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TRACE FOSSILS AND PROBLEMATICA

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CONTENTS

INTRODUCTION

A vast majority of the fossils dealt with in this part of the *Treatise* consist of tracks, trails, and burrows; these collectively may be designated as *trace fossils.* Only a small minority are *body fossils,* all of them difficult to interpret and doubtful as to classificatory status. Actually, a considerable number of the so-called body fossils are not fossils at all, since they have come to be recognized as inorganic structures. Those that formerly were given a generic name (e.g., *Eozoon, Eophyton*) are summarized under a separate heading at the end of the text. Trace fossils and doubtful sorts of body fossils are often termed *Problematica,* because of their more or less obscure nature.

Although a large part of the trails and burrows were made by worms, they are treated here rather than in the chapter on worms, which is restricted to such body fossils as are normally attributed to annelids and other phyla of worms.

Owing to lack of a satisfactory classificatory system for the fossils here dealt with, their names have been arranged alphabetically within the several parts, because this is most convenient for reference.

Tracks, trails, and burrows are often hard to interpret, leaving considerable uncertainty as to origin, and thus they never have been very popular with paleontologists. Their importance for paleozoology is small and they can only rarely be used as index fossils. In almost all textbooks on paleontology a detailed chapter on trails and burrows *(Lebensspuren)* is missing. The present treatment is the first one which tries to cover all forms so far described and to deal with them uniformly. In the future it will certainly be necessary to make corrections, especially in nomenclature, for it is often extremely difficult or impossible to assign type-specimens in this special field of paleontology. Here, "genera" and "species" do not have the usual taxonomic meaning, but are only supposed to indicate a certain formal assemblage. The naming of fossils, their delimitation, and thus their synonymy is nowhere in paleontology so dependent on personal opinion as in this group of fossils.

DEFINITIONS

hieroglyphs (FUCHS, 1895). "Problematical fossils. . . . , which . . . in their appearance are suggestive of drawings, ornaments or even letters."

ichnocoenosis (LESSERTISSEUR, 1955). An association of *Lebensspuren,* corresponding to "biocoenosis."

ichnofossil (German, *Spuren-Fossil,* SEILACHER, 1953). Trace fossil.

Ichnolites (E. HITCHCOCK, 1841). Name proposed for a "class" including all sorts of tracks.

ichnolithology (E. HITCHCOCK, 1841). Same as ichnology, but term not widely adopted.

ichnology (BUCKLAND, about 1830). The entire field of *Lebensspuren* (all tracks, trails, and burrows); in the fossil state, paleoichnology or palichnology; Recent, neoichnology.

Lebensspur (ABEL, 1912) (French, *trace d'activité* LESSERTISSEUR, 1955). Trace fossil or ichnofossil; also used for Recent tracks and burrows; introduced into English literature by Japanese authors. ABEL included also pathological phenomena, etc. Shortest definition (given by HAAS, 1954, and improved by SEILACHER, 1955): "Lebensspuren are structures in the sediment left by living organisms."

Spreite. German noun literally translated as "spread," meaning something spread between two supports, as the web of a duck's foot.

trace fossil (S. SIMPSON, 1956, originally published without definition but the following one given by SIMPSON in 1957). Sedimentary structure resulting from the activity of an animal moving on or in the sediment at the time of its accumulation; includes tracks, burrows, feeding marks, and other traces.

tracks (PETTIJOHN, 1957). Impressions left in soft material by the feet of animals.

trails (PETTIJOHN, 1957). More or less continuous markings left by an organism as it moved over the bottom.

vestigiofossil (MOORE, 1956). Unpublished suggestion to replace the term "ichnofossil" because of its bilinguistic derivation from both Latin and Greek.

GEOLOGICAL OCCURRENCE

Trace fossils and problematic fossils occur in the minerogenic and biogenic, marine, limnic, and continental sedimentary rocks of all geologic systems from the Precambrian to the Recent. In a number of rocks they are so characteristic and numerous as to furnish the name of the stratigraphic unit, e.g., *Scolithus* [*recte Skolithos*] Sandstone, Fucoid Sandstone, Grès à *Harlania,* etc. In this type of sediment contemporaneous body fossils are usually absent, but the trace fossils inform us of the existence of large numbers of bottom-dwelling animals. Trace fossils can thus give much information about the area of sedimentation. A prerequisite to this use of trace fossils is sufficient knowledge of the Recent *Lebensspuren* of all biotopes, a goal which neoichnology has yet to attain.

PRESERVATION

Lebensspuren are very transient structures as compared with shells, skeletons, or other hard parts, and in general they have little chance of being preserved as fossils. Nevertheless, the large number of trace fossils in many marine, limnic, and even continental sediments shows that their fossilization is possible. A favorable consistency and rapid solidification of the sediment are prerequisites. Among other factors, grain size of the sediment is correlated with distinctness of preservation.

Trace fossils occur as deformations of the sediment or its bedding planes. Burrows may be preserved as hollows or fillings of hollows. Often animal activity is indicated merely by the disturbance of the lamination as seen in vertical sections (*Wühl-Gefüge* or *Fossi-Textur* of RUDOLF RICHTER).

Only a part of the *Lebensspuren* become imprinted on the surface of the sediment. Surface tracks and trails, especially various footprints, are likely to be exposed to destruction by flooding or by shifting of the topmost strata at the bottom of shallow seas and only a small fraction of them are preserved.

SEILACHER emphasized recently that many *Lebensspuren* are made *within* deposits of sediment *(Innen-Spuren)*, mainly at the level of the boundary between a sand and underlying clay layer. This holds good for complete forms and especially for reliefs ("demireliefs" of earlier literature). The latter are found at the lower surface of sandstone beds and represent sand fillings of impressions made on the surface of clay within the sediment. They are distinguished from surface tracks on sand by their much more distinct preservation, as verified by experiments with Recent animals. SEILACHER calls this type of preservation "positive endogenic hyporelief" and depending on the mode of formation, he distinguishes epi- and hyporeliefs; either of them may be exogenic or endogenic and positive or negative.

Occasionally, a repetition of like forms close by or on top of each other may be observed (horizontal and vertical repetition of SEILACHER). In the fossil state this phenomenon may represent the work of starfishes and ophiuroids (e.g., *Asteriacites* SCHLOTHEIM). The animal that produced the trails causes repetition of them by changing its resting place. Impressions of this type are certain indications of trails, as opposed to body fossils.

HISTORICAL REVIEW

No complete history of palichnological investigations has yet been written. WINKLER (47) published a chronologically arranged annotated bibliography covering palichnological publications for the period 1828 to 1886. The following section will describe only a few stages of the rather intermittent development of this branch of paleontology. Among the very numerous (more than 1,000) publications on palichnology since about 1820, very few have dealt with the entire subject; the more complete works include FUCHS' (10) discussion of the *Fucoiden und Hieroglyphen*, ABEL's (1) *Vorzeitliche Lebensspuren*, LESSERTISSEUR's (23) *Traces d'activité*, and SEILACHER's (38-42) not yet completed series on *Studien zur Palichnologie*.

In the early years of paleontology many fossils, especially cylindrical and U-shaped burrows, which have now been identified as *Lebensspuren*, were considered to be remains of marine algae. This is apparent in names like *Fucoides, Algacites, Chondrites,* and the many generic names ending with *-phycus*. It was the ramification of the burrows which was considered most conclusive evidence for their interpretation as plants. In publications on these "algae" Recent Thallophyta were commonly figured in order to show the identity or relationship of the fossil form with them. Occasionally, even the drawings of the fossils were modified so as to make them look more like algae.

In 1881 NATHORST (28), on the basis of systematic neoichnological observations, pointed out the striking similarity of many Problematica with the tracks and trails of marine invertebrates. This evidence, together with previously published (1873) information that animal trails may ramify, permitted NATHORST to challenge the doctrine of plant origin for these fossils. Simultaneously, but independently, JAMES (19) in the United States, expressed the same conviction as the Swedish scientist, although his papers have often been overlooked. He showed most of the algal interpretations to be untenable and cautioned urgently against the widespread practice of merely describing and naming isolated and often insufficiently preserved findings. It is indeed proper that this habit of referring every mark found in the rocks of the earth to some sort of organism, and calling all uncertain marks marine plants, should be protested. If the practice is not discontinued, the nomenclature of the science will be so encumbered with useless names that chaos will result. As JAMES put it, when "every turn made by a worm or shell, and every print left by the claw of a Crustacean is described as a new addition to science, it is time to call halt and eliminate some of the old before making any more new species."

Only gradually did NATHORST's interpretation of many fossil "algae" as *Lebensspuren* become generally accepted. Several authors, led by DE SAPORTA, opposed him, and between the years 1880 and 1885 violent discussions between the representatives of the two schools of thought took place, as can be shown by the many publications of DE SAPORTA, DELGADO, NATHORST and others. Even today several "genera" of *Lebensspuren* (e.g., *Chondrites, Fucoides*), are sometimes interpreted as algae. Recent Canadian and Indian papers refer typical fucoids to "algae." FUCINI, in extensive publications, described Problematica, mainly inorganic markings, as plant fossils. Other trace fossils, such as the strange "spreadburrows" *(Spreiten-Bauten)* are not yet generally accepted as such (e.g., some French authors), and sometimes they are still considered body fossils. The discussion about these problematical fossils has lasted for decades, modern counterparts having been found only quite recently. FUCHS (10), after an extensive study of the vast material kept in European collections, on the whole confirmed NATHORST's interpretations. A number of especially peculiar forms, such as the "genera" *Paleodictyon, Hercorhaphe,* and *Spirorhaphe,* summarized under the term hieroglyphs *(Graphoglypten),* were assumed by FUCHS to be spawn, presumably of gastropods. Similar interpretations are still being discussed for similar forms (e.g., *Spirodesmos*).

After tens of years of stagnation following the turn of the century, substantial progress was made in *Lebensspuren* studies by ABEL and his pupils and especially in the course of "actuopaleontologic" investigations in marine biology of the North Sea tidal flats by RUDOLF RICHTER. His studies included a survey of Recent and fossil worm trails and burrows, an elucidation of general questions of palichnology and their utilization for paleogeography, an interpretation of many Problematica, as well as an analysis of numerous arthropod trails and Recent and fossil U-shaped burrows. The efforts and results of RICHTER's collaborators at the marine-geologic Forschungsanstalt "Senckenberg" in Wilhelmshaven (HÄNTZSCHEL, SCHÄFER, SCHWARZ, TRUSHEIM) are to be found in the same general direction. The most recent contributions are those of SEILACHER, which are also based on thorough investigations of Recent and fossil materials. He merits consideration for his realization that the majority of fossil *Lebensspuren* are made inside the sediment (interior traces), and especially for his well-thought-out, ecologically founded classification of all *Lebensspuren*.

