prisca* McCOY, 1855, p. 260; M] [=*Paleosabella* CLARKE, 1921, p. 91 *(nom. null.); Paläosabella* SOLLE, 1938, p. 157 *(nom. null.)*]. Possible synonym of *Topsentopsis* DE LAUBENFELS, 1955, p. *E*4.

Palaeopede ETHERIDGE, 1899, p. 127 [**P. whiteleggei*; M]. Borings in *Favosites*; consisting of chains of moniliform cells(?); longest chain 0.5 mm. [Referred to an endophytic alga similar to *Nostoc*.] *Dev.*, Australia(NewS.Wales).

Palaeoperone ETHERIDGE, 1891, p. 97 [**P. endophytica*; M]. Pinshaped, straight, tubular, tapering to ?distal end, ?proximal end inflated into globular chamber; observed in *Stenopora crinita* LONSDALE, occurring in matted clusters and irregularly arranged bundles. [Tentatively interpreted as fungi.] *Perm.*, Australia(NewS.Wales).

Paleobuprestis HÄNTZSCHEL, 1962, p. *W*230 [**P. maxima* WALKER, 1938, p. 138; OD] [=*Paleobuprestis* WALKER, 1938, p. 138, *nom. nud.*, established without designation of type species]. Channels under bark of *Araucarioxylon arizonicum*; diameter 2 to 10 mm.; recognizable all around tree; channels resembling work of Recent buprestids. *Trias.*, USA(Ariz.).——FIG. 81,*1a*. **P. maxima* WALKER, Chinle F., Petrified Forest Natl. Mon.; ×0.54 (Walker, 1938).——FIG. 81,*1b*. *P. minima* WALKER, Chinle F., Petrified Forest Natl. Mon., ×0.5 (Walker, 1938).

Paleoipidus HÄNTZSCHEL, 1962, p. W230 [**P. perforatus* WALKER, 1938, p. 140; OD] [=*Paleoipidus* WALKER, 1938, p. 140, *nom. nud.*, established without designation of type species]. Tunnels and burrows penetrating heartwood of *Araucarioxylon arizonicum* (see also *Paleobuprestis* and *Paleoscolytus*); diameter 2 to 5 mm.; boring near bark or through wood. *Trias.*, USA (Ariz.).

Paleoscolytus WALKER, 1938, p. 139 [**P. divergus*; M]. Channels under bark of *Araucarioxylon arizonicum*; diameter 5 mm.; running in all directions; not filled with castings; resembling channels of Recent bark beetles of family Scolytidae. *Trias.*, USA(Ariz.).——FIG. 81,*3*. **P. divergus*, Chinle F., Petrified Forest Natl. Mon.; *ca.* ×0.7 (Walker, 1938).

Penetrantia SILÉN, 1946 (see BASSLER, 1953, p. *G*37). [Recent boring bryozoan; the genus *Penetrantia* has been based on the anatomy of the producer, and not the morphology of the boring; VOIGT & SOULE (1973) described first fossil Cretaceous species *P. gosaviensis* from Upper Cretaceous, Austria(Gosau); according to BOEKSCHOTEN (1970) name should not be applied to fossil borings of *Penetrantia* type, thus BOEKSCHOTEN (1966, 1967) described such borings from the Pliocene, Netherlands, and Pleistocene, Europe (England), as *"Penetrantia."*]

Podichnus BROMLEY & SURLYK, 1973, p. 363 [**P. centrifugalis*; OD]. More or less compact groups of pits or cylindrical holes in hard, calcareous substrates; pits at center of group more or less perpendicular to surface, more peripheral pits typically deeper and larger, entering substrate obliquely, centrifugally; size of pits up to *ca.* 200 mμ. [Recent examples are produced by brachipod pedicles; see BROMLEY (1970, p. 61).] *L.Cret.-U.Cret.*, Eu.(Eng.-Swed.-Ger.); *Rec.*, Eu. (Nor., N.Sea).——FIG. 60,*6*. **P. centrifugalis*, U. Cret., Eng.; ×80 (Bromley & Surlyk, 1973). [Description supplied by R. G. BROMLEY.]

Pseudopolydorites GŁAZEK, MARCINOWSKI, & WIERZBOWSKI, 1971, p. 441 [**P. radwanskii*; OD]. U-shaped burrows without spreite; limbs rather closely spaced, circular in cross section, highest parts near openings somewhat curved; 3 to 5 cm. long; 6 to 8 mm. in diameter. [Borings in hardgrounds.] *U.Cret.(low.Cenoman.)*, Eu.(Pol.).—— FIG. 81,*5*. **P. radwanskii*, Sudót; *5a*, ×0.7; *5b,c*, showing two sides of the same section of *"Potamilla"* type B containing opening of boring, ×0.7 (Głazek, *et al.*, 1971).

Ramosulichnus HILLMER & SCHULZ, 1973, p. 9 [**Polydora biforans* GRIPP, 1967; OD]. Long, unbranched, commonly weakly curved borings, gradually expanding distally and ending blindly;

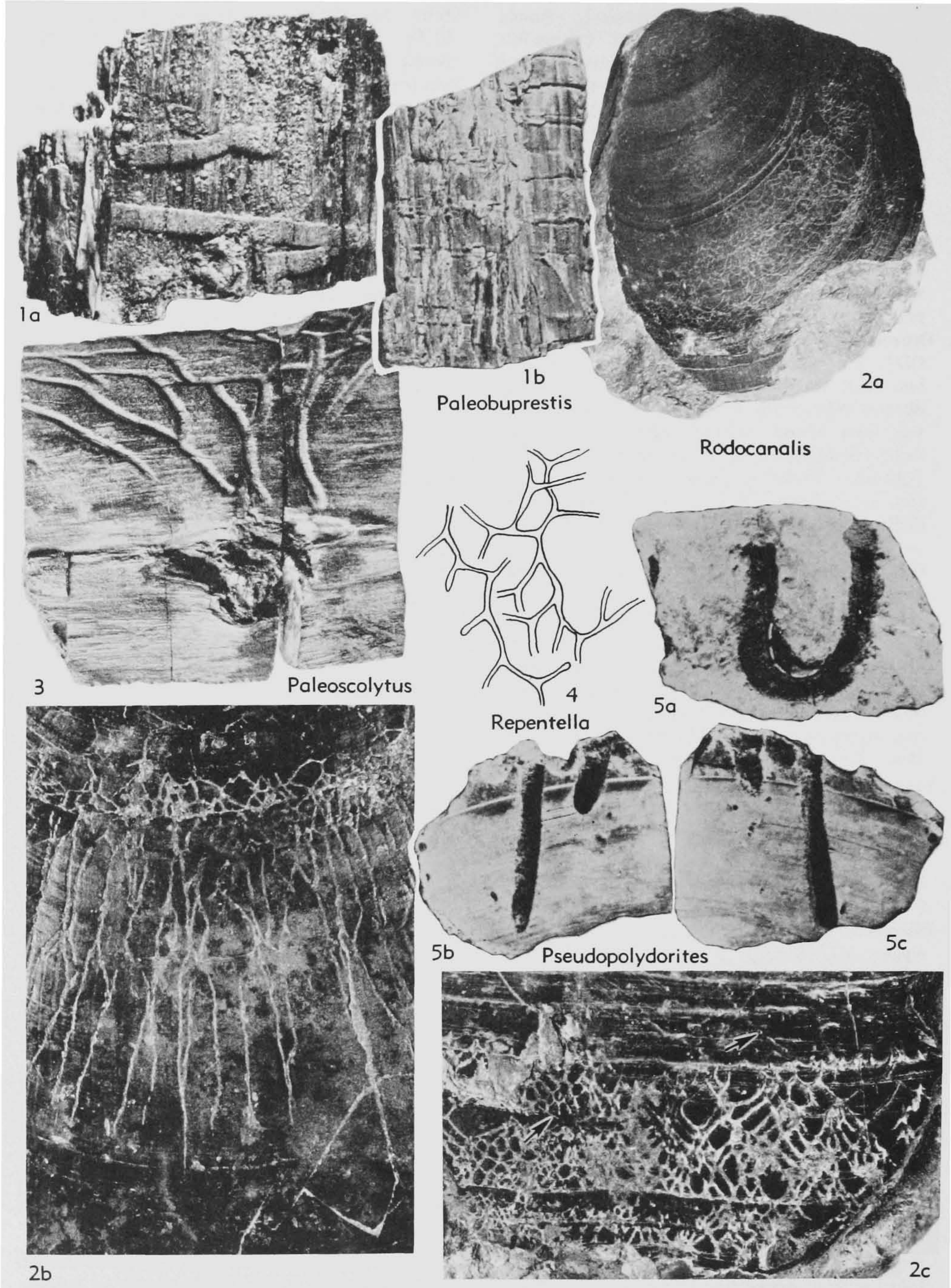

Fig. 81. Borings (p. W131, 133).

about 1 to 4 mm. in diameter and 1 to 5 cm. long; small aperture commonly connected to surface by numerous, diverging grooves or furrows; transverse section is nearly circular near aperture becoming oval to weakly dumbbell in outline toward the distal end; specimens representing the larger members of the genus have 4 rows of dimple-like chambers while the smaller ones do not. [Type species divided into two morphological groups which were thought by the authors to express the sexual dimorphism of the producers. The cavities near the apertural end of the larger borings were interpreted as brood chambers produced by female polychaetes while the smaller borings without these secondary cavities were interpreted to have been produced by males (see p. *W*123); produced in belemnite rostra.] *U.Cret. (Santon.-low. Maastricht.),* Eu. (Denm.-Eng.-N. Ger.-USSR). [Description supplied by W. G. HAKES.]

Repentella GISELA MÜLLER, 1968, p. 86[**R. maior*; OD]. Netlike arranged tunnels in shells of brachiopods (e.g., *Spirifer, Stropheodonta*), forming irregular polygons; tunnels straight or slightly sinuous, branched; walls smooth; 0.2 to 0.5 mm. in diameter, enlarging to 2.5 mm. on ramifications. *L.Dev.(mid.Siegen.),* Eu.(W.Ger.).——FIG. 81, *4. R. fragilis*; schem. drawing, ×2.7 (Gisela Müller, 1968).

Rodocanalis SCHLOZ, 1972, p. 164 [**R. reticulatus*; OD]. Netlike pattern of grooves on outer surface of pelecypod shells; grooves nearly as deep as wide, about 0.1 to 0.3 mm., which do not seem to connect with other borings. [Interpreted as being produced by etching.] *L.Jur.(Hettang.-Sinemur.),* Eu.(Ger.).——FIG. 81,*2*. **R. reticulatus* on *Plagiostoma giganteum* SOWERBY, Hettang.-Sinemur. boundary, S.Ger.; *2a,* ×0.6; *2b,* upper part, *R. reticulatus*; lower, *R.* sp., ×2.2 (Schloz, n, I.G.P. Stuttgart, cat. no. S.1121); *2c,* arrows point to *Talpina ramosa* HAGENOW, ×3 (Schloz, 1972). [Description supplied by W. G. HAKES.]

Rogerella DE SAINT-SEINE, 1951, p. 1053 [**R. lecontrei*; OD] [=*Rodgerella* NEWMAN, ZULLO & WITHERS, 1969, p. *R*252, *R*272 *(nom. null.)*]. Very deep borings of barnacles; cross section short and broad; observed in shells of corals, brachiopods, bivalves, gastropods, and echinoids. *Perm.,* USA(Texas). [According to BROMLEY, 1970, p. 69, *Clionites mantelli* WETHERELL, 1852, is identical with *Rogerella mathieui* DE SAINT-SEINE, 1956.] *M.Jur.-U.Cret.,* Eu.(Eng.-France-Ger.-Pol.)-USA; *Tert.(Mio.),* Eu.(France); *Tert. (Plio.),* Afr.(Morocco).——FIG. 80,*1. R. mathieui* DE SAINT-SEINE, Cret., France; *1a,b,* schem., various kinds of openings and tang. secs.; *1c,* long. sec.; *1d,* chamber (Codez & de Saint-Seine, 1958).

Seminolithes HYDE, 1953, p. 215 [**S. linii*; M]. Thin lenticular cavities in shells of brachiopods; usually perpendicular or inclined to surface, rarely almost parallel to it; shape and size variable, similar to flax seed; 2 mm. long, 0.3 to 0.5 mm. wide; somewhat resembling *Caulostrepsis* and *Bascomella.* [Producer unknown.] *Miss.,* USA (Ohio-Okla.-?Mo.).——FIG. 80,*4*. **S. linii,* Logan F., Ohio; *4a,b,* sediment-filled borings from shell of *Spirifer striatiformis,* both ×1 (Hyde, 1953).

Simonizapfes CODEZ & DE SAINT-SEINE, 1958, p. 704 [**S. elongata*; OD]. Long, narrow borings of barnacles; length (max.) 4.5 mm., width (max.) 1.1 mm.; shallow; observed in hard parts of corals, oysters, gastropods, belemnoids and other fossils. *Jur.,* Eu.(Eng.-France-Ger.-Pol.).——FIG. 80,*2*. **S. elongata,* France; *2a-d,* schem., opening, tang. sec. (max.), long. sec., chamber (Codez & de Saint-Seine, 1958).

Spathipora FISCHER, 1866, p. 986 (see BASSLER, 1953, p. *G*37). [Borings of bryozoans; according to BOEKSCHOTEN (1970, p. 44) and BROMLEY (1970, p. 57), to be regarded as ichnogenus. The taxonomy is confused; a few Recent species have been erected on strength of anatomical criteria only, others are based on pattern of their borings system.]

Specus STEPHENSON, 1952, p. 51[**S. fimbriatus*; OD]. Small club-shaped borings in shells of gastropods and pelecypods *(Breviarca, Ursirivus),* straight, curved, or irregular in trend, circular in cross section, diameter increasing to rounded end (from 0.2 to 0.75 mm.); maximum length about 8 mm. [Possibly made by sponges, questionably referred to Clionidae, commensal rather than parasite?; interpreted by VOIGT (1970, p. 377) as made by worms or wormlike organisms; perhaps not borings, according to BROMLEY (1970), who noted that distribution and orientation resemble embedment structures.] *U.Cret.(Cenoman., Woodbine F.),* USA(Texas).——FIG. 82,*3*. **S. fimbriatus*; ferruginous casts of sponge borings in shells of bivalve mollusks (shell substance removed in solution), ×3 (Stephenson, 1952).

Stichus ETHERIDGE, 1904, p. 257 [**S. mermisoides*; M]. Borings in pelecypod *Fissilunula clarkei* (MOORE), related to *Palaeopede* ETHERIDGE, 1899. [Made by ?algae or fungi.] *U.Cret.,* Australia (New S.Wales).

Talpina VON HAGENOW, 1840, p. 671 [**T. ramosa*; SD HÄNTZSCHEL, 1962, p. *W*231]. Straight tunnel systems in rostra of belemnoids, commonly branched, diameter *ca.* 0.2 mm.; numerous oval or circular openings toward exterior. [According to MORRIS (1851) and LESSERTISSEUR (1955, p. 81), produced by boring bryozoans; VOIGT considered only *Talpina pungens* probably identical with boring bryozoan *Terebripora prima* (VOIGT, 1962); type species *T. ramosa* interpreted as phoronid, not bryozoan, boring (VOIGT, 1972); *T. solitaria* VON HAGENOW, 1840 = type species of *Nygmites* HÄNTZSCHEL, 1962, p. *W*230; *T. dendrina* MORRIS, 1851 (=*Dendrina belemniticola* MÄGDEFRAU, 1937, p. 55) = type species of

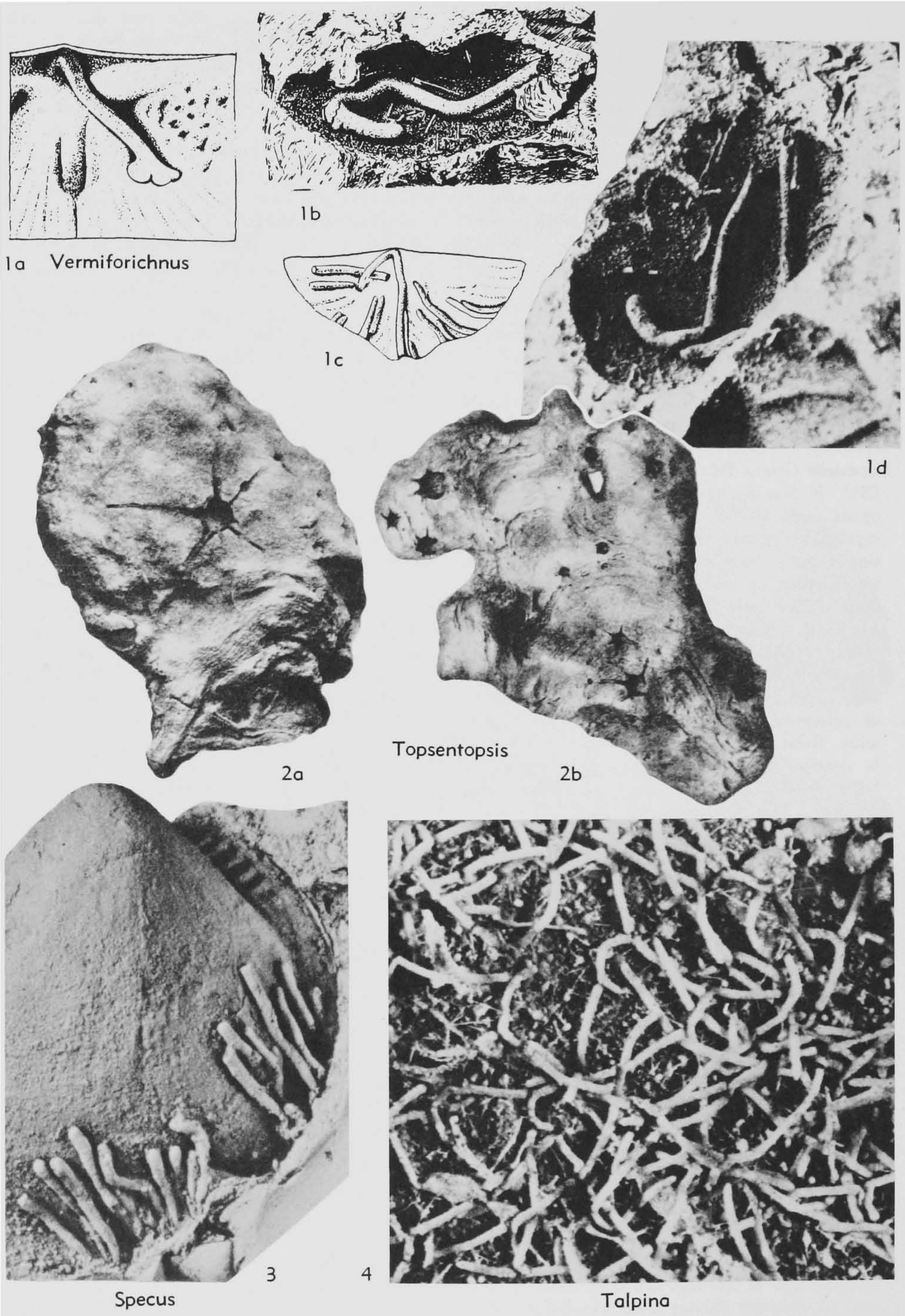

FIG. 82. Borings (p. W133, 135-136).

Dendrina QUENSTEDT, 1849 (SD HÄNTZSCHEL, 1965, p. 30).] *?Jur.,U.Cret.,* Eu.(Eng.-France-Ger.-Pol.-USSR); *U.Cret.(Campan.),* Eu.(Ire.).——FIG. 82,*4*. **T. ramosa,* Danian-Montian(?), France(Vigny, near Paris); steinkerns of tunnel systems, shell dissolved, ×5.7 (Voigt, 1972).

Tarrichnium WANNER, 1938, p. 398 [**T. balanocrini*; M]. Irregularly branched, ribbonlike, sharply entrenched traces on stalks of *Balanocrinus*; surface of ribbons slightly convex, some divided by 1 or 2 very thin longitudinal furrows; with fine bowl-shaped impressions. [Made by ?hydrozoan; see HILL & WELLS (1956, p. *F*88).] *U.Tert. (Mio.),* E.Indies.——FIG. 83,*1*. **T. balanocrini; 1a,* ×2.5; *1b,* ×1.4 (Wanner, 1938).

Terebripora D'ORBIGNY, 1842, p. 22 (see BASSLER, 1953, p. *G*37). [Borings of bryozoans; according to BOEKSCHOTEN (1970, p. 44) and BROMLEY (1970, p. 57), to be regarded as ichnogenus; taxonomy of *Terebripora* and that of *Spathipora,* p. *W*133, similarly confused.] *Jur.-Rec.,* Eu.-Asia-Atl.-Pac.

Teredolites LEYMERIE, 1842, p. 2 [**T. clavatus*; OD]. Clusters of clublike tubes, about 2 cm. long. [Apparently made by bivalves; name based on tubes only. See TURNER, 1969, p. *N*740 and Fig. E214.] *Cret.,* Eu.(France).

Thalamophaga RHUMBLER, 1911, p. 229 [**T. ramosa*; SD LOEBLICH & TAPPAN, 1964, p. *C*183] [For synonymy with *Orbithophage* SCHLUMBERGER, 1903; *Marsupophaga, Tubophaga, Nummophaga* RHUMBLER, 1911; *Arthalamophagum* RHUMBLER, 1913, see LOEBLICH & TAPPAN (1964, p. *C*183)]. Very small borings in tests of foraminifers, consisting of irregular "chambers" 2 to 8 microns in diameter and connected by stolonlike tubes. [Regarded by RHUMBLER (1911, p. 228) as of doubtful systematic position, possibly representing boring foraminifer morphologically modified by its parasitic mode of life; LOEBLICH & TAPPAN (1964, p. *C*183) placed it in the Foraminiferida (family Allogromiidae RHUMBLER), mentioning only Recent occurrences (Atlantic), whereas RHUMBLER (1911, p. 229-230) cited descriptions of similar borings in fossil shells and tests which he suggested as made by *Thalamophaga* or other (synonymous) genera; according to BOEKSCHOTEN (1966, p. 344), *Thalamophaga* probably belongs to group of algal or fungal borings.] *?Jur.,* Eu.(Ger.), *Rec.,* Atl.-Medit.

Topsentopsis DE LAUBENFELS, 1955, p. E41 [**Topsentia devonica* CLARKE, 1921, p. 88; M] [=*Topsentia* CLARKE, 1921, p. 88 (obj.) (*non* BERG, 1899); *Palaeosabella* CLARKE, 1921, p. 91 *(partim)* (type, *Vioa prisca* MCCOY, 1855, p. 260); for discussion of the confused nomenclature and synonymy, see TEICHERT, 1945 (p. 200) and CAMERON, 1969a (p. 189)]. Borings of quite variable size, consisting of cavities and tubes or channels; cavity central, irregularly spheroidal or ovoid; tubes radiating from it, simple or branching, sometimes enlarging distally; diameter of central cavity 1 to 10 mm., of tubes 0.5 to 3 mm. [Interpreted as sponge borings; according to DE LAUBENFELS (1955, p. *E*41), sponge affinities doubtful; observed in many stromatoporoids.] *?Sil.,* USA; *Dev.,* USA.——FIG. 82,*2*. **T. devonica*

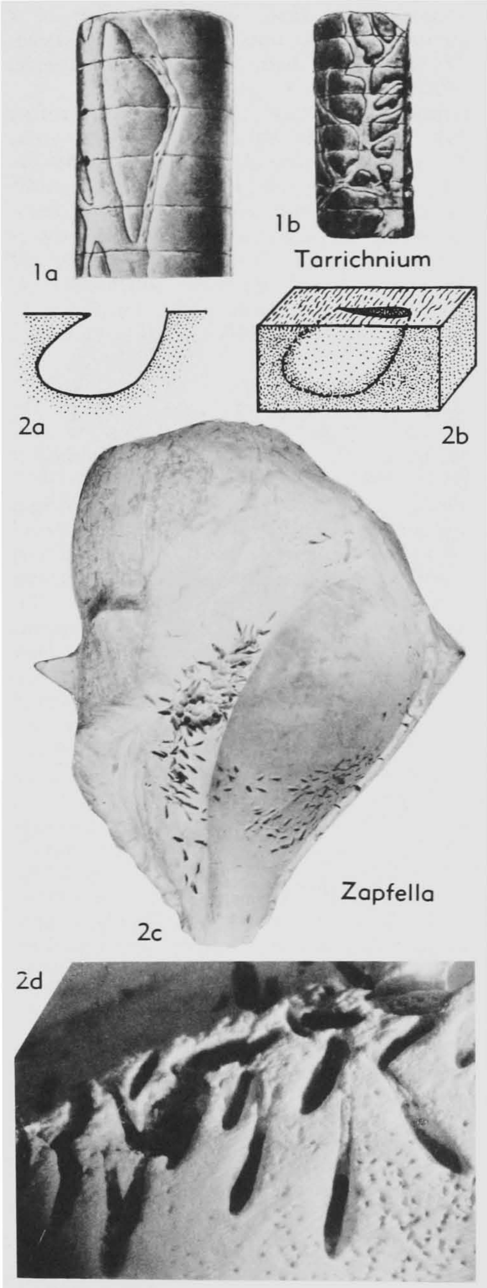

FIG. 83. Borings (p. *W*135-136).

CLARKE, Dev., Iowa; on lower surface of a stromatoporoid, *2a*, from Shellrock stage, reduced; *2b*, Cedar Valley beds, ×0.2 (Fenton & Fenton, 1932).

Trypanites MÄGDEFRAU, 1932, p. 151 [*T. weisei*; M] [=?*Calciroda* MAYER, 1952, p. 455 (type, *C. kraichgoviae*); see A. H. MÜLLER, 1956b, p. 410]. More or less straight tunnels, usually vertical, 1 to 2 mm. wide, without ramification; closely spaced; occasionally contain excrement of producer (see Fig. 76). [Made by rock and hardground borers; apparently polychaetes.] *L. Ord.*, USSR; *Sil.* (Pleist. drift), Eu.(Ger.); *U. Dev.*, USSR; *M.Trias.(Muschelkalk)*, Eu.(Ger.); *U.Jur.*, Eu.(Pol.).

Vermiforichnus CAMERON, 1969, p. 190 [*V. clarkei*; M] [=*Gitonia* CLARKE, 1908, p. 154 (?*partim*) (type, *G. corallophila*); for discussion of this and the additional synonyms *Clionolithus priscus* (McCOY) and *Palaeosabella prisca* (McCOY), see CAMERON, 1969b, p. 692]. Borings, straight to slightly curved; rarely irregular, hooked or coiled; unbranched, smooth; nonintersecting; sometimes with subclavate termination; diameter 0.05 to 3 mm., commonly 0.2 to 2 mm. [Interpreted as worm borings, perhaps of Spionidae, possibly by the worm *Vermiforafacta rollinsi* CAMERON, 1969, which has been found in such a boring (see CAMERON, 1969b, p. 694); observed in calcareous algae, corals, bryozoans, brachiopods, mollusks; best known from Devonian strata.] *Ord.-Perm.*, cosmop.——FIG. 82,*1a-c*. **V. clarkei* (=*Palaeosabella prisca* (McCOY)), USA(N.Y.); *1a*, M.Dev.(Hamilton Gr.), portion of thickened substance of shell of brachiopod (*Leptostrophia*), flattened form in thinner part, ×?; *1b*, L.Dev. (Oriskany Ss.), hook-shaped boring in cast of brachiopod, ×?; *1c*, M.Dev.(Hamilton Gr.), sketch to show bend in tube where shell is thickest, ×? (Clarke, 1921).——FIG. 82,*1d*. *Vermiforichnus* tubes in *Meristella*, L.Dev.(Oriskany Ss.), USA; ×2 (Clarke, 1921).

Zapfella DE SAINT-SEINE, 1956, p. 449 [**Z. pattei*; M]. Saclike bore holes, 1 to 4 mm. long, 0.5 to 1 mm. wide, and up to 5 mm. deep; slitlike opening. [Made by barnacles (Acrothoracica); found in corals, brachiopods, mollusks, echinoids, and solid rock.] *Jur.-Tert.*, Eu.(Eng.-France-Aus.-Hung.-Italy-Pol.)-N.Afr.(Alg.)-N.Z.——FIG. 83,2. *Zapfella* borings in *Galeodes (Volema) cornuta* AGASSIZ, Mio., Hung.; *2a*, long. sec., schem.; *2b*, chamber, schem.; *2c*, ×0.9; *2d*, ×4.5 (Codez & de Saint-Seine, 1958).

GENERIC NAMES OF RECENT BORING ORGANISMS USED FOR FOSSIL BORINGS

PORIFERA

Cliona GRANT, 1826, p. 78. The name of the widely distributed marine boring sponge *Cliona* has often been used for similar borings observed in Mesozoic and Tertiary, and even Paleozoic fossils. Names of Recent species of *Cliona* or new species names have been applied to fossil borings apparently made by clionids (e.g., from the Upper Paleozoic of USA (ELIAS, 1957), from the Cretaceous of USA (STEPHENSON, 1941, 1952) and Europe (NESTLER, 1960; SCHREMMER, 1954), and from the Tertiary of Europe (BOEKSCHOTEN, 1966; RADWAŃSKI, 1964)). However, as shown recently by BROMLEY (1970, p. 77), the suitable ichnogeneric name for such Mesozoic and Tertiary borings is *Entobia* BRONN, 1838 (*emend.* BROMLEY, 1970). This name alone should be used (for Paleozoic sponge borings other ichnogeneric names are available). A detailed description of Recent clionid borings, their morphology and ecology, and their significance as agents of erosion and sedimentation has been given by BROMLEY (1970, p. 70-77).

BRYOZOA

The question of whether borings of bryozoans are to be regarded as ichnofossils is still a matter of dispute. BOEKSCHOTEN (1970) and BROMLEY (1970) are undoubtedly correct for considering them to be true ichnofossils. As BROMLEY (1970, p. 57) has stated, *Terebripora* D'ORBIGNY and *Spathipora* FISCHER "are in reality ichnogenera, since they were erected for empty borings, and they therefore rightly belong to the ichnologist rather than to the zoologist." The criteria employed in establishing these two ichnogenera were based entirely on the morphology of the borings and not the soft-body morphology of the producers. BOEKSCHOTEN and BROMLEY further emphasized that the names of Recent boring Bryozoa such as *Immergentia* SILÉN and *Penetrantia* SILÉN should be used for only the Recent animals and not their borings. Ichnogeneric names should be used for all fossil bryozoan borings even if they are morphologically congruent with these Recent Bryozoa.

The opposing viewpoint has been most recently expressed by VOIGT & SOULE (1973). They have pointed out that the tunnel systems made by bryozoans correspond well to the soft-body morphology of the animals, particularly to the structure of the zooids. In their opinion, bryozoan borings can not be compared with other borings generally regarded as trace fossils with ichnogeneric names. (See also POHOWSKY, 1974.)

Bryozoan borings may have an exceptional position among all the other borings. However, they are also cavities for which generic names based on the anatomy of the producer should not be applied.

Because of these two differing opinions, there now exists a regrettable state of taxonomic confusion with respect to the establishment of names for Recent and fossil bryozoan borings. Several genera are composed of both "biospecies" (zoological species) and ichnospecies (species determined solely on the morphologic pattern of the tunnel system). This situation has been recently emphasized by BOEKSCHOTEN (1970, p. 43-44). It is hoped that future studies employing modern techniques (casting-embedding procedure, scanning electron microscopy) will help to clear up this unfortunate circumstance.

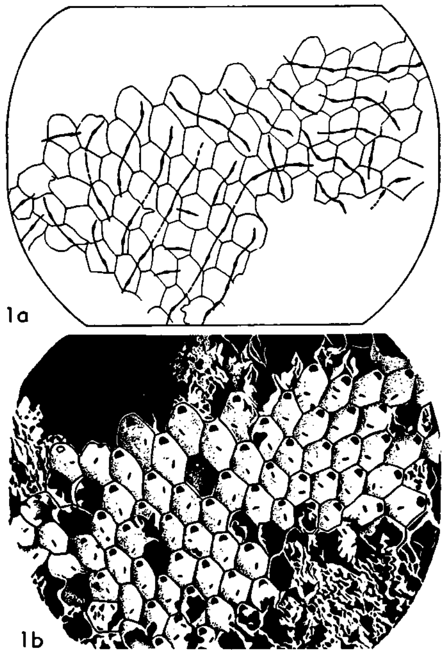

FIG. 84. Borings (p. W137).

Harmeriella? cretacea VOIGT, 1957, p. 348. Very small borings in the cheilostome bryozoan *Strichomicropora membranacea* (VON HAGENOW, 1839), oblong, about 0.05 mm. long, *ca.* 0.03 mm. in diameter; away from apertures of bored zooecia; longitudinal axes of borings often arranged parallel to one another or even aligned. [Probably made by a colony of sessile organisms, presumably by a ?parasitic ctenostome bryozoan; according to VOIGT, 1957, p. 354, has doubtful affinities with Recent boring bryozoan *Harmeriella* BORG, 1940.] *U.Cret.(low.Maastricht.)*, Eu.(Ger., Isle of Rügen).——FIG. 84,*1*. *Harmeriella? cretacea* borings in *Stichomicropora membranacea* (VON HAGENOW); *1a*, schem. drawing, borings connected by lines; *1b*, ×10 (Voigt, 1957).

Immergentia SILÉN, 1946, p. 6 (see BASSLER, 1953, p. G37). *Rec.* [Single *Immergentia*-like fossil described (*Immergentia? lissajousi* WALTER, 1965, from Oxfordian of France) does not belong to this genus (BOEKSCHOTEN, 1970, p. 44, and E. VOIGT, pers. commun., 1971).]

BIVALVIA

Recent bivalve borings in rocks are rather well known, thus their identification is relatively simple. Such borings or their steinkerns have commonly been named after their producer. This concerns mainly the following genera known from the Upper Cretaceous or Lower Tertiary to the Recent which are distributed all over the world: *Aspidopholas* FISCHER, 1887 (TURNER, 1969, p. N712); *Gastrochaena* SPENGLER, 1783 (KEEN, 1969b, p. N699); *Jouannetia* DES MOULINS, 1828 (TURNER, 1969, p. N718); *Lithophaga* RÖDING, 1798 (SOOT-RYEN, 1969, p. N276); *Petricola* LAMARCK, 1801 (KEEN, 1969a, p. N689).

RADWAŃSKI (1964, 1965, 1969) has studied the "lithophocoenoses" of Miocene littoral sediments in Poland. His publications serve as excellent examples of the description and environmental interpretation of bivalve borings produced by the genera listed above. (See also KAUFFMAN, 1969, p. N168-N170, and especially BROMLEY, 1970, p. 64.)

POLYCHAETA

Dodecaceria Oersted, 1843, p. 44. Voigt (1970, p. 375) described small borings in boulders of Upper Cretaceous (Santonian) limestones in North Germany (Lower Saxony). Similar borings have been found in the Upper Maastrichtian "Tuffkreide" of Holland (Voigt, 1971). They are slightly clubshaped, straight, or somewhat curved, with a faint median depression, oblong or oval in cross section, 5 to 15 mm. long, 2 to 4 mm. in diameter, resembling the tubes of the Recent genus *Dodecaceria* Oersted. The Santonian specimens were named *Dodecaceria(?)* sp., and later were united with the Dutch borings in a new species *D. cretacea* (Voigt, 1971).

The borings of the Recent species *Dodecaceria concharum* from the North Sea occur in soft sandstones and limestones, in shells of mollusks or in calcareous algae. Another modern species, *D. fistulicola* Ehlers, described from Upper Tertiary and Pleistocene rocks of the United States (Ore., Calif.) lives in colonies only and represents a nonboring species of this genus (Howell, 1962, p. W163; Reish, 1952).

Very small meandering borings (0.5 mm. in diameter) have been observed in shells of *Cypricardia* from the Pliocene in Italy. Rovereto (1901, p. 228) named them *"Dodekaceria"(?)* sp. According to Voigt (1970, p. 373), these borings should be placed in the genus *Maeandropolydora* Voigt.

Polydora Bosc, 1802, p. 150. Small U-shaped borings with spreite (diameter of tubes *ca.* 0.5 mm.) as made by the Recent spionid *Polydora ciliata* (Johnston) have sometimes been placed in the ichnogenus *Polydora* (e.g., *P. biforans* in Upper Cretaceous belemnites found on the beach of the Baltic Sea) (Gripp, 1967). Borings of the *Polydora* type have commonly been observed particularly in shells of Tertiary mollusks and in rocks (Douvillé, 1908; Gekker & Ushakov, 1962; Papp, 1949; Radwański, 1964; Tauber, 1944, and others); see Boekschoten, 1966, p. 357.

Some Recent species (e.g., *Polydora hoplura*) live in "pseudo-borings" or blisterlike cavities. Differences between true borings and pseudoborings originated by embedment have been discussed by Bromley (1970, p. 50); see also Blake & Evans (1973).

The paleontologic history of *Polydora* up to 1908 was reviewed by Bather (1909); for a later discussion see Voigt (1965, p. 206).

Potamilla Malmgren, 1865, p. 401. Isolated cylindrical borings, several cm. long, 1 to 6 mm. in diameter, straight or somewhat curved, not branched, with rounded end "like a glove finger," vertical or oblique to the bedding plane, have been compared with borings of the Recent polychaete genus *Potamilla* and sometimes given the same name. They have been observed in Carboniferous and Jurassic hardgrounds (e.g., Eng., Switz.; see Hölder & Hollmann, 1969), Rhaetic-Liassic dolomite pebbles (Poland, Tatra Mts.; Radwański, 1959), Upper Cretaceous hardgrounds (France; Ellenberger, 1947), and Miocene littoral sediments (Poland; Radwański, 1964-69).

SIPUNCULIDEA

A boring (narrow entrance tunnel and expanded inner chamber) in the test of an *Echinocorys* (U. Cret., Isle of Wight) has been tentatively interpreted by Joysey (1959, p. 398) as made by an echiuroid and compared with burrows of *Thalassema neptuni* von Gaertner.

Sabella Linné, 1767, p. 1268. Branched cylindrical borings (3-5 cm. long, 3-5 mm. diam.) in shells of *Cypricardia* (Plio., Italy) have been named *Sabella?* sp. by Rovereto, 1901, p. 228. [*Sabella* is more favorably compared with tubes of *Potamilla.* Recent species of *Sabella* (in the present sense of the genus) do not bore.]

PHORONIDEA

Phoronis Wright, 1856, p. 167. A branched burrow system in the test of an Upper Cretaceous echinoid (*Echinocorys*) from the Isle of Wight has been compared by Joysey (1959, p. 398) with borings of *Phoronis ovalis* Wright which are known to occur in shells of Recent mollusks. The Cretaceous burrow system has not been named.

Phoronopsis Gilchrist, 1908, p. 153. Straight or slightly curved vertical borings (length up to 3 cm., diam. 0.1-1 mm.) in Maastrichtian and, rarely, Tertiary limestones of Israel have been interpreted by Avnimelech (1955) as made by phoronids, particularly the genus *Phoronopsis.*

Small vertical borings (diam. 0.5-2 mm.) observed in hardgrounds of the Upper Maastrichtian "Tuffkreide" of Maastricht (Netherlands) have been compared by Voigt (1970) with tunnels of Recent phoronids. They have been named *(?) Phoronopsis* sp. Their upper ends are frequently surrounded by agglutinating foraminifers (e.g., *Bdelloidina vincetownensis* Hofker).

CIRRIPEDIA

Trypetesa Norman, 1903, p. 369. Tomlinson (1963, p. 164) described fan-shaped burrows with elongate slitlike apertures which he observed in shells of myalinids from Pennsylvanian and lowermost Permian rocks of USA (Kans., Texas, Okla.). He recorded them as the largest fossil acrothoracican burrows (length about 1 cm., width *ca.* 5 mm.) and compared them with those made by the Recent cirriped *Trypetesa* NORMAN (1903) and thus named them *T. caveata*. However, SEILACHER (1969b, p. 709) interpreted them as borings of the *Polydora* type.

Ulophysema oeresundense BRATTSTRÖM, 1936, p. 1. Conical borings (outer diam. 0.8-0.9 mm., inner diam. 4-5 mm.) in the Upper Cretaceous echinoid *Echinocorys* from North Jutland (Denmark) have been ascribed by MADSEN & WOLFF (1965) to the Recent cirriped *Ulophysema oeresundense* BRATTSTRÖM. These borings are morphologically identical with those made by *Ulophysema* living parasitically in the echinoids *Echinocardium* and *Brissopsis* of the North Sea.