CLASSIFICATION

The possible diversity of *Lebensspuren* made by an individual animal, dependent on its activity (crawling, eating, running, burrowing, swimming), and the dependence of traces on fortuitous properties or conditions of the sediment, make it impossible to classify *Lebensspuren* in a manner corresponding to a zoological pattern. One can not arrange all trace fossils according to their producers, because the makers of *Lebensspuren* can only rarely be detected unequivocally. In early stages of paleontological research, when trace fossils were mostly interpreted as marine algae, they were arranged exclusively according to morphological characters. The shape of the "thallus" was regarded as a determining factor; fucoid species were distinguished according to the angle of divergence of their branches.

FUCHS (10), admitting them to be trace fossils, tried to arrange them in family-like groups, mainly after morphological criteria: crawling trails and burrows, hieroglyphs, fucoids, and *Spreiten*-burrows classed as Alectoruridae ("the darkest and most enigmatical area in the kingdom of the problematical fossils"). The difficulties of classification, partly due to many homeomorphies, caused RICHTER to express caution against too narrow a grouping of trace fossils. He gave good examples of a possible simple classification in his distinction of U-shaped burrows with or without *Spreite* (Rhizocorallidae, Arenicolitidae) and in his division of worm trails and burrows according to "architectural basic forms" *(bauliche Grund-Formen)* on a mechanical and biological basis. KREJCI-GRAF (22) suggested a very detailed classification on a genetic basis, distinguishing superordinal units consisting of tracks (organic and inorganic), trails, burrows, hieroglyphs, and fucoids. Chiefly, he gave definitions of these units and an extremely detailed subdivision with isolated examples, but no real classification of the trace fossil genera.

Classification according to ecological principles proposed by SEILACHER (1953) is based on the fact that different groups of animals with similar life habits produce trails with similar basic characters, even though the animals themselves have quite different body shapes. Working out these common basic characters he recognized five groups: dwelling burrows (Domichnia); feeding burrows (Fodinichnia); feeding trails (Pascichnia); resting trails (Cubichnia) (="repose imprints" KUENEN, 1957); and crawling trails (Repichnia). For each of these groups characteristic features may be noted. Thus many *Lebensspuren,* provided that they are well preserved, become attributable to one of these groups, which may be characterized as follows:

(1) DOMICHNIA, simple or U-shaped tunnels made in the sediment at right angles to the surface, representing the permanent domicile of hemisessile anglers or whirlers;
(2) FODINICHNIA, extensive tunnels and tunnel systems with good utilization of space and surface, used by hemisessile sediment-eaters simultaneously as domicile and "mine" or hunting-ground;
(3) PASCICHNIA, highly winding bands or tunnels, not crossing each other, with intense utilization of the surface available for grazing or feeding that often results in surface ornamentation such as meanders ("parqueting," *Parkettierung*);
(4) CUBICHNIA, isolated impressions with outlines corresponding roughly to shapes of their producers, often arranged parallel to each other as a result of like orientation (rheotactic rectification) toward currents (vertical and horizontal repetition possible);
(5) REPICHNIA, furrows, longitudinal swellings, and crawling tunnels of variable direction, ramified or unramified, smooth or sculptured.

SEILACHER's system has the advantage of collecting ecologically similar groups of *Lebensspuren.* Questions as to identity of their producers may be disregarded here, for these can only rarely be answered unequivocally from morphological criteria. The characterization of groups is independent of time; for example, the assemblage termed Cubichnia is equally valid for extinct arthropods of the Paleozoic (e.g., trilobites), as for Recent arthropods that have a corresponding way of life.

The classification suggested by LESSERTISSEUR (23) is based mainly on morphological features and distinguishes *traces exogènes* (simple bilobate, and trilobate crawling trails, meanders, spirals, starlike trails, etc.) and *traces endogènes* (burrows and tunnels of various forms, fucoids, resting trails, U-shaped burrows with or without *Spreite* and screw-shaped burrows).

NOMENCLATURE OF TRACE FOSSILS

It has become customary to use binary nomenclature for trace fossils in the same way as that used for body fossils. With trace fossils, however, "genera" and "species" have a different meaning from that which is applicable to body fossils. As may be understood from the history of palichnology, the number of names created is much greater than is necessary. Much too finely differentiated genera and species have been distinguished as a result of their having been thought to be plant fossils. This is especially true for the host of fucoids, as evidenced by description of the "genus" *Fucoides* by JAMES (1894). The numerous isolated descriptions scattered throughout world literature in paleobotanical, paleozoological, faunistic, stratigraphical, regional geological, and strictly palichnological papers have led to an excessive number of described genera and species. Owing to the world-wide distribution of numerous trace fossils and to their frequently considerable vertical ranges the "new" forms were often published without knowledge or consideration of earlier literature. As early as 1884, JAMES (19) pronounced an unheeded warning against the ballast of useless names.

Binary nomenclature has not been accepted universally for problematical fossils. Many authors have declined to give formal names to trace fossils, an understandable and justified procedure, especially with poorly preserved forms. However, experience shows that these unnamed forms usually escape notice in later literature. Furthermore, several attempts have been made to name trails simply as "species" of one genus, *Ichnium,* including trails of vertebrates as well as invertebrates. It is also possible to give purely descriptive names to morphologically corresponding assemblages (e.g., *Ichnia catenaria, Ichnia spicea*), if an individual description or name is to be avoided.

FAUL's (1951) suggestion that vertebrate tracks be designated by formulas has little chance of becoming generally accepted; in any case this is not applicable to trails of invertebrates.

Despite its drawbacks, the binary system appears to be the most suitable one. It is unavoidable that trace fossils, which were formerly assumed to be bodily preserved plants or animals and were named accordingly, now carry inconsistent names and must retain them (e.g., *Fucoides*, for feeding burrows of marine animals, and *Spongia ottoi* GEINITZ, for the feeding trail of an arthropod or worm). It is inadmissible to name the trail by the neozoological name of the presumed producer, as was done for a beaded trail from the German Jurassic called *Corophium* by PUTZER.

Addition of the suffix *-ichnus* to the generic name of trace fossils is recommended in order to render them immediately recognizable. If, in addition, the name offers a morphological mark of distinction (e.g., *Sagittichnus* SEILACHER) or if the producer can clearly be indicated (e.g., *Pelecypodichnus* SEILACHER), such a name will convey a clear conception of the named object. When giving new names this aim ought to be kept in mind.

IMPORTANCE OF TRACE FOSSILS FOR STRATIGRAPHY, PALEOGEOGRAPHY, AND PALEOECOLOGY

Lebensspuren usually have little importance in stratigraphy. In restricted areas, however, they may attain the rank of index fossils for the field geologist. A burrow (e.g., *Arenicolites franconicus* TRUSHEIM, from the Muschelkalk of Southern Germany) may serve as an example; this fossil occurs abundantly in a layer only 3 to 4 cm. in thickness and may be followed for a horizontal distance of 26 km.

The vast majority of trace fossils remain unchanged through the geologic eras. This is true for nondescript, smooth furrow-like crawling trails and cylindrical burrows, as well as for more distinctive U-shaped burrows with *Spreite* and even for the honeycomb-like networks named *Paleodictyon* which are known from Silurian to Tertiary time. Only occasionally do trace fossils turn out to be true index fossils; one example is the beaded coprolite, *Tomaculum* GROOM, which so far has been found only in Ordovician strata of England, France, Czechoslovakia, and Germany.

In structurally complicated areas where inverted beds must be reckoned with, burrows and trails may be useful for distinguishing the top and bottom of strata. Especially well suited to this purpose are U-shaped burrows, which are invariably built either horizontally or with the curved part toward the bottom. Similarly, a sequence of strata may be correctly oriented with the help of footprints of vertebrates or of *Lebensspuren* preserved in relief at the bottom of a sandstone bed overlying clay.

Trace fossils may be useful for paleoecologic and paleogeographic investigation of ancient habitats, if their ecological significance is understood. Whereas faunas mostly represent thanatocoenoses, the trace fossils are important as examples of autochthonous life within or on the sediment.

Our insufficient knowledge of Recent trails and traces makes difficult the use of trace fossils for reconstruction of areas of sedimentation. Recent *Lebensspuren* have been thoroughly investigated in only a few biotopes, especially on the shore and in shallow seas. Besides, we know mainly surface traces. Therefore, *Lebensspuren* often have been considered to be evidence of sedimentation in shallow seas, especially if other assumed criteria for shallow seas, such as ripple marks, seemed to confirm this deduction. Such assumptions are dangerous, since digging and burrowing animals and ripple marks have been identified in submarine photographs taken at considerable depths. Drilling cores taken by the Albatros Expedition from depths of more than 5,000 m. are reported to be shot with burrows of unknown animals. Similarly, the presence of *Lebensspuren* must not be taken as certain indication that the sediments concerned were laid down under the influence of the tide, that is, in areas of sedimentation corresponding to tidal flats of the Dutch and German North Sea coast. Trails and traces offer no certain criteria for the recognition of fossil *Watten* (HÄNTZSCHEL, 1953, 1955).

Perhaps one may draw conclusions concerning the area of sedimentation from "ichnofacies" features comprising associations of traces, which so far have received little notice. SEILACHER (1954) found conspicuous differences between the ichnofacies of the Flysch and that of the Molasse, as well as in older sediments of corresponding types. However, further investigations are needed before ichnofacies may be safely used in paleogeographic studies; present conclusions are highly tentative.

TRACE FOSSILS

The definition of "trace fossils" in the introduction shows which fossils are to be dealt with in this chapter. They might have been arranged according to the system based on ecological principles suggested by SEILACHER, which does justice to their peculiarities as compared with body fossils. However, inasmuch as many genera cannot at present be placed within this system, the genera are arranged alphabetically here for simplicity and easy reference. Besides, the individual descriptions generally indicate the position of the trace fossil within SEILACHER's system.

The author wants to emphasize again that with the trace fossils the meaning of "genus" differs much from that applicable to body fossils. In a number of instances it has been impossible to prepare clear, exact and unequivocal descriptions because of unsatisfactory original illustrations, unavailable or lost type material, and varying opinions as to the limits of the "genera." Likewise, great diversity of the fossils themselves, and the generally unsatisfactory status of trace-fossil research have adversely affected the preparation of meaningful descriptions. The writer is well aware of the shortcomings of this work.[1]

SYSTEMATIC DESCRIPTIONS

Acanthichnus HITCHCOCK, 1858. Linear trails of insects, in 2 parallel rows; each impression turned slightly outward, generally quite numerous; tracks opposite; "genus" including widely different "species" (17). *Trias.*, USA(Mass.).

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

Annelidichnium KUHN, 1937 [**A. triassicum*]. Tunnel fillings with irregular sculpture; ornamented with sharp or rounded longitudinal ridges or blunt tubercles (16). *U.Trias.*, Ger.

Archaeonassa FENTON & FENTON, 1937 [**A. fossulata*]. Trails made by Gastropoda; see "group" *Scolicia* DEQUATREFAGES, 1849 (p. W215) (23). *L.Cam.*, Can.(B.C.).

Arenicolites SALTER, 1857 [**Arenicola carbonarius* BINNEY, 1852]. U-shaped, thick or thin, rounded

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[1] It should be noted that in some of the generic descriptions that follow, designation of the author as well as the date of the type-species is lacking. In every such case the pertinent information is unobtainable, owing to the rather casual way that trace fossils have commonly been treated in the literature.

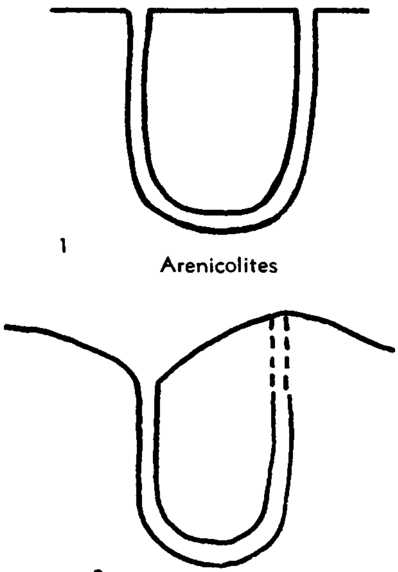


FIG. 109. Trace fossils (p. W183).

or compressed burrows without *Spreite;* walls unsculptured, sculptured, or lined; perpendicular to bedding plane (1,23). *Cam.-Rec.,* Eu.-N.Am.——FIG. 109,*1. A.* sp. SALTER; *schematic* (130).——109,*2. A. franconicus* TRUSHEIM; schem. cross sec. of burrow, ×0.8 (130).

Arthraria BILLINGS, 1874 [**A. antiquata*]. Bars on bedding surfaces with spheroidal expansions at each end, similar to pair of dumbbells; related to *Bifungites* DESIO (6). [The specimens from the Cincinnatian of Ohio, according to CASTER's and the author's investigations, are certainly U-shaped burrows with *Spreite,* similar to and possibly identical with *Corophioides* or *Diplocraterion* (33).]. *Cam.-Dev.,* N.Am.

Arthrophycus HALL, 1852 [**Fucoides alleghaniensis* HARLAN, 1831 (=*Fucoides harlani* CONRAD, 1838; *?Rauffella palmipes* ULRICH, 1889)] [=*Harlania* GOEPPERT, 1852; *Arthrophicus* PACHECO, 1908 (obj.); *Arthrichnites* (author, date unknown)]. Curving "stems," simple or usually in bunches; surface showing regularly spaced transverse ridges, commonly bearing median depression; "branches" may reach length of 2 feet (60 cm.) or more; variously regarded as inorganic, seaweed, burrows, or trails produced by arthropods or worms; for most probable explanation as feeding burrows see SARLE, 1906, and SEILACHER (41). [According to SEILACHER, the "genus" can be regarded as a synonym of *Phycodes* RICHTER, 1850 (1,23).] *Sil., ?Dev.,* N.Am.-S.Am.-N.Afr.-?Eu.——FIG. 111,*3.* **A. alleghaniensis* (HARLAN), L.Sil., N.Y.; ×0.3 (Häntzschel, n).

Asabellarifex KLÄHN, 1932. Poorly founded, rather superfluous "genus" proposed for vertical burrows resembling *Sabellarifex,* but believed to be burrowed in downward direction, not built upward as tubes like *Sabellarifex* (16). *L.Cam.(Pleist.* drift), Ger.-Swed.

Asaphoidichnus MILLER, 1880 [**A. trifidus*]. Trackways with 2 rows of impressions comprising separate and distinct tracks, anterior third of each track trifid and thrown outward, middle toe a little longer than others; distance between rows about 1.5 inches (37.5 mm.) (23). [Probably made by trilobites.] *Ord.,* USA(Ohio).——FIG. 110,*3. A. dyeri* MILLER; ×0.5 (100).

Asteriacites SCHLOTHEIM, 1820 [*non* SCHLOTHEIM, 1822] [**A. lumbricalis*] [=*Heliophycus* MILLER & DYER, 1878; *Spongaster* FRITSCH, 1908 (*non* EHRENBERG, 1860)]. Impressions in form of starfishes with transversely sculptured arms, commonly showing horizontal or vertical repetition (39). [Interpreted as resting tracks of brittle stars, auluroids, and asteroids.] *Sil.-Tert.,* Eu.-N.Am.——FIG. 110,*2.* **A. lumbricalis,* L.Jur., Ger.; ×0.5 (39). (See also FIG. 130,*4.*)

Asterichnites BROWN & VOKES, 1944 [**A. octoradiatus*]. Rows of stellate imprints, each consisting of unmarked central disc and 8 radiating grooves 13 to 18 mm. long; arranged in rows on stratification planes (16). [Probably produced by tentacles of dibranchiate cephalopod.]. *L.Cret.,* N.Am.——FIG. 110,*1.* **A. octoradiatus,* Mowry Sh., USA (Mont.); *1a,b,* ×0.08, ×0.6 (55).

Asterophycus LESQUEREUX, 1876 [**A. coxii*]. "Front" expanded at its base in 5 flattened starlike oblong or obovate divisions; surface wrinkled longitudinally; diameter 6 to 12 cm. (16). [Interpreted by DAWSON (5) as burrows of ?worms.] *Carb.,* N.Am.——FIG. 111,*1.* **A. coxii,* Ky.; ×0.3 (93).

Asterosoma VON OTTO, 1854 [*non* GRUBE, 1867] [**A. radiciforme*]. Big stars (diameter ca. 20 cm.) with elevated center; rays bulbous, tapering toward ends, longitudinally wrinkled (16). [Very probably burrows with radiating (?feeding) trails.] *U.Cret.(Turon.),* Eu.——FIG. 111,*2.* **A. radiciforme,* Ger.; ×0.3 (103).

Astropolithon DAWSON, 1878 [**A. hindii*]. Oval depressions surrounded by raised ridge from which several raised lines radiate, in some forms bifurcating; rays poorly developed, especially in smaller specimens. [Originally explained as "fucoids with radiating fronds" but later (DAWSON, 5) as mouths of large burrows with radiating trails. No type or other specimen could be located.] *L.Cam.,* Can.(Nova Scotia).——FIG. 112, *5.* **A. hindii;* ?×0.7 (5).

Atollites MAAS, 1902 [*non* ZUBER, 1910] [**A. zitteli*]. Starlike fossils, formerly regarded mostly as belonging to Scyphozoa (*Treatise,* p. *F73,* Fig.

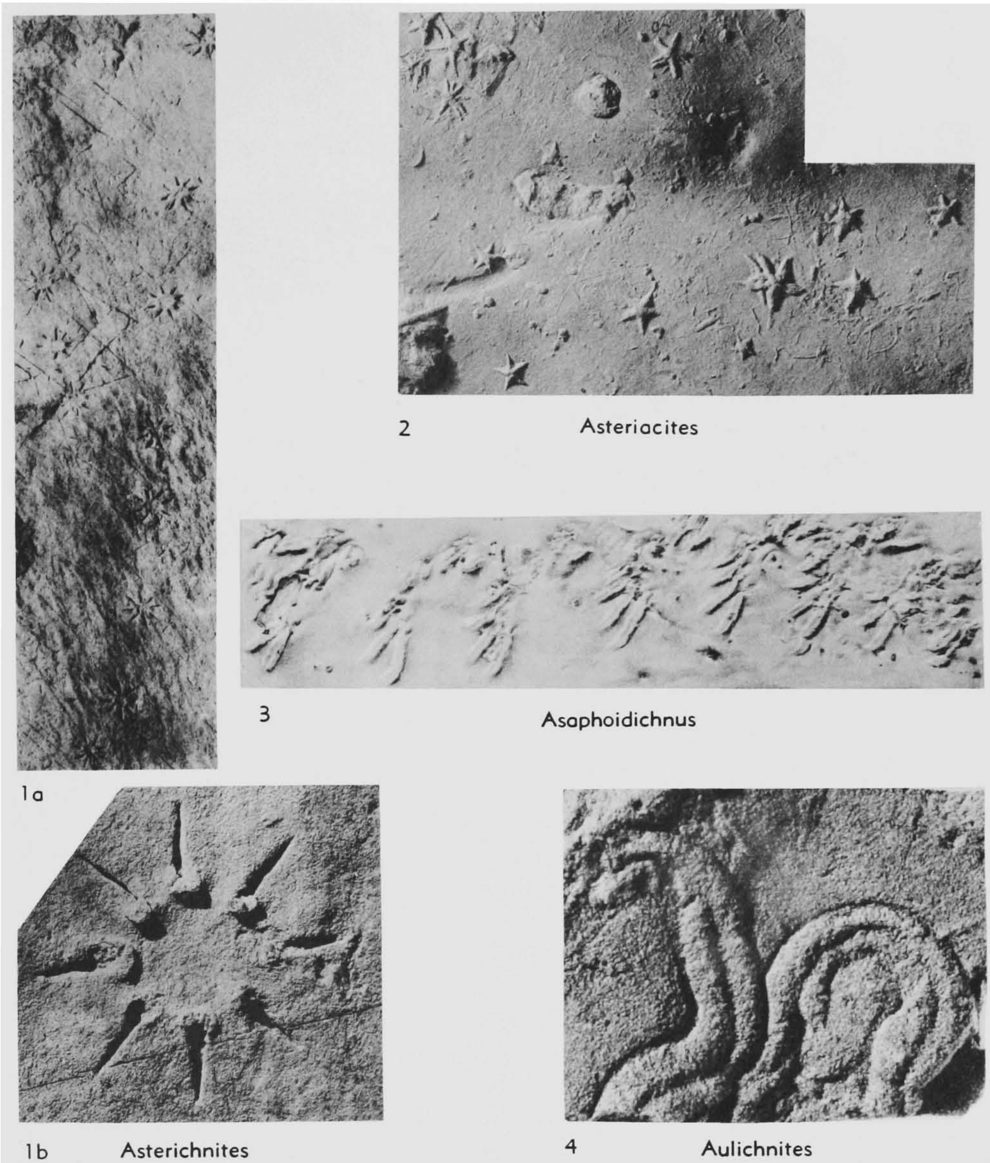


FIG. 110. Trace fossils (p. *W*184-*W*185).