COPROLITES

The term coprolite has been defined in different ways (AMSTUTZ, 1958, p. 498). The shortest definition, "fossilized excrements of animals," seems to be best because it is independent of size and chemical composition of the "fossils" in question. It includes larger excrements, small fecal pellets (composing "coprogene sediments"), and microcoprolites.

In regard to their "systematic position" within paleozoology, ABEL (1935) classified them as lebensspuren, together with tracks, trails, borings, and other structures. However, coprolites do not correspond entirely to the widely accepted definition of trace fossils as structures left by living organisms in the sediment or on hard substrates. Thus, the special position of the coprolites requires them to be considered separately.

General questions about coprolites (size, shape, composition, occurrences, preservation, fossilization) are briefly discussed in the introduction to the annotated bibliography of coprolites (HÄNTZSCHEL, EL-BAZ, & AMSTUTZ, 1968). This work lists nearly 400 publications dealing exclusively or in part with coprolites.

This section describes only those coprolites that are identified by generic and specific names, and which are of undoubted invertebrate origin. For all other forms that have not been named, the reader is referred to the above-mentioned bibliography.

Names have been given mostly to microcoprolites observed in thin sections of sedimentary rocks. Especially, crustaceans of the order Anomura produce readily distinguishable excrements of which Recent and fossil examples are known (BRÖNNIMANN, 1972). According to BRÖNNIMANN, transverse sections of different anomuran coprolites such as *Favreina, Helicerina, Palaxius, Parafavreina,* and *Thoronetia* reveal internal canals with different morphologies and arrangements. A single name *Tibikoia* (HATAI, KOTAKA, & NODA, 1970) has been introduced for larger fecal particles up to 5 mm. in length.

The term Coprolichnia, proposed by MACSOTAY (1967) for all coprolites is etymologically incorrect, because the ending *-ichnia* means tracks, and should not be used for coprolites. Besides, the term is superfluous.

VYALOV (1972a) coined the term Coprolithidii for "coprolites proper" which he further subdivided into genetic groups according to their makers.

Aggregatella ELLIOTT, 1962, p. 40 [**A. pseudohieroglyphicus*; OD]. Microcoprolites forming clusters or tangles of pellets, 0.5 to 1.0 mm. long, similar to but smaller than those of Recent ophiuroids or brittle stars. *U.Jur.*, SW.Asia(Iraq).——FIG. 85,2. **A. pseudohieroglyphica,* Najmah F., Duliam Liwa; thin section, ×13 (Elliott, 1962).

Bactryllium HEER, 1853, p. 117 [**B. canaliculatum*; SD HÄNTZSCHEL, herein] [=*Bactryllum* AZPEITIA MOROS, 1933, p. 52 *(nom. null.)*; *Bactrydium* EMBERGER, 1968 *(nom. null.)*]. Small rounded or flat bacilliform bodies, few mm. to 1 cm. long, about 0.6 mm. wide; smooth or mostly with delicate transverse striations and 1 or 2 longitudinal furrows; ends rounded; material siliceous. [Interpretation as ?diatoms (HEER, 1853, 1877; FLICHE, 1906) very improbable; STEINMANN's interpretation (1907) as small dorsal plates of predatory worms has escaped notice; most probably are fecal pellets (excrements of gastropods, ROTHPLETZ, 1913; ALLASINAZ, 1968).] *Trias.-Jur.,* Eu.——FIG. 86,*1a*. **B. canaliculatum,*

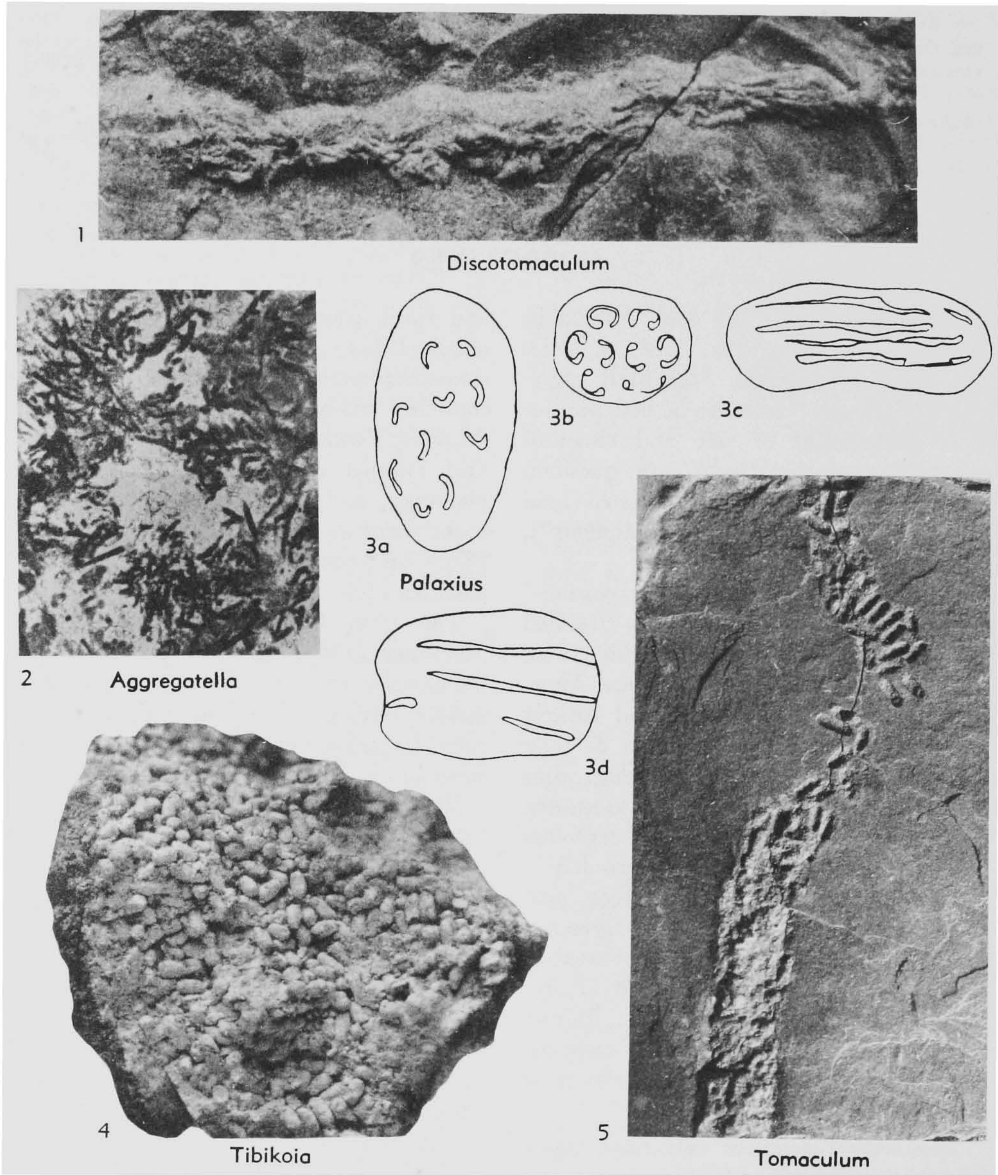

FIG. 85. Coprolites (p. *W*139, 141, 143).

L.Trias.(Carn.), Italy(Lago del Predil); ×6 (Allasinaz, 1968).——FIG. 86,*1b*. *B. heeri* ALLASINAZ, L.Trias.(Carn.), Italy(Lago del Predil); ×6 (Allasinaz, 1968).——FIG. 86, *1c*. *B. striolatum* HEER, U.Trias.(Rhaet.), Italy(Vedeseta); ×12 (Allasinaz, 1968).——FIG. 86,*1d*. *B. deplanatum* HEER, U.Trias.(Rhaet.), Italy(Gerosa); ×12 (Allasinaz, 1968).

Coprolithus PARÉJAS, 1948, p. 512. Name used for coprolites of crustaceans, proposed as informal term, not a "genus"; nevertheless, three "species" (*C. salevensis, C. prusensis,* and *C. decemlunulatus)* have been erected and described by PARÉJAS, 1948; see also *Favreina* BRÖNNIMANN, 1955.

Coprulus RICHTER & RICHTER, 1939, p. 163. Mechanical-ecological subsidiary name, proposed as neutral and informal name for excrement in form of isolated, loose pills, but designated as *Coprulus* "n.g." without a species name; used as "genus" by MAYER (1952) with "species" *C. oblongus* and *C. sphaeroideus* from Middle Triassic (up. Muschelkalk) of southern Germany.

Discotomaculum CHIPLONKAR & BADWE, 1972, p. 2 [**D. variabilis*; OD]. Zigzag burrow, 0.4 to 1.0 cm. wide, preserved in convex epirelief, filled with tiny discoid flakes of variable orientation (crisscross, parallel to subparallel, or transverse) to length of burrow. No evidence of burrow lining. Similar to *Tomaculum* but flakes may not be fecal in origin. [Interpreted as domichnia.] *L.Cret.*, India.——FIG. 85,*1*. **D. variabilis*, Bagh Beds; ×1 (Chiplonkar & Badwe, 1972). [Description supplied by W. G. HAKES.]

Favreina BRÖNNIMANN, 1955, p. 40 [**F. joukowskyi* (="Organisme B" JOUKOWSKY & FAVRE, 1913, p. 315; *"Coprolithus" salevensis* PARÉJAS, 1948, p. 512); OD]. Subtriangular and rounded dark organic remains of apparently homogeneous texture; 0.5 to 1.5 mm. long, 0.2 to 0.4 mm. wide; longitudinal section showing long, thin, straight and parallel canals distributed in regular but intermittent pattern; transverse section showing minute pores either arranged in 2 or more flattened, oblong rings or distributed irregularly; diameter of pores 12 to 40 microns. [Interpreted by PARÉJAS (1948) as coprolites of crustaceans, by CUVILLIER (in CUVILLIER & SACAL, 1951) as primitive Charophyta, by BRÖNNIMANN (1955) as microfossils *incertae sedis*, and by BRÖNNIMANN & NORTON (1960) as coprolites of crustaceans (Anomura). KENNEDY, JAKOBSON, & JOHNSON (1969) described an association of *Thalassinoides* with the microcoprolite *Favreina* from the Great Oolite Series of England.] *M.Trias.*, SW.Asia (N.Iraq); *L.Jur.-U.Tert.(mid.Mio.)*, Eu.(France-Eng.-Switz.-Yugosl.-Hung.-Romania-S. Italy-Turkey-?USSR)-N.Afr. (Morocco-?N. Alg.-Libya)-Asia (Arabia-Israel-N.Iraq-Qatar-Iran)-USA (Texas)-C. Am. (Guatemala)-Gulf Mexico-W. Indies (Cuba-Trinidad).——FIG. 87,*2a,b*. **F. joukowskyi*, U. Jur.(mid.Portland.), W.Indies(Cuba); *2a,b*, transv. sec., long. sec.; ×26 (Brönnimann, 1955).——FIG. 87, *2c*. *F. asmarica* ELLIOTT, mid.Mio.(up. Asmari F.), Iran(AsmariMt., Masjid-i-Sulaiman); ×20 (Elliott, 1962).——FIG. 87,*2d*. *F. martellensis* BRÖNNIMANN & ZANINETTI, M.Trias,, S. France; diag. transv. sec. (Brönnimann, 1972).

Helicerina BRÖNNIMANN & MASSE, 1968, p. 154 [**H. spinosa*; OD]. Rod-shaped coprolites, up to 0.5 mm. long, oval in cross section and provided with groovelike depression; with 1(?), 2, 3, or 5 longitudinal canals showing bilaterally symmetric pattern, "upper" canals interconnected by fissural spaces; median canal of forms with 3 or 5 canals with spinelike extension breaking through to exterior; much shorter extensions developed on lateral canals of coprolites with 5 canals; similar to *Favreina* and *Palaxius* but differing from both by angular shape of canals and by spinelike extensions sometimes connected with exterior. [Produced by Anomura.] *L.Cret.(uppermost Barrem. or lower-*

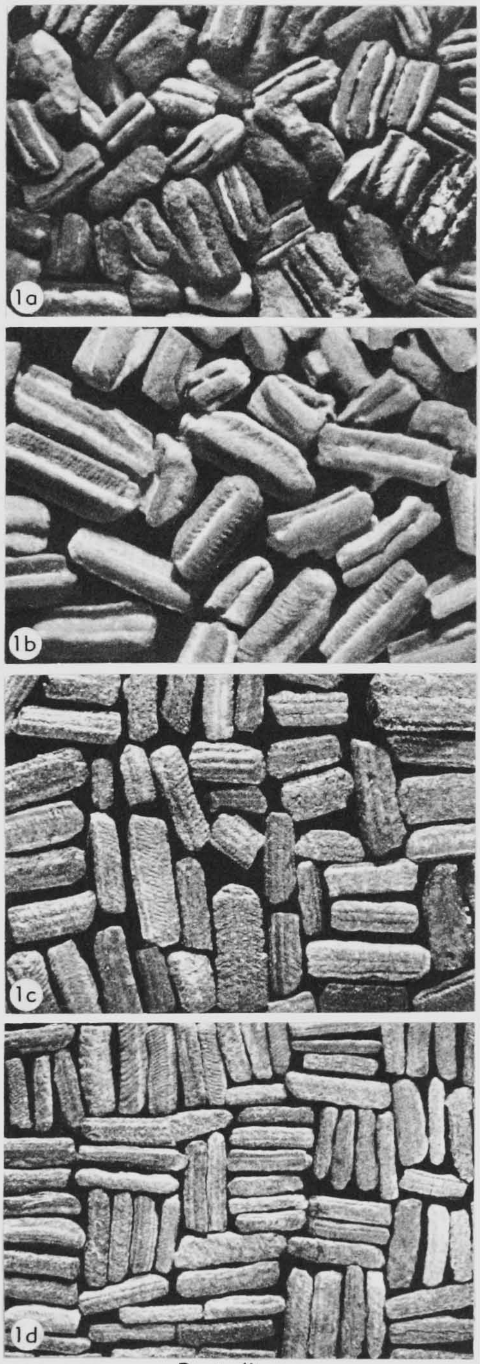

FIG. 86. Coprolites (p. *W*139-140).

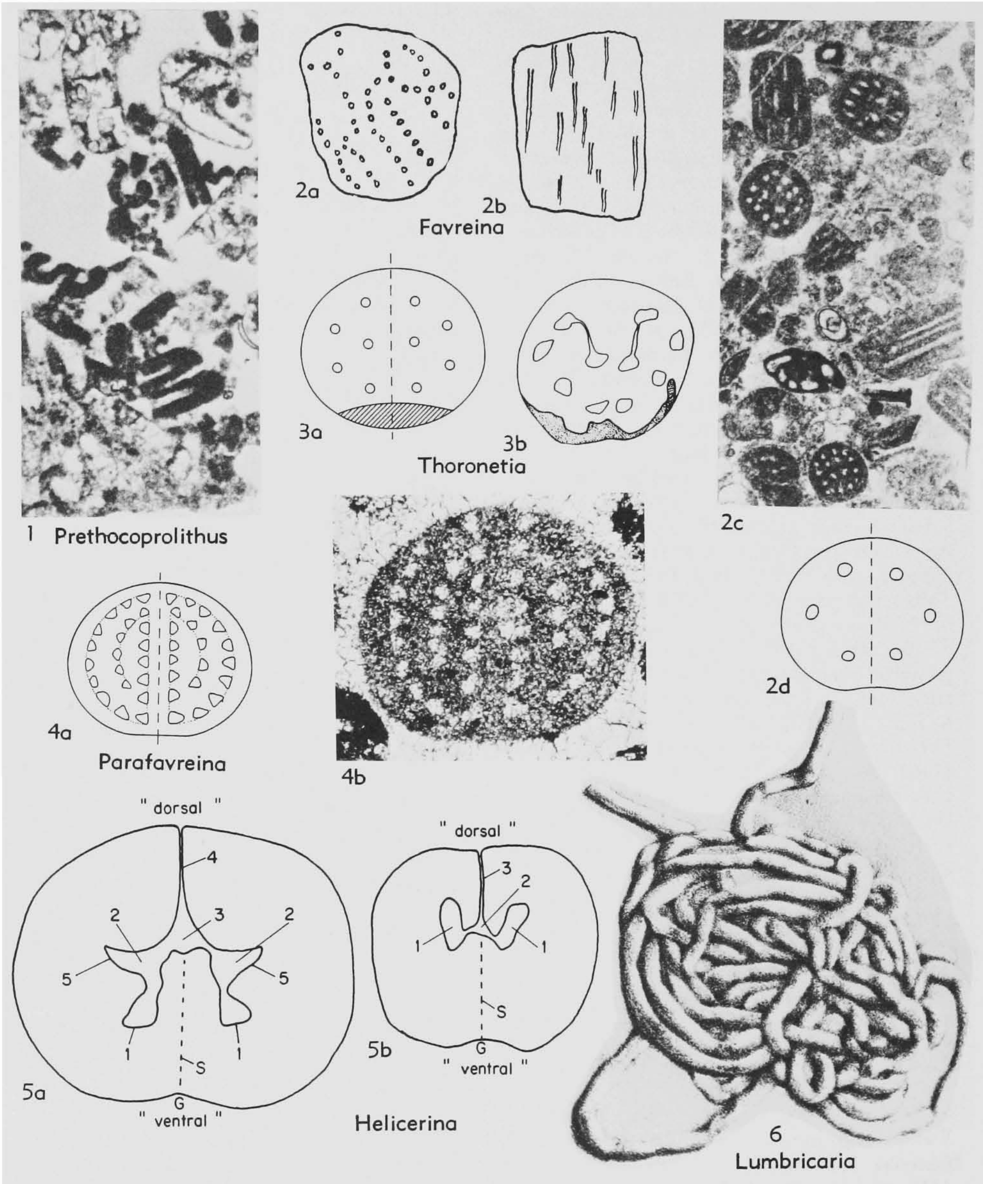

FIG. 87. Coprolites (p. W141-143).

most Apt.), Eu.(S.France).——FIG. 87,*5a.* **H. spinosa,* up.Barrem. or low. Apt.; [*1,* basal canals; *2,* lat. canals; *3,* median canal; *4,* spinelike "dorsal" extension of median canal; *5,* spinelike extension of lateral canals; *S,* plane of bilateral symmetry; *G,* "ventral" median groove], *ca.* ×330 (Brönnimann & Masse, 1968).——FIG. 87,*5b. H. alata* BRÖNNIMANN & MASSE, up.Barrem. or low. Apt.; [*1,* lat. canals; *2,* median canal; *3,* spinelike "dorsal" extension of median canal; *S* and *G* as in *5a*], *ca.* ×330 (Brönnimann & Masse, 1968).

Lumbricaria MÜNSTER (in GOLDFUSS), 1831, p. 222 [**L. intestinum*; SD HÄNTZSCHEL, 1962, p. *W*202] [=vermiculites PARKINSON, 1811, p. 93 (name not intended for genus); *Medusites* GERMAR, 1827, p. 108 (long unused name seemingly intended for rare, very thin tangles), Cololithen AGASSIZ, 1833, p. 676 (clearly not intended as generic name); *Lumbricites* (GOLDFUSS: "auctt.")]. Entangled intertwined strings, cross section somewhat round, diameter 1 to 4 mm.; length (max.) up to 170 cm., sometimes narrowed at irregular intervals; calcitic, rarely (e.g., *L. recta*) phosphatic; surface rough; strings consisting of very small fragments of planktonic crinoid *Saccocoma pectinata* (GOLDFUSS). [Interpreted as disgorged guts of fish and other animals (AGASSIZ, 1833; FRISCHMANN, 1853; O. KUHN, 1966) or ejected entrails of holothurians (GIEBEL, 1857; FENTON & FENTON, 1934c), as worms or wormlike animals (MÜNSTER [in GOLDFUSS], 1831; DE QUATREFAGES, 1846), as coprolites (EHLERS, 1868), as ?excrements of annelids (BROILI, 1924), partly of fish (MAYR, 1967; MÜLLER, 1969); intestinal fillings of worms (MAYR, 1967); according to JANICKE, (1970) certainly coprolites of cephalopods (Ammonoidea or more probably Teuthoidea) as earlier suggested by GOLDFUSS (1862). In the opinion of JANICKE (1970) the rare species *Lumbricaria coniugata* and *L. filaria* (=*Medusites* GERMAR, 1827) are not coprolites but perhaps conglobated filaments of algae; *L. antiqua* and *L.? gregaria* PORTLOCK (1843, p. 361) from the Silurian of Ireland identified as trails or ?burrows; *L. flexuosa* and *L. spiralis* SAVI & MENEGHINI (in MURCHISON, 1850, p. 491) from the Tertiary (Macigno) of Italy are unrecognizable.] *L.Jur.(up.Lias.)*, Eu.(S.Ger.); *U.Jur.(low.Tithon., Solnhofen Limestone)*, Eu.(S.Ger., Bavaria).——FIG. 87,*6*. **L. intestinum*, U.Jur.; ×0.8 (Goldfuss, 1831).

Palaxius BRÖNNIMANN & NORTON, 1960, p. 838 [**P. habanensis*; OD]. Coprolites of oval to subpentagonal or subrectangular shape; width 0.5 to 2 mm., breadth about 0.5 mm.; pierced by crescent or hookshaped longitudinal canals (max. length 45-140 microns, width 15-35 microns), arranged in 2 symmetrical groups. [Structurally closely related to coprolites of Recent thalassinid *Axius stirhynchus*.] *L.Cret.*, Eu.(Hung.); *L.Tert.(Eoc.)*, C.Am.(Guatemala); *U.Tert.(Mio.)*, W.Indies (Cuba)-N.Afr.(Libya).——FIG. 85,*3a,d*. **P. habanensis*, Mio., Cuba; ×26 (Brönnimann & Norton, 1960).——FIG. 85,*3b,c*. *P. petenensis* BRÖNNIMANN & NORTON, Eoc., Guatemala; ×26 (Brönnimann & Norton, 1960).

Parafavreina BRÖNNIMANN, CARON, & ZANINETTI, in BRÖNNIMANN, 1972, p. 100 [**P. thoronetensis*; OD]. Rod-shaped, about 250 microns in diameter, "ventral" side slightly compressed; perforated by two bilaterally symmetric groups of longitudinal canals, which in transverse section resemble isosceles triangles. [Interpreted as anomuran coprolites.] *Trias.(Nor.-Rhaet.)-L.Jur.(M.Lias)*, Eu.(Aus.-France-Spain)-N.Afr.(Alg.).——FIG. 87,*4*. **P. thoronetensis*, Trias.(Rhaet.), S. France; *4a*, diagram. transv. cross sec. (BRÖNNIMANN, 1972); *4b*, transv. cross sec., ×116 (BRÖNNIMANN *et al.*, 1972b). [Description supplied by W. G. HAKES.]

Prethocoprolithus ELLIOTT, 1962, p. 38 [**P. centripetalus*; OD]. Rodlike, elongate cylindrical bodies, hollow, tapering to rounded ends, circular in cross section, straight or curved, with central tubular cavity; 0.75 to 1 mm. long, 0.25 to 0.5 mm. in diameter; resembling the coprolites of Recent gastropod genera *Patina, Trochus,* and *Gibbula*. *U.Jur.*, Asia(Iraq).——FIG. 87,*1*. **P. centripetalus*, Najmah F., Iraq(Dulaim Liwa); thin section, ×24 (Elliott, 1962).

Thoronetia BRÖNNIMANN, CARON, & ZANINETTI, in BRÖNNIMANN, 1972, p. 100 [**T. quinaria*; OD]. Rod-shaped, about 300 microns in diameter, possessing "ventral cap" of denser material than rest of coprolite; in transverse section, internal canals appear subcircular to tear-shaped in outline. [Interpreted as galatheid anomuran coprolite.] *Trias.(Rhaet.)*, Eu.(France).——FIG. 87,*3*. **T. quinaria*; *3a*, diagram cross sec. (BRÖNNIMANN, 1972); *3b*, holotype transv. sec., ×90 (BRÖNNIMANN *et al.*, 1972a). [Description supplied by W. G. HAKES.]

Tibikoia HATAI, KOTAKA, & NODA, 1970, p. 8 [**T. fudoensis*; M]. Oblong fecal pellets, cylindrical, sometimes ovoid or of short rodlike shape; circular in cross section; both ends bluntly and flatly rounded; surface smooth; about 1 mm. long, diameter 0.5 mm. [Regarded as excrements of worms.] *Cenoz.*, Asia(Japan).——FIG. 85,*4*. *T.* sp., Kogata F.; upper view of fecal pellets, ×4 (Hatai, Kotaka & Noda, 1970).

Tomaculum GROOM, 1902, p. 127 [**T. problematicum*; M] [=*Syncoprulus* RICHTER & RICHTER, 1939a, p. 164 (type, *S. pharmaceus*)]. Strands of elliptical fecal pellets (="*Coprulus*" RICHTER & RICHTER, 1939a, p. 163) up to 10 cm. long and 1 to 2 cm. broad; lying on bedding planes; within strands pellets commonly lumped together in clusters; length of pellets 1 to 5 mm., diameter 0.5 to 1.5 mm. [Interpreted by BARRANDE (1872) as *"oeufs d'origine indéterminée,"* by GROOM (1902) as eggs, possibly of trilobites, and by RICHTER & RICHTER (1939a) as coprolites. Similar structures have been described by CHAMBERLAIN & CLARK (1973, p. 677) from the Oquirrh Formation (Pennsylvanian-L. Permian of Utah).] *Ord.*, Eu.(Eng.-Ire.-France-Spain-Ger.-Czech.).——FIG. 85,*5*. **T. problematicum*, Herscheid slates, Ger.; ×2.5 (Richter & Richter, 1939a).

TRACE FOSSILS OR MEDUSAE INCERTAE SEDIS

Starlike fossils reminiscent of medusae are known since the early Paleozoic. Their affinities are uncertain, and most of them have been described as "medusoid." Some have been placed in the Trachylinidae *incertae sedis* (HARRINGTON & MOORE, 1956c, p. *F*73), some in Medusae *incertae sedis,* and others were regarded as unrecognizable (HARRINGTON & MOORE, 1956e, p. *F*153).

Probably some of the controversial forms are body fossils that may be related to medusae or may even represent genuine medusae. However, the suspicion exists that in other cases we are dealing with trace fossils. This is true especially for some starlike fossils found in Mesozoic to Cenozoic European flysch deposits. For example, many authors have regarded the genera *Atollites* MAAS, *Bassaenia* RENZ, and *Lorenzinia* DA GABELLI as trace fossils. NOWAK (1957) has looked upon these genera as starlike feeding burrows of crustaceans (?brachyuran). The large unnamed "star," from 30 to 50 cm. in diameter, found in Polish flysch has been compared by NOWAK (1957) and HÄNTZSCHEL (1970) with grazing trails of worms. However, no extensive investigations regarding this abundant fossil material have as yet been made.

On the other hand, the interpretation of some of these forms as medusae is uncertain and very controversial. This is indicated by the example of the previously mentioned genera *Atollites* and *Lorenzinia.* KIESLINGER (1939) suggested that both are perhaps medusae and that *Atollites* may be a synonym of *Lorenzinia.* Contrary to this, HARRINGTON & MOORE (1956b, p. *F*43; 1956c, *F*73) considered *Lorenzinia* as belonging to the Scyphomedusae and *Atollites* to the Hydrozoa.

Considering the scarcity of body fossils in flysch deposits, which for the most part have been interpreted as turbidites, it is unlikely that such delicate animals as medusae, even if abundant in this type of environment, would be preserved. The interpretation of these forms as trace fossils seems more acceptable, since these problematical fossils occur together with many proven trace fossils on the same bedding planes.

All authors interpreting Jurassic starlike fossils such as *Palaeosemaeostoma* have had to offer interpretations which were either improbable or unproven. Thus, it was supposed that the animals died from desiccation after a rapid, tectonically controlled retreat of the sea. An interpretation as trace fossils presents no difficulties although we do not yet have well-documented Recent counterparts of such stellate imprints. It is to be hoped that a better knowledge of the biology of sessile medusae will help to solve these problems.

Under these circumstances, it seems best, in the author's opinion, to treat all these problematical fossils in an individual section, as is done below.

Atollites MAAS, 1902, p. 320 [**A. zitteli*; SD KIESLINGER, 1939, p. A88] [=*Attolites* LUCAS & RECH-FROLLO, 1965, p. 167 *(nom. null.)*]. Starlike but of varying morphology; central area small, circular, surrounded by 12 to 14 narrow, radial bands changing into an external zone of pyriform lobes, thicker and wider at periphery. [Originally described as medusa; according to HARRINGTON & MOORE (1956c, p. *F*73), belonging to hydrozoan medusae (?Trachylinida *incertae sedis*); however, interpreted by NOWAK (1957) as trace fossil, explained tentatively as feeding burrows made by crustaceans; likewise, SEILACHER (1959, p. 1070) and VYALOV (1968a, p. 332) mentioned the genera *Atollites* and *Lorenzinia* among trace fossils, which seems logical. Some "species" of *Lorenzinia* have been placed in *Atollites* and vice versa; KIESLINGER (1939, p. *A*88) considered *Atollites* a junior synonym of *Lorenzinia* or at least as subgenus, but most authors distinguish between the two genera; GRUBIĆ (1970, p. 185) regarded *Atollites* as "undoubtedly true fossil medusae" but (GRUBIĆ, 1961; 1970, p. 187) interpreted *Lorenzinia* as a true trace fossil (see Fig. 88, *4a*).] [Found in German flysch deposits.] *Cam.,* USSR(Sib. Plat.), *M.Jur.,* USSR; *L.Cret.-Tert.,* Eu.(Ger.).——FIG.

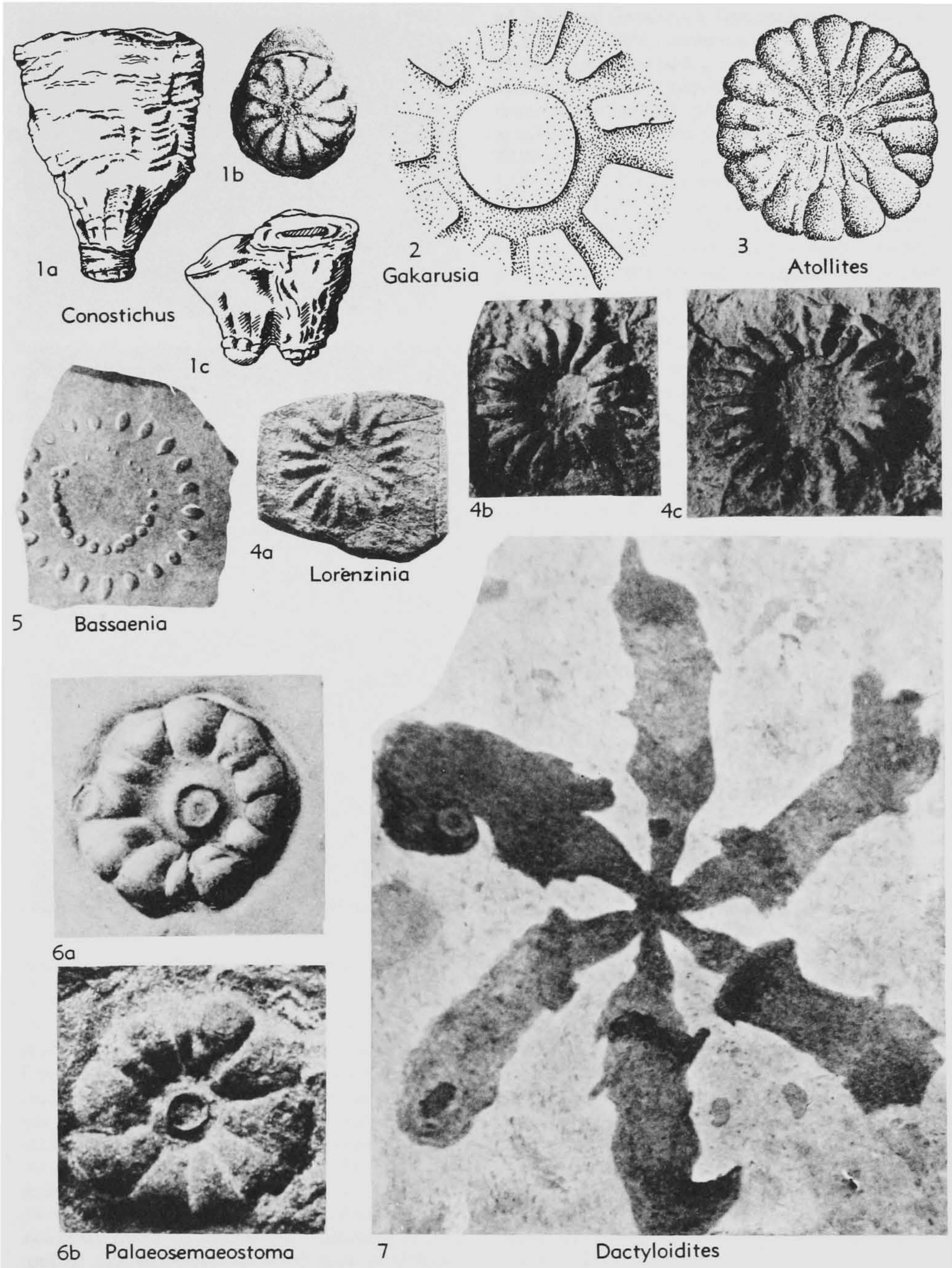

FIG. 88. Trace fossils or medusae incertae sedis (p. *W*144-148).

88,*3*. **A. zitteli,* L.Cret., Ger.; ×1 (Kieslinger, 1939).

Bassaenia RENZ, 1925, p. 222 [**Lorenzinia (Bassaenia) moreae*; M]. Very similar to *Lorenzinia* DA GABELLI, differing from it by a second circle of 22 separated small knobs. [Originally described as problematic imprints of medusae; regarded by RENZ (1925) and KIESLINGER (1939, p. A88) as "subgenus" of *Lorenzinia*; HARRINGTON & MOORE (1956b, p. *F*43) hesitatingly assigned *Bassaenia* to Scyphomedusae (?family Callaspididae); interpreted as rosetted trail by HÄNTZSCHEL (1962, p. *W*185), VYALOV (1964a, p. 113), GRUBIĆ (1970, p. 187), and KSIĄŻKIEWICZ (1970, p. 313).] [Found in flysch deposits.] *U.Cret.-L.Tert.*, Eu. (Greece-Pol.).——FIG. 88,*5*. **B. moreae* RENZ, U.Cret., Greece; ×0.5 (Renz, 1925).

Brooksella canyonensis BASSLER, 1941, p. 522 [for genus *Brooksella* WALCOTT, 1896 (p. 611) and its synonym *Laotira* WALCOTT, 1896 (p. 613), see HARRINGTON & MOORE, 1956a, p. *F*23]. Stellate disclike structure, 7 cm. in its major diameter; consisting of 8 to 10 radiating lobes of fairly equal size, rather uniformly arranged, terminating with a distinct edge; most lobes with a few radial grooves. [Various interpretations have been 1) body fossil: supposed jellyfish (BASSLER, 1941); Protomedusa (HARRINGTON & MOORE, 1956a); 2) inorganic: reverse imprint of a subradial fracture system of unknown origin (CLOUD, 1960); resembling structures produced by gas evasion from sediments or by compaction around compressible or soluble objects such as gas domes or crystals (CLOUD, 1968, 1973); 3) trace fossils: perhaps starlike feeding burrow (SEILACHER, 1956a); result of metazoan life process, probably sediment-feeder, perhaps an annelid, better named *Asterosoma? canyonensis* (GLAESSNER, 1969).] *U.Precam.(Nankoweap Gr., Grand Canyon Ser.)*, N.Am.(USA); *M.Cam.-U.Cam.*, USSR(Sib.Plat.)-USA(Ala.-Wyo.).——FIG. 89,*1*. *B. canyonensis*, Precam., Ariz.; ×0.48 (van Gundy, 1951).

Conostichus LESQUEREUX, 1876, p. 142 [**C. ornatus*; M] [=*Conostychus* LESQUEREUX, 1880, p. 14 *(nom. null.)*; *?Duodecimedusina* KING (in HARRINGTON & MOORE), 1955, p. *F*154 (type, *D. typica*); *Conostiches* POGUE & PARKS, 1958, p. 1629 *(nom. null.)*; for discussion of several species of *Conostichus* as synonyms of *Duodecimedusina* see BRANSON, 1960, p. 195 (as *Duodecimedusa*, erroneously); *Consotichus* CHAMBERLAIN, 1971a, p. 242 *(nom. null.)*]. Biogenic sandstone structures of variable shape, 4 to 9 cm. high, 3 to 14 cm. wide; mostly conical or subconical but also high forms with flat or rounded twelve-lobed basal discs and nearly parallel sides; bodies commonly fluted by transverse constrictions and longitudinal furrows and ridges; internally concentric conical sand laminae. [Regarded as of plant origin by STOUT (1956); compared with sponges by LESQUEREUX (1880); according to FUCHS (1895, p. 411), probably a member of the "group" Alectoruridae representing strobilation stage of medusa (for this interpretation see also BRANSON, 1960, p. 195; 1961, p. 134); according to BRANSON (1959, 1960, 1961), scyphomedusa or at least of scyphomedusan affinity (order Coronatida, fam. Conostichidae); HENBEST (1960, p. *B*384) considered *Conostichus* trace fossil (with apex down, sand-filled trace of a sedentary burrowing animal); interpreted as trace fossil by CASTER (oral commun. in MARPLE, 1956, p. 29); CHAMBERLAIN (1971a, p. 220) regarded *Conostichus* as dwelling burrow of animal having greater affinities with Actinaria than with Scyphomedusae; *Conostichus*-like structures from Devonian of Bolivia have been interpreted as the feeding cones of an *Arenicola*-like worm (BARTHEL & BARTH, 1972, p. 579); for detailed discussions see BRANSON (1959, 1960, 1961, 1962) and CHAMBERLAIN (1971a, p. 220).] *Dev.*, S.Am. (Bol.); *?Carb.-L. Perm. (Singa F.)*, NW. Malay; *Penn.*, USA(Okla.-Mo.-Ohio-Ill.); *?L.Perm.*, USA (Texas).——FIG. 88,*1a*. **C. ornatus*, Penn.(Potts-

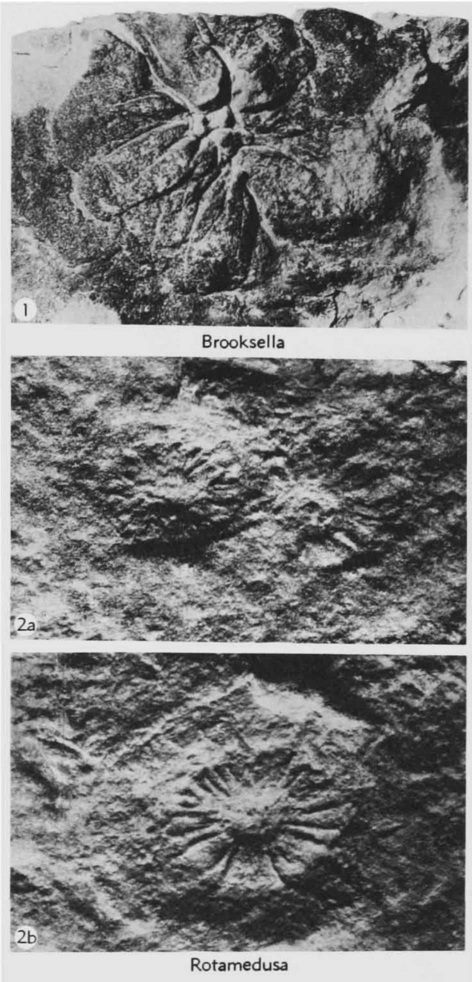

FIG. 89. Trace fossils or medusae incertae sedis (p. *W*146, 148).

ville ser.), Ohio; ×0.3 (Marple & Stout, 1956).——FIG. 88,*1b*. *C. pulcher* BRANSON, Penn. (HoldenvilleSh.), Okla.; ×0.7 (Branson, 1961).——FIG. 88, *1c*. *C.* sp., Penn., Ohio; ×0.3 (Marple & Stout, 1956).

Dactyloidiscus ŚLĄCZKA, 1965, p. 470 [**D. beskidensis*; M]. Discoid starlike impressions, 2 to 5 cm. in diameter; convex, consisting of 14 to 18 radiating transversely wrinkled lobes of mostly unequal length. [Regarded as medusa; convex upper surface interpreted as exumbrella; similar to the "medusa" described by ZAHÁLKA (1957) (U.Cret., Czech.) and compared by him with *Palaeosemaeostoma* RÜGER & RÜGER-HAAS; description of *Dactyloidiscus* up to 1971 only in Polish language, not yet figured.] [Found in flysch deposits.] *U.Cret.(Istebna Ss.)*, Eu.(Pol.).

Dactyloidites HALL, 1886, p. 160 [**D. bulbosus* (=*Buthotrephis? asterioides* FITCH, 1850, p. 862); M]. Starlike impressions of varying sizes and shapes, with 4 to 7 (commonly 6 or 7) "rays." [Interpreted as algae or sponges (HALL, 1886; RUEDEMANN, 1934; RESSER & HOWELL, 1938), as imprints of medusae (WALCOTT, 1890), as bodily preserved medusae (WALCOTT, 1898), and as worms or starlike worm trails (RUEDEMANN, 1934). Distinctly rosette-like "species" *D. edsoni* (RUEDEMANN, 1934) in all probability is a starlike trace fossil (very similar to unnamed starlike trace fossils from Paleozoic of North America and Bohemia).] *L.Cam.*, N.Am., USA(N.Y.); *?M. Cam.*, N.Am.(USA,Vt.).——FIG. 88,*7*. **D. asterioides* (FITCH), L.Cam., N.Y.; ×1 (Walcott, 1898).

Gakarusia HAUGHTON, 1964, p. 258 [**G. addisoni*; M]. Central disc, 2 cm. in diameter, somewhat elevated, with 10 or 11 short "rays" of different width and trapezoidal cross section, beginning some distance in from margin of disc. [Interpreted by HAUGHTON as "medusoid."] *U.Precam.(Transvaal Syst., Pretoria Ser.)*, S.Afr.——FIG. 88,*2*. **G. addisoni*; ×0.73 (Haughton, 1964).[1]

Kirklandia CASTER, 1945, p. 175 [**K. texana*; OD]. Problematic starlike fossil described in detail by HARRINGTON & MOORE (1956c, p. *F*70, fig. 54). [Interpreted by CASTER (1945) as belonging to Hydromedusae; according to HARRINGTON & MOORE (1956c, p. *F*69) "unquestionable trachylinid medusa"; specimen of "*?Kirklandia* sp." from the M.Jur. of Germany (HARRINGTON & MOORE, 1956c, p. *F*72, fig. 55) was at first described by LÖRCHER (1931) as *Medusina* sp. and assigned "rather certainly" by RÜGER (1933, p. 39) to *Palaeosemaeostoma* RÜGER & RÜGER-HAAS (1925); CASTER (1945, p. 198) called "genus" "a perplexing fossil"; *Kirklandia multiloba* ŚLĄCZKA (1964, p. 482) (Paleoc., Pol.) similar to *Atollites zitteli* MAAS; possible interpretation of these various starlike Problematica as trace fossils (feeding and dwelling burrows) was recently discussed by HÄNTZSCHEL (1970, p. 206-208); more thorough investigations of these problematic medusoid "genera" are required to clarify their true nature.] *M.Jur.*, Eu.(Ger.); *L.Cret. (Comanch. Ser.)*, USA(Texas); *L.Tert.(Paleoc.)*, Eu.(Pol.).——FIG. 90,*2*. **K. texana*, L.Cret. (PawpawF.), Texas(Denton Co.); ×0.7 (Caster, 1945).

[1] Considered a concretion by CLOUD (1968). [W. G. HAKES.]

Lorenzinia DA GABELLI, 1900, p. 77 [**L. apenninica*; M]. Starlike; circular or elliptical rings consisting of 16 to 26 (20 on an average) cylindrical or spindle-shaped ribs of equal length or small roundish knobs encircling smooth flat central area; ribs or knobs rather regularly spaced or arranged; diameter of star 2 to 5 cm. [Originally, and by many authors today, regarded as medusa (listed by GRUBIĆ, 1970, p. 187; see also HARRINGTON & MOORE (1956b, p. *F*43), where described as ?scyphomedusa). Divergent opinions for interpretations as feeding burrows, see SEILACHER (1955, fig. 5, no. 88, without discussion; 1962, p. 229), NOWAK (1957), GRUBIĆ (1961), ŚLĄCZKA (1964), VYALOV (1968a), and KSIĄŻKIEWICZ (1970); supposed to have been made by crustaceans; according to SEILACHER (1962, p. 229), predepositional, not surface trail; questionable whether *Atollites* MAAS, 1902, should be regarded as synonym of *Lorenzinia* as suggested (e.g., by KIESLINGER, 1939, p. A88); see also HÄNTZSCHEL (1970, p. 208, 210, and p. *W*144).] [Found in flysch deposits.] *?Ord.*, Eu.(Ire.); *?L.Carb.(Kulm)*, Eu.(Ger.); *Cret.-Tert.* Eu.(Pol.)-Japan.——FIG. 88,*4a*. **L. apenninica*, ?Cret.-Eoc., Italy; holotype, ×0.7 (Gortani, 1920).——FIG. 88,*4b*. *L. gabellii* VYALOV, U. Cret., Carpath.; ×1 (Vyalov, 1968a).——FIG. 88,*4c*. *L.* sp. *aff. L. kulcynskii* (KUZNIAR), U. Cret., Carpath.; ×0.84 (Vyalov, 1968a).

"Medusina" tergestina MALARODA, 1947, p. 57. Feeding burrow, according to SEILACHER (1959, p. 1070). [Discussion on confused situation and nomenclatorial status of *Medusina* WALCOTT, 1898, has been offered by CASTER (1945, p. 196, footnote 7) and HARRINGTON & MOORE (1956e, p. *F*153).] [Found in flysch deposits.] *U.Cam.*, Sib.; *L.Tert.(Eoc.)*, Eu.(Aus.-Spain-Italy).

Nimbus BOGACHEV, 1930, p. 103 [jr. hom.; *non* MULSANT & REY, 1870] [**N. helianthoides*; M]. Large starlike fossil with 32 rays; central elliptical field, 6 and 9 cm. in diameter; somewhat resembling *Atollites* and similar forms. [Explained as belonging to Trachymedusae or Narcomedusae.] [Found in flysch deposits.] *L.Tert.(low.Eoc.)*, USSR.

Palaeoscia CASTER, 1942, p. 26 [**P. floweri*; OD]. Disclike impressions, circular in outline, composed of series of regular or irregular circles; several cm. in diameter; small porelike depression in center; about 16 slightly impressed grooves (*ca.* 1 cm. long) may radiate from center of depression.

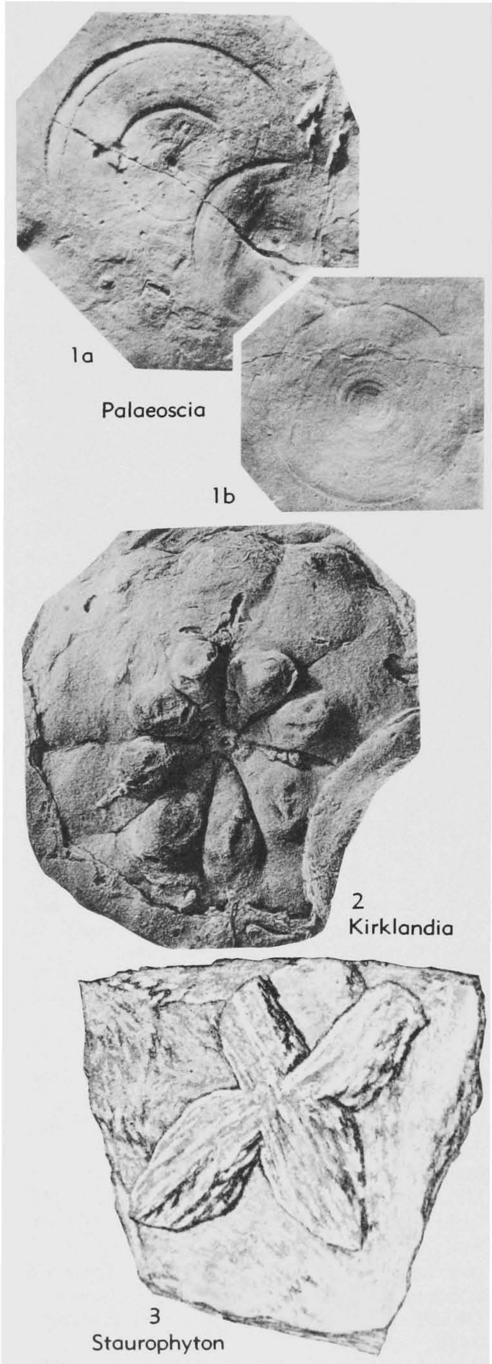

FIG. 90. Trace fossils or medusae incertae sedis (p. W147-148).

[Originally interpreted as belonging to order Siphonophorida, family Porpitidae (HARRINGTON & MOORE, 1956d, p. F150); according to OSGOOD, 1970, p. 395-397, perhaps partly feeding traces similar to those of Recent *Scolecolepis*, somewhat resembling sweep marks comparable to "*Dystactophycus*" MILLER & DYER, 1878b.] *U.Ord.*, USA (Ohio).——FIG. 90,*1*. **P. floweri*, Corryville beds, Ohio (Stonelick Creek, Clermont Co.); *1a,b*, concave epireliefs, ×0.5, ×0.53 (Osgood, 1970).

Palaeosemaeostoma RÜGER & RÜGER-HAAS, 1925, p. 17 [**Medusina geryonides* VON HUENE, 1901, p. 1 (=*Medusa gorgonoides* WAGNER, 1932, p. 163, *nom. null.*); M]. Starlike, about 5 cm. in diameter; rosette of 10 to 12 pillowy sectors sharply defined by grooves (for description see HARRINGTON & MOORE (1956c, p. F76)). [Regarded by most authors as body fossils belonging to medusae; according to RÜGER & RÜGER-HAAS (1925), sessile scyphomedusa; assigned by HARRINGTON & MOORE (1956c, p. F76) with some doubt to order Trachylinida *(incertae sedis)* of the Hydrozoa. FUCHS (1901) did not consider *Medusina geryonides* a medusa but rather related to *Gyrophyllites* GLOCKER. SEILACHER (1955, fig. 5) interpreted it as feeding burrow and also referred it to the ichnogenus *Gyrophyllites*; for discussion of interpretation as medusa or trace fossil see HÄNTZSCHEL (1970, p. 206-208).] *M.Jur.*, Eu.(Ger.); *U.Cret.*, Eu.(Czech.).——FIG. 88,*6*. **P. geryonides* (VON HUENE). M.Jur., Ger.; *6a*, holotype, ×1 (von Huene, 1901); *6b*, another specimen, ×0.5 (Kieslinger, 1939).

Rotamedusa SIMPSON, 1969, p. 698, 700 [**R. roztocensis*; OD]. Subcircular imprints (max. diam. 1-2.5 cm.); consisting of a central circular depression, featureless, surrounded by 2 low concentric ridges, innermost ridge flat, symmetrical in cross section and covered by up to 24 very narrow radial ribs mostly terminating abruptly at margins; outer ridge intermittent. [?Starlike trace fossil interpreted by SIMPSON as the counterpart of a medusa [outer wall = velum, narrow ribs = counterparts of radial canals, surface = exumbrellar, central depression = central orifice]; provisionally placed *incertae sedis* in hydrozoan order Trachylinida (see HARRINGTON & MOORE, 1956c, p. F68-76); probably deposited by a suspension current, together with silt-size sediment fraction.] *L.Tert. (mid.Eoc., Hieroglyphic Beds, Magura Ser.)*, Eu.(Pol.).——FIG. 89,*2*. **R. roztocensis*, mid.Eoc., Pol.(Stryszawa-Roztoki); *2a,b*, ×1.5, ×1.8 (Simpson, 1969).

Staurophyton MEUNIER, 1891, p. 134 [**S. bagnolensis*; M]. Similar to *Radiophyton* MEUNIER (1887, p. 59). [Originally described as of plant origin; ?trace fossil; see HARRINGTON & MOORE (1956c, p. F23), also HÄNTZSCHEL, 1965, p. 18.] *Ord.*, Eu.(France).——FIG. 90,*3*. **S. bagnolensis*, L.Ord.; ×1 (Meunier, 1891).

BODY FOSSILS

This chapter contains descriptions of "genera" of doubtful or completely uncertain classificatory status. Many of them were described only once and never discussed again. Additional "genera" of this type may be found in the section on "unrecognizable genera." HOFMANN (1972a, p. 28) suggested that the term dubiofossil be used for fossils whose taxonomic origin is uncertain or unknown. With this usage, dubiofossils occupy a place intermediate between body fossils with an assigned taxonomic position and pseudofossils (see p. W168).

Some genera, which were considered to be body fossils in the first edition of Part W of the *Treatise,* have now been included in the new chapters Microproblematica and Coprolites.

Precambrian Metazoa, most of which belong to the Ediacara fauna, are not being considered here. Their position in the zoological system is, for the most part, no longer problematical because it has now been demonstrated that they are coelenterates, annelids, and arthropods. These forms will be fully discussed in Part A of the *Treatise* by M. F. GLAESSNER (Adelaide).

Anthonema WALTHER, 1904, p. 142 [**A. problematica*; M]. Small oblong bodies, finely serrated, 5 to 7 mm. long; tapering to one end, broad end 1.5 mm. (max.) wide. [Interpretation left undecided by WALTHER; according to JANICKE (1967, p. 82, R. FÖRSTER, pers. commun.), very probably larvae of crustaceans.] *U.Jur.(Solnhofen Limestone),* Eu.(S.Ger.).

Anzalia TERMIER & TERMIER, 1947, p. 65 [**A. cerebriformis*; M]. Reef-forming organisms of brainlike aspect, with large central cavity and very numerous small apertures resembling oscula of sponges. [For new discussion of systematic position see TERMIER & TERMIER (1964).] *Cam.,* Afr.(Morocco).——FIG. 91,*7*. **A. cerebriformis*; ×0.4 (Termier & Termier, 1947).

Ceramites LIEBMANN in FORCHHAMMER, 1845, p. 162 [*non* MASSALONGO, 1859, p. 11] [**C. hisingeri*; M]. Described from Alum Shale (U.Cam.) of southern Sweden and Bornholm as a "fucoid," probably represents species of *Dictyonema* HALL, 1851, perhaps *D. flabelliforme* EICHWALD (Dr. CHRISTIAN POULSEN, pers. commun., 1956).

Cestites CASTER & BROOKS, 1956, p. 183 [**C. mirabilis*; M]. Fringed ribbon reduced to carbonaceous film, with longitudinal lines. Regarded as lobe of fossil cestid ctenophoran, but identification questionable. *Ord.,* USA(Tenn.).——FIG. 91,*3*. **C. mirabilis*; ×2 (Caster & Brooks, 1956).

Charniodiscus FORD, 1958, p. 213 [**C. concentricus*; OD]. Disclike structure, 5 to 30 cm. in diameter; central area rough-surfaced; smooth flange with or without concentric corrugations. [Possibly associated with frondlike fossil *Charnia* FORD; interpreted by FORD (1958) as basal part of *Charnia,* and by GLAESSNER (1959) as medusalike base of coelenterate related to the Pennatulacea.] *Precam.,* Eu.(Eng.); *U.Proteroz.(low. Vend.),* USSR(Russ. Plat.).

Chuaria WALCOTT, 1899, p. 234 [**C. circularis*; M]. Disclike bodies resembling conical shells of discinoid or patelloid shape, 2 to 5 mm. in diameter; concentrically wrinkled; dark bituminous matter covering surface. [Originally interpreted as brachiopod-like fossils (remains of a compressed conical discinoid shell); according to SCHINDEWOLF (1956) possibly small, wrinkled clay galls or concretions; CLOUD (1968) regarded the type species and *Chuaria wimani* BROTZEN as algae; EISENACK (1966) considered *C. wimani* (Precam., Swed.) unrecognizable, neither gastropod nor brachiopod, nor eggs of trilobites, nor hystrichosphaerid, nor megaspore, but perhaps ?chitinous foraminifer; HOFMANN (1971, p. 24) considered the genus to be compressed globular bodies of biologic or nonbiologic origin. GUSSOW (1973, p. 1111) considered *Chuaria* to be of definite organic origin, either a large planktonic organism or a cyst or spore sac. FORD & BREED (1973a, p. 1257; 1973b, p. 547) regarded *Chuaria* to be algal in origin and classified it as a sphaeromorphid acritarch.] *Precam.,* USA-Can.-Eu.(Swed.)-USSR.——FIG. 91,*6*. **C. circularis*; U. Precam., USA(Ariz.); *6a,b,* ×12 (Walcott, 1899); *6c,* ×7 (Gussow, 1973); *6d,* ×7 (Ford & Breed, 1973b).

Curculidium HANDLIRSCH, 1907, p. 665 [*"*Curculionites senonicus"* KOLBE, 1888, p. 136; M] [=*Curculionites* KOLBE, 1888, p. 136 (*non* HEER, 1847; *nec* GIEBEL, 1856); *nom. nud.*]. Name proposed for burrow of curculionid, presumably in wood; recognized by QUENSTEDT (1932b, p. 182) as belonging to *Doratoteuthis syriaca* WOODWARD. *U.Cret.(Senon.),* SW.Asia (Lebanon).

Diorygma BIERNAT, 1961, p. 20 [**D. atrypophilia*; OD]. Protuberances growing upward from floor of pedicle valves of *Desquamatia subzonata* (BIERNAT) on either or both lateral margins of

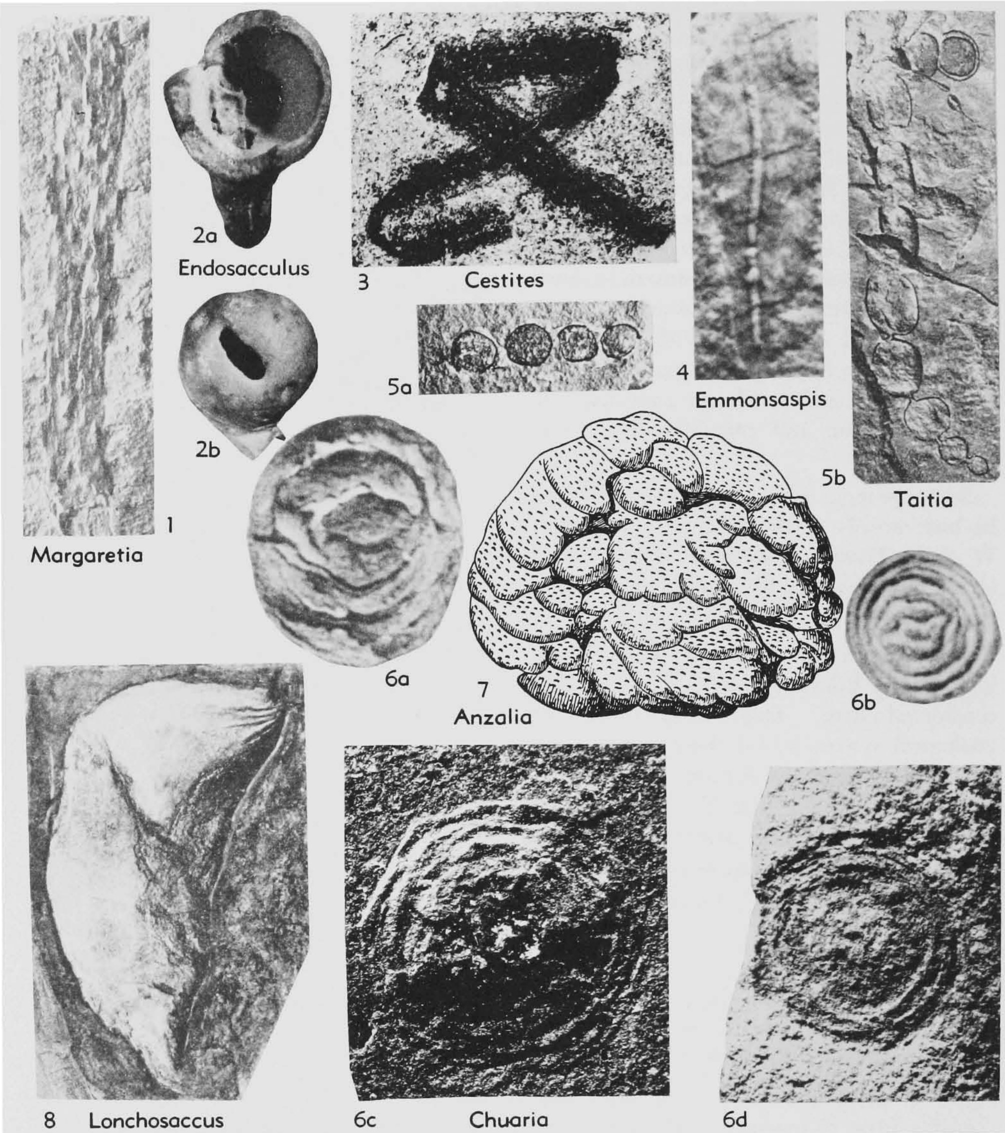

FIG. 91. Body fossils (p. *W*149-152).

ventral diductor muscle field, enclosing 2 contiguous tubes united along their entire length, with round or somewhat elliptical apertures; tubes straight or slightly sinuous, opening into mantle cavity region of brachiopod; ventral tube larger than the dorsal; tubes probably developed by simultaneous growth of their inhabitants and brachiopod. [First interpreted as a boring made by annelid-like parasite; MACKINNON & BIERNAT, 1970, regarded *Diorygma* cohabitant of *Desquamatia subzonata* living within shell, probably to be placed within the Phoronidea.] *M.Dev.*, Eu. (Pol.).——FIG. 92,*2*. **D. atrypophilia*, in *Desquamatia subzonata* (BIERNAT); ×2 (Biernat, 1961).

Emmonsaspis RESSER & HOWELL, 1938, p. 233 [**Phyllograptus? cambrensis* WALCOTT, 1890, p. 604; OD]. Oval-shaped impression, more blunt at one end than other, with rod beginning about one-third of way back and extending almost to posterior end, mostly with ribbing beginning at about center line and extending to outer margins. [Possibly a chordate.] *L.Cam.*, USA(Vt.).——FIG. 91,*4*. **E. cambrensis* (WALCOTT), RomeF.

(*Olenellus* Z.); mag. unknown (Resser & Howell, 1938).

Endosacculus Voigt, 1959, p. 219 [**E. moltkiae*; OD]. Globular, gall-like deformations in internodes of octocoral *Moltkia minuta* Nielsen; diameter about 5 mm.; with narrow ventral slitlike opening, about 2.5 mm. long; interior of "cyst" smooth. [Interpreted as made by barnacles (Ascothoracida); according to Bromley (1970, p. 67), not borings but more probably result of embedding.] *U.Cret.(Campan.-U.Maastricht.),* Eu. (Neth.-Swed.-?USSR).——Fig. 91,*2*. **E. moltkiae,* Maastricht., Neth.; *2a,* cyst with somewhat damaged opening, ×3; *2b,* cyst opened, showing the thin walls, ×3 (Voigt, 1959).

Escumasia Nitecki & Solem, 1973, p. 903 [**E. roryi*; OD]. Bilaterally symmetrical, flattened body (75 to 205 mm. in length) consisting of 2 arms, a trunk, stalk, and attachment disc; arms protrude from trunk, are long, slender, rounded, and commonly equal in length, and are located at each end of a slitlike opening; trunk (longer than wide) possesses "anal opening" on one side and tapers rapidly to stalk at basal end; attachment disk rounded and expanded basally. [Not assigned to any phylum by authors who very tentatively suggested that *Escumasia* may have been derived from the Coelenterata as an unsuccessful lineage; unequal length in arms considered to be the result of predation.] *M.Penn.,* USA(Ill.).——Fig. 92A,*1*. **E. roryi,* Carbondale F. (Francis Cr. Sh.); reconstr., ×1 (Nitecki & Solem, 1973). [Description supplied by W. G. Hakes.]

Halysium Swidzinski, 1934, p. 146 [**H. problematicum*; M] [=*Halimeda saportae* Fuchs, 1894, p. 204; *Arthrodendron* Ulrich, 1904, p. 138 (*non* Seward, 1898; *nec* Scott, 1900) (*nom. nud.*); perhaps = *Hormosira moniliformis* Heer, 1877, p. 161]. Ovate capsules, commonly flattened, smooth or minutely granulated, consistency differing from matrix; some specimens with carbonaceous lining; capsules forming branching rows. [?Alga.] [Found in flysch deposits.] *U. Cret.-L.Tert.,* Eu.-N.Am.(Alaska).——Fig. 92,*3*. **H. problematicum,* U.Cret., Italy; ×0.6 (Seilacher, 1962).

Leckwyckia Termier & Termier, 1951, p. 187 [**L. aenigmatica*; M]. Smooth, sharply pointed, acutely conical tube; upper end widening regularly and showing transverse units separated by constrictions. [Originally regarded as problematic in origin; interpreted by Destombes (1964) as rachis of trilobite, perhaps of *Dalmanitina*.] *Ord.,* Afr. (Morocco).

Lonchosaccus Ruedemann, 1925, p. 84 [**L. uticanus*; M]. Formed like bent bag, length more than twice width, with thick, substantial wall, now carbonized; 2 "extremities" drawn into apertures. [Systematic position unknown, ?annelid.] *Ord.,* USA(N.Y.).——Fig. 91,*8*. **L. uticanus,* Utica Sh.; holotype, ×? (Ruedemann, 1925).

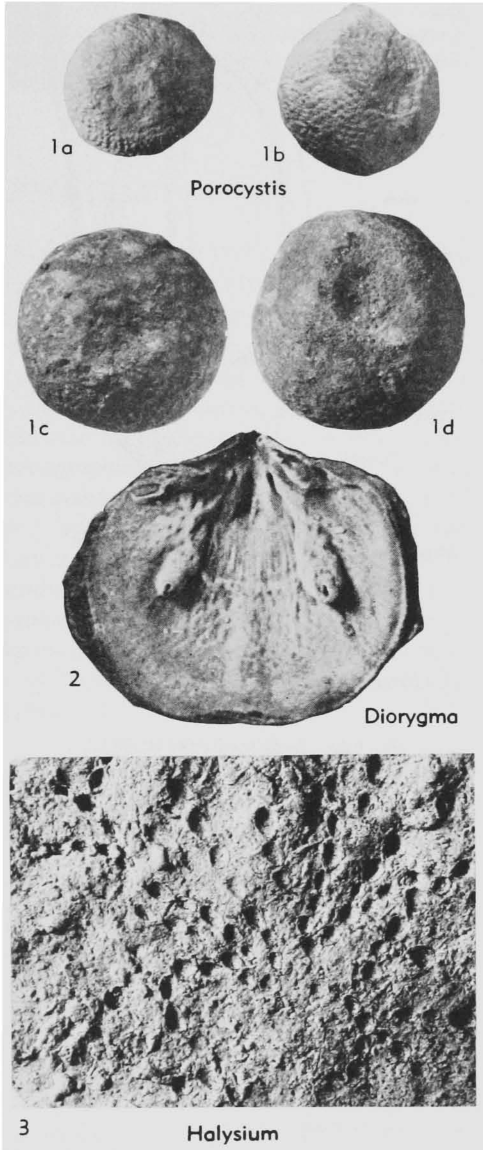

Fig. 92. Body fossils (p. *W*149-152).

Margaretia Walcott, 1931, p. 2 [**M. dorus*; OD]. Thin membranous sheet with elongate oval perforations arranged on longitudinal and obliquely transverse lines; tegument presumably leathery. [Compared with algae and alcyonarians.] *M. Cam.,* N.Am.(Can., B.C.)-USA(Idaho).——Fig. 91, *1*. **M. dorus,* Burgess Sh., B.C.; holotype, ×0.7 (Walcott, 1931).

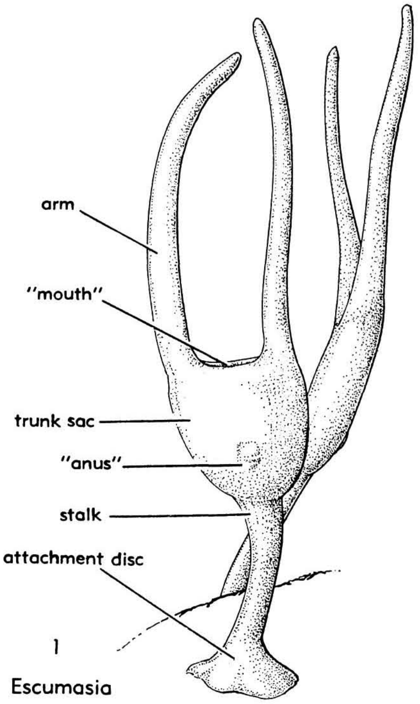

FIG. 92A. Body fossils (p. W151).

Palaeobalanus schmidi "VON SEEBACH, 1876." Name sometimes used erroneously for borings in Lower Muschelkalk of Thuringia; for details see MÄGDEFRAU, 1932, p. 150-151.

Porocystis CRAGIN, 1893, p. 165 [**P. pruniformis*; (=*Siphonia globularis* GIEBEL, 1853; *Araucarites? wardi* HILL, 1893); M]. Spheroids, generally prolate, with flattened, slightly protuberant area; whole surface covered with ridges and oval or circular depressions; commonly arranged rather irregularly in rows; diameter about 2 cm. [Interpreted by GIEBEL (1853) as alga, by HILL (1889-93) as fruit of *Goniolina, Parkeria,* or *Araucarites,* by CRAGIN (1893) as cheilostomatous bryozoan, by RAUFF (1895) as calcareous alga, by JARVIS (1905) as gigantic monothalamian foraminifer. For bibliography see ADKINS, 1928, p. 57-58.] *L.Cret.,* USA(Texas).——FIG. 92,*1*. **P. pruniformis,* L.Alb. (large specimens)-M.Alb. (small specimens); *1a-d,* ×1 (Häntzschel, 1962).

Taitia CROOKALL, 1931, p. 175 [**T. catena*; M]. Small chains commonly composed of 6 to 7 (max., 11) circular or oval bodies; adjacent bodies united by thin isthmus 1 mm. long and 1 mm. wide; bodies generally constant in size (diam., 1 cm.), some progressive diminution in size toward extremity; characteristic but problematical fossil of Scottish Downtonian rocks. *U.Sil.,* Eu.(Scot.).——FIG. 91,*5*. **T. catena; 5a,b,* ×0.7, ×1 (Crookall, 1931).

Tullimonstrum RICHARDSON. 1966, p. 76 [**T. gregarium*; M]. Bilaterally symmetrical soft-bodied animal with head region, trunk, and tail; complete specimens very rare; total length of longest and smallest individuals known, estimated from fragmentary material, ranges from 8 to 34 cm.; head tapering to long proboscis bearing at its distal end jaw-like apparatus; jaws bearing minute stylets; entire proboscis constitutes one-third of animal's length but rather rarely preserved; head region poorly defined; transverse bar delimits head and trunk, consisting of medial plate and thin rod terminating in small ovoid bodies; trunk mostly segmented, narrowing to spatulate to nearly circular tail which shows 8 to 12 segments; tail lobe laterally expanding into flexible, triangular ribs. [Probably marine organism; impossible to assign *Tullimonstrum* to any known phylum al-

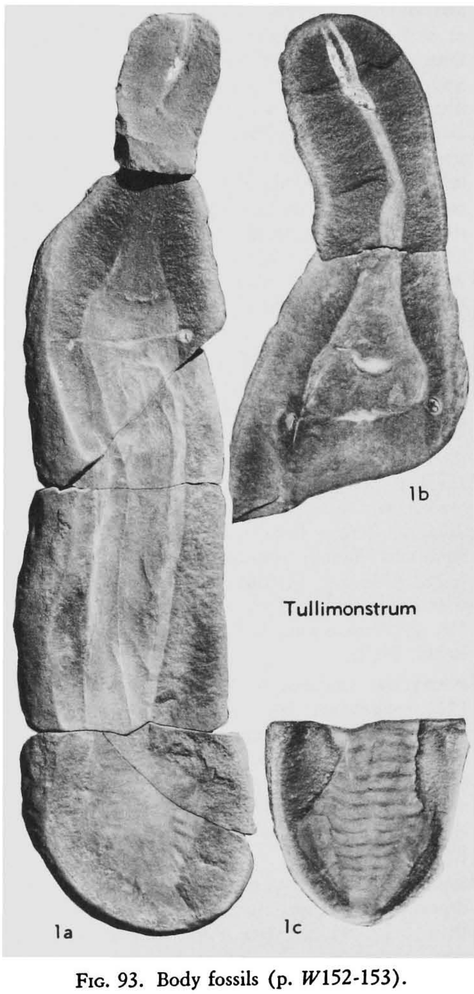

FIG. 93. Body fossils (p. W152-153).

though several thousand specimens with a documented geographical range of 200 miles have been investigated; ? a relic in the Pennsylvanian of a more ancient group.] *M.Penn.*, N.Am.(USA, Ill.).——FIG. 93,*1*. **T. gregarium*, Francis Creek Sh., Ill.; *1a*, concretion, ×0.6 (Johnson & Richardson, 1970); *1b,c*, proboscis, and spadelike tail, both ×0.53 (Johnson & Richardson, 1969).

MICROPROBLEMATICA

In the first edition of *Treatise*, Part W (HÄNTZSCHEL, 1962), and in the supplement to that volume (RHODES, *et al.*, 1966), only very few microfossils of uncertain taxonomic position were included in the section on Body Fossils. However, in this revised and expanded edition, a separate section is devoted to Microproblematica, excluding microcoprolites, which are covered in the section on coprolites. A complete record of all the Microproblematica, such as originally proposed by ELLIOTT (1958), is neither intended nor practical. For such a goal to be attained, the entire micropaleontological literature of the world must be reviewed. The author wishes to thank Dr. G. DEFLANDRE (Paris) and Dr. A. EISENACK (Reutlingen) for help in supplying references.

Many problematical microorganisms are known only from thin sections of sedimentary rocks as, for example, the many genera which FLOWER (1961) described from the Ordovician of the United States. Photomicrographs do not completely and accurately reflect the three-dimensional shape of these fossils, and definite identification with some plant or animal group is very difficult. The same problem is encountered with forms having less characteristic shapes, such as small pellets of calcareous, siliceous, or pyritic composition. Furthermore, the state of preservation can make the interpretation of such microorganisms very difficult, e.g., that of the chloritic pellets from the Ordovician of France described as a *Papinochium* by DEFLANDRE & TERS (1966).

Numerous forms are in dispute which may be of either plant or animal origin or which may be inorganic. For example, *Distichoplax* PIA (1934) was regarded by PIA and by ELLIOTT (1962) as an alga, but LEMOINE (1960) interpreted it as belonging to the Rhabdopleuridae or a closely related family. In spite of the uncertainty of their position in the system, these microproblematica have proven to be, in some cases, stratigraphically useful fossils. In France, DEFLANDRE & TERS (1966) determined the age of previously undifferentiated Lower Paleozoic rocks as Ordovician by studying certain microorganisms (very probably Acritarcha). In Lower Cretaceous limestones of Cuba, microproblematica have been used in stratigraphic correlation (BRÖNNIMANN, 1955).

It is hoped that in the future the systematic classification of many microproblematica will be clarified through electron microscope and stereoscan investigations.

Aeolisaccus ELLIOTT, 1958, p. 422 [**A. dunningtoni*; OD]. Small thin-walled tubes, slightly irregular or somewhat curved, hollow, gently tapering, probably open at both ends; maximum length 1.7 mm., diameter commonly 1.0 mm.; walls consisting of crystalline calcite, with septate or camerate structure(?) [Probably pelagic organism; doubtfully interpreted as shells of small extinct pteropods; compared with the calcareous alga *Tubulites* BEIN, 1932 (U.Perm., Ger.), by HECHT, 1960.] *Perm.*, SW. Asia(S.Turkey-Arabia); *U.Trias.-M.Jur.*, SW.Asia(N.Iraq); *U.Jur.(Kimmeridg.-Portland.)*, *L.Cret. (Alb.)-U.Cret. (Maastricht.)*, Eu.(Yugosl.).——FIG. 94,*5*. **A. dunningtoni*. U.Perm., Arabia; *5a*, approx. long. sec. of irregular elongate tube; *5b*, sec. showing numerous individuals; both ×50 (Elliott, 1958). [Also occurs in M.Trias.-U.Trias.(Anis.-Nor.), Eu.(Czech.).]

Ampelitocystis DEUNFF, 1957, p. 1 [**A. feuguerollensis*; OD]. Chitinous shell, oviform or of wide-bellied or bulgy shape, with one opening; 4 to 7 spinelike processes (50-200μ long) attached to its thickened margin in rather symmetrical arrangement; shell (max.) 50 to 90 microns in diameter,

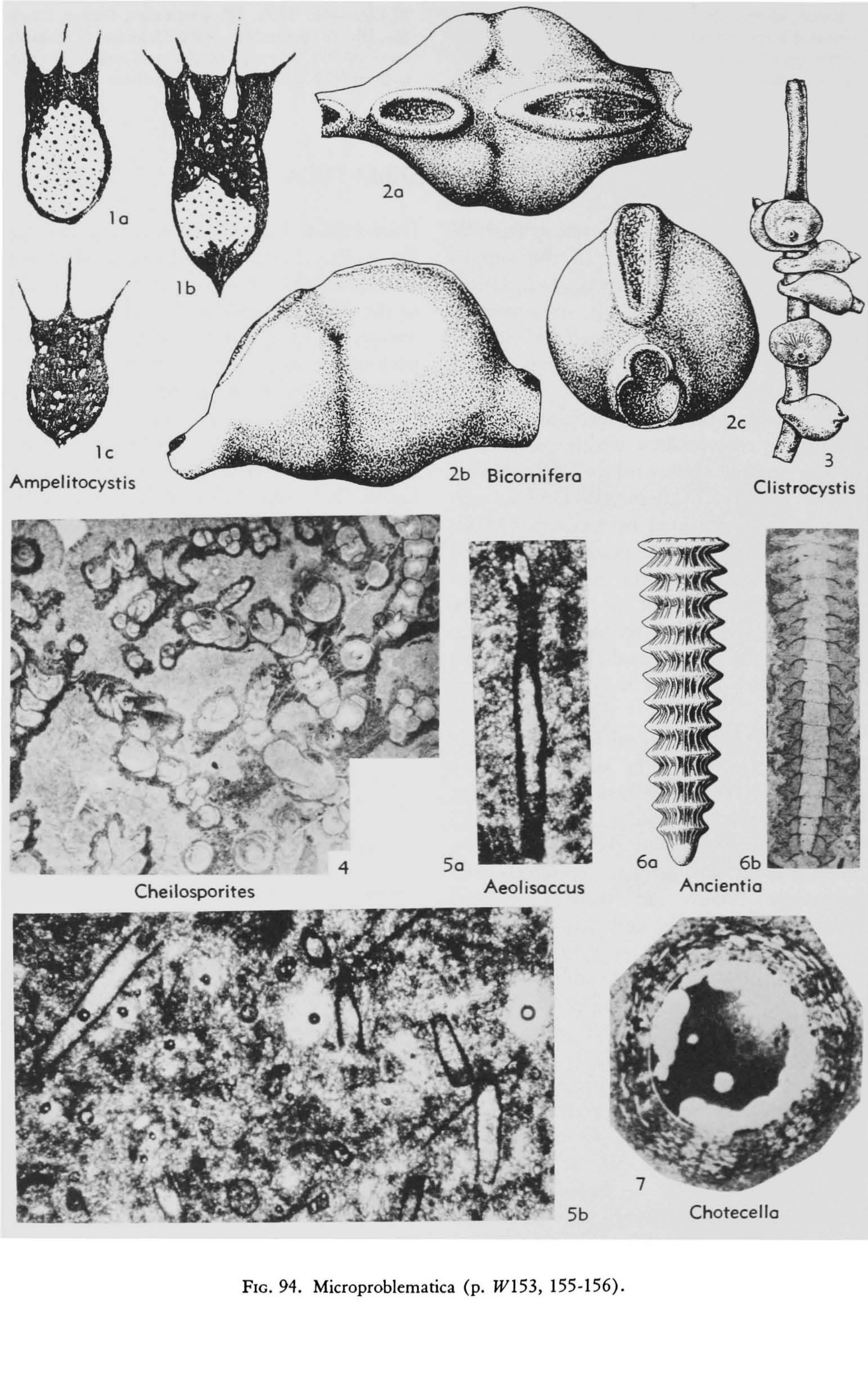

FIG. 94. Microproblematica (p. W153, 155-156).