59). [Very probably starlike feeding trails; resembling some forms of *Lorenzinia*.] *L.Cret.*, Czech.

Aulichnites FENTON & FENTON, 1937 [**A. parkerensis*]. Very similar to *Scolicia* DE QUATREFAGES, 1849 (3) but without elevated mesial ridge (23). *Penn.*, N.Am.——FIG. 110,*4*. **A. parkerensis*, USA(Tex.); ×1 (Howell, n).

Balanoglossites MÄGDEFRAU, 1932 [**B. triadicus*] [=*Unculiferus* HUNDT, 1941]. Burrows, 1 to 3 cm. wide and up to 15 cm. deep, irregularly branching, with several openings that do not taper; may bear transverse ridges and delicate longitudinal striations on wall (23). [Traces of the bristle rows of a polychaete(?).] *Ord., M.Trias. (Muschelkalk)*, Ger.

Bassaenia RENZ, 1925 [**Lorenzinia (B.) moreae*]. Sometimes regarded as subgenus of *Lorenzinia* GABELLI, 1900; more probably feeding trail than scyphozoan (*Treatise*, Part F, p. *F*43, Fig. 32,6). *U.Cret.*, Greece.

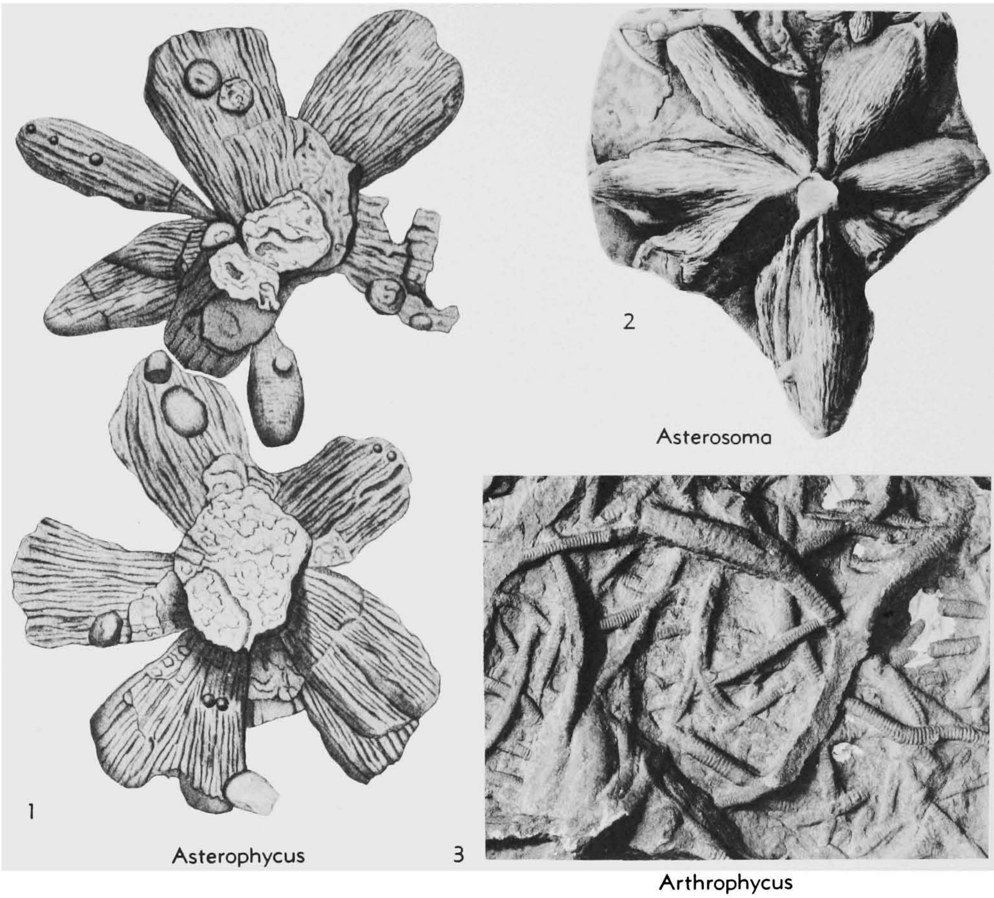


FIG. 111. Trace fossils (p. W184).

Belorhaphe FUCHS, 1895 [*Cylindrites zickzack* HEER, 1877] [=*Beloraphe* AUCTT.]. Sharply zigzag-shaped locomotion traces; commonly with short protrusions at corners (10). *Cret.-L.Tert. (Flysch)*, Eu.——FIG. 112,*1*. *B.* sp. FUCHS, Aus.; ×0.4 (10).

Bergaueria PRANTL, 1946 [**B. perata*]. Cylindrical protrusions with smoth walls; length and diameter subequal, about 40 mm.; lower end rounded, with shallow trough; at lower surface of bedding planes in sandstones (23). [?Resting trails of actinians.] *Ord.*, Czech.——FIG. 112,*4*. **B. perata*; *4a*, casts in overlying sandstone; *4b*, original burrow-cavities in underlying shale, ×0.3 (107).

Bifasciculus VOLK, 1960 [**B. radiatus*]. Feeding burrow, consisting of many (up to 40) tunnels, 2 to 3 cm. long, ending blindly, radiating from a center, bent slightly upward and downward (16). *Ord.(Griffel-Schiefer)*, Ger.——FIG. 113,*2*. **B. radiatus*; ×1 (133).

Biformites LINCK, 1949 [**B. insolitus*]. Bimorphous form, consisting of narrow section, partly divided by longitudinal furrows, continuing into wider section with prominent transverse ribs; resembles shafted hand grenade; fillings visible at lower surface of layers (24). [According to SEILACHER, comprises dwelling burrows *(Domichnia)*.] *U. Trias.(M.Keuper)*, Ger.——FIG. 114,*1*. **B. insolitus*; *1a*, ×0.8; *1b*, schematic, ×1 (24).

Bifungites DESIO, 1940 [**B. fezzanensis* (?=*Buthotrephis impudica* HALL, 1852)]. Structures like dumbbells within bedding planes, 2 to 3 cm. long; ends spherical or more commonly hemispherical; diameter up to 1 cm.; somewhat resembling *Arthraria* (41). *L.Cam.*, Pakist.; *Ord.*, Czech.; *?Sil.*, USA(N.Y.); *Dev.*, N.Afr.——FIG. 113,*1*. **B. fezzanensis*, M.Dev.-U.Dev., N.Afr.; ×0.7 (6).

Bifurculapes HITCHCOCK, 1858 [**B. laqueatus*; SD HÄNTZSCHEL, herein] [=*Bifurculipes*, *Biferculipes*, *Bifurcalipes* HITCHCOCK, 1865 *(errore)*]. Four regular rows of tracks, resembling small forks when united at base, as happens commonly; may have 2 additional rows; pairs of tracks opposite

(17). [Made by insects or crustaceans.] *Trias.*, USA(Mass.).——Fig. 112,*3*. **B. laqueatus*; ×0.7 (96).

Blastophycus Miller & Dyer, 1878 [**B. diadematus*]. According to James (1884), identical to *Trichophycus*. Seilacher (personal communication, 1955) regards these fossils as worm burrows projecting above surface of sediment (19). *Ord.*, USA(Ohio).

Bostricophyton Squinabol, 1890 [**B. pantanellii*; SD Andrews, 1955] [=*Bostrichophyton* Andrews 1955 *(errore)*]. Spiral threads, similar to *Chondrites intricatus* or *C. arbulescens* (16). *Cret.-L. Tert.*, Eu.——Fig. 112,*2*. **B. pantanellii*, Tert. (Flysch), Italy; ×0.7 (10).

Boteillites. According to Seilacher (personal communication 1956) name used in Italian paleontological collections for trace fossil from the Italian Flysch. [Probably manuscript name.]

Camptocladus Fenton & Fenton, 1937 [**C. intertextus*]. Nondescript, branched, flexuous, intertwined burrows; "genus" proposed on assumption that burrows are of crustacean origin (23). *Penn.*, USA(Tex.).

Caridolites Nicholson, 1873 [**C. wilsoni*]. Tracks, not described in detail; thought to be made by *Ceratiocaris* (16). *L.Paleoz.*, Eng.

Caulerpites Sternberg, 1833 [**Fucoides lycopodioides* Brongniart, 1828; SD Andrews, 1955] [=*Caulerpides* Schimper, 1869]. Very heterogeneous "genus" including plants (even conifers, according to Schimper) as well as trails (e.g., *C. marginatus* Lesquereux, 1869=aff. *"Taonurus"*; *C. annulatus* Ettingham, 1863=aff. *Keckia*; other "species" partly also classified with Recent genus *Caulerpa* Lamouroux, 1809; trails like *Nereites*, *Phymatoderma* and similar "genera").