120 to 170 microns high (without spines). [Systematic position unknown; morphologically somewhat similar to certain Ciliata.] *M.Sil. (Wenlock.),* Eu.(France).——FIG. 94,*1*. **A. feuguerollensis,* Calvados; *1a-c,* ×195 (Deunff, 1957).

Ampulites FLOWER, 1961, p. 115 [**A. vasiformis*; OD]. Short, simple, vase-shaped tubes, 1 mm. long, circular in section, basally broad, contracting to a neck; wall thin, calcitic; attached to corals; observed only in thin sections. [Systematic position unknown.] *Ord.,* USA(N.Mex.).

Ancestrulites FLOWER, 1961, p. 115 [**A. tubiformis*; OD]. Cylindrical, thick-walled tubes, 1 mm. long, about 0.5 mm. wide, calcitic; forming small colonies attached to corals; known only from thin sections. [Systematic position unknown.] *Ord.,* USA(N.Mex.).

Ancientia ROSS, 1967, p. 39 [**A. ohioensis*; OD]. Small, hollow, calcitic structures, about 0.4 mm. long, 0.3 to 0.5 mm. high, diameter about 2 mm.; tubes having well-defined longitudinal series of imbricate rings that extend distally and partially overlap; externally prominent longitudinal costae or striae; proximal region smoothly rounded; longitudinal section displaying 2 longitudinal series of dentate imbricate segments whose microstructure consists of inclined fine laminae; tubes occurring only as fragments (greatest length observed 6.5 mm.); external features resembling *Cornulites sterlingensis* MEEK & WORTHEN, differing from it by much smaller size, cylindrical tube, and more strongly developed striation. [Phylum, class, order uncertain.] *U.Ord.(Cincinnat., Richmond Gr., Waynesville F.),* USA(Ohio).——FIG. 94,*6a*. *A.* sp.; reconstr. of external aspect, ×7.5 (Ross, 1967).——FIG. 94, *6b*. **A. ohioensis*; long. sec., ×7.5 (Ross, 1967).

Bacinella RADOIČIĆ, 1959, p. 89 [**B. irregularis*; OD]. Aggregate (3 by 10 mm. in size) of irregularly shaped or polygonal chambers (0.1-0.4 mm. wide); walls of chambers composed of micritic calcite. [Systematic position unknown.] *M. Jur.(Anis.)-L.Cret.(Barrem./Apt.),* Eu.(Czech.); *Cret.,* Eu.(Yugosl.). [Description obtained from JABLONSKY (1973, p. 418) by W. G. HAKES.]

Bicornifera LINDENBERG, 1965, p. 22, *emend.* KEIJ, 1969, p. 243 [**B. alpina*; OD]. Calcareous shells consisting of 2 chambers of different size separated by double wall, with small round tube of unknown original length at both ends or at one end only; walls of shell hyaline, externally smooth; length 0.5 mm., height 0.3 mm. [Systematic position unknown.] *L.Tert.(Oligo.),* Eu. (S.Ger.-SW.France-W. Aus.-NW.Yugosl.-Turkey)-USA(Ala.).——FIG. 94,*2*. **B. alpina,* Oligo., Aus.; *2a-c,* different views, ×75 (Lindenberg, 1965).

Birrimarnoldia HOVASSE & COUTURE, 1961, p. 1054 [**Arnoldia antiqua* HOVASSE, 1956; OD] [=*Arnoldia* HOVASSE, 1956, p. 2584, obj. (*non* MAYER, 1887, *nec* KIEFER, 1895, *nec* VLASENKO, 1931)]. Siliceous or iron oxide globules, 35 to 800 microns in size; wall 12 to 20 microns thick, apparently consisting of arenaceous matter; probably without openings; obviously consisting of several chambers arranged in row. [Interpretation as foraminifer is questionable, according to DEFLANDRE, 1957; LOEBLICH & TAPPAN (1964, p. C786) believe it to be inorganic.] *L.Proteroz.(Birrim.),* Afr.(Côte-d' Ivoire).

Calcisphaera WILLIAMSON, 1881, p. 521 [**C. robusta*; SD S. A. MILLER, 1889, p. 155] [=*Granulosphaera* DERVILLE, 1931, p. 132 (type, *Calcisphaera laevis* WILLIAMSON, 1879, p. 521); *Calcisphaerula* BONET, 1956, p. 44 (type, *C. innominata,* p. 56; OD)]. Hollow calcitic spheres, ranging in size from less than 0.1 to 0.5 mm.; thickness of shells varies from 3 to more than 200 microns. [Technically, *Granulosphaera* may be valid name; similar objects have been described as *Cytosphaera, Diplosphaerina (=Diplosphaera), Palaeocancellus (=Cancellus),* and *Polyderma* by DERVILLE (1931, 1950); as *Asterosphaera, Radiina,* and *Radiosphaera* by REITLINGER (1957); as *Fibrosphaera* by DE LAPPARENT (1924); as *Cadosina* and *Stomiosphaera* by WANNER (1940). Of uncertain affinities, variously interpreted as foraminifers, acritarchs, and algae (?charophytes, ?dasycladaceans); not all objects necessarily of the same affinities; for discussion and literature references see KONISHI (1958), TEICHERT (1965), RUPP (1966), STANTON (1966), WRAY (1967), FLÜGEL & HÖTZL (1971).] *Cam.-Rec.,* cosmop. [Description supplied by CURT TEICHERT.]

Cayeuxipora GRAINDOR, 1957, p. 2075. Established without designation of type species for small siliceous bodies with a reticulate surface ornamentation; about 10 microns in diameter. [Regarded as foraminifer by GRAINDOR (1957), and regarded by DEFLANDRE (1957) as resulting from bacterial activity.] *Proteroz.(Briovér.),* Eu. (France). [Description supplied by CURT TEICHERT.]

Cayeuxistylus GRAINDOR, 1957, p. 2077. Proposed without species for form similar to *Cayeuxipora* but having a long spine. *Proteroz.(Briovér.),* Eu.(France). [Description supplied by CURT TEICHERT.]

Cheilosporites WÄHNER, 1903, p. 100 [**C. tirolensis*; M]. Large arborescent colonies, only fragmentarily preserved; height of single shrubby colonies about 5 cm., "branches" composed of uniserial but branching rows of chambers (diameter 0.6 to 4.0 mm. max.), penetrated by axial siphon; chambers enlarging and altering their shape distally from casklike to bowl-like and finally in uppermost parts of "branches" vaselike; wall 0.01 to 0.04 mm. thick, consisting of calcite grains 0.01 to 0.02 mm. in diameter; probably guide fossil for Rhaetian. [WÄHNER (1903), LEUCHS (1928), SIEBER (1937), and LOEBLICH &

Tappan (1964) regarded *Cheilosporites* as alga; Pia (1939) compared it with Sphinctozoa resembling *Amblysiphonella*; tentatively referred by Fischer (1962) to Foraminiferida, representative of new family Cheilosporitidae; see also Loeblich & Tappan, 1964, p. C786.] *U.Trias.(Rhaet.)*, Eu.(Ger.-Aus.-N.Alps-Yugosl., S.Alps).——Fig. 94,*4*. **C. tirolensis*, Trias. (Rhaet.), Aus.; ×2.5 (Fischer, 1962).

Cheneyella Flower, 1961, p. 113 [**C. clausa*; OD]. Low-arched tiny body, 0.7 mm. long, 0.2 mm. high, covered with a rather thick plate; broadly attached to *Catenipora*; observed only in thin sections. [Systematic position doubtful.] *Ord.*, USA(N.Mex.).

Chisibyllites Deflandre, 1961, p. 126 [**C. kerguelenensis*; M]. Lenticular bodies, calcareous, nearly always with ellipsoidal inclusions of unknown nature and origin; observed only in limestone and only in thin sections. [Systematic position questionable, somewhat similar to radiolarians or foraminifers.] In limestone of unknown age; Ind.O.(Kerguelen I.).

Chotecella Obrhel, 1964, p. 217 [**C. leiotheca*; M]. Small hollow globules with smooth surface, diameter 500 to 800 microns; wall 85 to 170 microns thick; formed by several very thin irregularly adjacent layers; globules showing organic structure consisting of carbonaceous matter; somewhat similar to *Leiosphaeridia* Eisenack, 1958, and *Tasmanites* Newton, 1875. [Origin unknown, plant or animal.] *Uppermost Sil.-lowermost Dev.*, Eu.(Czech.).——Fig. 94,*7*. **C. leiotheca*, Dev., Czech. (Choteč, near Prague); holotype, thin sec., ×50 (Obrhel, 1964).

Claviradix Ferguson, 1961, p. 140 [**C. ashi*; OD]. Small cone-shaped bodies with small central elevations on upper surface; size about 2 mm.; 8 to 10 tapering radii growing from edge; stem projecting from underside of body and terminating in root which may be hollow; whole finely striated and pitted; similar to *Palaeocoryne* Duncan & Jenkins, 1869 (*emend.* Ferguson, 1961). [Neither hydrozoan nor algal nor bryozoan in origin.] *U.Carb.(low.Namur.)*, Eng.——Fig. 95,*2*. **C. ashi; 2a,* lower surface; *2b,* upper surface; *2c,* body, stem, and roots, all ×17 (Ferguson, 1961).

Clistrocystis Kozłowski, 1959, p. 273 [**C. graptolithophilius*; M]. Padlock-like chitinous forms bearing very small cone about 0.5 mm. long; individuals side by side on stipes of *Mastigograptus* sp. and embracing them; longitudinal axis perpendicular to graptolite stipes. [Systematic position unknown; possibly cysts of aquatic invertebrates; compared by Kozłowski (1965) with egg capsules of *Sepia* and explained as those of cephalopods.] *M.Ord.* (Pleist. drift), Eu.(Pol.).——Fig. 94,*3*. **C. graptolithophilius*; on a stipe of *Mastigograptus* sp., ×25 (Kozłowski, 1959).

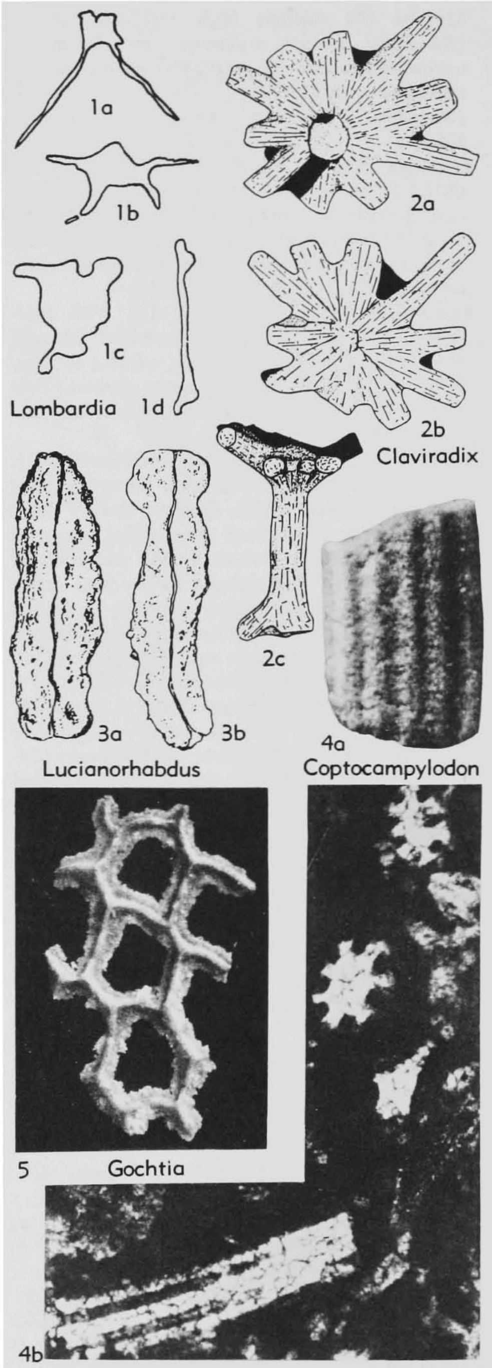

Fig. 95. Microproblematica (p. W156-157, 161).

Coelenteratella KORDE, 1959, p. 627 [**C. antiqua*; M] [=*Coelenterella, nom. null.* in translation of KORDE's paper, no. 2233, by the Bureau des Recherches Géologiques et Minières, Paris]. Small cuplike bodies; height about 7 mm., wall thickness *ca.* 0.15 mm.; fixed by foot about 8 mm. long. [Questionable coelenterate.] *M.Cam.*, USSR (Sib.).

Coptocampylodon ELLIOTT, 1963, p. 297 [**C. lineolatus*; OD]. Calcareous cylindrical bodies, solid, slightly curved or irregular, mostly up to 3.0 mm. long (incomplete), 0.25 to 1.0 mm. in diameter, ends irregularly rounded; outer surface commonly smooth but with 5 to 8 deep equidistant longitudinal grooves; transverse section resembling stellate structure with truncated rays. [Often regarded as remains of dasyclad alga *Acicularia* but certainly not alga or spicular elements of calcareous sponges; great similarity to calcareous joints of octocoral *Moltkia*; probably dissociated calcareous skeletal remains of small octocoral.] *L.Cret.*, Asia(Iraq-Borneo).——FIG. 95,*4*. **C. lineolatus; 4a,* NE.Iraq (Sulaimania Liwa); lat. view, ×37 (Elliott, 1963); *4b,* L. Cret., Iraq(Dulaim Liwa); thin section, ×37 (Elliott, 1963).

Cucurbita JABLONSKY, 1973, p. 420 [**C. infundibuliforme*; OD]. Club-shaped structure (0.1-0.3 mm. long; 0.05-0.1 mm. max. diam.) with a curved, convex funnel-like collar (0.2-0.3 mm. max. diam.) projecting from narrow end; funnel-like collar creates an opening to a central "cavity"; walls of structure composed of dark, micritic calcite. [Systematic position unknown; may be related to the tintinnids.] *?M.Trias., U. Trias.*, Eu.(Czech.). [Description supplied by W. G. HAKES.]

Cystosphaera FLOWER, 1961, p. 113 [**C. rotunda*; OD]. Round body, 1 mm. in size, covered by numerous small thin plates; thin walls enclosing round calcitic bodies with dark carbonaceous centers; broadly attached to *Catenipora*; known only from thin sections. [Systematic position unknown.] *Ord.*, USA(N.Mex.).

Dicasignetella KEIJ, 1969, p. 21 [**D. eocaenica*; OD]. Calcareous test, ovate or globular in front view, consisting of thick solid shield, enclosing 2 unequal chambers connected by large pore; height about 0.45 mm., width 0.3 mm., frontal shield 0.15 mm. wide; frontal shields of chambers ornamented by 2 rows of costae; on shields a frontal circular orifice flanked by paired blunt perforated spines; distal chamber smaller than proximal one. [Systematic position unknown; several features (e.g., separate chambers) in common with cheilostomatous Bryozoa, but other ones (e.g., the thick shield) uncharacteristic of Bryozoa.] *L.Tert. (up.Eoc., Barton.)*, Eu.(Belg.).——FIG. 96,*1*. **D. eocaenica; 1a,b,* holotype, dorsal side, frontal shield of proximal chamber, ×120 (Keij, 1969b).

Draffania CUMMINGS, 1957, p. 407 [**D. biloba*; OD]. Flask-shaped or pyriform rounded, "hollow" bodies, consisting of two unequal hemispherical globes with an elongate neck 0.25 mm. long originating between them; aperture of neck circular in outline, internal diameter 0.02 mm.; walls calcareous, relatively thick (0.06 to 0.12 mm.), layered, commonly perforate; greatest dimension, 0.85 mm.; maximum transverse cross section 0.75 by 0.65 mm. [Origin unknown. Originally compared with Foraminifera or other protozoans, pedicellaria of Echinodermata, and several plants, notably the Charophyta, with no systematic assignment; see BELFORD (1967).] *L.Carb.*, Eu.(G.Brit.-Belg.)-W.Australia.——FIG. 96A,*1*. **D. biloba*, Broadstone Ls., Scot.; *1a-c,* lat. side, and apertural views, all ×45; *1d,* vert. sec., diagram., ×55; *1e,* horiz. transv. sec., ×70 (Cummings, 1957). [Description supplied by W. G. HAKES.]

Eliasites FLOWER, 1961, p. 112 [**E. pedunculatus*; OD]. Spherical body, 0.8 to 0.9 mm. in size; wall thick, fibrous, composed of few plates; with central cavity; attached to *Catenipora*; observed only in thin sections. [Systematic position doubtful.] *Ord.*, USA(Texas).

Eotaeniopsis EISENACK, 1955, p. 184 [**E. articulata*; OD]. Rectangular chitinous integuments, flattened, black or brown; joined to short "chains" of 2 or 3 links; 90 to 470 microns long, 50 to 215 microns wide; single links of unequal size; corners rounded; surface smooth, bright. *U.Sil. (Beyrichia limestone,* Pleist. drift), Eu.(N.Ger.). ——FIG. 96,*4*. **E. articulata; 4a-f, ca.* ×45 (Eisenack, 1955).

Fentonites FLOWER, 1961, p. 117 [**F. irregularis*; OD]. Small planispiral shells or tests, 1 mm. in diameter, calcitic, thick-walled; internal cavity small and greatly reduced; surfaces irregular; attached to corals; observed only in thin sections. [Systematic position unknown.] *Ord.*, USA(N. Mex.).

Gochtia EISENACK, 1968, p. 305 [**G. rete*; M]. Finely meshed network of irregular 4- to 7-sided polygons formed by very thin rounded ribs 20 to 50 microns thick, with an axial channel; polygons 180 to 500 microns long; attached to thin flat basal plate; only fragments up to 2 mm. in size found, consisting of dahllite. [Systematic position unknown.] *U.Sil.(up.Ludlov.) (Beyrichia limestone,* Pleist. drift), Eu.(N.Ger., Isle of Hiddensee).——FIG. 95,*5*. **G. rete*; ×30 (Eisenack, 1968).

Goldringella FLOWER, 1961, p. 117 [**G. plana*; OD]. Tiny planispiral shells, thin-walled; whorl cavity rounded; 1.2 mm. in diameter, 0.6 mm. high; attached to corals by the broad flat side; observed only in thin sections. [Systematic position unknown.] *Ord.*, USA(N.Mex.).

"Guttulae" HILTERMANN & SCHMITZ, 1968, p. 301. Informal name for problematical bodies of microscopic size from freshwater sediments; re-

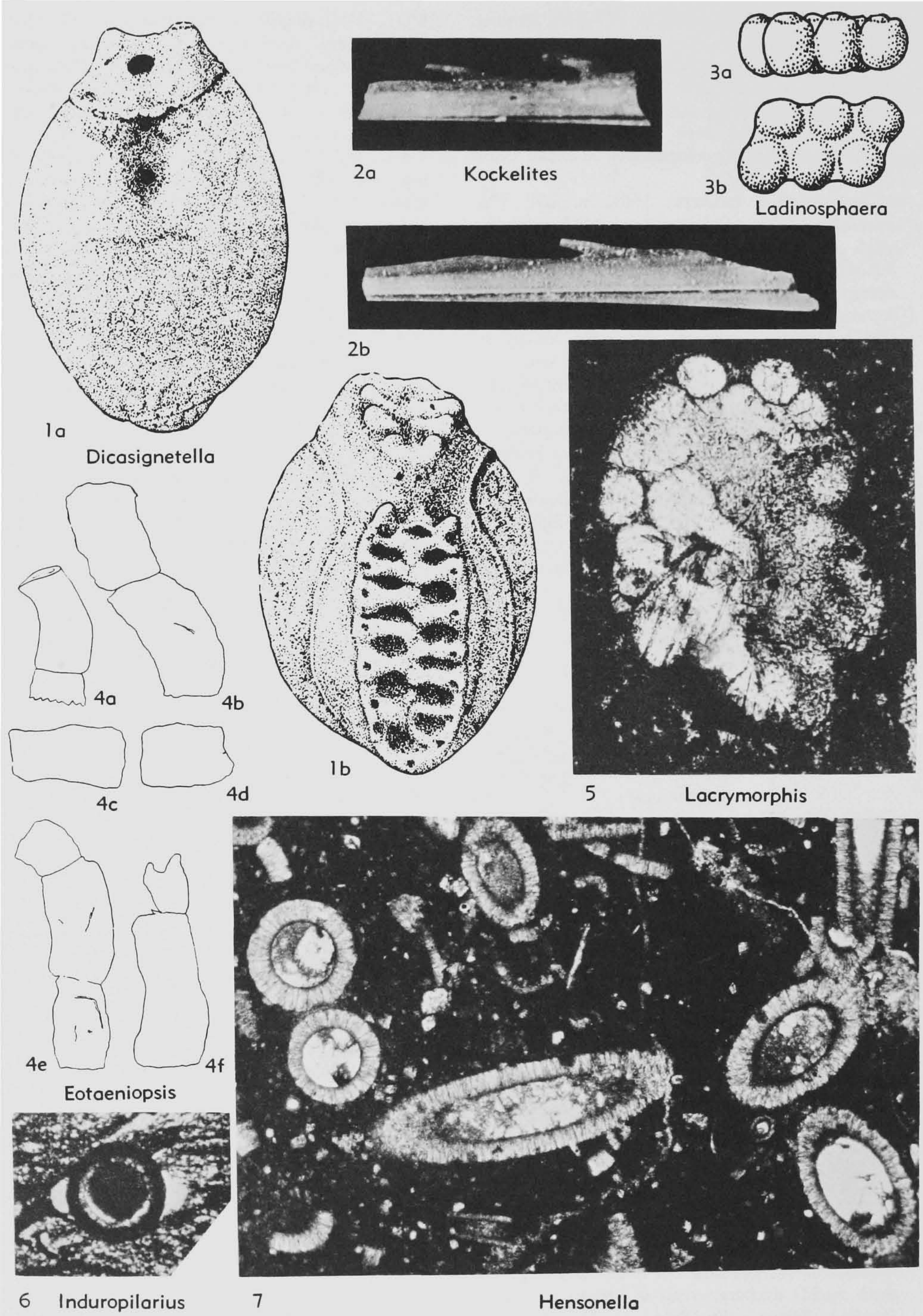

FIG. 96. Microproblematica (p. W157, 159-160).

sembling in shape drops of liquid; white or gray, bright, surface smooth, 0.2 mm. long, 0.12 mm. wide; composed of apatite; in thin sections marginal layer (microcrystalline and somewhat translucent) and large darker inner part distinguishable. [May perhaps be isolated parts of some larger organisms, but inorganic origin is not to be excluded. The generic name *Guttula* and the species name *randeckensis* were proposed by HILTERMANN & SCHMITZ (1968) as conditional names and have no standing under the *Code*, Art. 15.] *U.Tert.(Mio.)*, Eu.(S.Ger.).——FIG. 97,*5*. "Guttulae"; *5a*, numerous specimens, ×49; *5b*, cross section showing internal structure, ×1,300 (Hiltermann & Schmitz, 1968).

Harjesia FLOWER, 1961, p. 111 [**H. anomala*; OD]. Tiny flask- or vase-shaped bodies, 1.4 mm. long, 1.2 mm. wide, with long neck above and solid calcitic body in central cavity; thick-walled; calcitic, with rodlike inclusions; only one specimen known from thin section; attached to coral. [Systematic position unknown.] *Ord.*, USA(N. Mex.).

Hensonella ELLIOTT, 1960, p. 229 [**H. cylindrica*; OD]. Calcareous tubes, hollow, cylindrical, straight, slightly tapering, up to 2.5 mm. long (?incomplete); diameter 0.1 to 0.5 mm.; walls consisting of very thin dark impervious inner layer and thick outer layer of aragonite with radiate structure. [Affinities doubtful; according to ELLIOTT (1960, 1962), not calcareous alga; perhaps small scaphopod.] *?L.Cret.*, Eu.(Yugosl.); *L.Cret.*, SW.Asia(Arabia-Israel-Iran-Iraq)-N.Afr.(Algeria)-E.Indies(Borneo).——FIG. 96,*7*. *H. *cylindrica*, NE. Iraq; ×30 (Elliott, 1960).

Hikorocodium ENDO, 1951, p. 126 [**H. Elegantae*; M] [=*Hicorocodium* KOCHANSKY & HERAK, 1960, p. 90 *(nom. null.)*]. Cylindrical bodies, rather straight, with rounded end, occasionally branched or with rounded protuberances; "thallus" composed of 1 or 2 central "stems" (diam. 0.1-2 mm.), made up of mass of very fine threadlike filaments, and dichotomously branched tubular pores (diam. 0.1-0.2 mm.) in peripheral part; outer part of "thallus" calcified. [Systematic position uncertain; originally interpreted by ENDO (1951a) and others as codiacean alga allied to *Gymnocodium* PIA; compared with hydrozoans by KOCHANSKY-DEVIDÉ & RAMOVS (1955), KOCHANSKY-DEVIDÉ (1958), E. FLÜGEL (1959), and KOCHANSKY & HERAK (1960); H. FLÜGEL (1963) recommended research on possible sponge nature.] *L.Carb.-Perm.*, Asia (Turkey-Iran-Japan); *Perm.*, Eu.(Yugosl.-S.Anatol.).

Hydrocytium(?) silicula MATTHEW, 1890, p. 146. Minute oval bodies; 0.5 mm. long, 0.25 mm. wide; with strong cuticle and pedicle-like knob at one end. *Cam.*, Can.(N.Scotia).

Induropilarius DEFLANDRE & TERS in TERS & DEFLANDRE, 1966, p. 342 [**I. aenigmaticus*; OD]. Silico-organic globules 0.1 mm. in diameter, with thick membrane; globule consisting entirely, or only periphercally, of fine radial-fibers. *Ord.*, Eu.(W.France).——FIG. 96,*6*. **I. aenigmaticus* Vendée, France; ×160 (Ters & Deflandre, 1966).

Ivesella FLOWER, 1961, p. 108 [**I. adnata*; OD]. Capsule-like bodies, 0.8 mm. wide, 0.6 mm. high, high-arched; wall thin, consisting probably of a single piece; origin material perhaps chitinous; attached to colonies of *Palaeophyllum*; observed only in thin sections. [Systematic position unknown.] *Ord.*, USA(Texas).

Kockelites ALBERTI, 1968, p. 129 [**K. longus*; OD]. Conical bodies, tapering, 1.5 to 3.5 mm. long, cross section flat, oval; on upper side 1 to 5(?) tiny teeth, with forward inclination; on posterior part of lower side 2 furrows converging at acute angle; in anterior of body a hollow with ramifications leading into the teeth; only fragments known, rendering complete diagnosis impossible. [Systematic position unknown.] *Sil.-M.Dev.(Eifel.)*, Eu.(W.Ger.). [Unpublished occurrences (H. ALBERTI, pers. commun., 1971): *L.Dev.-M.Dev.*, Eu. (W.France-Aus.)-Afr. (Morocco), *Sil.-Dev.*, Eu.(Swed.,Gotl.-Aus.).]——FIG. 96,*2*. **K. longus*, Dev.(up.Ems.-low Eifel.), Harz Mts.; *2a,b*, ×30 (Alberti, 1968).

Kruschevia FLOWER, 1961, p. 111 [**K. verruca*; OD]. Small fibrous bodies, narrowly elevated,

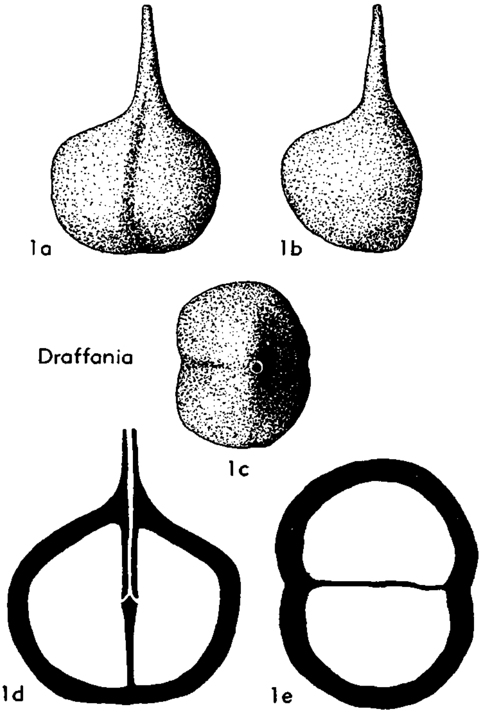

FIG. 96A. Microproblematica (p. *W*157).

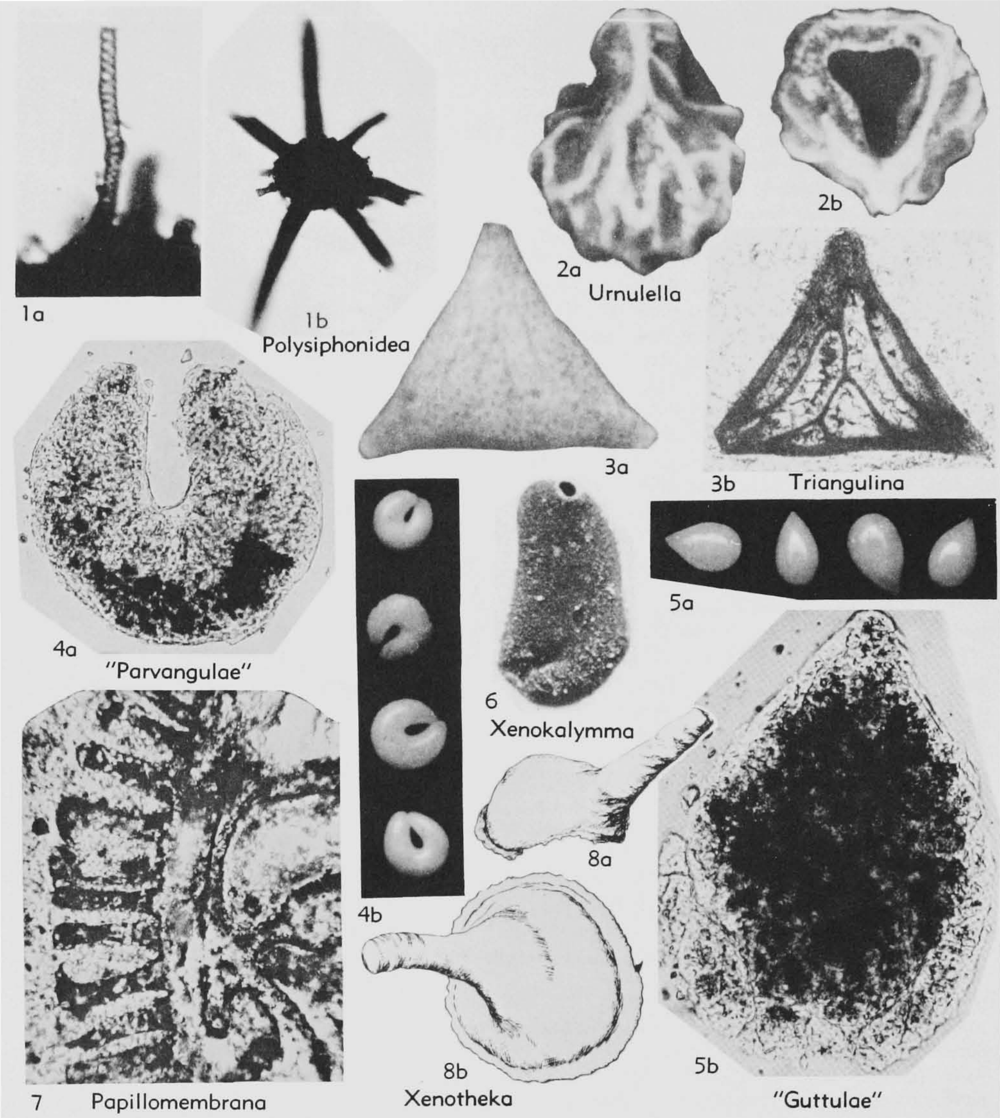

FIG. 97. Microproblematica (p. W157, 159, 163, 165, 167-168).

tip rounded, height and width 0.2 to 0.3 mm.; attached to *Catenipora*; observed only in thin sections. [Systematic position unknown.] *Ord.,* USA(Texas-N.Mex.).

Lacrymorphus ELLIOTT, 1958, p. 424 [**L. perplexus*; OD]. Small hollow bodies, 65 to 80 microns in diameter, tiny spherical, pear-, acorn-, or retort-shaped, not sections of tubes; very thin-walled; occurring in clusters, often nearly touching each other, but never with polygonal outline; ?aggregations fortuitous. [?Clusters of unicellular green algae.] *U.Trias.,* SW.Asia(N.Iraq); *L.Cret.-U.Cret.(Cenoman.-Turon.),* Eu.(Yugosl.).——FIG. 96,5. **L. perplexus,* U.Trias., N.Iraq; ×109 (Elliott, 1958).

Ladinella OTT in KRAUS & OTT, 1968, p. 273 [**L. porata*; M]. Tubes (0.025-0.04 mm. in diam.) grouped together in node- or tongue-shaped "colonies," about a mm. in size; in cross section, walls surrounding cavities display "pseudosepta" but tubes themselves are not similarly partitioned. [Systematic position unknown, but producers were considered by author to have lived in "communities" probably with a commensal relationship to a variety of organisms.] *M.Trias.*, Eu.(S.Aus.); *M.Trias.-U.Trias.*, Eu.(Czech.). [Description supplied by W. G. HAKES.]

Ladinosphaera OBERHAUSER, 1940, p. 44 [**L. geometrica*; M]. Small globules (6 or 9) linked in one plane forming regular geometric figures; diameter about 0.5 mm., surface of globules obviously perforated or retiform. [?Plant, ?animal, ?inorganic; see LOEBLICH & TAPPAN (1964, p. C786).] *M. Trias.(Ladin.)*, Eu.(Aus.).——FIG. 96,*3*. **L. geometrica; 3a,b*, ×50 (Oberhauser, 1960).

Lamellitubus OTT in KRAUS & OTT, 1968, p. 274 [**L. cauticus*; OD]. Double-walled tube (approx. 1 mm. external diam. and approx. 0.5 mm. internal diam.); partially branched; whole specimens create surfaces of branched tubes; internal surface smooth and lined with micritic calcite; external surface uneven and undulating; internal wall thicker than external wall and connected to it by thin lamellae (0.05-0.10 mm. apart). [Systematic position not assigned by author.] *M.Trias.*, Eu.(S.Aus.); *M.Trias.-U.Trias.*, Eu.(Czech.). [Description supplied by W. G. HAKES.]

Lenaella KORDE, 1959, p. 626 [**L. reticulata*; OD]. Cylindrical calcareous organism, about 1 mm. long and 0.5 mm. wide; wall perforated by very fine holes. [Systematic position unknown, ?hydrozoan.] *L.Cam.*, USSR(Sib.).

Linotolypa EISENACK, 1962, p. 136 [**L. arcuata*; OD]. Thin ?chitinous threads arranged as links or meshes which form minute hollow globules. [?Planktonic organism.] *?Ord.*(Pleist. drift), Eu.(Ger.), *M.Ord.*, USA(Va.); *M.Sil.(Wenlock.)*, Eu.(Swed., Gotl.); *M.Trias.(Muschelkalk)*, Eu.(N.Ger., Holstein); *L.Cret.*, Australia; *L.Cret.(up.Apt.)*, Eu.(N.Ger.)——FIG. 98,*2*. **L. arcuata*, M.Trias., Ger.; ×500 (Eisenack, 1962).

Lithraphidites DEFLANDRE, 1963, p. 3486 [**L. carniolensis*; OD]. Rodlike, calcareous; cross section cruciform; 26 microns long, 2 microns wide; apparently pierced by thin canal. *L.Cret.(up. Apt.)-U.Cret.*, Eu.(France)-Australia, reworked in *Oligo.*, Eu.(France).——FIG. 98,*5*. **L. carniolensis*, Cret., France; *5a*, fragment, ×5,000; *5b*, holotype, ×3,200 (Deflandre, 1963).

Lombardia BRÖNNIMANN, 1955, p. 44 [**L. arachnoidea*; OD] [=*Formes découpées* LOMBARD, 1938; *"Sections de thalles"* LOMBARD, 1945]. Free, calcareous, transparent microfossils; spined, broad-branching or angularly bone-shaped; symmetrical; central body of variable size and shape and granular in aspect; extensions with dark median line; diameter up to 1.5 mm. [Interpreted by LOMBARD (1945) as algae, by PARÉJAS in LOMBARD (1938) as remains of sponge skeletons, and by BRÖNNIMANN (1955) as sections of microscopic symmetrical holothurian remains or microscopic planktonic crinoids or ophiuroids.] *U.Jur.*, Eu.(France-Switz.)-W.Indies(Cuba).——FIG. 95,*1a,b*. **L. arachnoidea*, Portland., Cuba; *1a,b*, ×62 (Brönnimann, 1955).——FIG. 95,*1c*. *L. perplexa* BRÖNNIMANN, Portland., Cuba; ×62 (Brönnimann, 1955).——FIG. 95,*1d*. *L. angulata* BRÖNNIMANN, Portland., Cuba; ×62 (Brönnimann, 1955).

Lucianorhabdus DEFLANDRE, 1959, p. 142 [**L. cayeuxi*; OD]. Very small rodlike microorganisms, shape varying from cylindrical or subcylindrical to slightly curved or seldom even fungiform, 8 to 30 microns long, 7 to 8 microns wide; one end conical or spherical; rods consisting of 4 parallel elements closely connected, each element rhomboidal in cross section; surface wrinkled or granular. [First described by CAYEUX (1897) as *"bâtonnets de nature indéterminée"* and suggested to be calcareous algae; systematic position uncertain, ?related to coccolithophorids. Stratigraphic use questionable, as these forms have been found redeposited in Tertiary sediments.] *U.Cret.*, Eu.(France-Eng.-Pol.)-W.Australia.——FIG. 95,*3*. **L. cayeuxi*, U.Cret. (Maastricht.), France(Vanves, Seine); *3a,b*, ×1,300 (Deflandre, 1959).

Microrhabdulinus DEFLANDRE, 1963, p. 3486 [**M. ambiguus*; OD]. Rodlike, cylindrical, straight or slightly curved; cross section polygonal or roundish; 55 microns long, 3 to 4 microns wide; microstructure homogenous but very unique. *U. Cret.*, Eu.(France).——FIG. 98,*3*. **M. ambiguus*, Senon., France(Saint-Denis de Maronval); *3a,b*, *ca.* ×3,200, ×2,000 (Deflandre, 1963).

Microrhabduloidus DEFLANDRE, 1963, p. 3486 [**Microrhabdulus rugosus* BOUCHÉ, 1962, p. 92; OD]. Rodlike, calcareous, 7 to 35 microns long; cross section roundish or angular; with or without thin canal; microstructure homogeneous or irregularly heterogeneous. *L.Tert.(Eoc., Lutet.)*, Eu.(France).

Microrhabdulus DEFLANDRE, 1959, p. 140, *emend.* DEFLANDRE, 1963, p. 3486 [**M. decoratus*; OD]. Very small calcareous rods, cylindrical or spindle-shaped, straight or slightly curved, with narrow rather distinct axial canal; both ends blunt; 16 to 33 microns long, 1.5 to 2 microns wide. [Probably entire organisms, not fragments; ?related to coccolithophorids.] *U.Cret.*, Eu.(France-Eng.-Pol.)-USA(Texas)-W.Australia; reworked in *M.Eoc., Oligo.*, Eu.(France).——FIG. 98,*1*. **M. decoratus*, U.Cret.(Maastricht.), France(Vanves, Seine); ×3,200 (Deflandre, 1959).

Microtubus E. FLÜGEL, 1964, p. 75 [**M. communis*; OD]. Very small cylindrical tubes, mostly curved, seldom straight, probably articulated transversely; length 0.2 to 2.0 mm. (commonly 0.3-0.5 mm.), diameter 0.05 to 0.2 mm.; walls smooth, without distinct structure, obviously not agglutinated, 0.02 to 0.04 mm. thick. [Probably sessile organism, belonging to worms (?Serpulidae).] *U.Trias.(Rhaet.*, reef ls.), Eu.(S.Ger.-N. Alps-S.Alps-NW.Yugosl.-AegeanSea-?C.Italy).——

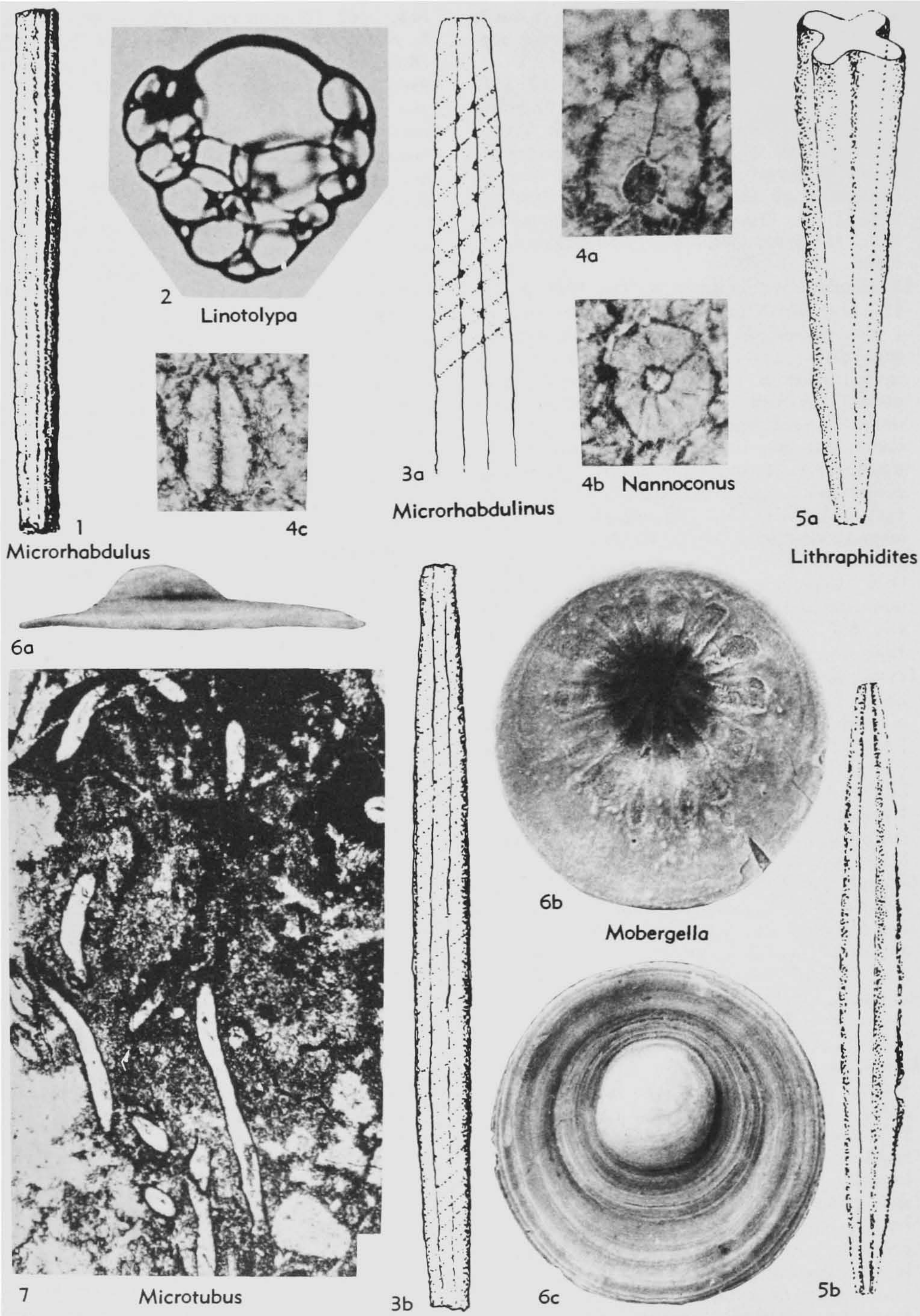

FIG. 98. Microproblematica (p. W161, 163).

FIG. 98,7. *M. communis, Dachstein-Riffkalk, Aus.(Donnerkogel); ×30 (Flügel, 1964).

Mobergella HEDSTRÖM, 1923, p. 5 [**Discinella holsti* MOBERG, 1892, p. 5; M]. Phosphatic shell with excentrical apex, circular or ovate, convex, flattened, diameter 0.6 to 6.5 mm.; 7 pairs of muscle imprints, bilaterally arranged, radiating from apical region on inner side; great morphological variability in shell types, e.g., in degree of convexity (three species distinguishable). [MOBERG (1892) described *Mobergella* as species of brachiopod *Discinella* HALL, 1872; HEDSTRÖM (1923) referred it to patellacean gastropods; POULSEN (1963) suggested affinities to Monoplacophora; according to FISHER (1962, p. *W*132), "undoubtedly a hyolithelminth operculum"; ÅHMAN & MARTINSSON (1965) regarded it as probably a sedentary hyolithellid, and BENGTSON (1968) interpreted this form as operculum of a ?sedentary tube-dwelling organism.] *L.Cam.* (chiefly in glacial drift boulders), Eu.(Swed.-Nor.)-NE.Asia(Sib.).——FIG. 98,6. **M. holsti* (MOBERG), Swed.(Venenäs); *6a-c,* lat., concave, and convex views, ×15 (Bengtson, 1968).

[Concerning the validity of the name *Mobergella* given by HEDSTRÖM (1923) as a junior objective synonym of *Discinella* HALL, 1872, and his use of the name homonymously for a genus separated from *Discinella* and based on *Discinella holsti* MORBERG, 1892, see BENGTSON, 1968, p. 330.]

Mooreopsis FLOWER, 1961, p. 112 [**M. rotundus*; OD]. Solid round bodies, 1 mm. in diameter, consisting of finely granular calcite; surface rounded, ?hemispherical; without central cavity; broadly attached to *Catenipora*; observed only in thin sections. [Systematic position doubtful.] *Ord.*, USA(Texas).

Moundia FLOWER, 1961, p. 108 [**M. fibrosa*; OD]. Low-arched bodies, 2 mm. long, 1.5 mm. wide, 1 mm. high, consisting of few thick calcareous plates with vertical fibrous appearance; small central cavity with aperture in ?anterior end; attached to coral *Catenipora*; observed only in thin sections. [Systematic position unknown.] *Ord.,* USA(Texas).

Nannoconus KAMPTNER, 1931, p. 288 [**N. steinmanni*; OD]. Microscopically small peg-shaped microorganisms with axial canal or large central cavity, 5 to >50 microns (commonly 15 to 20μ) long, 5 to 10 microns wide; outline conical, spherical, pear-shaped, barrel-shaped, cylindrical, or U-shaped; composed of numerous wedge-shaped individual elements; wedges arranged in mounting spiral or spirals, oblique to axis; 2 terminal apertures. [Systematic position "still obscure" (BRÖNNIMANN, 1955); ?skeletal remains of planktonic Protozoa; regarded as embryonic stage of *Lagena* or *Lagena* proper (DE LAPPARENT, 1931), as alga (CADISCH, *fide* COLOM, 1945) and as belonging to *Fibrosphaera* DE LAPPARENT (COLOM, 1945); ?relationship to oogonia of algae (BRÖNNIMANN, 1955); see also CAMPBELL, 1954, p. *D*170-*D*171.] *U.Jur.-U.Cret.,* Eu.-N.Afr.-C.Am. (W.Indies (Cuba)-?Mexico).——FIG. 98,*4a,b*. **N. colomi* (DE LAPPARENT), L.Cret., Cuba; *4a,b,* long., transv. secs., *ca.* ×1,575 (Brönnimann, 1955).——FIG. 98, *4c. N. steinmanni* KAMPTNER, L.Cret., Cuba; (slightly retouched), *ca.* ×1,575 (Brönnimann, 1955).

Niccumites FLOWER, 1961, p. 113 [**N. oculatus*; OD]. Spherical or somewhat flattened body, finegrained calcitic, seemingly finely granular texture; attached to *Catenipora* by irregular masses of coarsely crystalline calcite; observed only in thin sections. [Systematic position unknown.] *Ord.,* USA(N.Mex.).

Palambages WETZEL, 1961, p. 338 [**P. morulosa*; OD]. Spheroidal bodies, morphologically similar to mulberries; about 45 to 120 microns in diameter; composed of 8 to (?) 18 oval membranous cells, 12 to 50 microns in diameter. [?Egg-balls of copepods or coenobia of algae or hystrichosphaerids.] *U.Cret.(Senon.)-Paleoc.(Dan.),* Eu. (Denm.-Pol.).

Palamphimorphium DEFLANDRE & TERS in TERS & DEFLANDRE, 1966, p. 342 [**P. speciosum*; OD]. Microorganism consisting of 2 different parts, somewhat round central body 0.13 mm. long and 0.06 mm. wide, silico-organic, enveloped by translucent quartzose material of similar oblong shape; central body with blackish membrane containing globules of delicate structure. *Ord.,* Eu. (W.France).

Paleocryptidium DEFLANDRE, 1955, p. 184 [**P. cayeuxi*; OD]. Tiny spherical or ellipsoidal hollow bodies with entirely smooth shell of organic material; diameter about 9 microns. [Regarded as ?acritarch by DEFLANDRE (1955), as possible sponge by PACLTOVÁ (1972) whose material, however, may not be congeneric.] *Proteroz.(Briovér.),* Eu.(France-?Czech.). [Description supplied by CURT TEICHERT.]

Papillomembrana SPJELDNAES, 1963, p. 63 [**P. compta*; M]. Compressed bodies of primarily cylindrical or spherical shape, 0.4 to 0.5 mm. in diameter; having thin outer (?carbonaceous) membrane with dense papilla-like protuberances, thin-walled and hollow. [Systematic position unknown, somewhat resembling dasycladacean algae.] *U.Precam.(Esmark.),* Eu.(Nor.)——FIG. 97,7. **P. compta*; ×355 (Spjeldnaes, 1963).

Papinochium DEFLANDRE & TERS in TERS & DEFLANDRE, 1966, p. 342 [**P. dubium*; OD]. Apparently globular, sometimes deformed or crushed, with hollow blunt appendices; diameter of globule without appendices 0.15 mm.; often fossilized in fibrous chlorite. *Ord.,* Eu.(W. France).

"Parvangulae" HILTERMANN & SCHMITZ, 1968, p. 301. Informal name for white problematical bodies of microscopic size from freshwater sediments; in shape resembling horseshoes; surface smooth, about 0.15 mm. in diameter; ends of horseshoe somewhat tapering and inclined toward

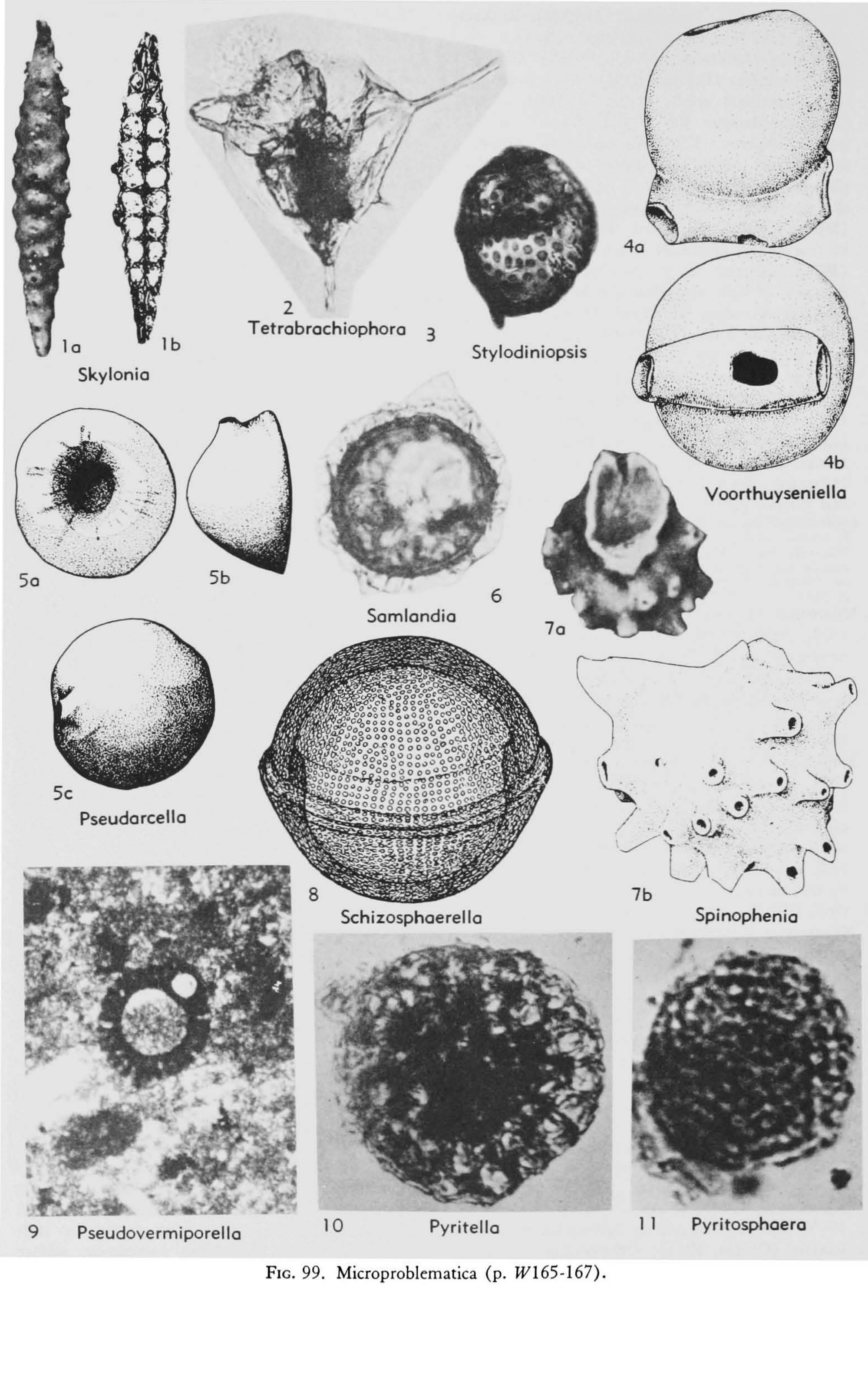

FIG. 99. Microproblematica (p. W165-167).

each other; thin, marginal, rather translucent layer and less translucent inner part, both of microcrystalline apatite, distinguishable in thin sections. [Parvangulae may be interpreted as isolated parts of larger organisms, but inorganic origin is not to be excluded. The generic name *Parvangula* and the species name *randeckensis* were proposed by HILTERMANN & SCHMITZ (1968) as conditional names and have no standing under the *Code,* Art. 15.] *U.Tert.(Mio.),* Eu.(S.Ger.).——FIG. 97,*4*. "Parvangulae"; *4a,* cross section showing internal structure, ×1,870; *4b,* numerous specimens, ×70 (Hiltermann & Schmitz, 1968).

Pedicillaria FLOWER, 1961, p. 114 [**P. bifurcata*; OD]. Resembling echinoderm pedicillaria; stalk narrowing from broad attachment, terminating in bifurcated tip; attached to corals; observed only in thin sections. [Systematic position unknown.] *Ord.,* USA(N.Mex.).

Pictonicopila DEFLANDRE & TERS, 1966, p. 240 [**P. polymorpha*; OD]. Vesicular globules with thin membrane, 3 to 60 microns in diameter; mostly united to irregular loose "colonies," 0.3 to 0.4 mm. in size, composed of individuals of equal or various size; globules mostly hollow, some with surface layer consisting of very small polygonal bodies (1-3 microns in size), closely spaced. *Ord.,* Eu.(W.France).

Plutoneptunites DEFLANDRE, 1961, p. 127 [**P. antarcticus*; M]. Interlacing and occasionally coalescing filaments of varied shape, straight or curved; one end rounded, without septa; often with concentric integument, 2 to 3 microns thick; sometimes acute-angled or rectangularly branched; similar to colonies of blue algae. [Systematic position unknown; *"au sein des Protocaryotes"* (DEFLANDRE, 1961), ?Cyanophyceae, ?fungal hyphae.] In limestones of unknown age; Ind.O. (Kerguelen I.).

Polysiphonidia EISENACK, 1971, p. 458 [**P. enigmatica*; OD]. Oval central body, somewhat irregular in outline, 72 to 180 microns in diameter; with very small tubes radiating irregularly; 2 kinds of tubes to be distinguished; 7 to 20 larger ones, structureless, 10 to 15 microns in diameter, 420 microns long (max.); 2 to 5 smaller ones, short, annulated, 52 microns long (max.); central body and tubes chitinous. [Systematic position unknown.] *U.Sil.(Beyrichia limestone,* Pleist. drift); Eu.(Pol., Pomerania).——FIG. 97,*1*. **P. enigmatica*; holotype, *1a,* ×467; *1b,* ×130 (Eisenack, 1971).

Pseudarcella SPANDEL, 1909, p. 199 [*emend.* LE CALVEZ, 1959; *emend.* LINDENBERG, 1965] [**P. rhumbleri*; M] [=*Pseudoarcella* SZCZECHURA, 1969 *(nom. null.)*]. For description as foraminifer, see LOEBLICH & TAPPAN (1964, p. C522). [According to LINDENBERG (1965, p. 28), not a protozoan; LOEBLICH & TAPPAN (1968) assigned this genus to the tintinnids.] *L.Tert.(low.Eoc.),* Eu. (?France-Belg.); *L. Tert. (up. Eoc.),* Eu. (?France-SE.Pol.-Belg.); *L.Tert.(Oligo.),* Eu. (Ger.-Aus.),——FIG. 99,*5*. **P. rhumbleri* SPANDEL, L.Tert.(Oligo.), Aus.; *5a-c,* different views, ×73 (Lindenberg, 1965).

Pseudovermiporella ELLIOTT, 1958, p. 419 [**P. sodalica*; OD] [=?*Vermiporella* STOLLEY, 1893, p. 140 (type, *V. fragilis*); for discussion see KOCHANSKY & HERAK, 1960, p. 72; ELLIOTT, 1962, p. 40]. Small calcitic tubes, diameter up to 1.4 mm., meandriform, forming tangled coils or loops; tubes consisting of an innermost, thin, dark compact-walled tube and an outer tubular layer pierced by numerous radial pores 0.03 to 0.04 mm. in diameter; pores approximately at right angles to surface and forming distinct regular mesh, which has a dark calcareous layer on its inner surface; tubes showing creeping habit, occurring free or attached to other ones or to shell fragments. [Tentatively considered as unusual primitive dasyclad alga.] *Sil., Perm.,* Eu. (Yugosl.-USSR)-Asia (Arabia-N.Iraq-?Japan)-?N. Afr.(?Tunisia).——FIG. 99,*9*. **P. sodalica,* Arabia; transv. sec. of small individual, ×50 (Elliott, 1958).

Pyritella LOVE, 1958, p. 433 [**P. polygonalis*; OD]. Oval to round microorganisms, diameter 20 to 55 microns, composed of closely packed translucent cells, appearing roughly polygonal at surface, separated by walls up to 1 micron thick; found in pyrite aggregates of the *"Kies-Kügelchen"* type (NEUHAUS, 1940). [Systematic position unknown, probably of plant origin (?fungi).] *L. Carb.,* Eu.(Scot.).——FIG. 99,*10*. **P. polygonalis,* holotype; *ca.* ×1,000 (Love, 1958).

Pyritosphaera LOVE, 1958, p. 433 [**P. barbaria*; OD]. Spherical or subspherical microorganisms, ranging in diameter from 2 to 35 microns, with uniform and closely packed radial spines covering outer surface; spiny processes rapidly tapering, 1 to 2 microns long; surface of organisms closely associated with iron pyrite and always coated by this mineral; organisms obtained from framboidal granules of the *"Kies-Kügelchen"* type (NEUHAUS, 1940). [Systematic position unknown, perhaps of plant origin, but probably neither bacteria nor actinomycetes.] Described under name *Pyritosphaera* only from Cambrian and Lower Carboniferous of Europe, but occurring worldwide in marly sediments of every age. *Cam.(up. Revin.),* Eu.(Belg.); *L.Carb.,* Eu.(Scot.).——FIG. 99,*11*. **P. barbaria,* L.Carb., Scot.; *ca.* ×2,000 (Love, 1958).

Samlandia EISENACK, 1954, p. 76 [**S. chlamydophora*; OD]. Globular or slightly ellipsoidal body, 70 to 90 microns in size; with inner thick-walled integument, enveloped by second very thin integument, both connected by numerous small pillars; apical slip-hole. [Perhaps an acritarch.] *Tert.(low.Oligo.),* Eu.(Samland, formerly NE.

Ger., now USSR).——Fig. 99,*6*. **S. chlamydophora;* ×420 (Eisenack, 1954).

Schizosphaerella Deflandre & Dangeard, 1938, p. 1116 [**S. punctulata*; M] [=*Nannopatina* Stradner, 1961, p. 78 (Deflandre, 1971, pers. commun.)]. Calcareous globules, 12 to 30 microns in size, consisting of 2 valves of dissimilar shape, commonly occurring separated from one another; one with marginal circular furrow into which other dome-shaped valve is fitted; both valves with sometimes irregular punctation; this ornamentation similar to that of diatom *Pyxidicula.* [Planktonic organism of unknown systematic position.] *M.Jur.(Bajoc.)-U.Jur.(low.Oxford.),* Eu.(W.France, Normandy).——Fig. 99,*8*. **S. punctulata,* U.Jur.; oblique view, ×1,875 (Deflandre & Dangeard, 1938).

Skylonia Thomas, 1961, p. 359 [**S. mirabilis*; OD]. Small spindle-shaped fossil, calcareous, slender, fusiform, tapering symmetrically, 2 mm. long, chambered; chambers in close contact, arranged quadriserially, hexagonal externally, *ca.* 15 chambers in each longitudinal row, length and width of median chamber 0.17 mm., maximum width 0.35 mm. [Systematic position unknown.] *Tert.(low.Mio.),* Afr.(Kenya).——Fig. 99,*1*. **S. mirabilis; 1a,* surface view, ×25; *1b,* long. thin section, ×23 (Thomas, 1961).

Slocomia Flower, 1961, p. 111 [**S. quadrata*; OD]. Calcareous bodies, subquadrate in cross section, 2 mm. long, 1 mm. high; surface extensively perforate; attached to corals; observed only in thin sections. [Systematic position unknown.] *Ord.,* USA(N.Mex.).

Spinophenia Szczechuria, 1969, p. 89 [**S. multituba*; OD]. Calcareous test, hyaline, spherical; 0.24 to 0.34 mm. high, 0.3 mm. wide; wall thin, finely perforated; surface of test covered by numerous thornlike tubes, irregularly arranged, open, with aperture mostly surrounded by "collar" of heterogeneous shape; aperture of very different size and shape. [Perhaps related to rhizopods.] *L.Tert.(up.Eoc.),* Eu.(SE.Pol.).——Fig. 99,*7*. **S. multituba; 7a,b,* apertural view, ×80, ×225 (Szczechura, 1969).

Stylodiniopsis Eisenack, 1954, p. 75 [**S. maculatum*; OD]. Small oval or pear-shaped integument, thin-walled, 80 to 100 microns in size; with thin pedicle; covered with numerous, uniformly distributed, circular or oval spots; somewhat similar to *Palaeoperidinium spinosissimum* Deflandre and *Stylodinium* Klebs (dinoflagellate). [Systematic position uncertain.] *L.Tert. (low.Eoc.),* Eu.(N.Ger., Isle of Fehmarn); *L. Tert.(low.Oligo.),* Eu.(Samland, formerly NE. Ger., now USSR).——Fig. 99,*3*. **S. maculatum,* Samland; *ca.* ×250 (Eisenack, 1954).

Tetrabrachiophora Eisenack, 1954, p. 76 [**T. natans*; M]. Approximately globular integument (chitinous?), very thin, diameter about 100 microns; with 4 thin cylindrical branches of un-

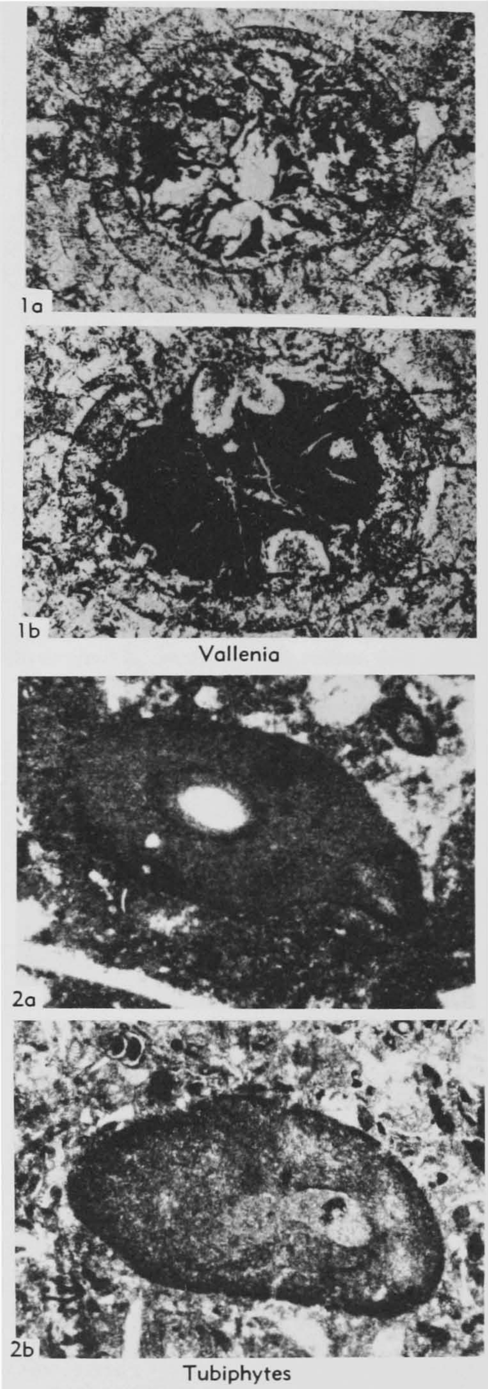

Fig. 100. Microproblematica (p. W167).

known length, diameter 5 microns. [Very probably integument of planktonic organism.] *L.Tert. (low.Oligo.),* Eu.(Samland, formerly NE.Ger., now USSR).——FIG. 99,*2*. **T. natans*; ×290 (Eisenack, 1954).

Tholella FLOWER, 1961, p. 105 [**T. idiotica*; OD]. Thin-walled, high-arched test consisting of numerous plates, 1 mm. wide, 1.2 mm. high; main cavity supplemented by an accessory one; attached to corals; observed only in thin sections. [Systematic position doubtful.] *Ord.,* USA(N. Mex.-Texas-Utah).

Triangulina QUILTY, 1970, p. 180 [**T. aequilateralis*; OD]. Test triangular or subtriangular, at least one angle quite sharp, diameter 0.5 to 0.7 mm., surface smooth; subdivided into 4 to 6 chambers arranged bilaterally; external wall perforate, 2 to 5 times as thick as intercameral walls, which are commonly bilamellar; walls usually composed of fibrous calcite; "aperture" a narrow conical opening. [Foraminiferal relationship is excluded because of wall structure; some similarities to Crisiidae (Bryozoa) exist, but affinities improbable.] *Tert.(up.Eoc.),* SW.Australia; *Tert.(up.Oligo., Janjukian-low.Mio., Longford.),* Australia(N.Tasmania-Victoria).——FIG. 97,*3*. **T. aequilateralis,* low.Mio., Tasmania(Cape Grim); *3a,b,* ×70 (Quilty, 1970).

Tubiphytes MASLOV, 1956, p. 82 [**T. obscurus*; M] [=*Nigriporella* RIGBY, 1958, p. 584 (type, *N. magna*); for discussion see KONISHI, 1959]. Pear- or quince-shaped symmetrical ovoid bodies, about 2 mm. long (max. 6 mm.); composed of fibrous calcareous material; outer margins sharply delimited; usually with 1 or 2 small circular inclusions suggesting an initial tube or vacuole; rock-forming organism in Permian of USSR. [Systematic position questionable; described by MASLOV as alga; interpreted by RIGBY as hydrozoan.] *Carb.,* USA;*-Perm.,* Eu.(Aus.)-USA (Texas-N.Mexico-Wash.)-Asia (SE.Arabia-N.Iraq-USSR-Afghan.-Burma-S.China-Japan)-C.Am.(Guatem.)-N.Am.(Mexico).——FIG. 100,*2*. *T.* sp. *(=Nigriporella),* L.Perm.(Zinnar F.), Iraq(Mosul Liwa); *2a,b,* thin section, ×30, ×21 (Elliott, 1962).

Umbella MASLOV in BYKOVA & POLENOVA, 1955, p. 40 [**U. bella*; OD] [=*Umbellina* LOEBLICH & TAPPAN, 1961, p. 284; obj.]. Globular to ovoid, hollow calcite bodies, long diameter as much as 0.45 mm., short diameters 0.40 mm.; shell composed of radially oriented calcite fibers, ranging from 10 to 150 microns in thickness. [Originally regarded as foraminifer; by others believed to be related to Charophyta or of uncertain affinities; name possibly applied to two different kinds of organisms (see *Treatise,* p. C322; TEICHERT, 1965, p. 103; POYARKOV, 1966; VEEVERS, 1970, p. 180; PECK, 1974)]. *Dev.,* N.Am.(USA), Eu.(Belg., USSR), Australia. [Description prepared by CURT TEICHERT.]

Urnulella SZCZECHURA, 1969, p. 90 [**U. costata*; OD]. Scoop-shaped calcareous test, fibrous, imperforate; about 0.4 mm. high, 0.3 mm. wide; surface ornamented by narrow ribs; distinct lateral ridge along longer axis; aperture approximately triangular; surrounded by a "collar"; shape and ornamentation of test rather varied. [Perhaps allied to rhizopods.] *L.Tert.(up.Eoc.),* Eu.(SE. Pol.).——FIG. 97,*2*. **U. costata; 2a,b,* side view, apertural view, ×43 (Szczechura, 1969).

Vallenia RAUNSGAARD PEDERSEN, in BONDESEN, RAUNSGAARD PEDERSEN, & JØRGENSEN, 1967, p. 20 [**V. erlingi*; OD]. Regular globular to flat elliptical structures of complex and uniform nature, diameter 0.25 to 1.5 mm., consisting of outer and inner spherical layer, both 3 to 5 microns thick, and 30 to 120 microns apart, occasionally connected by small indistinct radial "pillars"; in inner part of globules inside inner layers lies a dark to opaque carbonaceous core with irregular outer limitation; in a few specimens a special cellular structure occurs in outer part of core. [Abundant in dark grey dolomite; photosynthetic ?planktonic organisms, of ?vegetal origin, systematic position and phylogenetic affinity uncertain.] *L.Proteroz.(Ketilid., Vallen Gr.),* SW.Greenl.——FIG. 100,*1*. **V. erlingi,* Grænsesø F.; *1a,b,* thin sec., ×37.5 (Bondesen, Pedersen, & Jørgensen, 1967).

Voorthuyseniella SZCZECHURA, 1969, p. 82 [**V. lageniformae*; OD] [=*Lagena-x* VOORTHUYSEN, 1949, p. 31; for discussion see SZCZECHURA, 1969, p. 83)]. Test calcareous, thin, hyaline, imperforate surface smooth, glossy; test consisting of globular or compressed main part and elongated horizontal gutterlike part at its base; in globular part a round or slitlike aperture, in basal part 2 lateral openings and one in the middle of bottom, latter sometimes prolonged into short internal tube; 0.25 to 0.3 mm. high, 0.27 to 0.37 mm. wide. [Similar to *Bicornifera* LINDENBERG, 1965; systematic position unknown, assignment to Foraminifera excluded by SZCZECHURA, 1969.] *Tert. (low.Eoc., Ypres.-up.Plio.),* Eu.(France-Belg.-Neth.-Ger.-Port.-Italy)-S.USA (Ala.)-E.Asia(Taiwan), *Rec.*(S.China Sea-Gulf Mexico).——FIG. 99,*4*. **V. lageniformae,* up.Eoc., Pol.; *4a,b,* viewed from different sides, ×225 (Szczechura, 1969).

Warthinites FLOWER, 1961, p. 117 [**W. adhaerens*; OD]. Low-spired, widely umbilicate shells; spire slightly convex; 1 mm. in diameter, 0.6 mm. high; whorl gently rounded; attached by surface of spire on *Catenipora*; observed only in thin sections. [Systematic position unknown.] *Ord.,* USA(N.Mex.).

Xenokalymma EISENACK, 1968, p. 306 [**X. trematophora*; OD]. Very small lid-shaped cases, flat-arched, bean-shaped in outline, with circular frontal opening; consisting of black organic (chitinous?) material; about 1.1 mm. long, 0.5

mm. wide, diameter of the opening *ca.* 0.1 mm. [Affinities to *Xenotheka* EISENACK, 1937, likely.] *U.Ord.(Caradoc., Keila beds, D_2)*, USSR(Est.).—FIG. 97,*6*. **X. trematophora*; ×30 (Eisenack, 1968).

Xenotheka EISENACK, 1937, p. 239 [**X. klinostoma*; M]. Small, approximately loaf-shaped integument, consisting of dark chitinous material, 0.5 mm. long, 0.2 mm. high; flat-bottomed, with annulated tube tending obliquely upward, tube with circular opening; somewhat similar to *Xenokalymma* EISENACK, 1968. [Foraminifer, according to LOEBLICH & TAPPAN (1964, p. C183); EISENACK (1970) suggested relationship to group Graptoblasti KOZŁOWSKI, 1949, and doubted (EISENACK, pers. commun., 1971) foraminifer relationship.] *Ord.*(Pleist. drift), Eu.(S.Finl.-Samland, formerly NE.Ger., now USSR).—FIG. 97,*8*. **X. klinostoma*, S.Finl.; *8a,b*, ×47 (Eisenack, 1970).

PSEUDOFOSSILS

This chapter deals with structures that in one way or another are suggestive of being "fossils," but are certainly or most probably of inorganic origin.

Concretions, clay galls, various trail-like markings, and even mud cracks and structures of diagenetic origin have been described and named as plant or animal fossils. Errors of this type occurred frequently when paleontology was a new field, but more recent examples may also be found (e.g., markings and structures of tectonic or diagenetic origin described by FUCINI (1936, 1938) from the Verrucano of Florence and published in two voluminous books accompanied by many plates). Such structures are best grouped under the name "pseudofossils" (Hofmann, 1971).

["Tonrollen" or clay rolls are cylindrical or cornet-shaped bodies of varying sizes that are formed when thin layers of clay break up and the fragments curl up in rolls during desiccation. Such bodies have frequently been mistaken for fossils, or at least as possible fossils. This subject has been discussed by VOIGT (1972a) who felt that "Tonrollen" could easily be mistaken for segments of an arthropod carapace. Examples would be "Protadelaidea howchini" TILLYARD (in DAVID & TILLYARD, 1936, p. 64) and the peculiar bedding plane structures from the Jotnian Sandstone in Sweden reported by LANNERBRO (1954). Recently, ELSTON and CLARK discovered "fossil-like objects" in the Precambrian of Arizona (Fig. 101). Their picture of one of the Arizona specimens on the cover of *Geotimes* (December, 1972) launched a lively discussion by GLAESSNER (1973a), CHOWNS (1973), TEICHERT (1973), and LINDSTRÖM (1973) who seriously doubted its organic origin, but ELSTON (written communication, July, 1973) suggested that a unique preservational situation occurred whereby the clay layers might have been covered by thin algal mats or films.—CURT TEICHERT & W. G. HAKES.]

Obviously, the names listed below are invalid. They are included here at the request of the Editor for their historical interest and for the sake of completeness. Naming of "type species" is, of course, unnecessary. Nevertheless, in those cases in which "type species" have been formally designated or in which the "genera" are "monospecific," they have been cited.

Recently HOFMANN (1971) has discussed, in detail, the Precambrian "macro-pseudofossil," Eozoon canadense. This name has no taxonomic status in paleontology. It is proposed that the existing name of such inorganic shapes be retained for discussion and summarization. Pseudofossils should continue to be identified but their names should not be printed in italics. Such names could be used as lithological terms such as oolite, styolite, and similar structures. Thus, MARTINSSON (1965) called a certain type of ripple mark "Kinneyan ripple marks," with reference to supposed algae described by WALCOTT (1914), under the "generic" name Kinneyia. In contrast, OSGOOD (1970, p. 388) rejected "quasilegal names for inorganic forms." They appear in his work, it is true, in italic print, but also in quotation marks.

FIG. 101. Casts of Precambrian pseudofossils in hyporelief from arkose member of Troy Quartzite, central Arizona, formed by curling and desiccation of a thin film of sediment, ×0.15 (from Geotimes, Dec. 1972; photo courtesy U. S. Geological Survey).

[It should be noted that, according to Art. 2(b) of the *International Code of Zoological Nomenclature*, formal names given to objects here regarded as pseudofossils, if originally described as animal remains, "continue to compete in homonymy with names in the animal kingdom," that is, they cannot validly be used again for animal taxa.—Ed.]

Aenigmichnus HITCHCOCK, 1865, p. 20 [*A. multiformis; M]. Parallel lines, commonly changing to rows of dots or to moniliform lines, covering wide spaces; highly variable. [Surely inorganic (markings of drifting or rolling bodies).] *Trias.*, USA(Mass.).

Aequorfossa NEVIANI, 1925, p. 148 [*A. farnesinae; M]. Pseudofossil, interpreted by NEVIANI (1925) as medusa; see KIESLINGER (1939) and HARRINGTON & MOORE, 1956e, p. *F*159. *U.Tert.* *(up.Plio.)*, Eu.(Italy).

Ammosphaeroides CUSHMAN, 1910, p. 51. See LOEBLICH & TAPPAN (1964), p. *C*786.

Anellotubulata WETZEL, 1967, p. 343 ("group"): see Mikrocalyx WETZEL, 1967, p. *W*176.

Antholithina CHOUBERT, TERMIER, & TERMIER, 1951, p. 28 [*A. rosacea; M]. Almost circular cross sections with radially disposed structures ("septa"), observed in thin sections. [Regarded by authors as calcareous algae. According to SCHINDEWOLF (1956, p. 468), grains with external covering of iron-oxyhydrate which in part has penetrated radially into the interior.] *Precam.*, Afr.(Morocco).

Archaeophyton BRITTON, 1888, p. 123 [*A. newberryanum; M]. Thin films of graphite lying parallel to bedding planes of limestones; at first regarded as "the most ancient plant yet discovered." *Precam.*, USA(N.J.).

Archaeospherina DAWSON, 1875, p. 139 [proposed without species name]. Small globular grains of serpentine distributed homogeneously throughout ophicalcite in highly metamorphic rocks, associated with Eozoon canadense. [Regarded by DAWSON as chamber fillings or germs or buds of Eozoon or as distinct organisms (Foraminifera?); for discussion see HOFMANN (1971, p. 12).] *Precam.*, N.Am.(Can.).