Chondrites Sternberg, 1833 [*non* M'Coy, 1848] [**Fucoides targionii* Brongniart, 1828; SD Andrews, 1955] [=*Algacites* Schlotheim, 1822 *(partim)*; *Fucoides* Brongniart, 1823 *(partim)*; *"Gigartinites"* Brongniart, 1823 (not used as genus); *Caulerpites, Sphaerococcites* Sternberg, 1833 *(partim)*; *Buthotrephis* Hall, 1847; *Phymatoderma* Brongniart, 1849; *?Trevisania* Zigno, 1856; *Phycopsis* Fischer-Ooster, 1858; *Bythotrephis* Eichwald, 1860; *Nulliporites* Heer, 1865; *Chondrides, Leptochondrides* Schimper, 1869; *?Theobaldia* Heer, 1877 *(partim)*; *Palaeochondrites* de Saporta, 1882; *Chondropogon* Squinabol, 1890; *?Prochondrites* Fritsch, 1908; *Labyrinthochorda* Weissenbach, 1931; *Clematischnia* Wilson, 1948]. Very plantlike, regularly ramifying tunnel structures which neither cross each other nor anastomose; should be interpreted as dwelling burrows or feeding burrows; width of tunnels remaining equal within a system, otherwise varying from large (e.g., *Buthotrephis*) to small (e.g., *Chondrites*); very common trace fossil, usually named "fucoid"; some with transverse-

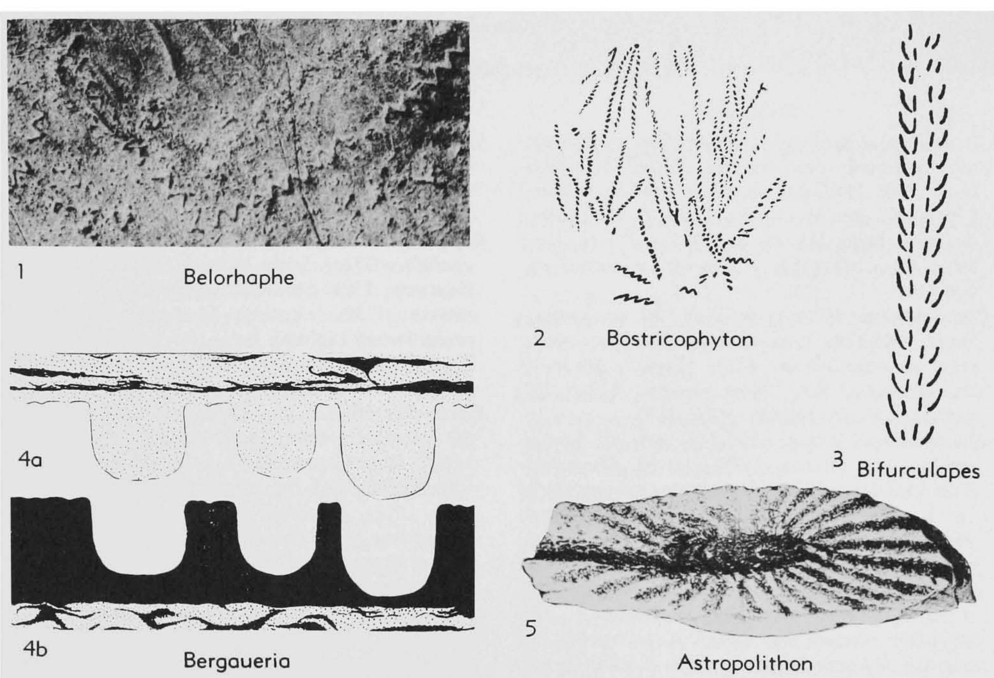
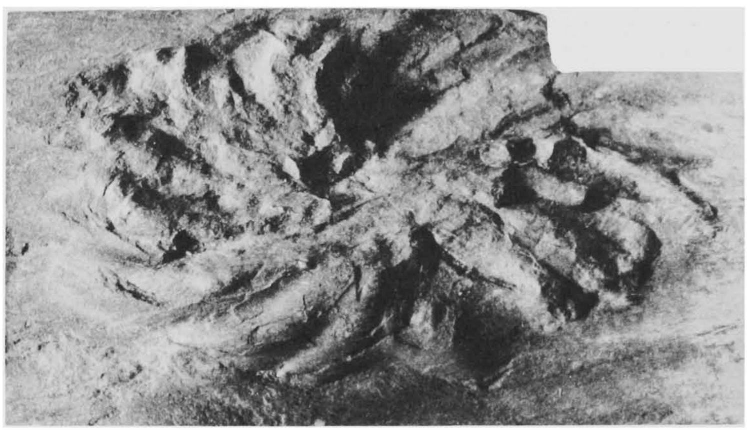


Fig. 112. Trace fossils (p. W184-W187).

1 

Bifungites

2 

Bifasciculus

FIG. 113. Trace fossils (p. W186).

ly built-in ellipsoidal excrement pills; surface pattern commonly very regular, effected by phobotaxis (43). [Probably made by marine worms.] *Cam.-Tert.*, cosmop.——FIG. 115,*1*. *C.* sp., U.Cret.; *1a*, small form, Maastr., Sp.; ×1 (12); *1b*, large form, Aus.; ×1 (15); *1c*, reconstr. of tunnel system (43).

Climacodichnus HITCHCOCK, 1865 [**C. corrugatus*]. Small, ladderlike rows of impressions, resembling steps of *Acanthichnus* (18). [Possibly made by arthropods.] *Trias.*, N.Am.——FIG. 117,*3*. **C. corrugatus*, USA(Mass.); ×0.2 (18).

Climactichnites LOGAN, 1860 [**C. wilsoni*] [=*Climachtichnites* MILLER, 1877 *(errore)*; *Climactichnides* CHAPMAN, 1878]. Very large crawling tracks (width about 15 cm., maximum length 3 to 4 m.), with prominent, slightly arched or V-shaped transverse ridges and very delicate, closely spaced arched rills; dishlike impressions, oval, distinctly bounded at the end (?or beginning) of tracks (1,23). [Probably formed by mollusks, arthropods, or worms.] *U.Cam.*, N.Am.——FIG. 115,*2*. **C. wilsoni*, Potsdam Ss., USA(N.Y.); ×0.02 (134).——FIG. 116,*5*. *C. youngi* (CHAMBERLIN), St. Croix, USA(Wis.); ×0.3 (134).

Cochlea HITCHCOCK, 1858 [*non* MARTYN, 1784; *nec* GRAY, 1847)] [**C. archimeda*]. Trackway resembling an archimedean screw (17). [Junior homonym.] *Trias.*, USA(Mass.).

Cochlichnus HITCHCOCK, 1858 [**C. anguineus* (=*Palaeophycus kochi* LUDWIG, 1869)] [*Sinusia* KRESTEW, 1928 (*non* CARADJA, 1916); *Sinusites* RENIER, 1938 *(errore)*]. Regularly meandering trails, resembling sine curve (17). *Carb.*, Eu.-N. Am.; *Trias.*, N.Am.——FIG. 116,*1*. **C. anguineus*, Trias., USA(Mass.); ×0.7 (17).

Confervites BRONGNIART, 1828 [**C. thoreaeformis;* SD ANDREWS, 1955] [=*Confervides* SCHIMPER, 1869]. 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 (1881), some "species," such as *C. padellae* HEER, 1877, are probably trace fossils resembling *Chondrites* (*Treatise*, p. E104).] *Jur.-Tert.*, Eu.

Conopsoides HITCHCOCK, 1858 [**C. larvalis*]. Tracks in 3 (?4) rows, divergent from median line; foot linear, blunt anteriorly; track terminated, usually in front, by slight mound of mud (17). *Trias.*, USA(Mass.).

Copeza HITCHCOCK, 1858 [**C. triremis*]. Resembling *Lithographus* HITCHCOCK, but having oblique markings within longitudinal ones (17). *Trias.*, N.Am.——FIG. 116,*4*. **C. triremis*, USA(Mass.); ×0.7 (96).

Coprinisphaera SAUER, 1955 [**C. ecuadoriensis*]. Balls with a hole; about 6 cm. in diameter; walls about 1 cm. thick; mostly hollow or filled with consolidated mass similar to argillaceous excrement; found in loess-like tuffs *(cangagua)*. [Probably breeding places of scarabaeid beetles.] *Pleist.* (guide fossil of 3rd interglacial stage), S. Am.(Ecuad.-Colomb.).

Corophioides SMITH, 1893 [**C. polyupsilon*] [=*Arenicoloides* BLANCKENHORN, 1916; *Arenicolithes* HILDEBRAND, 1924 *(errore)*, *Corophyoides* ÖPIK, 1956 *(errore)*. U-shaped *Spreiten* burrows similar to *Rhizocorallium*, but shorter and always perpendicular to bedding plane (33). [*Arenicoloides* comprises crescent-shaped grooves in bedding planes produced by erosion of burrows to their basal ends.] *Cam.-U.Cret.*, Eu.-Asia.——FIG. 117,*1*. *C. luniformis* (BLANCKENHORN), L.Trias., Ger.; *1a*, side, ×0.6; *1b*, side (somewhat schematic), ×1; *1c*, lower ends of U-shaped burrows with *Spreite*, ×0.6 (1).——FIG. 117,*2*. *C.* sp. cf. *C. rosei* DAHMER, L.Cam., Pak.; ×0.6 (41).

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

Cosmorhaphe FUCHS, 1895 [=*Cosmoraphe* FUCHS, 1895]. "Free meanders" of extraordinarily regular form in 2 size orders; windings not close to each other; form reminiscent of some spawn-strings of gastropods (10). *Cret.-L.Tert.(Flysch)*, Eu.——FIG. 118,*3*. *C.* sp., Low.M.Eoc.(Flysch), Pol.; ×0.6 (89).

Crossopodia M'COY, 1851 [**C. scotica;* SD HÄNTZSCHEL, herein] [=*Crassopodia* TATE, 1859 *(errore)*; *Crossochorda* SCHIMPER, 1879; *Chrossocorda, Chrossochorda, Chrossocarda* WILLIAMSON, 1887 *(errore)*]. Meandering trails resembling *Nereites, Myrianites,* and partly *Psammichnites;* width about 1 cm.; "segments" forming a broad dense fringe on each side; mostly with median furrow (23). [Concerning *C. henrici* (GEINITZ) see *Dictyodora*]. *Ord.-Carb.*, Eu.-Asia(Pak.).——FIG. 118,*2*. **C. scotica* (M'COY), Ord., Fr.; ×0.5 (116).——FIG. 118,*4*. *C. tuberculata* (WILLIAMSON), Carb., Eng.; ×0.3 (140).

Cruziana D'ORBIGNY, 1842 [**C. furcata;* SD SEILACHER, 1955] [=*Bilobites* D'ORBIGNY, 1839 (*non* DEKAY, 1824; *nec* RAFINESQUE, 1831); *Bilobichnium* KREJCI-GRAF, 1932]. Shallow pocket-like pits, passages, or pocket burrows shoveled or scratched by trilobites; cross ribs obliquely placed but more regularly distributed and set at more acute angle than in *Rusophycus,* which should be interpreted as resting-trails (41). *Cam.-Sil.*, cosmop.——FIG. 119,*5*. *C. furcifera* D'ORBIGNY, Ord., Port.; *5a, 5b,* both ×0.3 (63).——FIG. 119, *6*. *C.* sp., Ord., Bol.; ×0.4 (83).

1b

1a **Biformites**

FIG. 114. Trace fossils (p. *W*186).

Cunicularius HITCHCOCK, 1858 [**C. retrahens*]. Nondescript ramified tunnel tracks (17). *Trias.*, USA(Conn.-Mass.).

Curvolithus FRITSCH, 1908 [**C. multiplex;* SD HÄNTZSCHEL, herein]. Interior tracks, ribbon-shaped, flat, consisting of 3 parts, with broad, usually smooth central stripe (1). [Produced by gastropods.] *Ord.*, Czech.; *Jur.*, Ger.——FIG. 119, *3*. *C.* sp., M.Jur., Ger.; ×0.7 (41).

Cylindricum LINCK, 1949 [**C. gregarium* (=*Tubifex antiquus* PLIENINGER, 1845)]. Plugs (fillings of tubes) shaped like test tubes, rounded at lower end, with smooth walls, not pointed; present in groups at lower surface of sandstone beds, perpendicular to bedding-plane; diameter up to 5 mm., length up to several cm.; dwelling burrow (24). *U.Trias.(M.Keuper)*, *?M.Jur.*, Eu.——FIG.

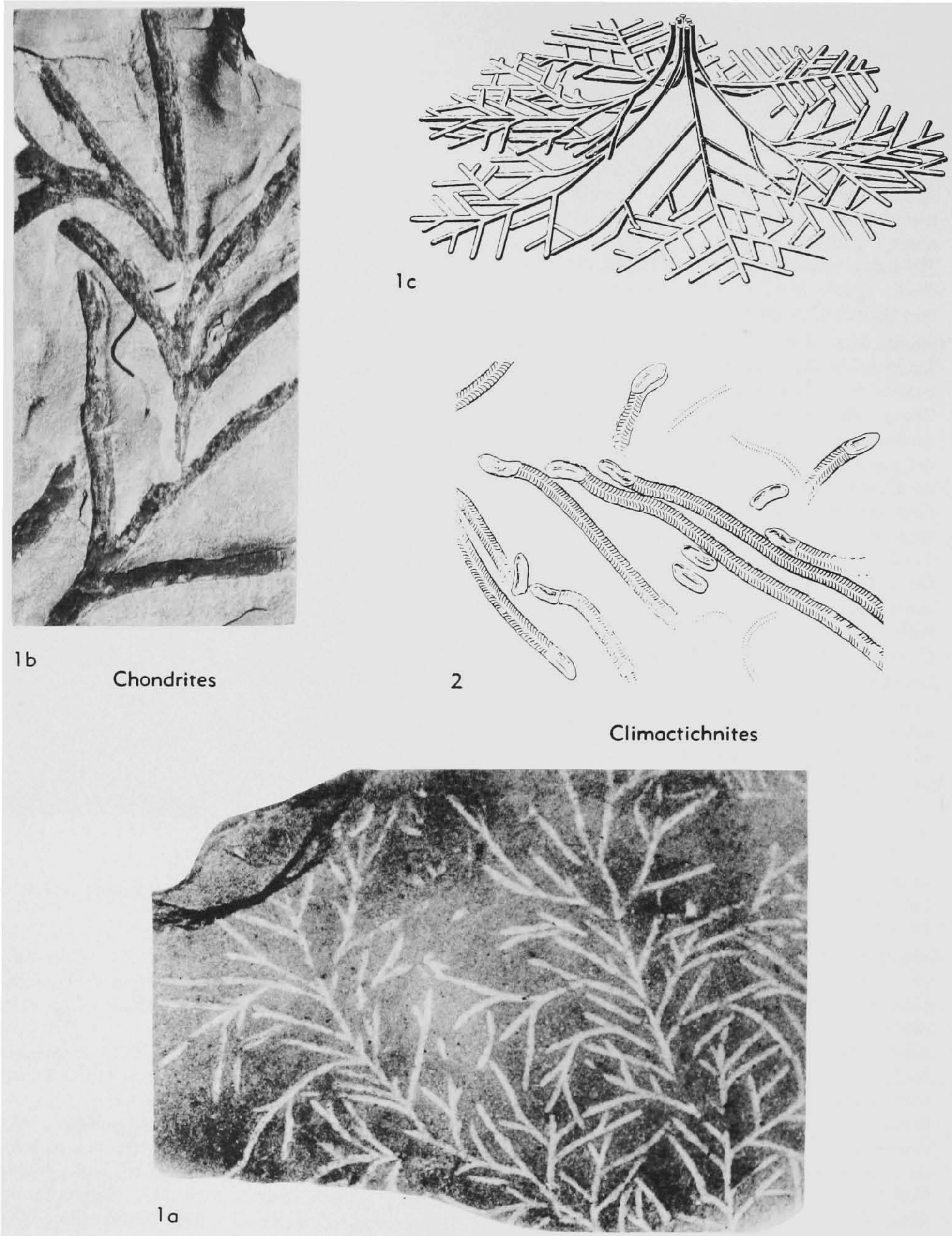


FIG. 115. Trace fossils (p. W187-W188).

118,*1*. **C. gregarium*, U.Trias.(M.Keuper), Ger.; ×1 (24).

Cylindrites GOEPPERT, 1841 [*non* GESNER, 1758; *nec* GMELIN, 1793; *nec* SOWERBY, 1824] [**C. spongioides;* SD ANDREWS, 1955] [=*Spongites* GEINITZ, 1842 *(partim)* (*non* OKEN, 1815); ?*Astrocladia furcata* GERSTER, 1881; *Goniophycus* SAPORTA, 1884]. Like *Palaeophycus*, used as general term for cylindrical and not vertical fillings of burrows (16). [Junior homonym.] *Mesoz.*, Eu.

Dactylophycus MILLER & DYER, 1878 [**D. tridigitatus*]. Very poorly figured; according to JAMES

(19), fragments of burrows or inorganic; according to SEILACHER (personal communication, 1956), resembling small *Phycodes*. *Ord.*, USA(Ohio).

Daedalus ROUAULT, 1850 [*non* REDTENBACHER, 1891] [**Vexillum desglandi* ROUAULT, 1850, SD HÄNTZSCHEL, herein] [=*Vexillum* ROUAULT, 1850 (*non* BOLTEN, 1798); *Humilis* ROUAULT, 1850; *Vescillum* LEBESCONTE, 1892 *(errore)*]. *Spreiten* structures, J-shaped at beginning, later spirally twisted; *Spreiten* surface may cut through itself, as in *Dictyodora* (1,23). *Ord.-Sil.*, Eu.-N.Am. ——FIG. 120,*1*. **D. desglandi* (ROUAULT); *1a,b*, Ord., Fr., ×0.4 (92); *1c*, diagram showing gradation from vertical to spiral, L.Sil., USA (115).

Daimonelix BARBOUR, 1892 [**D. circumaxilis;* SD ANDREWS, 1955] [=*Daemonelix* BARBOUR, 1895; *Helicodaemon* CLAYPOLE, 1895; *Daemonhelix*, AUCTT. (*non Daemonhelix krameri* VON AMMON, 1900)]. Large vertical, open, spiral structures, regular in form, mostly coiled with strict uniformity; with transverse rhizome-like piece at base (1,23). [Explained as fresh-water sponges, or casts of rodent burrows; some forms also resembling concretions.] *Mio.*, N.Am.——FIG. 121,*9*. **D. circumaxilis*, USA(Neb.); side view, ×0.3 (50).

Delesserites STERNBERG, 1833 [**Fucoides lamourouxii* BRONGNIART, 1828; SD ANDREWS, 1955] [=*Delesserites* BRONN, 1853 (*non* RUEDEMANN, 1925) *Delesserella* RUEDEMANN, 1926]. Heterogeneous "genus," including obvious trails (e.g., *D. sinuosus, D. gracilis, D. foliosus* LUDWIG, 1869, from German Paleozoic) and equally obvious plants (e.g., probably *D. lamourouxii*, and, according to PIA, 1927, *D. salicifolia* RUEDEMANN, 1925, Ord., N.Y.); Cenozoic "species" under the name of Recent genus *Delesseria* LAMOUROUX (2).

Dendrotichnium DELLARENA, 1949. Name with neither diagnosis nor species, provisionally given for treelike branched trail. *U.Cret.(Flysch)*, Sp.

Desmograpton FUCHS, 1895. Elevated reliefs, roughly in form of letter *H*, usually lined up in ribbons; form variable; "vertical branches" pressed together or standing apart, ends pointed or club-shaped. *Cret.-L.Tert.(Flysch)*, Eu.——FIG. 120,*2*. *D.* sp., Italy; ×0.6 (Seilacher, n).

Dictyodora WEISS, 1884 [**Dictyophytum? liebeanum* GEINITZ, 1867] [?=*Nemertites* MACLEAY, 1839 (certainly *N. sudeticus* ROEMER, 1870); *Myrianites gracilis* DELGADO, 1910, and very probably several other "new species" of *Myrianites* in DELGADO, 1910]. Complicated spread *(Spreiten)* structure, irregularly conical, with its point toward hanging wall; delicately striated exterior surface (=*Dictyodora s.s.*) intensely "folded" and commonly cutting through itself [sections of this surface=*Palaeochorda marina* (GEINITZ)]; lower, nonhorizontal margin padlike [=*Crossopodia henrici* (GEINITZ)] (41). L.Cam., Asia(Pak.); *Carb.*, Eu.——FIG. 119,*4*. **D. liebeana* (GEINITZ), L.Carb., Aus.; ×0.3 (1).——FIG. 119,*2*. *D. simplex* SEILACHER, L.Cam., Pak., drawing of a model; ×0.5 (41).

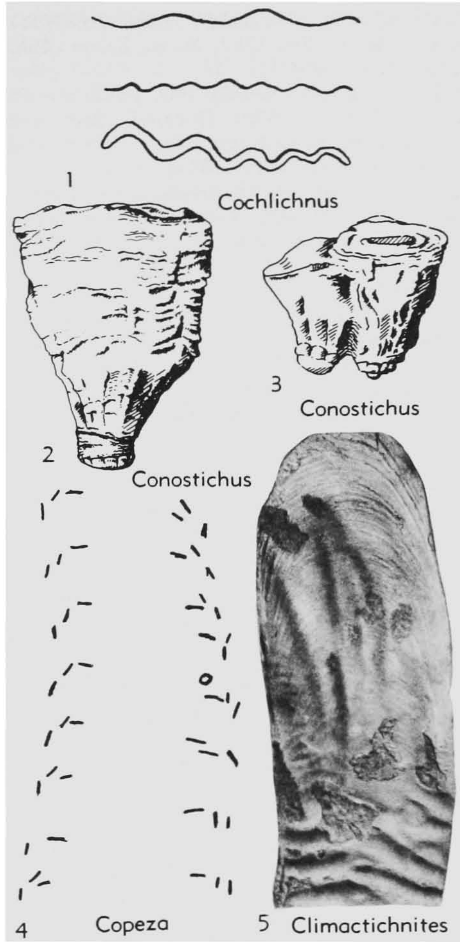


FIG. 116. Trace fossils (p. W188-W189) and body fossil (p. W223).