Aristophycus MILLER & DYER, 1878, p. 3 [*A. ramosum; M]. Branching structures; main "stem" dividing into secondary, tertiary and quaternary branches, forming a regular anastomosing raised pattern; main branches 2 to 6 mm. in diameter; secondary branches bifurcating consistently from main branch from below at angle of 30 to 60° off horizontal; preserved as convex epireliefs on the upper surface of the beds. [Described by MILLER & DYER (1878b) as a "fucoid"; interpreted by NATHORST (1881a), JAMES (1884, 1885), DAWSON (1888), and MILLER (1889) as inorganic ("mud washing," rill marks); by SEILACHER (1955, pers. commun.) as *"figures de viscosité"*; by OSGOOD (1970) as *incertae sedis* but probably inorganic (?"some form of diagenetic flow pattern"); a seemingly plausible explanation as rill marks is not possible owing to mode of preservation of pattern as convex epire-

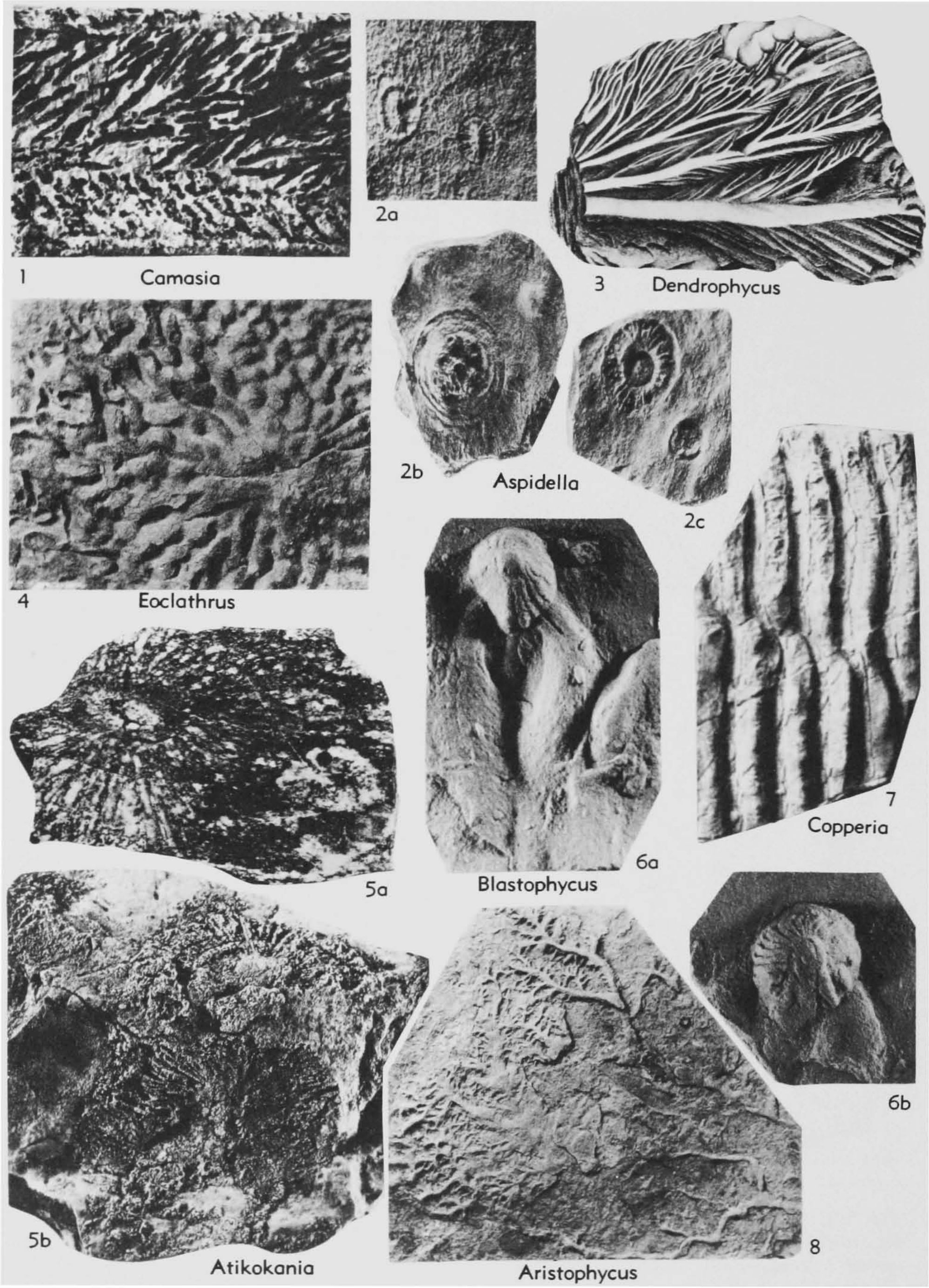

FIG. 102. Pseudofossils (p. W169-171, 173).

lief.] *U.Ord.(Cincinnat.),* USA(Ohio).——FIG. 102,*8*. *A. ramosum, Maysville beds, Cincinnati; convex epirelief, holotype, ×0.4 (Osgood, 1970).

Aspidella BILLINGS, 1872, p. 478 [*A. terranovica;

M]. Ovate structures, up to 3 by 4 cm. in size; rooflike ridge in central area of ellipse, with fine radial ridges and grooves extending to periphery; narrow ringlike border; mostly on bedding planes all oriented in one direction; having general aspect of small *Patella* flattened by pressure. [BILLINGS (1872) regarded Aspidella as fossil; MATTHEW (in PACKARD, 1898) interpreted it as slickensided mud concretions striated by pressure; WALCOTT (1899) and VAN HISE & LEITH (1909) were doubtful whether organic or inorganic; regarded by SCHINDEWOLF (1956) as inorganic and identical with Guilielmites GEINITZ; according to GOLDRING (1969), partly attributable to water- or gas-escape structures and interpreted by CLOUD (1968) as compaction and spall marks; according to HOFMANN (1971), inorganic, focused surfaces of rupture; for detailed discussion, complete summary of references, and various interpretations, see HOFMANN (1971, p. 16).] *Precam.*, N.Am. (Can., Newf.).——FIG. 102,*2*. *A. terranovica, St. John's F., Newf. (near St. John's); *2a-c*, ×1.3 (Hofmann, 1971).

Astrorhiza cretacea FRANKE, 1928, p. 7. Very small tubes, hollow, about 3 mm. long, 0.25 mm. in diameter, consisting of sandy particles bound together by calcareous cement. [Erroneously ascribed to agglutinated Cretaceous foraminifers from North Germany; same valid for "?Astrorhiza laguncula" (BORNEMANN, 1854) in FRANKE (1936, p. 11), from the "L.Jur." of North Germany; according to HILTERMANN (1952, p. 424), representing calcareous integuments around small roots of plants (German, *"Wurzel-Röhrchen"*).]

Atikokania WALCOTT, 1912, p. 17 [*A. lawsoni; OD] [=Attikokania METZGER, 1927, p. 6 *(nom. null.)*]. Pearshaped or cylindrical bodies, silicified in limestones, 3 to 35 cm. in diameter; with 1 or 2 "central cavities" and with radially arranged canals of irregular cross section and a concentric pattern of quartz in limestone. [At the time of its discovery Atikokania was regarded as the most ancient fossil, with varied interpretations: WALCOTT (1912a) compared it with a genus of Archaeocyatha and considered it related to sponges; ROTHPLETZ (1916, p. 73) regarded it as a lithistid sponge similar to *Aulocopium*; inorganic origin proposed by WALCOTT (1914), ABBOTT & ABBOTT (1914), SEWARD (1931), SCHINDEWOLF (1956), GLAESSNER (1962), CLOUD (1968) and others; for a complete list of references and summary of various interpretations see HOFMANN (1971, p. 26); according to HOFMANN (1971, p. 26), chemical, radial crystal growth, diffusion and replacement are involved; see also OKULITCH (1955, p. *E*20) and DE LAUBENFELS (1955, *E*33, *E*103).] *Precam.*, N.Am.(Can.).——FIG. 102,*5*. *A. lawsoni, Steeprock Gr., former Steep Rock Lake, Ont.; *5a,b*, ×1.7, ×1.3 (Hofmann, 1971).

Batrachoides HITCHCOCK, 1858, p. 121 [jr. hom.; *non* LACEPÈDE, 1800] [*B. nidificans; OD] [=Batrachioides WEIGELT, 1927; Batracoides ILIE, 1937, *nom. null.*]. Shallow contiguous pits on bedding planes; about 2.5 cm. wide, depth about 1 cm.; compared with similar Recent excavations made by small fishes and tadpoles (SILLIMAN, 1851; HITCHCOCK, 1858). [Reasonably explained by KINDLE (1914) as interference ripples; see *Benjaminichnus* BOEKSCHOTEN, 1964, p. *W*189.] *Sil.*, USA(N.Y.); *Trias.*, USA(Mass.).

Blastophycus MILLER & DYER, 1878, p. 24 [*B. diadematus; M]. Bilobate structure with a budlike attachment at larger end covering junction of branches. [Originally described as "fucoid"; regarded by NATHORST (1881a, p. 97) as probably inorganic in origin; interpreted as cast of an enrolled trilobite associated with scour markings ("current crescent casts" POTTER & PETTIJOHN, 1964) by OSGOOD (1970, p. 390), whose explanation was based on laboratory experiments with *Flexicalymene* specimens; this "fossil," thus, is part body fossil, part inorganic.] *U.Ord.(Cincinnat.)*, USA(Ohio).——FIG. 102,*6*. *B. diadematus, Eden Gr., Cincinnati; *6a,b*, ×1, ×1.2 (Osgood, 1970).

Camasia WALCOTT, 1914, p. 115 [*C. spongiosa; OD]. Cross sections of compact layerlike bodies of spongioid appearance, numerous irregular tubelike openings. [Regarded as algae by FENTON & FENTON (1936); comparable structures from the Permian of England convincingly proved by HOLTEDAHL (1921) to be inorganic in origin; according to SCHINDEWOLF (1956), most probably diagenetic structures.] *Precam.(Belt Ser.)*, N.Am.(USA, Mont.), *Perm.*, Eu.(Eng.).——FIG. 102,*1*. *C. spongiosa, Belt Ser. (Newland Ls.), USA(Mont.); vert. sec., ×0.4 (Walcott, 1914).

Cayeuxina GALLOWAY, 1933, p. 156. See LOEBLICH & TAPPAN (1964), p. *C*786.

Chloephycus MILLER & DYER, 1878, p. 3 [*C. plumosum (=Buthotrephis filciformis U. P. JAMES, 1878, p. 9); M] [=Cloephycus DAWSON, 1888, p. 33; *nom. null.*]. Featherlike pattern; "stem" (0.5-5 mm. wide) with fine "filaments" issuing from it at angle of 20 to 30°. [Originally described as "fucoid," but doubtlessly inorganic as recognized by J. F. JAMES (1884), who described the form as "nothing more than a mark or series of marks . . . produced by the running of water down a sloping bank," and by NATHORST (1881a) and DAWSON (1888) (rill marks); according to OSGOOD (1970), modified groove casts.] *U.Ord.(Cincinnat.)*, USA(Ohio).——FIG. 103,*5*. C. plumosum, Eden Gr., Cincinnati; ×0.94 (Osgood, 1970).

Chondrus(?) binneyi KING, 1850, p. 2. Circular structures, irregularly scattered, each about 2 mm. in diameter, in form of raised ring with central depression. [Originally interpreted by KING as of plant origin; inorganic, according to STONELEY (1958, p. 332), comparable to pit and mound structures.] *U.Perm.*, Eu.(Eng.).

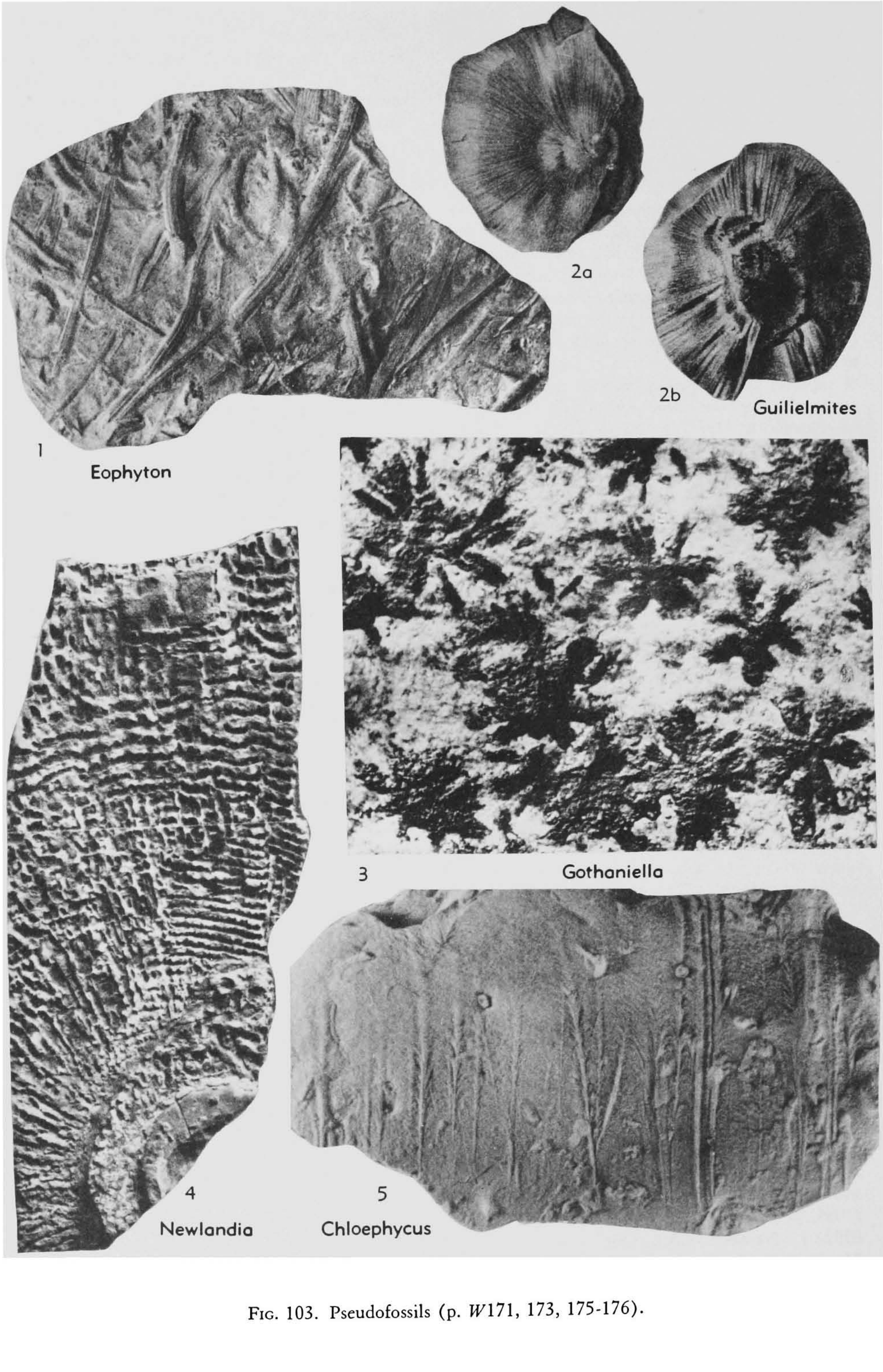

FIG. 103. Pseudofossils (p. W171, 173, 175-176).

Collinsia Bain, 1927, p. 282 [*C. mississagiense; M]. Structure composed of quartz and sericite containing series of ellipsoids consisting of sericitized clay cemented by silica; irregularly grouped around a layered core of oval cross section; walls reputedly showing "cellular structure" [not observed by Hofmann, 1971, p. 29]; found in massive quartzite; similar structures described as *Vallenia* Pedersen, 1966. [Interpreted as colonies of algal cells; according to Hofmann (1971, p. 29) inorganic, "chemical."] *Precam.,* N.Am. (Can.).

Copperia Walcott, 1914, p. 109 [*C. tubiformis; OD] [=Cooperia Choubert, Termier & Termier, 1951 *(nom. null.)*]. Differs from Greysonia Walcott, 1914, in greater irregularity of "growth" and more nearly cylindrical nature of tubes. [According to Fenton & Fenton (1936), identical with Greysonia and both "genera" of inorganic origin; C. ?minima Choubert, Termier, & Termier, 1951, from the Precambrian of Morocco described as calcareous alga; according to Schindewolf (1956), type "species" and African "species" originated by diagenetic and tectonic processes.] *Precam.,* USA(Mont.)-?N.Afr. (Morocco).——Fig. 102,*7*. *C. tubiformis, Belt Ser.(Newland Ls.), Mont.; surface of group of tubes formed in horiz. position, ×0.7 (Walcott, 1914).

Ctenichnites Matthew in Selwyn, 1890, p. 147 [no species named]. Straight and parallel striae in sets interfering with each other; very similar to glacial striae. [Inorganic; for discussion see Hofmann (1971, p. 20); interpreted by him as perhaps a combination of tool and flute marks.] *Precam.-Cam.,* N.Am.(Can.).

Cupulicyclus Quenstedt, 1879, p. 577 [no species designated]. Pressure cone, recognized as inorganic by Quenstedt himself. *M.Trias.(Muschelkalk)-L.Jur., Tert.,* Eu.(Ger.).

Cyathospongia(?) eozoica Matthew, 1890, p. 42. Needles interpreted as sponge spicules [Rauff (1893) expressed strong doubt about affinity with sponges; according to Cloud (1968), "probably crystals"; for discussion see Hofmann (1971, p. 21).] *Precam.,* N.Am.(Can., N.B.).

Dendrophycus Lesquereux, 1884, p. 699 [*D. desorii; M]. Characteristic featherlike patterns of long straight, branching ridges, closely spaced, dichotomous, anastomosis lacking, organic material absent. [Originally described as sea weeds (Lesquereux, 1844; Newberry, 1888, 1890), interpreted as rill marks (Dawson, 1888, 1890; James, 1889, Seward, 1898, Fuchs, 1894a, and Lull, 1915); more recent interpretation as "dendritic surge marks" by High & Picard (1968).] *Carb.-Trias.,* N.Am.(USA-Can.).——Fig. 102,*3*. D. triassicus Newberry, U.Trias., Conn.; *?ca.* ×0.2 (Newberry, 1888).

Dexiospira Ehrenberg, 1858, p. 309 (*non Dexiospira* Caullery & Mesnil, 1897). [Two species, no type species designated]. "Fossil" preserved as ?glauconite grains. [According to Loeblich & Tappan (1964, p. *C*786), inorganic (small concretionary bodies).] *?L.Sil.,* USSR.

Dinocochlea Woodward, 1922, p. 246 [*D. ingens; M]. Very large horizontal bodies, spirally twisted to right or left. [Erroneously described as gastropod steinkerns (Woodward, 1922); interpreted by Thomas (1935) as spiral concretion.] *L.Cret.,* G.Brit.(Eng.).

Dystactophycus Miller & Dyer, 1878, p. 2 [*D. mamillanum; M]. Resembling a small truncated cone, composed of flattened rings, larger ones overlapping smaller ones. [Originally described as alga; interpreted by Nathorst (1881a) as inorganic in origin; according to James (1884), impression of coral base that left its mark in concentric rings; explained by Osgood (1970) as casts of markings made by sweeping crinoid stems.] *U.Ord.,* USA(Ohio).——Fig. 104,*2*. *D. mamillanum, Richmond beds, loc. unknown; ×0.5 (Osgood, 1970).

Eoclathrus Squinabol, 1887, p. 552 [*E. fenestratus; M]. Irregular, elongate, ridgelike structures nearly parallel to each other. [Originally described as alga (e.g., E. insignis Fucini, 1936); doubtlessly of inorganic origin (markings on bedding planes).] *L.Dev., ?L.Perm., Tert.,* Eu. (Italy)-N.Afr.——Fig. 102,*4*. E. balboi Desio, L.Dev., N.Afr.; ×0.3 (Desio, 1940).

Eophyton Torell, 1868, p. 36 [*E. Linnaeanum; M] [=Rabdichnites Dawson, 1873 *(partim)*; Rhabdichnites Dawson, 1888 *(nam. van.)*; Eoichnites Matthew, 1891, p. 148 *(nom. van.)*; Aspidiaria silurica Vlček, 1902]. Straight, parallel or curved drag markings on bedding planes, produced by organisms or inorganic objects. [Originally interpreted as plant origin (monocotyledons); eponymous for the Lower Cambrian Eophyton Ss. of Sweden; for short description of various interpretations, see Kieslinger, 1939.] *Precam.-Rec.,* cosmop.——Fig. 103,*1*. E. sp., L. Cam.(*Mickwitzia* Ss.), Swed.; ×0.3 (Regnéll, 1962).

Eopteris morierei de Saporta, ?1878. "Fossil" similar to *Cardiopteris* Schimper; according to Gothan (1909) a ferric sulphide dendritic marking; description of "genus" and "species" not found. *Ord.,* Eu.(France).

Eospicula de Laubenfels, 1955, p. *E*33 [*E. cayeuxi; M]. Needles resembling spicules of calcisponges; lumpy and crooked. [Believed by Cayeux (1895) to be sponge; certainly inorganic in origin as shown by Rauff (1896) and Schindewolf (1956).] *Precam.,* Eu.(France).

Eozoon Dawson, 1865, p. 54 [*E. canadense; M] [=Eophyllum Hahn, 1880, p. 71 *(nom. van.)*]. Banded structures of coarsely crystalline calcite and serpentine. [Originally interpreted as gigantic Foraminifera; doubtlessly inorganic; for detailed discussion of 5 various types differing by texture

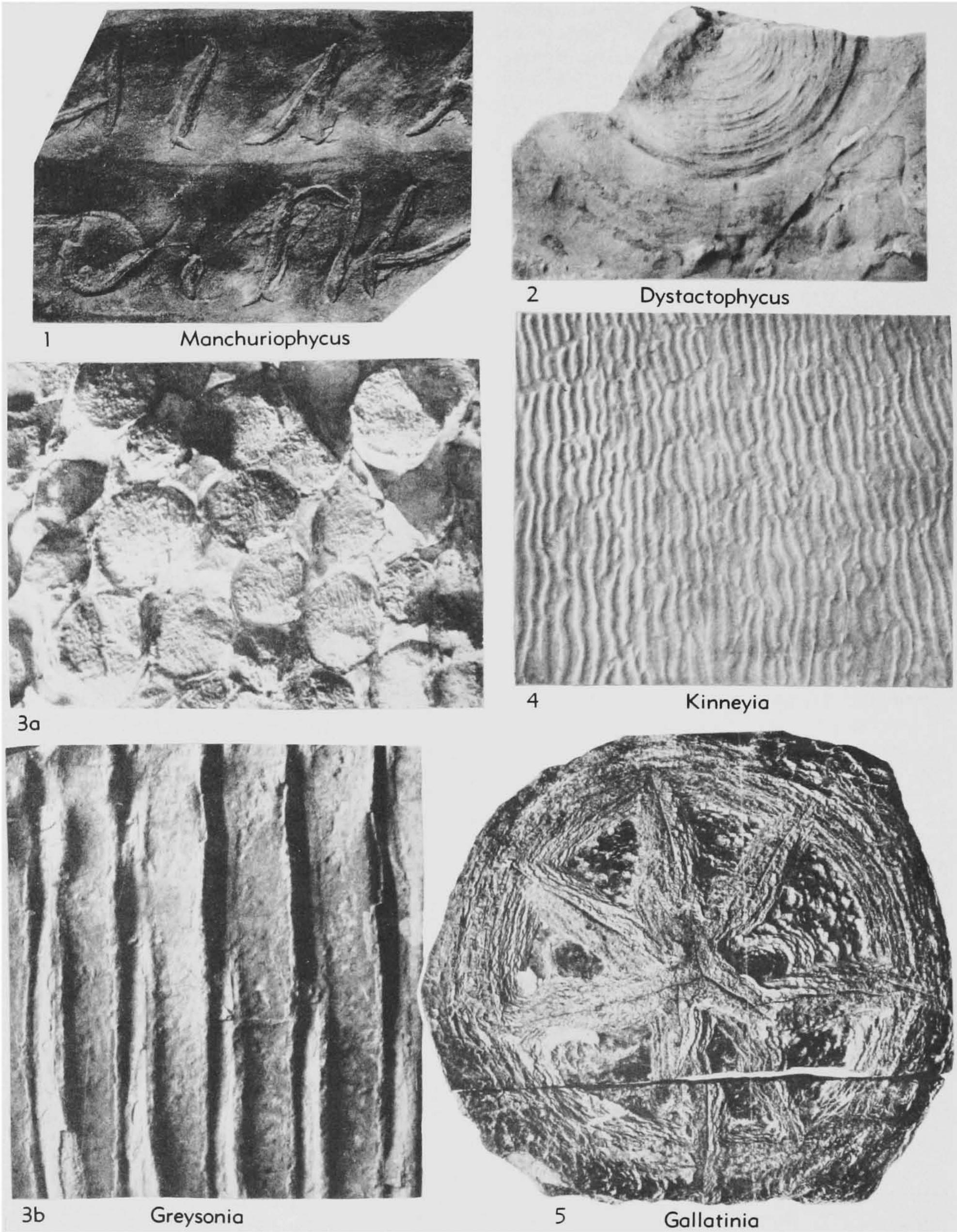

FIG. 104. Pseudofossils (p. W173, 175-176).

and mineral assemblage due to different metamorphic facies see HOFMANN (1971, p. 6); for a thorough historical summary of Eozoon papers see HOFMANN (1971, p. 6, fig. 4, pl. 1,2).] *Precam.*, N.Am.(Can.).

Flabellaria johnstrupi HEER, 1883, p. 70. Ripple marks, according to SCHENK (1890), not palm leaves as believed by HEER. *Tert.*, Greenl.

Forchhammera GÖPPERT, 1860, p. 438 [*F. silurica; M]. Originally interpreted as alga; according to C. POULSEN and A. ROSENKRANTZ (pers. commun. to HÄNTZSCHEL, 1956), inorganic;

now interpreted as probably dendritic markings. *L.Ord.*, Eu.(Denm., Bornholm).

Gallatinia WALCOTT, 1914, p. 116 [*G. pertexa; OD]. Discoid, flattened, circular "fossil" (20 cm. in diameter), with several raylike "arms" more or less irregularly arranged. [Originally described as of plant origin; according to RAYMOND (1935) and SCHINDEWOLF (1956), inorganic, to be interpreted as separation concretion.] *Precam.*, USA (Mont.).——FIG. 104,*5*. *G. pertexa, Belt Ser. (Newland Ls.); upper surface, ×0.3 (Walcott, 1914).

Gloeocapsomorpha tazenakhtensis CHOUBERT, TERMIER, & TERMIER, 1951, p. 30. "Organisms" observed in thin sections of limestones; interpreted as calcareous algae. [According to SCHINDEWOLF (1956), certainly inorganic structures produced by combination of tectonic movements and metamorphic recrystallization.] *Precam.*, Afr.(Morocco).

Gothaniella FUCINI, 1936, p. 69 [*G. sphenophylloides; M]. Small rosettes, occurring together with bigger and more pronounced ones called Sewardiella FUCINI, 1936. [Interpreted by FUCINI (1936) as algae, by SACCO (1940) as *?Sphenophyllum*; according to PIA (1937) and GOTHAN (1942), doubtlessly inorganic.] *L.Cret.("Verrucano")*, Eu. (Italy).——FIG. 103,*3*. *G. sphenophylloides, Verrucano, Italy; ×2 (Fucini, 1936).

Grammichnus HITCHCOCK, 1865, p. 19 [*G. alpha; M]. Series of elongate impressions, repeated serially. [According to HITCHCOCK (1865), origin doubtful; interpreted by BROWN (1912) and LULL (1915) as probably roll or drag markings.] *Trias.*, USA(Mass.).

Greysonia WALCOTT, 1914, p. 108 [*G. basaltica; OD]. Large "tubes," irregularly rhomboidal or pentagonal in cross section; ends of group of "tubes" similar to group of very small basaltic columns. [Originally described as alga; very similar forms from Permian of England discussed by HOLTEDAHL (1921) and considered inorganic in origin; according to RAYMOND (1935), shrinkage cracks; interpreted by FENTON & FENTON (1936) as results of segregation of $CaCO_3$ and dolomite by percolating water; according to SCHINDEWOLF (1956), partly resembling ripples transformed by tectonic and diagenetic processes.] *Precam.*, USA(Mont.); *Perm.*, Eu.(Eng.).——FIG. 104,*3*. *G. basaltica, Precam.(BeltSer., Newland Ls.), USA(Mont.); *3a*, view of end of tubes, ×0.7; *3b*, sec. of mass of basalt-like columns, ×0.7 (Walcott, 1914).

Guilielmites GEINITZ, 1858, p. 19 [no type species designated] [=Calvasia sp. VON STERNBERG, 1820; Carpolites umbonatus VON STERNBERG, 1825; Cardiocarpum umbonatum BRONN, 1837; Carpolites clipeiformis GEINITZ, 1856; Gulielmites QUENSTEDT, 1867, *nom. null.*; Gulielmites DAWSON, 1873 *(nom. null.)*; ?Gaussia CHACHLOF, 1934 *(partim)*; ?Gaussia NEUBURG, 1934; Guilelmites FUCINI, 1936 *(nom. null.)*; Verrucania FUCINI, 1936]. Discoidal or ellipsoidal bodies, 1 to 5 cm. in diameter, with central depression or raised middle part; surface shining, weakly radially striated; occurring only in very fine-grained sediments such as shales and similar rocks. [Many different interpretations (fruits or seed of plants; especially palms; cones of conifers or *Araucaria*; concretions; diagenetic structures; burrows of pelecypods or soft-bodied animals) have been completely discussed in detail by ALTEVOIGT (1968b), who explained Guilielmites as the result of a special kind of slipping in the rock. He described it as a round or oval plastic clay body originated by rolling movement around a nuclear body of plant or animal origin which was compressed during diagenesis to the final discoidal or ellipsoidal shape, interpreting the weak striation on surface as slickensides. Disc-like objects with fine radiating ridges have been described by WEBBY (1970c) who rejected a slickenside origin for them.] *Carb.-Tert.*, Eu.-Am.-Asia-Australia.——FIG. 103,*2*. G. umbonatus (VON STERNBERG), L.Perm., Ger.; *2a,b*, ×1 (Geinitz, 1856).

Halichondrites graphitiferus MATTHEW, 1890, p. 43. Long, thin "spicules" in graphitic shales and graphite lenses. [Interpreted by MATTHEW as sponge spicules; regarded by RAUFF (1893) as inorganic (systems of striae on graphite flakes?); according to CLOUD (1968), probably crystals; for other interpretations as crystal striations on cleavage planes or scratch markings or striations made by mineral impurities, see HOFMANN (1971, p. 22).] *Precam.*, Can.(N.B.).

Halleia FUCINI, 1936, p. 81 [*H. penicillata; M]. Not of plant origin; certainly inorganic; probably very slender flow markings. *L.Cret.("Verrucano")*, Eu.(Italy).

Hirmeria FUCINI, 1936, p. 103 [*H. notabilis; M]. Small parallel wrinkles, somewhat resembling Eoclathrus SQUINABOL, 1887; doubtlessly inorganic. *L.Cret.("Verrucano")*, Eu.(Italy).

Hurdia ?davidi CHAPMAN, 1926, p. 79. Reexamination of this supposed phyllocarid by BANKS (1962) proved it to be marking of tectonic origin. *Cam.*, Australia(Tasmania).

Interconulites DESIO, 1941, p. 83. Suggested as international name for cone-in-cone structures.

Kempia BAIN, 1927, p. 281 [*K. huronense; M]. Structures composed of rhythmic, curved, and regularly branching laminae of silica and less resistant weathering material; between resistant laminae to a pattern of "cellular" structure (fine tubuli or platelets, 0.2 mm. wide); observed in massive quartzite or argillite; somewhat similar to Newlandia WALCOTT. [Structures originally regarded as walls of colonial organisms, partly resembling stromatoporoids; according to HOFMANN (1971, p. 29), physiochemical phenomenon with diffusion banding resulting from rhythmic precipitation.] *Precam.,* N.Am.(Can.).

Kinneyia WALCOTT, 1914, p. 107 [*K. simulans; OD]. Reliefs reminiscent of very small ripple marks; 1 to 3 mm. wide, approximately parallel; similar to *Furchensteine* (furrow-stones) or corroded limestone flags. [Originally described as algae; regarded by RAYMOND (1935) and FENTON & FENTON (1936) as inorganic in origin; according to SCHINDEWOLF, probably ripplemarks, perhaps somewhat deformed by diagenetic or tectonic processes; Kinneyia dubia and K. labyrintica DESIO (1940) from the Lower Devonian of North Africa certainly of inorganic origin; generic name has been used adjectively by MARTINSSON (1965) for characterizing minute ripplelike structures observed in the Cambrian of Sweden ("kinneyian ripples").] *Precam.,* USA(Mont.); *Cam.,* Eu. (Swed.); *?Sil.,* N.Afr.——FIG. 104,*4*. *K. simulans, Precam.(Belt Ser., Newland Ls.), USA (Mont.); upper surface, ×0.7 (Walcott, 1914).

Kraeuselia FUCINI, 1936, p. 82 [*K. verrucana; M]. Narrow, long, tapering swellings, apparently screwshaped, twisted. [Inorganic.] *L.Cret.("Verrucano"),* Italy.

Lithodictuon CONRAD, 1837, p. 167 [*L. beckii; M] [=Dictuolites CONRAD, 1838 *(nom. van.)*; Dictyolites DAWSON, 1888 *(nom. null.)*]. Mud cracks, at first interpreted as plants. [Plant origin first questioned by HALL (1852).] *Sil.,* USA(N.Y.).

Manchuriophycus ENDO, 1933, p. 47 [*M. yamamotoi; OD]. Shrinkage cracks, in part (e.g., M. yamamotoi, M. inexpectans) in normal form of polygons. [Erroneously interpreted by ENDO (1933) as fillings of soft cylindrical stems of algae; explained by LEE (1939) as worm burrows; M. sawadai YABE (1939) and M. sibiricus MASLOV (1947) are flexuous or even curved spindleshaped sand-bodies with tapering ends, occurring mostly in troughs of simple or interference ripples; M. sawadai regarded by YABE (1939) as cylindrical organism without hard external crust *(inc. sed.),* and M. sibiricus interpreted by MASLOV (1947, 1956) with some doubt as of plant origin. All curved forms according to HÄNTZSCHEL (1949) are sinusoidal contraction cracks; the same or similar structures have repeatedly been described (not all being named Manchuriophycus) from sediments of various ages; more recent papers (discussion in SCHINDEWOLF, 1956) are mostly in agreement with HÄNTZSCHEL (1949) as inorganic in origin, partly as organic (even metazoan) in origin; for later descriptions and discussions of such structures, see FAREY & MCLAREN (1963), BARNES & SMITH (1964), YOUNG (1967), HOFMANN (1967), DONALDSON (1967), LAUERMA & PIISPANEN (1967), CLOUD (1968), GLAESSNER (1969).] *Precam.-Trias.,* Eu.-Asia-N.Am.-Greenl.——FIG. 104,*1*. M. sawadai YABE, Precam., Asia; ×0.4 (Yabe, 1939).

Matthewina GALLOWAY, 1933, p. 157. See LOEBLICH & TAPPAN (1964), p. C786.

Medusichnites MATTHEW, 1891, p. 143 [No species named] [=Taonichnites MATTHEW in SELWYN, 1890, p. 146]. Group of striae, more or less parallel; converging from furrowed margin. [Interpreted by MATTHEW as drag markings made by numerous tentacles of medusoid; doubtlessly inorganic; regarded by HOFMANN (1971, p. 19), particularly "Medusichnites Form γ" MATTHEW, 1891, as sole markings; similar structures reproduced in the laboratory; for discussion see HOFMANN, 1971, p. 20.] *Precam.,* N.Am.(Can.).

Membranites FUCINI, 1938, p. 216 [Three "species," no "type species" designated]. Probably inorganic. *L.Cret.("Verrucano"),* Eu.(Italy).

Mikrocalyx WETZEL, 1967, p. 344 [*M. pullulans *forma* syringata; OD]. Very small cylindrical tubes of chitin-like or calcareous material, finely annulated, about 250 microns long, 50 microns thick; "anterior" end funnel-shaped, expanding, "posterior" end open and bent like a hook; found only in fragments; "varieties" very heterogeneous; many "formae" distinguished. [Originally interpreted to possibly have been parts of some larger organisms settling in colonies; "genus" representative of WETZEL's "group" Annellotubulata (p. *W*169); similar forms have been described from the Ecca Series by MCLACHLAN (1973) who considered that they formed inorganically (McLACHLAN, written commun. to W. G. HAKES, 1973). Recently PICKETT & SCHEIBNEROVA (1974, p. 100) described "anellotubulates" resulting from reaction of hydrogen peroxide with certain iron minerals. An inorganic origin has also been described by RICHARDSON *et al.* (1973).—W. G. HAKES.] *Perm.,* S.Afr.; *L.Jur.(up.Lias.),* Eu.(N. Ger., from boreholes in Holstein).

Neantia LEBESCONTE, 1887, p. 786 [Four "species," no "type species" designated]. Wrinklelike structures. [Interpreted by LEBESCONTE as sponge; organic origin first doubted by DEWALQUE (1887); according to SEILACHER (1956), rill marks or ripplemarks; regarded by CLOUD (1968) as ripplemarks.] *Precam.,* Eu.(France).——FIG. 105,*2*. N. rhedonensis LEBESCONTE; ×0.8 (Lebesconte, 1887).

Newlandia WALCOTT, 1914, p. 104 [*N. frondosa; OD]. Irregular hemispherical or bowl-shaped bodies; diameter up to 80 cm.; consisting of concentric, subparallel, subequidistant layers; similar to *Collenia* or *Cryptozoon.* [Interpreted as algae by WALCOTT (1914), FENTON & FENTON (1936), and EDGELL (1964); according to PIA (1936) (describing and discussing similar Triassic specimens from Spain called "Newlandien"), inorganic in origin (rhythmical precipitates); other similar forms found by HOLTEDAHL (1921) in Permian of England and explained as inorganic structures;

regarded by Schindewolf (1956) and Glaessner (1962, p. 471) as formed by diagenetic processes.] *Precam.,* USA(Mont.)-W.Australia; *Perm.,* G.Brit. (Eng.); *Trias.,* Eu.(Spain).——Fig. 103,*4.* *N. frondosa, Precam. (Belt Ser., Newland Ls.), USA (Mont.); upper surface, large frond, ×0.5 (Walcott, 1914).

Nipterella paradoxica Hinde, 1889, p. 144 [=Calathium paradoxicum Billings, 1865, p. 358]. Regarded by Billings (1865) and several later authors as sponge; on reexamination of holotype, Nitecki (1968) recognized this form as a cherty concretion riddled with dendrites of pyrolusite; see also Nitecki's list of synonyms. *L.Ord.,* N. Am.(E.Can.).

Palaeotrochis Emmons, 1856 [Two "species," no type species designated]. Double cone, with grooved surface; cones juxtaposed base to base. [Regarded by Emmons (1856) as a coral ("the oldest organic body yet discovered"); according to Hall (1857), "nothing but concretions"; compared by Marsh (1868) with cone-in-cone-structures; interpreted by Diller (in Walcott, 1899) as biconical spherulites in an acid volcanic rock.] *Precam.,* USA(N.Car.).——Fig. 105,*1a,b,e.* P. minor; mag. unknown (Emmons, 1856).——Fig. 105,*1c,d,f.* P. major; mag. unknown (Emmons, 1856).

Palmacites martii Heer, 1855, p. 97 [=Palmanthium martii Schimper, 1870, p. 506]. "Fossil," interpreted by Heer (1855) as ?fruit or flower of a palm; according to Schimper & Schenk (1885), most probably inorganic. [Found in molasse deposits.] *U.Tert.,* Eu.(Switz.).

Panescorsea de Saporta, 1882, p. 25 [*P. glomerata; M] [=Panescorsaea Fuchs, 1895; Panescorea Andrews, 1955 *(nom. null.)*]. Long parallel ridges on bedding planes. [Erroneously explained by de Saporta as seaweed; interpreted as of inorganic origin by Newberry (1885), Nathorst (1886) and Fuchs (1895) (ripple marks or a special kind of current marks or flute casts).] *Cret.-Tert.,* Eu.(France-Italy).

Phyllitites Fucini, 1936, p. 78 [*P. rugosus; M]. Markings on bedding planes, certainly inorganic. [Erroneously explained as of plant origin.] *L. Cret.("Verrucano"),* Eu.(Italy).

Phytocalyx Bornemann, 1886, p. 13 [*P. antiquus; M]. Structureless conical or hemispherical bodies. [Originally regarded as algae; according to Hinde (1887), inorganic concretions or fillings of burrows.] *Cam.,* Eu.(Italy, Sardinia).

Piaella Fucini, 1936, p. 95 [*P. biformis; M]. Doubtlessly inorganic, not of plant origin as suggested by Fucini, 1936. *L.Cret.("Verrucano"),* Eu.(Italy).

Polygonolites Desio, 1941, p. 81. Suggested as international designation for mud cracks.