Dimorphichnus SEILACHER, 1955 [**D. obliquus*]. Asymmetrical trails with 2 different types of impressions—thin sigmoidal ones, produced by raking movement, and blunt ones, similar to impressions of toes, made by a supporting activity—both types arranged in series oblique to direction of movement (41). [Feeding trail of trilobites.] *L. Cam.*, Swed.-Pak.——FIG. 119,*1*. **D. obliquus*, Magnesian Ss., Pak.; *1a*, ×0.16; *1b*, ×0.8; *1c*, ×0.4 (41).

Diplichnites DAWSON, 1873 [**D. aenigma*] [=?*Acripes* MATTHEW, 1910]. Rather nondescript biserial walking track of arthropods with numerous steps; tracks differently arranged depending on direction of movement (straight or oblique). *L.Cam.*, Asia(Pak.); *?Dev.*, Can.(N.B.); *Carb.*, Can.——FIG. 121,*1*. *D.* sp., L.Cam., Pak.; schematic, ×1.3 (41).

Diplocraterion TORELL, 1870 [**D. parallelum;* SD RUDOLF RICHTER, 1926]. U-shaped burrow with *Spreite* similar to *Rhizocorallium*, but always built strictly perpendicular to bedding plane; vertex of U-tube built progressively deeper; tubes ending in large funnels, in small, shallow ones or remaining subcylindrical to surface (23, 33). *L.Cam.*, Eu.-N.Am.——FIG. 120,*3*. **D. parallelum, Mickwitzia* Ss., Swed.; ×0.7 (136).

Diplopodichnus BRADY, 1947 [**D. biformis*]. Long, continuous arthropod trails, consisting of 2 or 3 parallel grooves, each pair separated by a narrow, low ridge; rarely with faint foot impressions; common in Coconino Sandstone; somewhat similar to *Unisulcus* HITCHCOCK (16). *M.Perm.*, USA (Ariz.).

Dreginozoum VON DER MARCK, 1894 [**D. nereitiforme*]. Oval, patchlike structures on both sides of narrow median ridge; width about 15 mm. (16). *U.Cret.-Oligo.*, Eu.——FIG. 120,*5*. **D. nereitiforme*, U.Cret.(Campan.), Ger.; ×1.3 (Häntzschel, n).

Durvillides SQUINABOL, 1887 [**D. eocenicus*]. Meandering trail (2). *Eoc.*, Italy.

Ephemerites ABEL, 1935 [*non* GEINITZ, 1865]. Horizontal U-shaped burrows produced by larvae of ephemerids; occurring in fresh-water deposits (1). [Shown by SEILACHER, 1951, to be *Spreiten* burrows.] *Rec.*

Eugyrichnites AMI, 1905 [**E. minutus*]. Minute tortuous trails, about 1 mm. wide; with fine annulation (25 to 30 closely set parallel lines in 10 mm.); somewhat resembling *Gyrichnites* WHITEAVES, 1883; never figured and no specimens

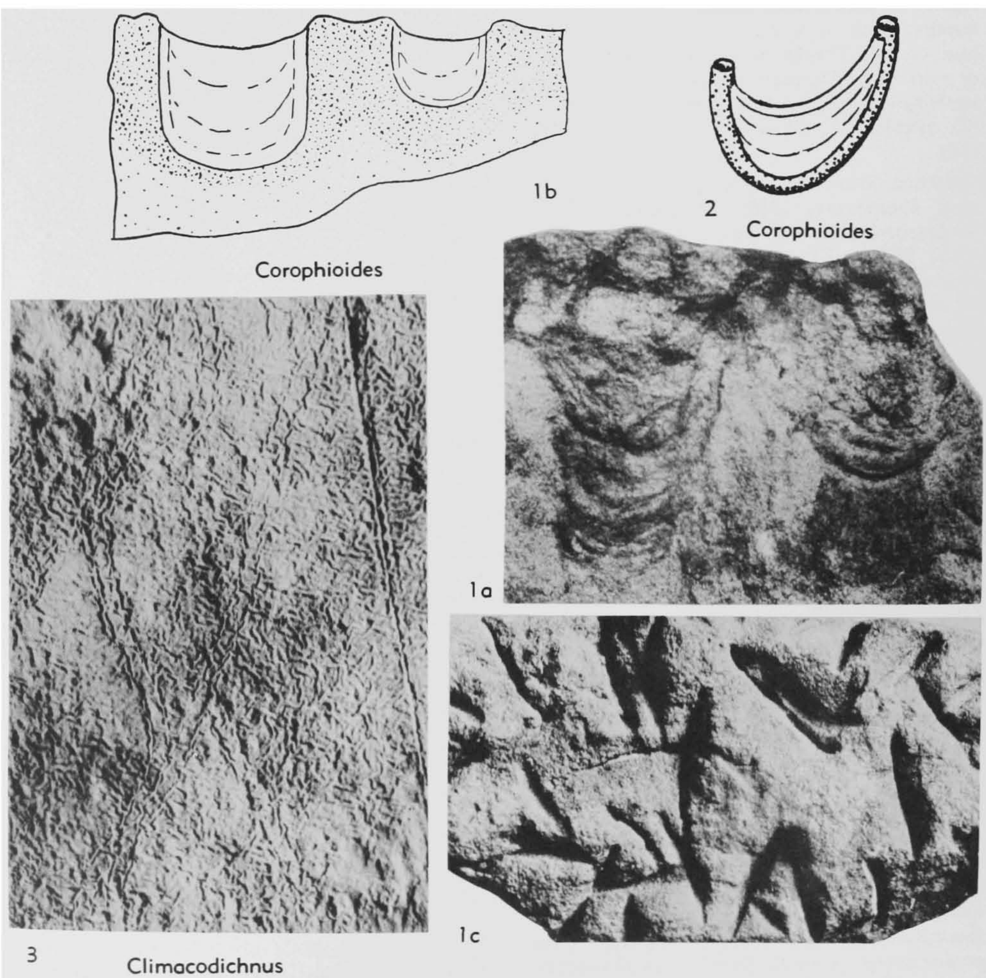


FIG. 117. Trace fossils (p. W188-W189).

could be located in Canadian collections (16). *?Sil.*, Can.(N.B.).

Felixium DELAUBENFELS, 1955 [**Rhizocorallium gläseli* FELIX, 1913]. Erroneously regarded as sponge by DELAUBENFELS (*Treatise*, p. *E*36); undoubtedly a burrow resembling *Spongites saxonicus* GEINITZ. *Cret.(Pleist.* drift), Ger.

Fraena ROUAULT, 1850 [**F. sainthilairei;* SD PÉNEAU, 1946] [=*Froena* PÉNEAU, 1946]. "Genus" at first comprising heterogeneous "species," especially bilobate trails belonging partly to *Cruziana,* later called *Rouaultia* (e.g., *F. lyelli*); on suggestion of TROMELIN & LEBESCONTE, 1875, and BUREAU, 1900, the name *Fraena* has been restricted to nonbilobate, smooth trails and elongate, cylindrical tunnel fillings, usually arranged horizontally; "genus" figured only once (16, 23). *Ord.*, Fr.

Fucoides BRONGNIART, 1823 [**F. orbignyanus;* SD ANDREWS, 1955]. Formerly used as generic name for regularly branching, plantlike tunnel structures; at present only used informally ("fucoid"), because too many widely differing "species" have been recognized. JAMES wrote in 1892-93 "that before many years the genus *(Fucoides)* began to overflow and then, like an overloaded wagon, broke down. . . . Among the debris we find tracks of crustaceans, burrows of worms, trails of mollusks, marks made by trailing tentacles of medusae, markings made by the tide or waves, rills made by running water, and holes formed by burrowing worms." [See also *Chondrites.*]

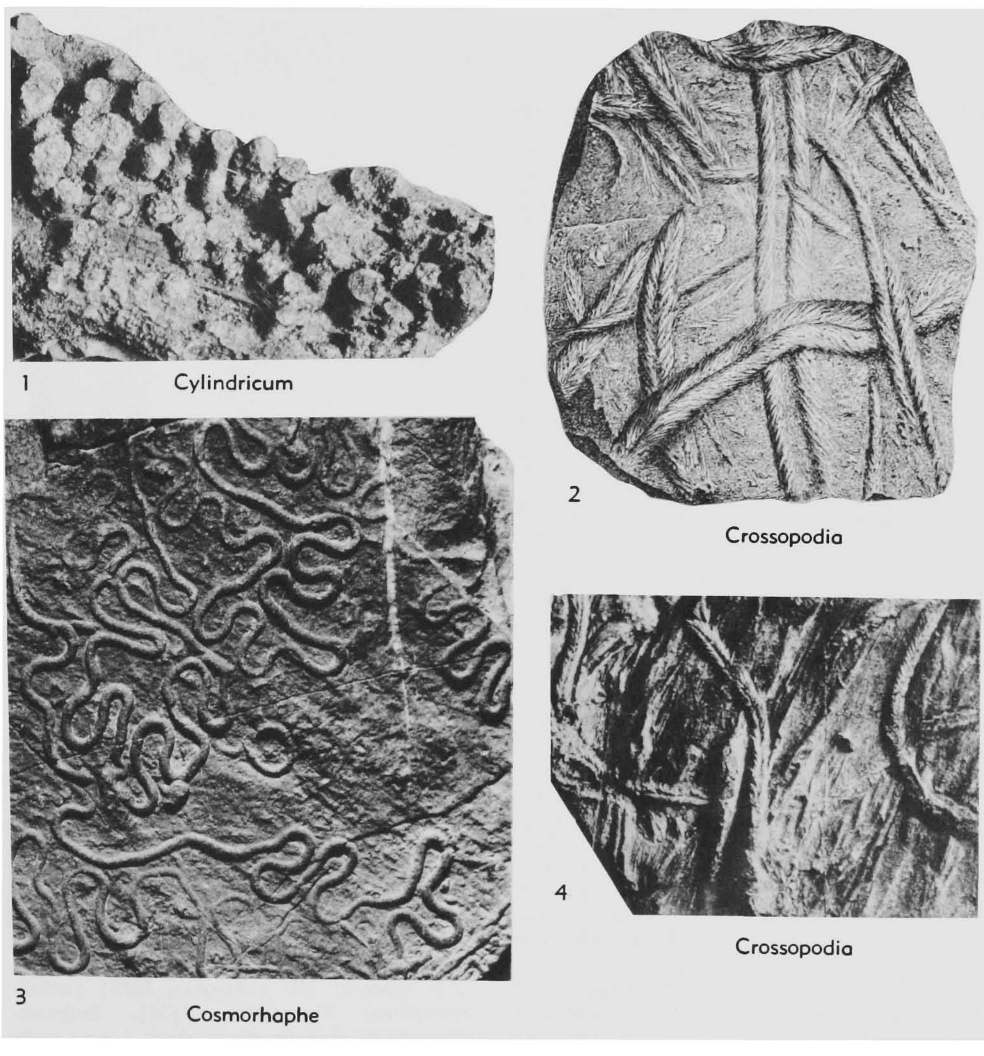


FIG. 118. Trace fossils (p. *W*189).