Protadelaidea Tillyard in David & Tillyard, 1936, p. 64 [*P. howchini; OD] [=Protoadelaidea Seilacher, 1956 *(nom. null.)*]. Fragments in

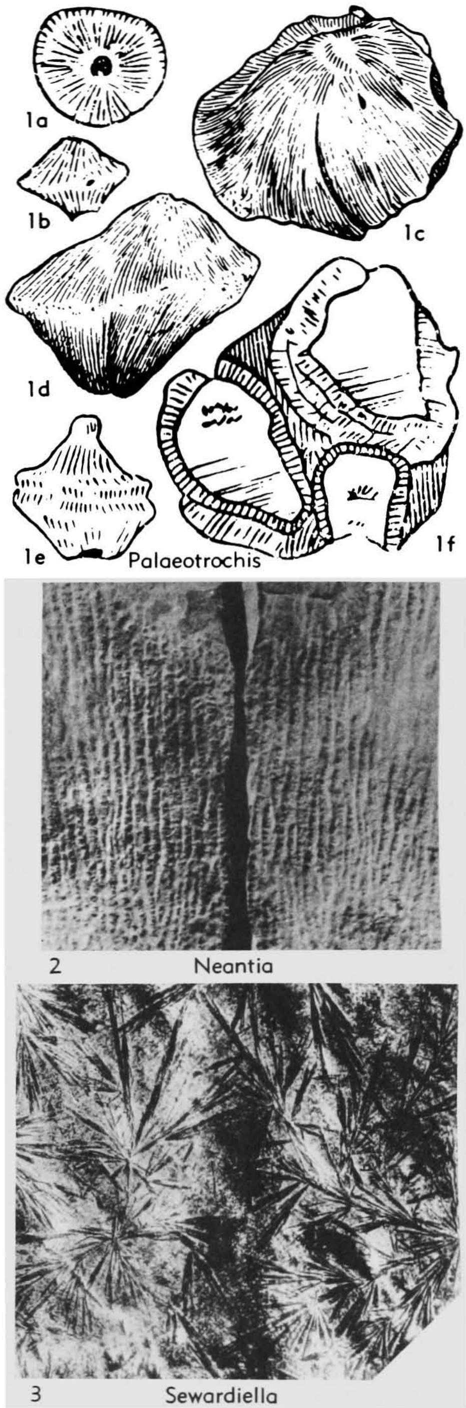

Fig. 105. Pseudofossils (p. *W*176-177, 179).

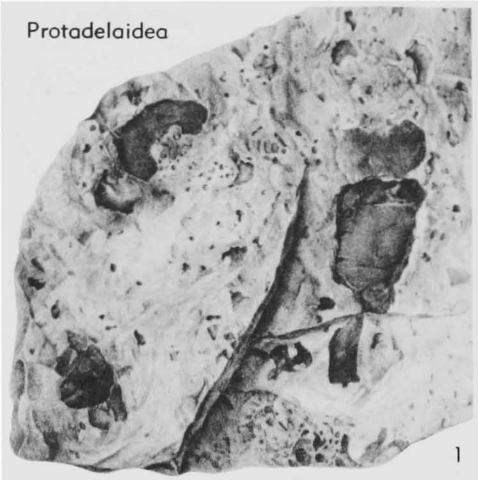

FIG. 105A. Pseudofossils (p. *W*177-178).

form of ochreous to black crusts in quartzites, with vaguely regular outlines. [Erroneously believed to represent body segments of giant arthropods; doubtlessly inorganic in origin as interpreted by TEICHERT in HUPÉ (1952), especially for very similar forms from the Precambrian of Morocco (mud flakes or flattened clay pellets); same opinion held by SCHINDEWOLF (1956), SEILACHER (1956), and CLOUD (1968); according to GLAESSNER (1959b), possibly formed also by pyritized soft plant tissue.] *Precam.(Adelaide System),* S. Australia.——FIG. 105A,*1*. *P. howchini; ×0.45 (David, 1950).

Pseudopolyporus HOLLICK, 1910 [*P. carbonicus; M]. "Fossil" closely resembling fungus (especially *Polyporus*) and originally described as such; according to PIA (1927), probably inorganic (concretion). *Penn.,* N.Am.(USA,W.Va.).

Reynella DAVID, 1928, p. 200 [*R. howchini; M]. Small fragments of exceedingly irregular shape. [Erroneously explained by DAVID (1922, 1928) as belonging to problematical crustaceans; according to GLAESSNER (1959b, p. 525) not recognizable as animal remains, certainly inorganic; interpreted by CLOUD (1968) as mud flakes.] *Precam.(Brighton Ls.),* S.Australia.

Rhysonetron HOFMANN, 1967, p. 504 [*R. lahtii; OD]. Long curved cylindrical rods or spindles, vermiform, rarely with branchings; occasionally with faint, distinctly oblique crescentic corrugations along sides; distinct median longitudinal markings; end of spindles tapering; largest specimen 14 cm. long, 7 mm. wide; constant in morphology; preserved as sand casts in troughs of ripple marks; cleanly separated from matrix. [Originally regarded as Metazoa of unknown systematic position, compared with tubes of modern annelids; interpreted by DONALDSON (1967) as originating through deformation of an algal mat; recently explained by HOFMANN (1971, p. 39) as diagenetic structure resulting from shrinkage crack filling modified by compaction and injecting processes followed by impression into substrate and superstrate, passing through a Manchuriophycus stage to the final Rhysonetron stage; similar structures observed in Precambrian quartzites in Finland (LAUERMA & PIISPANEN,

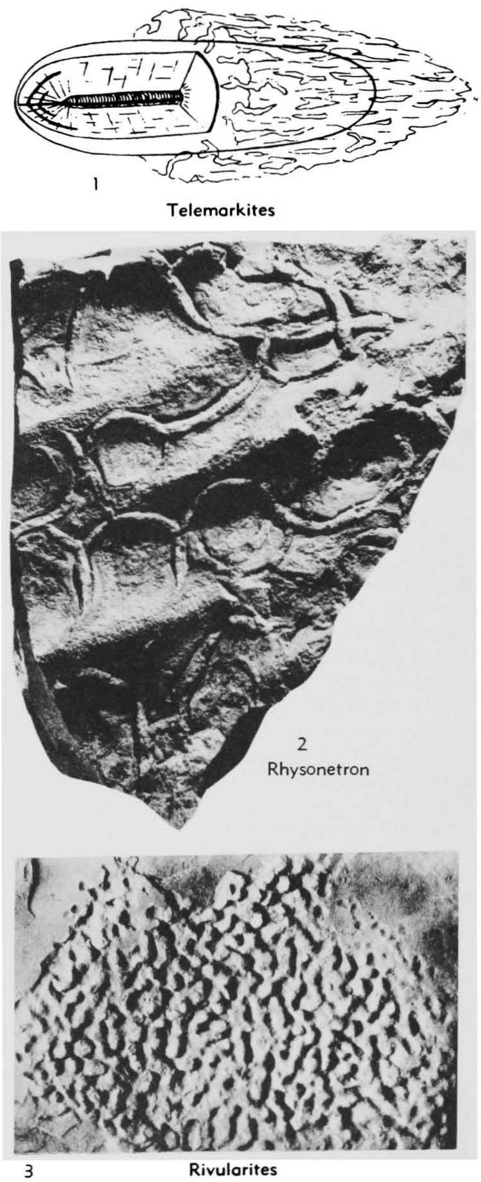

FIG. 106. Pseudofossils (p. *W*178-179).

1967).] *Precam.*, N.Am.(Can.).——FIG. 106,*2*. *R. lahtii, Huron.(Bar River F.), Ont.(Flack Lake); ×0.3 (Hofmann, 1971). [Courtesy Geol. Survey Canada, Photo 200446-B.]

Rivularites FLICHE, 1906, p. 46 [*R. repertus; M]. Type species (U.Trias., Lorraine) rather unrecognizable, pustulated surfaces of bedding planes?; neither holotype nor other specimens of type could be located. [Erroneously explained by FLICHE (1906) as algal in origin; American "species" R. permiensis WHITE (1929) (Hermit Shale, Ariz.) interpreted as alga, but bedding plane features doubtlessly inorganic in origin, very similar to mud flow markings; compared by C. L. FENTON (1946) with small symmetrical ripple marks; very similar pitted surfaces of bedding planes of dolomite (L. Trias., W.Pakistan) compared by KUMMEL & TEICHERT (1970) with Rivularites and interpreted as systems of capped interference ripples or as wrinkle marks (German, *Runzelmarken*) by TEICHERT (1970).] *Perm.*, USA (Ariz); *U.Trias.(Keuper)*, Eu.(France).——FIG. 106,*3*. R. permiensis WHITE, Perm.(Hermit Sh.), Ariz.; ×0.34 (White, 1929).

Rutgersella JOHNSON & FOX, 1968, p. 119 [*R. truexi; OD]. Bell shaped, elliptical to nearly round, strongly bilaterally symmetric structure (5 to 10 cm.) divided by a prominent "dorsal" ridge from which radiate numerous (40 to 52) convex segments; "lappets" occur around margin. [Originally considered a dipleurozoan and assigned to the family Dickinsoniidae by the authors; undoubtedly inorganic, considered by CLOUD (1973, p. 125) as the imprints of spokelike, radiate growths of pyrite which grew under pressure and prior to the lithification of the sediment.] *L.Sil.*, N.Am.(Pa.). [Description supplied by W. G. HAKES.]

Schafferia FUCINI, 1938, p. 133 [*S. verrucana; M]. Apparently markings on bedding planes [Originally interpreted as of plant origin.] *L. Cret.("Verrucano")*, Eu.(Italy).

Sewardiella FUCINI, 1936, p. 47 [*S. verrucana; M] [=Baieropsis (?)verrucana FUCINI, 1928, p. CVII (*non Baieropsis* FONTAINE, 1889, p. 205, a plant)]. Sharply stamped impressions of rosettes on bedding planes resembling *Annularia* or tiny palm branches or fans. [Originally interpreted by FUCINI (1928, 1936) as algae and by SACCO (1940) as belonging to Sphenophyllales, doubtlessly molds of radiate crystal aggregates (?gypsum, ?ice) as recognized by GOTHAN (1933, 1942), HÄNTZSCHEL (1935b), REDINI (1938), VON HUENE (1941).] *L.Cret.("Verrucano")*, Eu. (Italy).——FIG. 105,*3*. *S. verrucana; *ca.* ×0.8 (Fucini, 1936).

Sickleria MÜLLER, 1846, p. 83 [*S. labyrinthiformis; M]. Originally regarded by RÜPPELL (1845) and MÜLLER (1846) as plants, but immediately after MÜLLER's publication recognized by SCHIMPER (1846) as shrinkage cracks in sandstone. *L.Trias.(Buntsandstein)*, Eu.(Ger., Thuringia).

Sidneyia groenlandica CLEAVES in CLEAVES & FOX, 1935, p. 485. Somewhat distorted and poorly preserved "fossil" originally interpreted as abdominal region of an arachnid of Middle Cambrian age. [According to EHA (1953, p. 15-16), of Precambrian age and probably a group of damaged ripplemarks partly removed by erosion; regarded by SCHINDEWOLF (1956) as "at least very uncertain fossil."] *Precam.*, E.Greenl.

Spirocerium EHRENBERG, 1858, p. 310 [*S. priscum; M]. "Microfossil," according to LOEBLICH & TAPPAN (1964, p. C786), inorganic, globular mass of ?glauconite. *?L.Sil.*, USSR.

Stylolithes KLÖDEN, 1828, p. 58 [*S. sulcatus; M]. Regarded by KLÖDEN as problematical fossil; actually stylolites. ("Genus" described from *M. Trias.(Muschelkalk)*, Eu.(Ger.).

Tazenakhtia CHOUBERT, TERMIER & TERMIER, 1951, p. 31 [*T. aenigmatica; M]. "Organisms" observed in thin sections of limestones. [Interpreted as questionable foraminifers, but also compared with calcareous algae (*Nubecularites* MASLOV); according to SCHINDEWOLF (1956), inorganic structures due to combination of tectonic movements and metamorphic recrystallization.] *Precam.*, Afr.(Morocco).

Telemarkites DONS, 1959, p. 262 [*T. enigmaticus; M]. Ellipsoidal nodules with inner structure composed of concentric and radial elements and long axis parallel to bedding planes; central tube lying parallel to long axis; 2 to 4 cm. long, 1 to 2 cm. across; composed mainly of fine-grained quartz and feldspars (mostly albite), together with muscovite and calcite; many globular algae, three-dimensionally preserved, in cores of nodules, appearing to be arranged in colonies; probably silicified by gelatinous silica during lifetime; size and shape of nodules very similar to *Botswañella* PFLUG & STRÜBEL, 1969, but different in nature and origin. [According to DONS (1963), sponges or of organic-controlled inorganic origin (concretions formed by intervention of algae); regarded by CLOUD (1968, p. 54) as doubtful concretions; according to PFLUG & STRÜBEL (1969), concretions of algae-controlled synsedimentary origin.] *U.Precam.(Telemark Suite, Bandak Gr.)*, Eu.(S. Nor.).——FIG. 106,*1*. *T. enigmaticus; simplified reconstr. showing internal structures; ×1.3 (Dons, 1959).

Tubiphyton CHOUBERT, TERMIER & TERMIER, 1951, p. 29 [*T. taghdoutensis; M]. Supposed "organisms" observed in thin sections of limestones. [Interpreted as calcareous algae; according to SCHINDEWOLF (1956), inorganic structures due to combination of tectonic movement and metamorphic recrystallization.] *Precam.*, Afr. (Morocco).

UNRECOGNIZED AND UNRECOGNIZABLE "GENERA"

Numerous "genera," mostly based on badly preserved fossils, are included in this group, because descriptions are insufficient and illustrations inadequate. The majority of them are so nondescript that they do not deserve to be named. Many of these fossils will remain unrecognizable for a long time. In only a few cases are investigations of new and better material likely to clarify their systematic position.

Some of the unrecognizable "genera" mentioned in the first edition of the *Treatise,* Part W (HÄNTZSCHEL, 1962), have since been reinterpreted as trace fossils or have been found to be of inorganic origin. Such names are here transferred to the appropriate sections of this contribution. On the other hand, additional names, mostly of monospecific "genera," have been based on insufficiently described lebensspuren. These useless names should under no circumstances be revived. After this listing, many of these genera should never be mentioned or discussed again in the literature.

Amanlisia LEBESCONTE, 1891, p. 4 [**A. simplex*; M]. Interpreted as alga resembling *Palaeophycus simplex* HALL; according to SEILACHER (1956a, p. 167), uncharacteristic trail. *Precam.,* Eu.(France).

Amansites BRONGNIART, 1849, p. 58 ("Genus" introduced for the "group" of *Fucoides dentatus* BRONGNIART, 1828, p. 70). [Interpreted as plant in origin; according to SCHIMPER (1869, p. 214), graptolites.] *"Calcaire de transition,"* N.Am.(Can.).

Amaralia KEGEL, 1967, p. 5, 7 [**A. paulistana*; M]. Rather poorly figured trail composed of 2 different elements but probably belonging to each other: 1) narrow or wide network consisting of small round ribs, 1 to 2 mm. in breadth and height, with median furrow and occasionally with fine transverse annulation, and 2) elliptical or circular trails with or without connection with the networks, up to 15 mm. long and 7 mm. wide, somewhat comparable to resting trails like the "coffee-beans" *Isopodichnus,* but differing by commonly lacking median furrow; both components regarded as belonging to Bilobites by KEGEL. *Perm.(IratiF.),* S.Am.(Brazil, São Paulo).

Ampelichnus HITCHCOCK, 1865, p. 19 [**Grammepus uniordinatus* HITCHCOCK, 1858; M] [=*Ampelichnus sulcatus* HITCHCOCK, 1865, p. 19]. According to HITCHCOCK (1865, p. 19), of doubtful origin, track or plant. *Trias.,* USA (Mass.).

Archaeorrhiza TORELL, 1870, p. 7 [**A. tuberosa*; M]. "Plant, *radicibus similis*"; never figured. *L.Cam.,* Eu.(S.Swed.).

Archaeoscolex MATTHEW, 1889, p. 59 [**A. corneus*; M]. Dubious fossil, interpreted as insect larva; according to HANDLIRSCH (1906-08, p. 338-339), perhaps a myriapod; no specimens located in Canadian collections *U.Carb.* (age stated by MATTHEW: *Dev.*), Can.(N.B.).

Armelia LEBESCONTE, 1891, p. 5 [**A. barrandei*; M]. Interpreted as perhaps belonging to cystoids; according to SEILACHER (pers. commun., 1956), problematic body fossil. *Precam.,* Eu.(France).

Asabellarifex KLÄHN, 1932, p. 14. Poorly founded, rather superfluous "genus" proposed for vertical burrows resembling *Sabellarifex* RICHTER, but believed to be burrowed in downward direction, not built upward as tubes like *Sabellarifex* (HÄNTZSCHEL, 1965). *L.Cam.*(Pleist. drift), Eu.(Ger.-Swed.).

Astropolithon DAWSON, 1878, p. 83 [**A. Hindii*; M]. Oval or circular ridge, raised and arched or (depending on preservation) more or less compressed; diameter 3 to 7 cm.; articulated by numerous (about 30) "rays"; ridge surrounding central area, apparently smooth depression (with central ?axis). (Description based on Spanish specimens; no type or other specimens from Canada located; "genus" only once figured for about a century.) [Originally explained as of plant origin but later (by DAWSON, 1890, p. 605-606) as possible mouths of large burrows with radiating trails or as organisms; also compared by DAWSON (1878) with *Astylospongia radiata* LINNARSSON; Spanish specimens regarded as Scyphomedusae by VAN DER MEER MOHR & OKULITCH (1967) and VAN DEN BOSCH (1969); interpretation as trace fossils seems next to impossible, for some smaller Spanish specimens are preserved as sharply delimited ellipsoidal bodies, lying crowded and in part obliquely to one another.] *Cam.,* Eu.(Spain)-N.Am.(Can., N.Scotia).——FIG. 107,*3*. **A. hindii,* L.Cam.; ×?0.7 (Dawson, 1890).

Atlantaia BORRELLO, 1966, p. 26 [**A. argentina*; OD]. ?Inorganic. *Ord.(F.La Tinta),* S.Am.(Arg.).

Balanulina RZEHAK, 1888, p. 265 [**B. kittlii*; M]. Microfossil, interpreted as foraminifer; according to LOEBLICH & TAPPAN (1964, p. C786), unrecognizable. *L.Tert.(up.Oligo.),* Eu.(Aus.).

Beaumontia DAVID, 1928, p. 203 [*non* MILNE-EDWARDS & HAIME, 1851; *nec* EUDES-DESLONGCHAMPS, 1856] [**B. eckersleyi*; M] [=*Beaumontella* DAVID, 1928, p. 208 *(nom. null.)*]. Nodular bodies. [Interpreted by DAVID (1928) as various parts of eurypterids; according to GLAESSNER (1959b, p. 525), not recognizable as

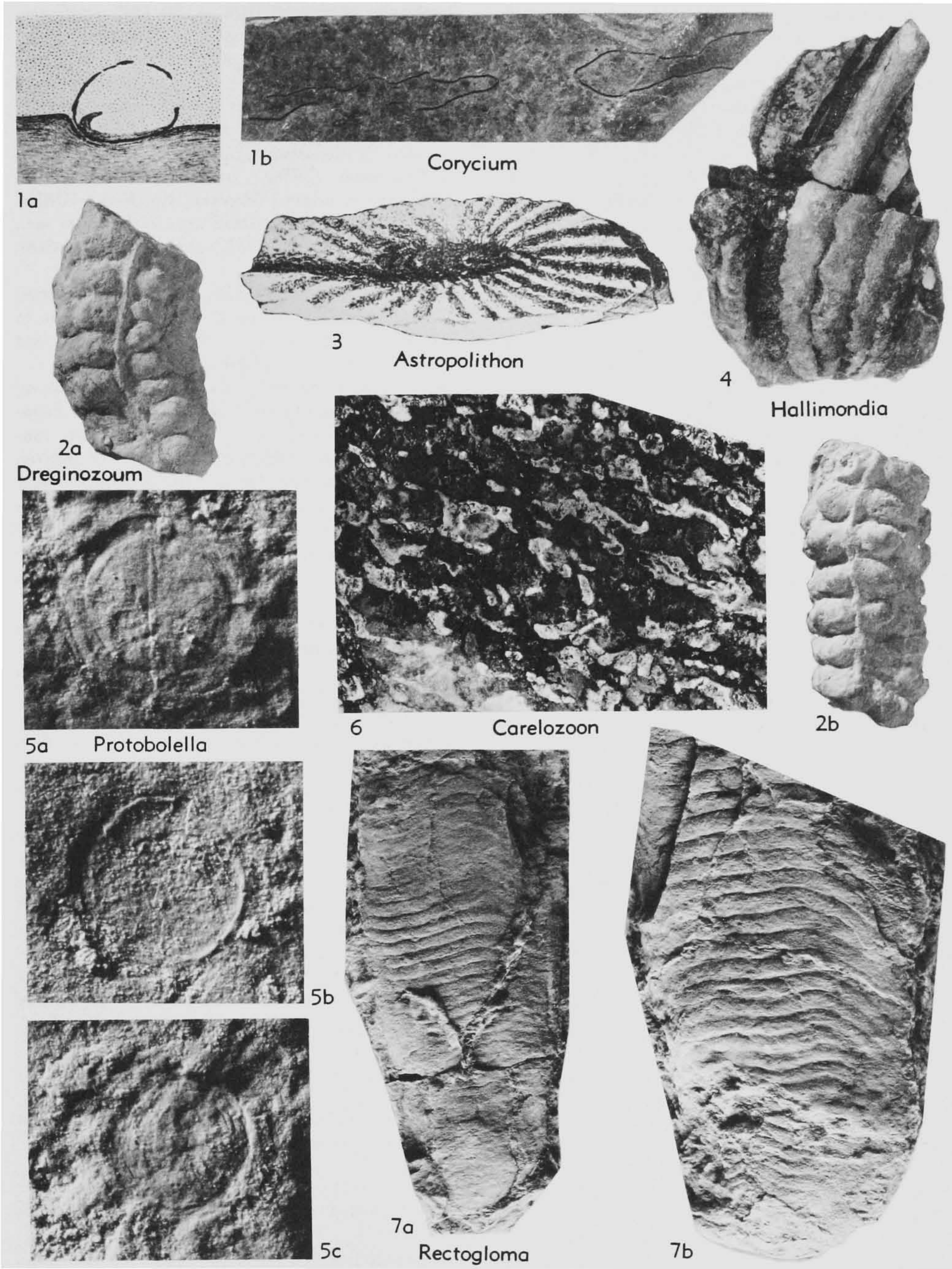

FIG. 107. Unrecognizable "genera" (p. W180, 182, 184-185, 187-188).

animal remains; regarded by CLOUD (1968) as mud flakes.] *Precam.(Beaumont Dol., Adelaide System)*, S.Australia.

Beltina WALCOTT, 1899, p. 238 [**B. danai*; M]. Angular fragments of thin chitinous or carbonaceous films, from approximately 1 to several cm. in size, commonly much distorted and compressed; without distinctive ornamentation. [Regarded by WALCOTT (1899) as fragmentary remains of Merostomata and compared with *Pterygotus* or *Eurypterus* fragments; considered by WHITE (1929) and FENTON & FENTON (1937a) as probably noncalcareous algae, if partly not inorganic ("segregated carbon"); according to CLOUD (1968), inorganic or algal in origin; for discussion of various interpretations, see HOFMANN (1971, p. 23).] *Precam.*, USA-Can.——FIG. 108,*2*. **B. danai*, Belt Ser.(Greyson Sh.), USA (Mont.); *2a*, body segment, ×?; *2b*, appendage with 2 large basal? joints and 2 smaller terminal joints, ×2; *2c*, unidentified fragment with terminal curved spine, ×4; *2d*, portion of jointed appendage, ×3 (Walcott, 1899).

Bipezia MATTHEW, 1910, p. 121 [**B. bilobata*; M] [=*Bipesia* MATTHEW, 1910, p. 125 *(nom. null.)*]. Spindle-shaped "footprints," pointed at both ends, in pairs opposite each other, coalescing laterally; 10 mm. long, 3 mm. wide. [Interpretation doubtful, certainly not of vertebrate origin, as MATTHEW believed; according to GLAESSNER (1957), possibly synonymous with *Isopodichnus* BORNEMANN, 1889.] *U.Carb.*(MATTHEW reported *Dev.*), Can.(N.B.).

Bisulcus HITCHCOCK, 1865, p. 18 [**B. undulatus*; M]. Continuous paired grooves separated by single ridge; poorly figured. [Doubtful whether trail or of inorganic origin; interpreted by HITCHCOCK (1865) as annelid trail, by LULL (1915) as ?mollusk trail; according to BROWN (1912), probably drag marks.] *Trias.*, USA(Mass.).

Bitubulites BLUMENBACH, 1803, p. 23 [**B. problematicus*; M]. "Genus" (especially the "species" *B. irregularis* VON SCHLOTHEIM, 1820, p. 376) possibly synonymous with *Rhizocorallium* ZENKER, 1836; name apparently not used again during the last century. *M.Trias.*, Eu.(Ger.).

Boliviana SALTER, 1861, p. 71 [Three species, no type species designated]. *?Sil.*, S.Am.(Bol.).

Bonariensia BORRELLO, 1966, p. 27 [**B. nuda*; OD]. ?Inorganic. *Ord.(F.La Tinta)*, S.Am. (Arg.).

Bucinella FUCINI, 1936, p. 82 [**B. verrucana*; M]. ?Uncharacteristic trail. *L.Cret.("Verrucano")*, Eu. (Italy).

Calcinema BORNEMANN, 1886, p. 290 [**C. triasinum*; M]. Thin-walled tube, straight or gently curved, cross section nearly circular, diameter 0.15 to 0.20 mm. [Imperfectly described, never again investigated; systematic position uncertain; interpreted by BORNEMANN as alga, this explanation questioned by FRANTZEN (1888) and PIA (1927).] *Low.M.Trias.(Muschelkalk, Schaumkalk)*, Eu.(Ger., Thuringia).

Camptocladus FENTON & FENTON, 1937, p. 1081 [**C. intertextus*; OD]. Superfluous name for branched, flexuous, intertwined burrows; "genus" proposed on assumption that burrows are of crustacean origin. *Penn.*, USA(Texas).

Carelozoon METZGER, 1924, p. 50 [**C. jatulicum*; M]. Irregularly ramifying annd branching, irregularly shaped structures about 0.5 mm. in diameter; circular in cross section, forming network in rock; with crustal layer and possible tabulae; reminiscent of stromatoporoids. [Affinities unknown; ?coelenterate, ?calcareous alga; according to SEILACHER (1956a) and CLOUD (1968), concretionary in origin.] *Precam.*, Eu.(Finl.)-?USSR.——FIG. 107,*6*. **C. jatulicum*, Finl.; cross sec., ×1.1 (Häntzschel, 1962, photo courtesy Geol. Survey Finland).

Caridolites NICHOLSON, 1873, p. 289 [**C. wilsoni*; M]. Tracks, not described in detail; thought to be made by *Ceratiocaris*. [Name apparently not used since 1873.] *L.Paleoz.*, G.Brit.(Eng.).

Ceraospongites MAYER, 1964, p. 108 [**C. lotzae*; M]. Gently curved, cylindrical bodies, some forming T-shaped structures, internally contain randomly oriented cylindrical cavities. [Considered a sponge by MAYER (1964) and established only on fragmentary material.] *M.Trias.(up.Muschelkalk)*, Eu.(S.Ger.).

Chapadamlidium BORRELLO, 1966, p. 28[**C. robustum*; OD]. ?Inorganic. *Ord.(F.La Tinta)*, S.Am.(Arg.).

Charruia RUSCONI, 1955. See KNIGHT *et al.*, 1960, p. *I*324, and FISHER, 1962, p. *W*140.

Chauviniopsis DE SAPORTA, 1872, p. 119 [**C. pellati*; M]. Interpreted as algae. *U.Jur.(low. Portland.)*, Eu.(France).

Chordophyllites cicatricosus TATE, 1876, p. 474. Cylindrical "stem" of rather great length on bedding planes; interpreted as plant in origin ("fucoid"); ?burrows. *L.Jur.*, G.Brit.(Eng.).

Clematischnia WILSON, 1948, p. 10 [**Buthotrephis succulens* HALL, 1847, p. 62; OD]. Irregularly bifurcating burrows, about 5 mm. in diameter; surface ringed by undulating ridges at 2 to 5 mm. intervals. [Interpreted as alga, but certainly trace fossil; "genus introduced with some hesitation"; chondritid-like burrows, according to OSGOOD (1970, p. 333), who proposed to include *Clematischnia* provisionally within *Chondrites s.l.*] *M.Ord.*, Can.

Climacodichnus HITCHCOCK, 1865, p. 20 [**C. corrugatus*; M]. Small, ladderlike rows of impressions, trackway 15 mm. wide, resembling steps of *Acanthichnus*. *Trias.*, USA(Mass.).

Codites VON STERNBERG, 1833, p. 20 [**C. serpentinus*; M]. Originally interpreted as plant, later regarded as ?sponge. *U.Jur.*, Eu.(France-Ger.).

Conchyophycus DE SAPORTA, 1872, p. 150 [**C. marcygnianus*; M]. Interpreted as alga with reservation; very doubtful. *U.Trias.*, Eu.(France).

Confervites BRONGNIART, 1828, p. 86 [No type species designated] [=*Confervides* SCHIMPER, 1869 *(nom. null.)*]. Most forms placed here, especially those from Tertiary beds, are remains of threadlike algae (PIA, 1927), or tissue residues of higher plants. [According to NATHORST

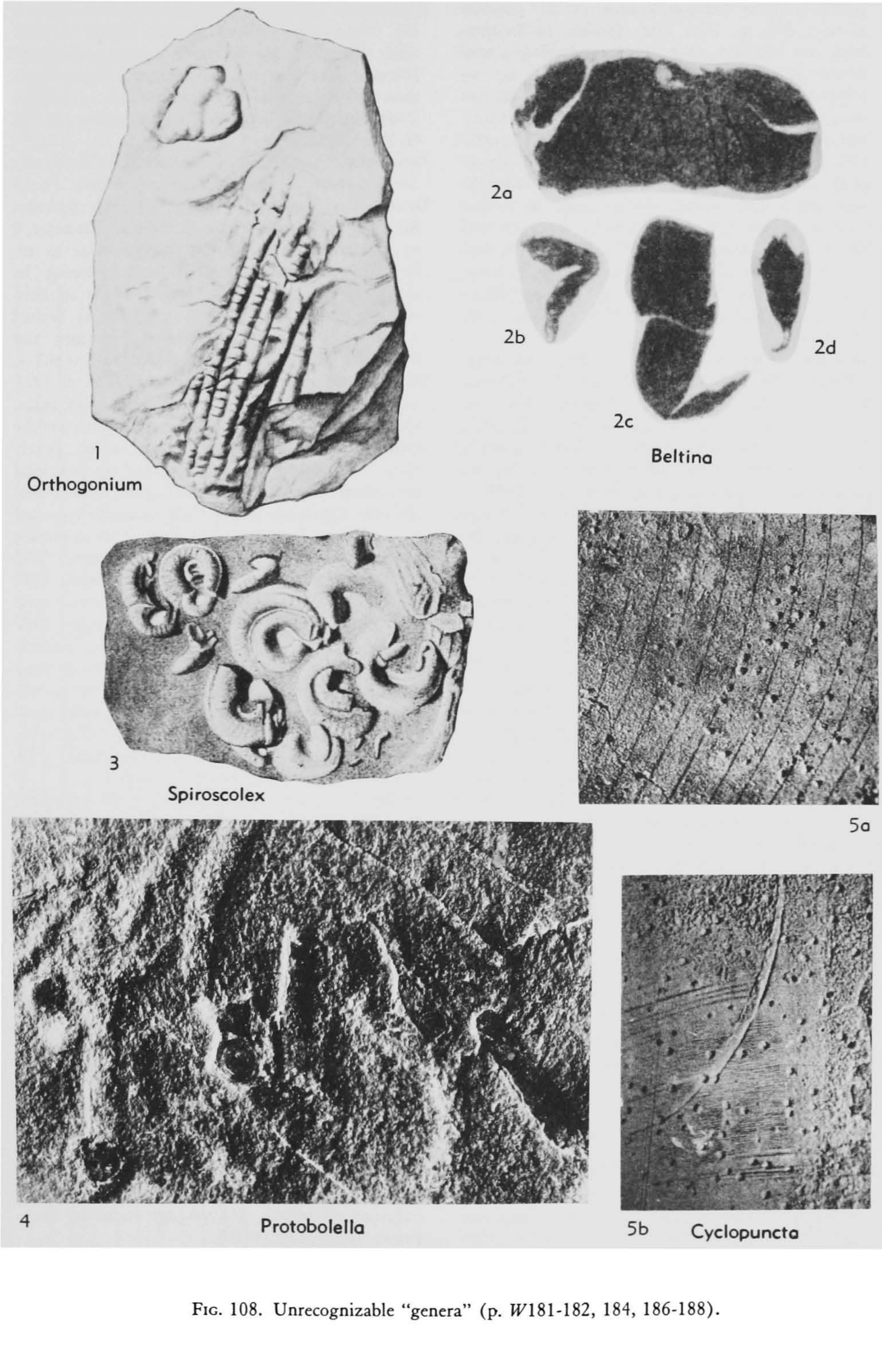

FIG. 108. Unrecognizable "genera" (p. W181-182, 184, 186-188).

(1881a), some "species," such as *C. padellae* HEER (1877, p. 103) from Jurassic of Switzerland, are probably trace fossils resembling *Chondrites; Confervites* has been regarded by DE LAUBENFELS (1955, p. E104) as representing unrecognizable supposed sponges.] *Jur.-Tert.*, Eu.

Cophinus KOENIG in MURCHISON, 1839, p. 697 [**C. dubius*; M]. Problematical structure resembling inverted 4-sided pyramid with columnlike rounding at each corner; always found in vertical position. [Tentatively explained by SOWERBY and SALTER (see MURCHISON, 1859, p. 147) as impressions of rooted crinoid stems which produced observed pattern by wavy and somewhat rotatory motion; possibly inorganic.] *U.Sil.(Ludlov.)*, G. Brit.(Eng.).

Corycium SEDERHOLM, 1911, p. 28 [**C. enigmaticum*; M] [=*Corycinium* C. L. FENTON, 1946, p. 259 *(nom. null.)*]. Saclike structures with carbonaceous walls occurring in sandy beds; filling mass commonly shows concentric internal structure. [The "fossil" or at least its carbon regarded as of organic origin by SEDERHOLM (1911), METZGER (1927), SEWARD (1931), RANKAMA (1948, 1950) and MATISTO (1963); compared by OHLSON (1961) with Recent lake balls; considered as inorganic in origin by KREJCI (1924, 1925), VAN STRAATEN (1949), SCHINDEWOLF (1956), and CLOUD (1968). *Precam.*, Eu.(Finl.).——FIG. 107,*1*. **C. enigmaticum; 1a*, vert. sec., ×0.7 (Sederholm, 1911); *1b*, ×0.2 (Häntzschel, 1962, courtesy Geol. Survey Finland).

Crenobaculus FRITSCH, 1908, p. 7 [**C. Draboviensis*; M]. Rod-shaped ?structure with series of small nodes on external surface; circular in cross section; up to 17 cm. long. [?Body fossil; original illustration nondescript.] *M.Ord.*, Eu.(Czech.). [Description supplied by W. G. HAKES.]

Cunicularis HITCHCOCK, 1858, p. 163 [**C. retrahens*; M]. ?Ramified trails. *Trias.*, USA (Conn.-Mass.).

Cyclopuncta ELIAS, 1958, p. 50 [**C. girtyi*; M]. Shallow subhemispherical holes; diameter 0.1 to 0.3 mm.; generally irregularly scattered on cephalopod shells, in some specimens tending to follow growth lines. [Such structures explained by GIRTY (1909) as perforations in shells probably made by small gregarious animals (e.g., the lorica-secreting infusorian *Folliculina*), scar being produced by prolonged passive attachment.] *Miss.*, USA(Okla.).——FIG. 108,*5*. **C. girtyi; 5a*, on *Cravenoceras* sp., ×8 (Elias, 1958); *5b*, on *Bactrites? smithianus*, ×4.6 (Girty, 1909).

Dasycladites FUCINI, 1936, p. 74 [**D. subclavaeformis*; M]. Nondescript form with trifid, pointed "branches," similar in outline to a dasycladacean algae. According to PIA (1937), so nondescript that it should never have been named. *L.Cret. ("Verrucano")*, Eu.(Italy).

Dazeodesma BORRELLO, 1966, p. 28 [**D. symmetrica*; OD]. ?Inorganic. *Ord.(F.La Tinta)*, S.Am.(Arg.).

Digitolithus FRITSCH, 1908, p. 23 [**D. rugatus*; M]. Main structure "as large as a finger," covered with tubercles; flat branches originate from it. [Origin uncertain, description based on a single discovery that was associated with a fucoid.] *Ord.*, Eu.(Czech.). [Description applied by W. G. HAKES.]

Discoidina TERQUEM & BERTHELIN, 1875, p. 15. See LOEBLICH & TAPPAN (1964, p. C786).

Discophycus WALCOTT, 1883, p. 19 [**D. typicalis*; M]. Discoid, slightly convex bodies; diameter 4 to 12 cm.; outline varying from circular to orbicular, substance ?coriaceous. [Interpreted by JAMES (1884) as inorganic (produced by air bubbles in mud); by RUEDEMANN (1925) as "actual remains of organisms" (seaweeds, sponges, and fragments of eurypterids).] *U.Ord.*, USA(N.Y.).

Dreginozoum VON DER MARCK, 1894, p. 6 [**D. nereitiforme*; M]. Narrow curving median ridge, about 1 mm. wide, with small oval disclike round-edged appendages on both sides, closely spaced like roll of coins; whole fossil up to several decimeters long, 10 to 15 mm. wide. [Somewhat obscure; apparently not a trail; variously regarded as resembling *Nereites*, algae, *Serpula*, or mollusks; similar fossils are *Oncophorus* GLOCKER, 1850 (?U.Cret., Czech.), *Platyrhynchus* GLOCKER, 1850 (*non* LEUCKART, 1816) (?U.Cret., Czech.) and particularly *Gyrochorte bisulcata* GEINITZ, 1883 (Oligo., Ger.); tentatively compared by HÄNTZSCHEL (1964a, p. 298) with egg capsules of some marine prosobranchs attached to a string as observed on the Recent genus *Busycon* (east coast USA).] *U.Cret.*, Eu.(Ger.).——FIG. 107,*2*. **D. nereitiforme*, U.Campan., Ger.(Beckum); *2a*, ×0.9; *2b*, ×1.1 (Häntzschel, 1964a).

Dryalus BARRANDE, 1872, p. 585 [**D. obscurus*; M]. ?Fragment of body fossil (of fish or crustacean, according to BARRANDE); interpreted by FRITSCH (1908) as belonging to a genus similar to *Acanthodes*. *Sil.*, Eu.(Czech.).

Duovestigia BUTTS, 1891, p. 19 [**D. scala*; M]. Described as amphibian footprint, but apparently of invertebrate origin; according to O. KUHN (pers. commun., 1960), probably limuloid. *U. Carb.*, USA(Mo.).

Durvillides SQUINABOL, 1887, p. 560 [**D. eocenicus*; M]. ?Meandering trail. *Eoc.*, Eu.(Italy).

Eocladophora FUCINI, 1936, p. 79 [Several "species," no type species designated]. Long, narrow, threadlike pads or ridges; probably inorganic. *L.Cret.("Verrucano")*, Eu.(Italy).

Eurypterella MATTHEW, 1889, p. 60 [**E. ornata*; M]. Dubious fossil interpreted as peculiar small crustacean; no specimens could be located in Canadian collections. *U.Carb.*(age stated by MATTHEW: *Dev.*), Can.(N.B.).

Fengtienia ENDO & RESSER, 1937, p. 326 [**F. peculiaris*; M]. Unrecognizable genus of "trilobite" founded on impression of 2 individuals lying side by side, perhaps in copulation. [According to ÖPIK (1959), probably only a *"Rusophycus"*;

see also HARRINGTON *et al.*, 1959, p. *O*102 and *O*525.] *M.Cam.*, China (Manchuria).

Flabellichnus KARASZEWSKI, 1971, p. 105 [**F. lewinskii*; M]. "Inflorescence"-shaped imprints, consisting of several "petals" rapidly narrowing and tapering; particular "petals" spindle-shaped. [Photos and description not sufficient for an interpretation.] *L.Jur.(low.Lias., Hettang.)*, Eu. (Pol.).

Fruticristatum WEBSTER, 1920, p. 288 [Three "species," no type species designated]. Originally described as an alga, never figured; apparently fillings of uncharacteristic burrows. *M.Dev.*, USA (Iowa).

Furca BARRANDE in FRITSCH, 1908, p. 8 [**F. bohemica*; M]. Structure with a straight-line anterior truncation and 4 gently recumbent posterior lobes, 2 "lateral" and 2 "medial," about 25 mm. long; external surface composed of numerous subrectangular plates. [?Pluteus larva of crinoid.] *Ord.*, Eu.(Czech.). [Description supplied by W. G. HAKES.]

Gleichenophycus MASSALONGO, 1884 [**G. granulosus* MASSALONGO in CAPELLINI, 1884, p. 541; SD ANDREWS, 1955, p. 162]. MASSALONGO's first description of the "genus" not found; according to FUCHS (1895, p. 406), *G. italicus* MASSALONGO identical with *Caulerpa lehmanni* HEER, 1877; ?screwlike burrow. [Found in flysch deposits.] *U.Cret.*, Eu.(Switz.-Italy).

Gracilerectus WEBSTER, 1920, p. 288 [**G. hackberryensis*; M]. Straight or curved, cylindrical "stems," similar to *Fruticristatum* WEBSTER. [Originally regarded as algae ("fucoids"), but most probably uncharacteristic burrows.] *M.Dev.*, USA(Iowa).

Grammepus HITCHCOCK, 1858, p. 155 [**G. erismatus*; SD LULL, 1953, p. 48]. Doubtful (?arthropod) trail. *Trias.*, USA(Mass.).

Granifer FRITSCH, 1908, p. 7 [**G. stolatus*; M]. Nodules with various morphologies; may be round or rod-shaped, several centimeters in dimension; covered with tiny nodes about 1 mm. in diameter. [?Concretion.] *Ord.*, Eu.(Czech.). [Description supplied by W. G. HAKES.]

Guttolithus FRITSCH, 1908, p. 7 [**G. Strasseri*; M]. Subconical structure with blunt apical end; 14 cm. long, diameter 2.2 to 4 cm.; external surface weakly nodose. [Origin uncertain; insignificant and unnecessary name based on single discovery.] *Ord.*, Eu. (Czech.). [Description supplied by W. G. HAKES.]

Hallimondia CASEY, 1961, p. 600 [**H. fasciculata*; M]. Straight, parallel, trough- or tubelike structures, unbranched, about 40 cm. long, 1 cm. in diameter, cross section approximately semicircular; tube walls built up of concentric wavy layers; "tubes" apparently commencing at a common point, grouped together at first, then gradually diverging, not interlaced; in limestones forming nuclei of phosphate nodules. [?Organic in origin.] *L.Cret.(up.Apt.)*, G.Brit.(Eng.).——FIG. 107,*4*. **H. fasciculata*, Sandgate Beds, Eng.; ×0.7 (Casey, 1961).

Halysichnus HITCHCOCK, 1858, p. 162 [**H. laqueatus*; SD LULL, 1953, p. 51]. Repeatedly looped, chainlike trail with ridges on each side. *Trias.*, USA(Mass.).

Harpagopus HITCHCOCK, 1848, p. 247 [**H. dubius*; SD LULL, 1953, p. 54]. Rather obscure tracks; obliquely placed elliptical impressions. *?M. Dev.*, USA(N.Y.); *Trias.*, USA(Mass.); *Jur.*, USA (N.J.).

Hauthaleia BORRELLO, 1966, p. 29 [**H. concava*; OD]. ?Inorganic. *Ord.(F.La Tinta)*, S.Am. (Arg.).

Helviensia DE LIMA, 1895, p. 94 [**H. delgadoi*; M]. Originally interpreted as alga; ?uncharacteristic burrows. *?U.Cam.*, Eu.(Port.).

Hippodophycus HALL & WHITFIELD, 1872, p. 203 [**H. cowlesi*; M]. Described as marine plant with swelling root. [According to M. GOLDRING (pers. commun., 1953), holotype (only described specimen) probably lost, perhaps inorganic]. *U. Dev.*, USA(N.Y.).

Hoplichnus HITCHCOCK, 1848, p. 230 [**H. quadrupedans*; M] [=*H. poledrus* HITCHCOCK, 1858, p. 136, *nom. van.*] [=*Chelichnus gigas* JARDINE, 1850, p. 208]. Hoofshaped, semioval reliefs resembling impressions of horseshoes; diameter about 5 cm. [Perhaps markings or (particularly the "species" *H. equus* HITCHCOCK, 1858) lebensspuren; for interpretation of similar hoofshaped structures from the German Buntsandstein (Thuringia) as U-shaped dwelling tubes with spreite similar to *Rhizocorallium*, see W. QUENSTEDT (1932a, p. 93).] *Penn.-Trias.*, USA; *?Penn.-Trias.*, Eu.(Eng.-Ger.).

Hylopus(?) variabilis MATTHEW, 1910, p. 120. Very doubtful "footprints," referred to vertebrates. [According to ABEL (1935, p. 78), not a vertebrate track, but an unrecognizable form.] *Dev.*, Can.(N.B.).

Ichnophycus HALL, 1852, p. 26 [**I. tridactylus*; M]. Doubtful tridactyl impressions, similar to foot of bird in outline. [According to OSGOOD (1970, p. 345), "probably a portion of a burrow," but not comparable with *Dactylophycus* MILLER & DYER as pointed out by MILLER (1889).] *Sil.*, USA(N.Y.).

Isnardia BORRELLO, 1966, p. 30 [**I. aenigmatica*; OD]. ?Inorganic. *Ord.(F.La Tinta)*, S.Am. (Arg.).

Keidelasma BORRELLO, 1966, p. 32 [**K. bonariensis*; OD]. ?Inorganic. *Ord.(F.La Tinta)*, S.Am. (Arg.).

Krishnania SAHNI & SHRIVASTAVA, 1954, p. 40 [**K. acuminata*; M]. Somewhat similar to *Fermoria* CHAPMAN but differing from it by its acuminately ovate shape, in outline resembling *Lingula*; longest axis 7.5 mm., maximum width 4 mm., narrowing abruptly at one end, rounded at other; deep marginal furrow with fine median rib dividing it. [Rather poorly figured, "need restudy"

(CLOUD, 1968).] *U.Precam.(Vindhyan),* C.India (Neemuch distr.).

Laminarites BRONGNIART, 1828, p. 54 [no type species designated]. "Genus" comprising very heterogenous "species"; similar to *Laminaria*; straight and parallel structures on bedding planes. [Seemingly in part of plant origin (e.g., *L. antiquissimus* EICHWALD, 1856), in part probably inorganic in origin (e.g., *L. lagrangei* DE SAPORTA & MARION, 1883), and partly, according to MESCHINELLI & SQUINABOL, 1892, also trails.]

Laminopsis FUCINI, 1938, p. 204 [**L. insignis*; M]. Probably inorganic. *?M.Trias.,* Eu.(Italy).

Lepidotruncus FRITSCH, 1908, p. 23 [**L. fortis*; M] [=*Lipidotruncus* FRITSCH, 1908, p. 28, *nom. null.*]. Large subcylindrical structure, length and width 17 cm.; may branch; surface covered with transverse, irregular striations. [Listed among "Problematica botanica" by author.] *Ord.,* Eu. (Czech.). [Description supplied by W. G. HAKES.]

Leptophycus FRITSCH, 1908, p. 21 [**Fucoides papyraceus* BARRANDE in FRITSCH, 1908, p. 21); M] [*non Leptophycus* JOHNSON, 1940 (stromatolite from the Pennsylvanian of Colorado, USA)]. Leaf-shaped structure rolled in the form of a cornet about 18 cm. long. [Erroneously regarded by FRITSCH (1908, p. 20) as belonging to *Alectorurus* SCHIMPER, 1869.] *Ord.,* Eu.(Czech.). [Description of structure supplied by W. G. HAKES.]

Lingulella montana FENTON & FENTON, 1936, p. 616. Small linguloid-shaped structures with concentric wrinkles paralleling anterior margin. [Considered to be brachiopod by FENTON & FENTON (1936); thought to resemble stromatolites by GLAESSNER (1962); and interpreted as inorganic by ROWELL (1971), who believed wrinkles formed as result of deformation by slippage.] *Precam.,* USA(Mont.). [Description supplied by CURT TEICHERT and W. G. HAKES.]

Lithodictyon TORELL, 1870, p. 7 [**L. fistulosum*; M]. Not figured; ?inorganic. *L.Cam.,* Eu. (Swed.).

Lithostachys FISCHER-OOSTER, 1858, p. 59 [**L. alpina*; M]. ?Plant. *?L.Cret.,* Eu.(Switz.).

Macrocystites FUCINI, 1936, p. 75 [**M. similis*; M]. Trail or inorganic (see PIA, 1937, p. 1098). *?M.Trias.,* Eu.(Italy).

Mastocarpites TREVISAN in DE ZIGNO, 1856, p. 22 [*non* TREVISAN, 1849 *(nom. nud.)*] [**Algacites erucaeformis* VON STERNBERG, 1833, p. 36; OD]. ?Coprolite (Andrews, 1955). *U.Jur.,* Eu.(Ger.).

Micrapium TORELL, 1870, p. 11 [**M. erectum*; M]. Never figured; according to NATHORST, 1881a, p. 50, burrows or of inorganic origin; see also WESTERGÅRD, 1931, p. 12. *L.Cam.,* Eu. (Swed.).

Myriodocites MARCOU (before 1880). *Fide* ZITTEL, 1880, p. 568, resembling *Nereites*; MARCOU's description not seen.

Naites GEINITZ, 1867, p. 8 [**N. priscus*; M]. Rather valueless name for a trail somewhat resembling that made by the Recent genus *Nais* MÜLLER, 1771. [Interpreted by GEINITZ as a bodily preserved annelid; according to PFEIFFER (1968, p. 693), an uncharacteristic burrow.] *L. Carb.,* Eu.(Ger.).

Nanopus? vetustus MATTHEW, 1910, p. 121. Doubtful "footprints," referred to vertebrates; according to ABEL (1935, p. 78), not a vertebrate track, but unrecognizable. *Dev.,* Can.(N.B.).

Nematolites KEEPING, 1882, p. 489 [No type species designated]. Poorly preserved, "curious irregular branching structures." *Sil.,* G.Brit.(Eng.).

Octoia BORRELLO, 1967, p. 4 [**B. subandina*; OD]. From description and figures doubtful whether or not of inorganic origin. *Dev.,* S.Am. (S.Bol.).

Oncophorus GLOCKER, 1850, p. 937 [*non* RUDOW, 1870; *nec* EPPELSHEIM, 1885] [**O. beskidensis*; M]. Sinuous trail. [Originally interpreted as body fossil; placed provisionally by GEINITZ (1852, p. 28) in his "genus" *Nereograpsus;* recognized by NATHORST (1881a, p. 85) as trace fossil; related to or identical with *Dreginozoum,* resembling *Gyrochorte bisulcata* E. GEINITZ; name apparently not used again for nearly a century.] *?U.Cret.,* Eu.(Czech.).

Orthocaris FRITSCH, 1908, p. 12 [**O. splendens*; M]. Rod-shaped structure with oblique plications; 18 mm. long, 8 mm. wide; external surface has a high luster. [Insignificant ?body fossil described from a fragment.] *Ord.,* Eu.(Czech.). [Description supplied by W. G. HAKES.]

Orthogonium GÜRICH, 1933, p. 146 [**O. parallelum*; M]. Consisting of several articulated rows suggestive of crinoid arms; row 3 or 4 mm. wide, about 6 cm. long; spongelike body similar to dictyospongiids (HÄNTZSCHEL, 1965). [Type of *Orthogonium* has been lost and the form not seen since (GLAESSNER written commun. to TEICHERT, 1972). Questionable fossil.] *Precam.(Nama Syst., Kuibis Quartzite),* SW.Afr.——FIG. 108,*1*. **O. parallelum*; ×0.6 (Gürich, 1933).

Ostrakichnites PACKARD, 1900, p. 66. Name proposed for trails insufficiently described by DAWSON (1873, p. 55) as *Protichnites carbonarius*; according to PACKARD, not belonging to *Protichnites.* [Name apparently not used since 1900.] *Carb.,* Can.(N.S.).

Palaeonereis EICHWALD, 1856, p. 409 [*non* HUNDT, 1940, p. 214]. ?Trails. [Notation "*Palaeonereis* m." [mihi] appears in EICHWALD, 1860, p. 680, with *P. prisca,* a species already mentioned by EICHWALD, 1856, p. 409.] *Ord.,* Eu.(Est.).

Palaeonereis HUNDT, 1940, p. 214 [*non* EICHWALD, 1856]. Small crawling trail or burrow. *L.Dev.,* Eu.(Ger., Thuringia).

Petromonile CASEY, 1961, p. 600 [**Siphonia* (or *Spongites*) *benstedii* BENSTED, 1862, p. 335; OD]. "Stems," about 10 mm. in diameter; irregularly branching, periodically lobed. [Originally described as "sponges"; according to CASEY, probably infilled feeding burrows (written commun., 1973).] *L.Cret.(up.Apt.)*, G.Brit.(Eng.).——FIG. 109,*1*. **P. benstedii* (BENSTED), low. Greensand, Kent (Maidstone, Iguanodon Quarry); *1a,b*, syntypes, ×0.7 (Casey, n; Inst. Geol. Sci. London Repos. no. GSM 114818,114819).

Phycoidella MATTHEW, 1890, p. 144 [**P. stichidifera*; M]. Strap-shaped "fronds" showing irregular rows of dark spots or granules transversely arranged on "stem." [According to MATTHEW, related to *Fucoides circinnatus* BRONGNIART and regarded as alga; perhaps trace fossil.] *Cam.*, N.Am.(Can.).

Potiria BORRELLO, 1966, p. 33 [**P. trunciformis*; OD.] ?Inorganic. *Ord.(F.La Tinta)*, S.Am. (Arg.).

Protobolella CHAPMAN, 1935, p. 117 [**Fermoria minima* CHAPMAN, 1935, p. 114; SM SAHNI, 1936] [=*Fermoria* SAHNI, 1936, p. 465; obj.]. Small disc-shaped carbonaceous structures, 2 to 4 mm. in diameter, concentrically wrinkled. [Interpreted as ?atremate brachiopod (CHAPMAN, 1935); compared with algae by SAHNI & SHRIVASTAVA (1954); HOWELL (1956); and others; according to MISRA & DUBE (1952) probably inorganic; regarded by CLOUD (1968) as "possibly algal, but need restudy"; for account of the nomenclature of genus and type species see ROWELL (1971); considered synonymous with *Chuaria circularis* WALCOTT, 1899.] *Precam. (VindhyanF.)*, India.——FIG. 108,*4*. *P.* sp.; attached to filament-like bodies; ×2 (Sahni, in Häntzschel, 1962).——FIG. 107,*5*. **P. minima*; *5a*, traces of concentric ornament on marginal brim; *5b*, severely exfol. disc, with marginal brim; *5c*, concentric traces probably due to crushing, ×10 (Rowell, 1971). [Considerably modified and edited version of text originally prepared by author.—Ed.]

Protostigma LESQUEREUX, 1878, p. 169 [**P. sigillarioides*; M]. Originally regarded as the oldest lycopod; according to OSGOOD (1970, p. 395), possibly cast of a burrow or internal mold of a nautiloid or a stromatoporoid; "must remain *Inc. sed*." *U.Ord.*, USA(Ohio).

Pseudotaeniopteris SZE, 1951, p. 81 [**P. piscatorius*; M]. Oval impressions with thick median vein; similar to *Taeniopteris* BRONGNIART, but not of plant origin. *L.Cret.(Wealden)*, China(Manchuria).

Ptilichnus HITCHCOCK, 1858, p. 144 [4 "species," no type species designated]. Finlike impressions, arranged in rows; others consisting of parallel slightly curved grooves. [Regarded by HITCHCOCK as swimming trails of fishes; according to BROWN (1912, p. 544-546), more likely markings of rolling or dragging objects.] *Trias.*, USA(Mass.).

Ptychoplasma FENTON & FENTON, 1937, p. 1080 [**P. excelsum*; OD]. Poorly figured trails. [Considered by FENTON & FENTON as having been made by bivalves.] *Penn.*, USA(Texas).

Pucksia SOLLAS, 1895, p. 302 [**P. machenryi*; M]. Long, narrow threadlike markings. [According to SOLLAS (1900, p. 278), indubitably organic in origin but of unknown systematic position.] *Cam.*, Eu.(Ire.).

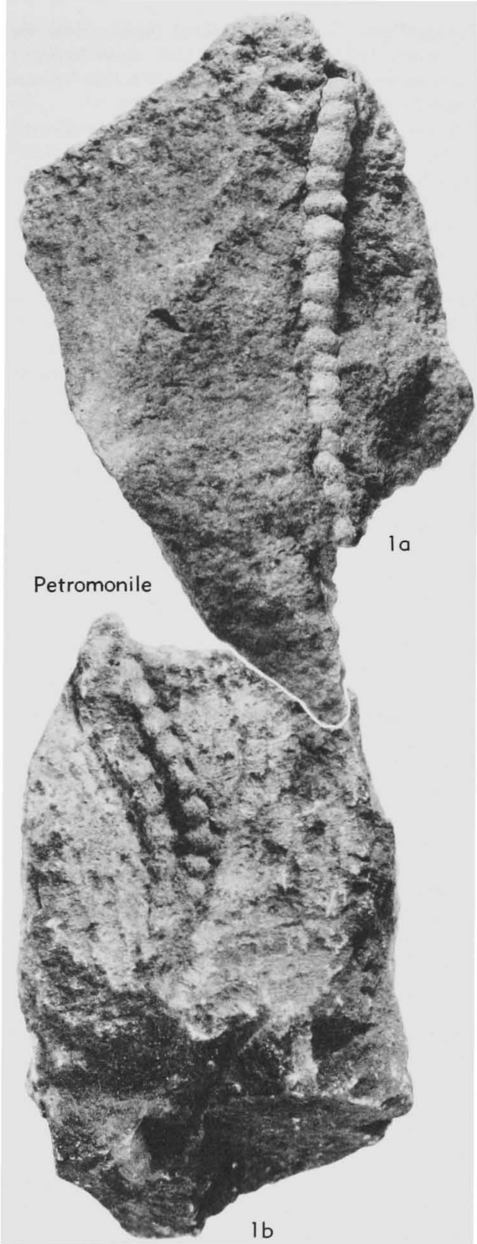

FIG. 109. Unrecognizable "genera" (p. *W*186-187).

Punctatumvestigium BUTTS, 1891, p. 44 [**P. circuliformis*; M]. Described as amphibian footprint, but obviously of invertebrate origin. *U.Carb.*, USA(Mo.).

Pyrophyllites. Star-shaped ?trace fossil; cited by DAWSON, 1890 (p. 604), together with *Scolithus* and *Asterophycus*; author unknown; no species described. *Sil.*, Can.(Ont.).

Quallites FRITSCH, 1908, p. 10 [**Q. graptolitarum* (=*Q. problematicus* FRITSCH, 1908, explan. pl. 9, fig. 6); M]. Disc-shaped structure (about 3 cm. in diameter) possessing numerous arms with crenulate edges (about 0.5 cm. wide and several centimeters long). *Sil.*, Eu.(Czech.). [Description supplied by W. G. HAKES.]

Radicites FRITSCH, 1908, explan. pl. 6, fig. 8 [**R. rugosus*; M] [=*Radix* FRITSCH, 1908, p. 8 (*non* DE MONTFORT, 1810) (type, *R. corrugatus*)]. Ramifying, branching structure with numerous transverse striations. *Ord.*, Eu. (Czech.). [Description supplied by CURT TEICHERT and W. G. HAKES.]

Radicopsis FUCINI, 1938, p. 179 [Many "species," no type species designated]. Probably inorganic; name perhaps not meant as genus. *?M.Trias.*, Eu.(Italy).

Radiophyton MEUNIER, 1887, p. 59 [**R. sixii*; M]. Tetraradiate, probably accidental structure. *U.Jur.*, Eu.(France).

Rectogloma VAN TUYL & BERCKHEMER, 1914, p. 275 [**R. problematica*; M]. Body shaped like an orthoconic cephalopod shell; elliptical in transverse section; apex terminating in spiral coil; closely placed sinuous sutures on surface which disappear completely on apical coil. [Coprolite, according to KNIGHT *et al.* (1960, p. *I*324); this is a doubtful interpretation.] *U.Dev.*, USA(Pa.).——FIG. 107,*7*. **R. problematica; 7a,b,* ×1.2 (Häntzschel, 1962, courtesy Am. Museum Nat. History).

Rhizomorpha HERNANDEZ-PACHECO, 1908, p. 86 [2 species, no type species designated]. Superfluous name for bulging structures on bedding planes; 3 to 12 mm. in diameter; irregularly branched. *L.Sil.*, Eu.(Spain).

Saccophycus U. P. JAMES, 1879, p. 17 [**S. inortus*; M]. Possibly burrows, smooth or striated longitudinally (see J. F. JAMES, 1885, p. 157); never figured. According to OSGOOD (1970, p. 299), the single specimen not located. *U.Ord.*, USA (Ohio).

Schilleria BORRELLO, 1966, p. 34 [*non* DAHL, 1907; *nec* GIRAULT, 1932] [**S. acuta*; OD]. ?Inorganic. *Ord.(F.La Tinta)*, S.Am.(Arg.).

Shikamaia OZAKI, 1968, p. 28 [**S. akasakaensis*; OD]. Flat, disclike "fossil" with undulated "dorsal" and flat "ventral" side, both traversed by median longitudinal "canal"; shell walls composed of calcite, varying in thickness from 0.5 to 2 cm.; transverse section of middle part of "fossil" showing elongate rhomboidal outlines with large inner cavity; systematic position problematic, all phyla of invertebrates, vertebrates and plants are excluded from consideration [!]. [Undoubtedly of inorganic origin.] *L.Perm.*, Japan.

Solicyclus QUENSTEDT, 1879, p. 578 [Published without species]. Elliptical reliefs, smooth internally; marginal seam divided by numerous radial rays. *L.Jur.*, Eu.(Ger.).

Sphaerapus HITCHCOCK, 1858, p. 164 [**S. larvalis*; SD LULL, 1953, p. 47] [=*Sphaeropus* LULL, 1953, p. 47; *nom. null.*]. ?Trackway consisting of 2 rows of small (diam. 3-5 mm.) hemispherical impressions. *Trias.*, USA(Mass.).

Spirochorda SCHIMPER in SCHIMPER & SCHENK, 1879, p. 51 [**Dictyota spiralis* LUDWIG, 1869, p. 114; OD]. Possibly braided trail. *U.Dev.*, Eu.(Ger.).

Spiroscolex TORELL, 1870, p. 12 [**Arenicolites spiralis* TORELL, 1868, p. LXII; OD]. Transversely ribbed, strongly curved, spiral structures 2 cm. in diameter; transverse ribs slightly elevated. [Originally interpreted as worms; regarded by NATHORST (1881a, p. 28) as impressions of tentacles of medusae; for discussion see also HOFMANN (1971, p. 18).] *?Precam.*, Can.; *Cam.*, Eu.(Swed.-Est.).——FIG. 108,*3*. **S. spiralis* (TORELL), Cam., Swed.; ×0.5 (Walcott, 1890).

Spongolithus FRITSCH, 1908, p. 14 [12 species, no type species designated]. ?Cylindrical structure 14 mm. thick with smaller numerous branches like the "leaves of a willow." Very heterogeneous group of ridgelike and tracklike structures. *Ord.*, Eu.(Czech.). [Description supplied by W. G. HAKES.]

Squamopsis FUCINI, 1938, p. 182 [Two "species," no type species designated]. Probably inorganic. *L.Cret.("Verrucano")*, Eu.(Italy).

Squamularia ROTHPLETZ, 1896, p. 892 [*non* GEMMELLARO, 1899] [**Caulerpa cicatricosa* HEER, 1877, p. 153; SD HÄNTZSCHEL, 1962, p. *W*242]. Possibly small fucoids. *Tert.*, Eu.

Striocyclus QUENSTEDT, 1879, p. 577 [Without species names]. Reliefs on bedding planes with radial, wormlike ornament and central hollow. *L.Jur.*, Eu.(Ger.).

Tandilinia BORRELLO, 1966, p. 34 [**T. mesoconica*; OD]. ?Inorganic. *Ord.(F. La Tinta)*, S.Am.(Arg.).

Thinopus antiquus MARSH, 1896, p. 374. Single "footprint" with 3 "toe-impressions," described as earliest record of a terrestrial vertebrate; according to ABEL (1935, p. 77), and others, not a vertebrate footprint; in ABEL's opinion, a "fossil" that can be interpreted in various ways; possibly fish coprolite. *U.Dev.*, USA(Pa.).

Triadonereites MAYER, 1954, p. 227 [**T. mesotriadica*; M]. General name for burrows of varying shape, annulated in part; believed to be made by *Triadonereis* MAYER, 1954. [No clear diagnosis.] *M.Trias.(Muschelkalk)*, Eu. (S.Ger.).

Trianisites RAFINESQUE, 1821, p. 286 [**T. cliffordi*; M]. See HARRINGTON & MOORE (1956e, p. *F*159).

Trichoides HARKNESS, 1855, p. 474 [**T. ambiguus*; M]. Hairlike bodies, generally straight, some slightly curved; length irregular, about 1 inch; never figured. [Perhaps inorganic.] *Ord.,* Eu.(Scot.).

Tropidaulus FENTON & FENTON, 1937, p. 1080 [**T. magnus*; OD]. Burrows, undersurface with transverse wrinkles and median keel or ridge, 1.5 to 2 cm. wide; rather poorly figured. [According to the authors, made by arthropods or large annelids.] *Penn.,* USA(Texas).

Truncus FRITSCH, 1908, p. 8 [**T. ramifer*; M]. Subcylindrical structure about 10 cm. long, exterior covered with dimples; bent branch extending to "left" side of structure. [?Inorganic.] *Ord.,* Eu.(Czech.). [Description supplied by W. G. HAKES.]

Valonites SORDELLI, 1873, p. 367 [**V. utriculosus*; M]. Small hemispherical, poorly figured forms, belonging to ?algae. *Tert.(Plio.),* Eu.(Italy).

Vesicolithus FRITSCH, 1908, only figure: pl. 3, fig. 5 [**V. guttalis*; M]. Hemispheres of different size occurring in quartzite; up to 1 cm. in diameter. [?Inorganic.] *Ord.,* Eu.(Czech.). [Description supplied by W. G. HAKES.]

Vucetichia BORRELLO, 1966, p. 35 [**V. psamma*; OD]. ?Inorganic. *Ord.(F. La Tinta),* S.Am.(Arg.).

Walcottia MILLER & DYER, 1878, p. 39 [**W. rugosa*; M]. "Genus" including 3 different "species" of long, tapering, rugose, flexuous impressions of wormlike shape. [*W. sulcata* U. P. JAMES, 1881, p. 44, was never figured, no type specimens or other material located; according to OSGOOD (1970, p. 398), perhaps small trails similar to *Cruziana; ?W. cookana* MILLER & DYER, 1878, p. 11, according to OSGOOD (1970, p. 380), "impossible to make any interpretation of the species."] *U.Ord.,* USA(Ohio).

Yaravidium BORRELLO, 1966, p. 36 [**Y. coniformis*; OD]. ?Inorganic. *Ord.(F. La Tinta),* S.Am.(Arg.).

Zearamosus WEBSTER, 1920, p. 286 [**Z. elleria*; M]. Originally described as of plant origin; ?burrows similar to *Gracilerectus* WEBSTER, 1920, and *Fruticristatum* WEBSTER, 1920. *Dev.,* USA (Iowa).

GENERA OF RECENT LEBENSSPUREN

"Generic" names have been proposed for three types of Recent lebensspuren. In a fourth case, an important Paleozoic trace fossil (*Nemapodia* EMMONS) has been proven to be present in the Recent environment. Names for Recent lebensspuren are neither necessary nor justifiable. Often their producer can be determined, in which case description of the traces are sufficient. Examples are "star-shaped feeding traces of *Corophium*" or a "*Paraonis* meander." When the producer is unknown, it is sufficient to give a morphological-ecological description such as "branching grazing trace of supposedly polychaete origin." Also, it is sufficient to indicate similarity in shape of the Recent form with that of a known fossil ichnogenus.

1

FIG. 110. Recent lebensspuren (p. W189).

Benjaminichnus BOEKSCHOTEN, 1964, p. 423 [*nom. subst. pro* Batrachoides HITCHCOCK, 1858, p. 121 (*non* LACEPÈDE, 1800)]. Proposed for possible fossil and Recent tadpole nests or similar traces. [Batrachoides antiquior and B. nidificans HITCHCOCK, 1858, p. 122 (Sil. and Trias., USA) interpreted by SHEPARD (1867) and KINDLE (1914, p. 160) as interference ripple marks. Recent tadpole nests should not be named; all supposed fossil tadpole nests are of inorganic origin as proved by CAMERON & ESTES (1971), thus Batrachoides HITCHCOCK and *Benjaminichnus* BOEKSCHOTEN are to be abandoned; for discussion and nearly complete references of papers dealing with tadpole nests see CAMERON & ESTES (1971).] ——FIG. 110,*1*. Tadpole structures from Tenn., in dry condition, ×0.12 (Maher, 1962).

Corophites ABEL, 1935, p. 463 [*nom. nud.*]. Suggested as name for burrows made by Recent amphipod *Corophium*, especially for (rare) simple shafts with sidewise branchings. *Rec.*

Ephemerites ABEL, 1935 [*non* GEINITZ, 1865]. Horizontal U-shaped burrows produced by larvae of ephemerids; occurring in fresh-water deposits. [Shown by SEILACHER (1951), to be spreiten burrows.] *Rec.*

Mystichnis VYALOV & ZENKEVICH, 1961, p. 58 [**M. pacificus*; M]. Crawling trails on bottom of Pacific at depth of 3,000 m.; 10 cm. wide; producer unknown. *Rec.*

Nemapodia EMMONS, 1844, expl. pl. 2, fig. 1. [**N. tenuissima*; M]. Described as fossil trails, but according to RICHTER (1924), trail of Recent gastropod feeding in meanders on surface of slabs of Paleozoic slates (as shown by RICHTER for *N. tenuissima*, described by GEINITZ (1852) from bedding planes of L.Carb. slates of Saxony).

INVALID NAMES

The following group contains a list of names considered to be invalid. These names are either available or unavailable.

Acanthus GROSSHEIM, 1946, p. 116 [*non* BLOCH, 1795; *nec* DUMONT, 1816; *nec* GISTL, 1834; *nec* LOCKINGTON, 1876)] [**A. dodecimanus*; M] (HÄNTZSCHEL, 1965). *L.Tert.*, USSR.

Agarites DE SAPORTA, 1890, p. 313 [*non* AGASSIZ, 1841] [**A. fenestratus*; M] (HÄNTZSCHEL, 1965). *U.Jur.*, Eu.(France).

Aglaopheniolites. According to SEILACHER (pers. commun., 1956), name used in Italian paleontological collections for trace fossil from Italian flysch. [Very probably manuscript name.]

Anapaleodictyon TANAKA, 1970 [MS. name, *nom. null.* for *Protopaleodictyon?*].

Arabesca VYALOV, 1972, p. 76. Two species described, *A. caucasica* and *A. daghestanica*, but no type designated, hence name not available. *Tert. (low. Paleoc.)*, USSR (N. Daghestan). [Description supplied by CURT TEICHERT.]

Boteillites. According to SEILACHER (pers. commun., 1956), name used in Italian paleontological collections for trace fossils from the Italian flysch. [Probably manuscript name.]

Cochlea HITCHCOCK, 1858, p. 162 [jr. hom.; *non* MARTYN, 1874; *nec* GRAY, 1847] [**C. archimedea*; M]. Trackway resembling an archimedean screw (HITCHCOCK, 1858). *Trias.*, USA (Mass.).

Corticites FUCINI, 1938, p. 170 [*nom. nud.*] [jr. hom.; *non* ROSSMAESSLER, 1840]. ?Inorganic (HÄNTZSCHEL, 1965). *L.Cret.("Verrucano")*, Eu. (Italy).

Cyclophycus ULRICH, 1880, *nom. nud.* (*fide* OSGOOD, 1970, p. 399).

Cylindrites GÖPPERT, 1842 (?1841), p. 115 [*non* GESNER, 1758; *nec* GMELIN, 1793; *nec* SOWERBY, 1824] [=*Spongites* GEINITZ, 1842 *(partim)* (*non* OKEN, 1815); *?Astrocladia furcata* GERSTER, 1881; *Goniophycus* DE SAPORTA, 1884]. Like *Palaeophycus*, used as general term for cylindrical and not vertical fillings of burrows (HÄNTZSCHEL, 1965). [Jr. hom.] *Mesoz.*, Eu.

Gordioides FRITSCH, 1908, pl. 11 [*nom. nud.*] [**G. spiralis*; M]. *Sil.*, Eu.(Czech.).

Itieria DE SAPORTA, 1872, p. 122 [jr. hom.; *non* MATHERON, 1842] (ANDREWS, 1955). *U.Jur.*, Eu. (France).

Leuconoe BOGACHEV, 1930, p. 73 [jr. hom.; *non* BOIE, 1830] [**L. paradoxa*; M]. Larva of arthropod of unknown systematic position (HÄNTZSCHEL, 1965). [Found in flysch deposits.] *L.Tert. (low. Eoc.)*, USSR.

Lunula HITCHCOCK, 1865, p. 17 [*non* KOENIG, 1825, *nec* LAMARCK, 1812] [**L. obscura*; M]. Trail consisting of narrow axis, with laterally extended lunate impressions on both sides (HITCHCOCK, 1865). [Possibly made by phyllopod or myriapod; jr. hom.] *Trias.*, USA(Mass.).

Montfortia LEBESCONTE, 1887, p. 782 [jr. hom.; *non* RECLUZ, 1843]. Small horizontal, oblique, or perpendicular burrows, 1 to 2 mm. wide, occasionally showing annulation; very similar to *Planolites* (SEILACHER, 1956a). [Probably worm trails; not a sponge as interpreted by LEBESCONTE.] *Precam.*, Eu.(France).

Nisea DE SERRES, 1840, p. 13 [*non* RAFINESQUE, 1815 *(nom. nud.)*] [=*Nemausina* DUMAS, 1876]. Irregularly shaped globular or ellipsoidal bodies which give off 2 or more long, transversely striped or slightly segmented tubes (HÄNTZSCHEL, 1965). [Interpreted as annelids, mollusks, or coelenterates.] *L.Cret.*, Eu.(S.France).

Palaeocrista HUNDT, 1941, p. 70 [*nom nud.*; diagnosis and designation of type species missing] (HÄNTZSCHEL, 1965). *L.Ord.*, Eu.(Ger.).

"?Palaeoscolex ratcliffei" ROBISON, 1969, p. 1172. Burrows, 7 to 10 mm. wide, mostly flattened; filled with ovoid pellets, 1.5 mm. long, 0.5 mm. wide; burrows sometimes containing bundles of pellets and thus similar to pelletal clusters known as *Tomaculum* GROOM. [In one of these burrows a body remain of the annelid *Palaeoscolex ratcliffei* ROBISON (1969, p. 1171) has been found; ROBISON believed these burrows were made by that annelid but he wrongly used the name for the burrow of its supposed producer.] *M.Cam.(Spence Sh.)*, N. Am.(USA, N.Utah).

Palaeotenia guilleri CRIÉ, 1883, p. 49. Name proposed by CRIÉ for *Fraena goldfussi* ROUAULT but obviously not used since 1885. *Ord.*, Eu.(France).

Parinassa HUNDT, 1941, p. 124 [**P. pennaeformis*; M] [*nom. nud.*; no diagnosis]. (Häntzschel, 1965). *L.Ord.*, Eu.(Ger.).

Phyllonia HUNDT, 1941, p. 53 [*nom. nud.*; diagnosis and designation of type species missing] (HÄNTZSCHEL, 1965). *L.Ord.*, Eu.(Ger.).

Platyrhynchus GLOCKER, 1850, p. 940 [jr. hom.; *non* LEUCKART, 1816, *nec* SWAINSON, 1820; *nec* CUVIER, 1826; *nec* WAGLER, 1830; *nec* AGASSIZ, 1846; *nec* VAN BENEDEN, 1876; *nec* CHEVROLAT, 1882] [**P. problematicus*; M] (HÄNTZSCHEL, 1965). Probably a track; similar to *Dreginozoum*. *?U.Cret.*, Eu.(Ger.).

Portelia BOURSAULT, 1889, p. 728 [jr. hom.; *non* DE QUATREFAGES, 1850] [**P. meunieri*; M]. Nondescript, branched cylindrical fillings of tunnels; very poorly figured (ANDREWS, 1955). *U.Jur.*, Eu.(France).

Sagittarius HITCHCOCK, 1865, p. 16 [jr. hom.; *non* VOSMAER, 1767; *nec* HERMANN, 1783] [**S. alternans*; M]. Two parallel rows of delicately curved tracks, with concave sides toward each other, resembling many small bows alternating with one another (HITCHCOCK, 1865). [Insect trail.] *Trias.*, USA(Mass.) (See HÄNTZSCHEL, 1962, fig. 129,*3*).

Saltator HITCHCOCK, 1858, p. 137 [jr. hom.; *non* VIEILLOT, 1816]. Inorganic markings or tracks made by animals moving by leaps; 2 "species" having little in common (HITCHCOCK, 1858). *Trias.*, USA(Mass.).

Schaderthalis HUNDT, 1931, p. 51, 56 [*nom. nud.*, no description nor diagnosis, 3 poor figures only] [**S. bruhmii*; M] [=*Schaderthalia* HUNDT, 1931, p. 67 *(nom. null.)*]. Very numerous tiny furrows, arranged parallel and closely adjacent, smooth and sharply incised; similar to finger impressions. [*"Schaderthalia"* regarded by SEILACHER (1960, p. 49) as identical to *Lophoctenium globulare* GÜMBEL, 1879, p. 469 (*nom. nud.*; no description nor diagnosis, figure only); PFEIFFER (1968, p. 672) ascribed *"Schaderthalis"* to his ichnogenus *Agrichnium* as *A. bruhmi* (PFEIFFER, 1968) though being much smaller than the type species *A. fimbriatum* (LUDWIG) and differing from it in much more regular arrangement and parallelism of the furrows.] *Low. (?) M. Dev. (Nereiten-Quarzit)*, Eu.(Ger., Thuringia).

Sphenopus FRITSCH, 1908, p. 11, 12 [jr. hom.; *non* STEENSTRUP, 1856] [**S. pectinatus*; M] (FRITSCH, 1908). *Ord.*, Eu.(Czech.).

Tubotomaculum RICHTER in GÓMEZ DE LLARENA, 1949, p. 117, 127 [=*nom. nud.*, used in title of announced but never published paper] (see under *Tomaculum* GROOM, 1902, p. W143)].

Tubulites H. D. ROGERS, 1838 [*nom. nud.*, provided for *Skolithos* HALDEMAN, not published; preoccupied by *Tubulites* GESNER, 1758].

Vermiculites ROUAULT, 1850, p. 744 [jr. hom.; *non* BRONN, 1848] [**V. panderi*; M]. Poorly described and never figured (ANDREWS, 1955). *Ord.*, Eu.(France).

Wellerites FLOWER, 1961, p. 115 [*non* PLUMMER & SCOTT, 1937] [**W. gracilis*; OD]. Long, slender, calcareous tubes, somewhat widening distally, 1 mm, long, 0.3 mm. wide; at bases forming small colonies attached to *Catenipora*; known only from single thin section. [Systematic position unknown.] *Ord.*, USA(N.Mex.).

Zonarites VON STERNBERG, 1833, p. 34 [jr. hom.; *non Zonarites* RAFINESQUE, 1831] [**Fucoides flabellaris* BRONGNIART, 1823, p. 311; SD ANDREWS, 1955, p. 262] [Probably = *Zonarides striatus* SQUINABOL, 1887 (*Saportia* SQUINABOL, 1891), as well as plants (e.g., *Z. digitatus* VON STERNBERG, 1833, = *Zonarides* SCHIMPER, 1869)]. "Genus" comprising starlike trace fossils (e.g., *Z. alcicornis* FISCHER-OOSTER, 1858) (ANDREWS, 1955). [According to SEILACHER (1955), branched feeding burrows with fecal pellets stuffed transversely into them. FUCHS (1895, p. 408) considered *Zonarites alcicornis* to belong to *Phymatoderma* BRONGNIART, 1849.] *?Perm., Tert.*, Eu.

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