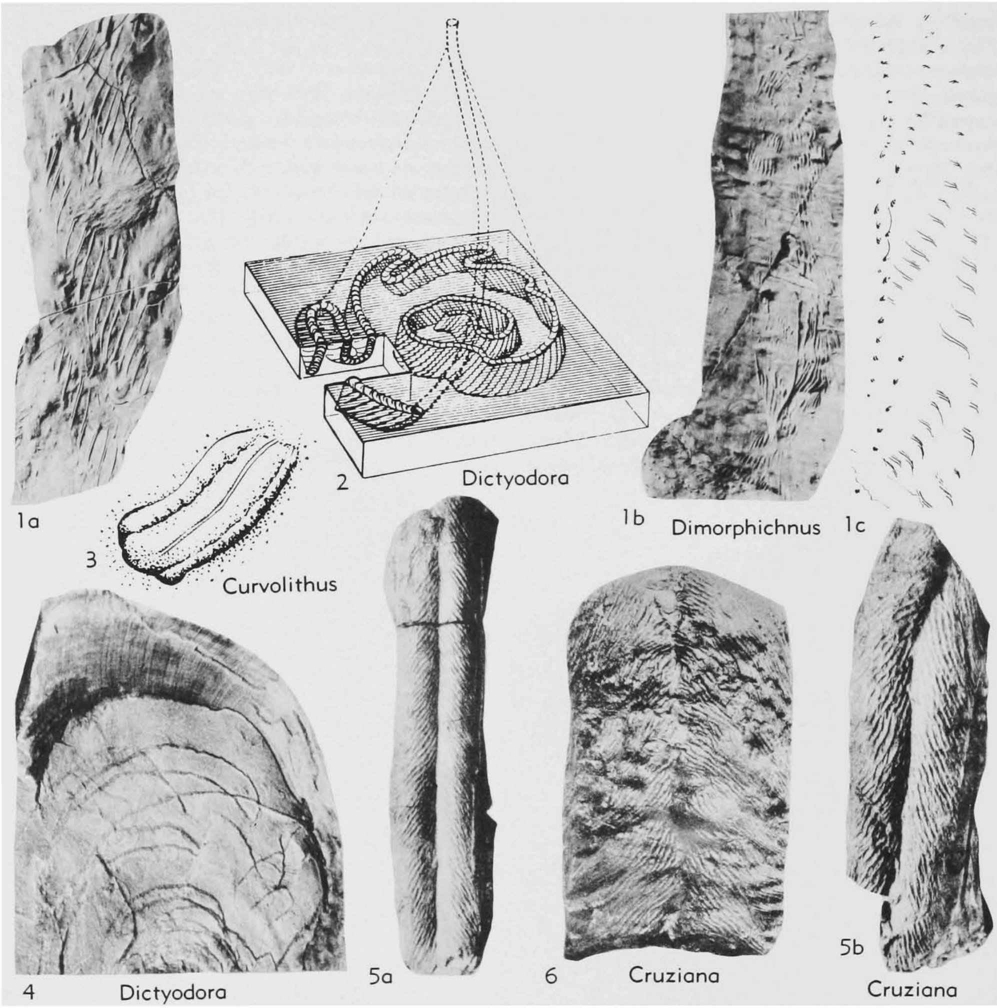


FIG. 119. Trace fossils (p. W189, W191).

Fucusopsis VASSOIEVITCH, 1932 [**F. angulatus*] [=*Fucopsis* GROSSHEIM, 1946 (obj.)]. Originally described as "hieroglyphs in form of tubes"; according to SEILACHER (1959), stretched burrows with threadlike sculpture (16). *Cret.-Tert.,* Eu.——FIG. 120,*4*. **F. angulatus,* U.Cret.(Senon.), USSR; ×0.3 (Hecker, n).

Goniadichnites MATTHEW, 1891 [**G. trichiformis*]. Small, sinuous trails no larger than slender thread, commonly branching, apparently forking dichotomously; resembling trails of Recent *Goniada* as figured by NATHORST (16). *Cam.,* Can.

Gordia EMMONS, 1844 [*non* MELICHAR, 1903] [**G. marina*] [=*Palaeochorda* M'COY, 1848 (*non P. marina* (EMMONS) *sensu* GEINITZ, 1867; see *Dictyodora* WEISS, 1884); *Palaeochordia* EICHWALD, 1855; *Herpystezoum* HITCHCOCK, 1848; *Helminthoidichnites* FITCH, 1850; *Unisulcus* HITCHCOCK, 1858; *Gordiopsis* HEER, 1865 *(nom. nud.)*]. Long, slender, smooth wormlike trails of uniform thickness throughout; mostly bent but not meandering; resembling hair-worm, *Gordius* (16). *Palaeoz.-Cenoz.,* Eu.-N.Am.——FIG. 121, *2*. *G.* sp.; schematic drawing, ×0.7 (Häntzschel, n).

Grammepus HITCHCOCK, 1858 [**G. erismatus;* SD HÄNTZSCHEL, herein]. Doubtful insect trail (17). *Trias.,* USA(Mass.).

Granularia POMEL, 1849 [*non* POLETAEVA, ?1936] [**G. repanda;* ?SD DESAPORTA, 1873] [=*?Alcyonidiopsis* MASSALONGO, 1856]. Sediment-filled tubes; diameter up to about 1 cm.; walls coarsely dressed with clay particles; somewhat similar to *Chondrites granulatus* (SCHLOTHEIM),

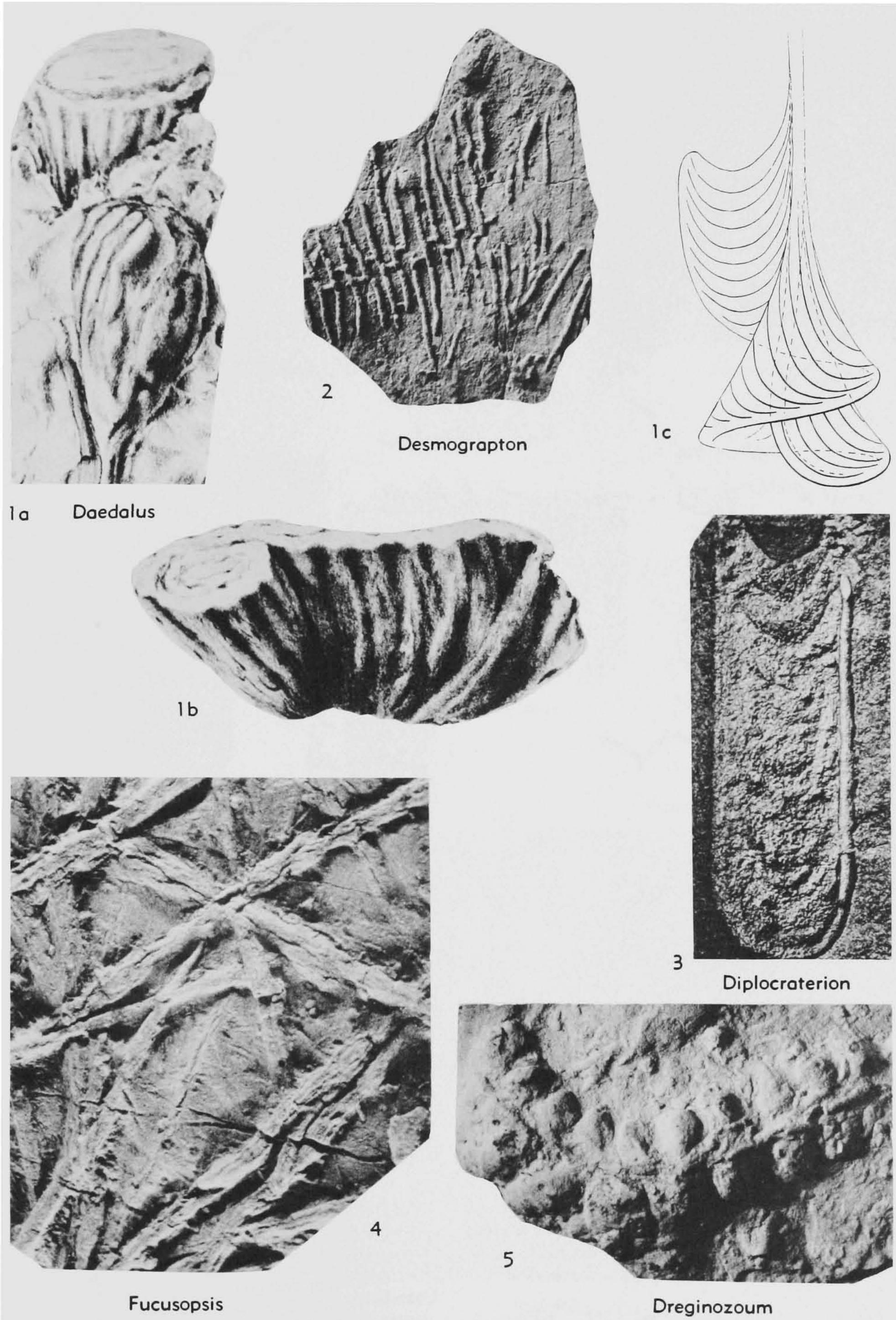


FIG. 120. Trace fossils (p. *W*191-*W*194).

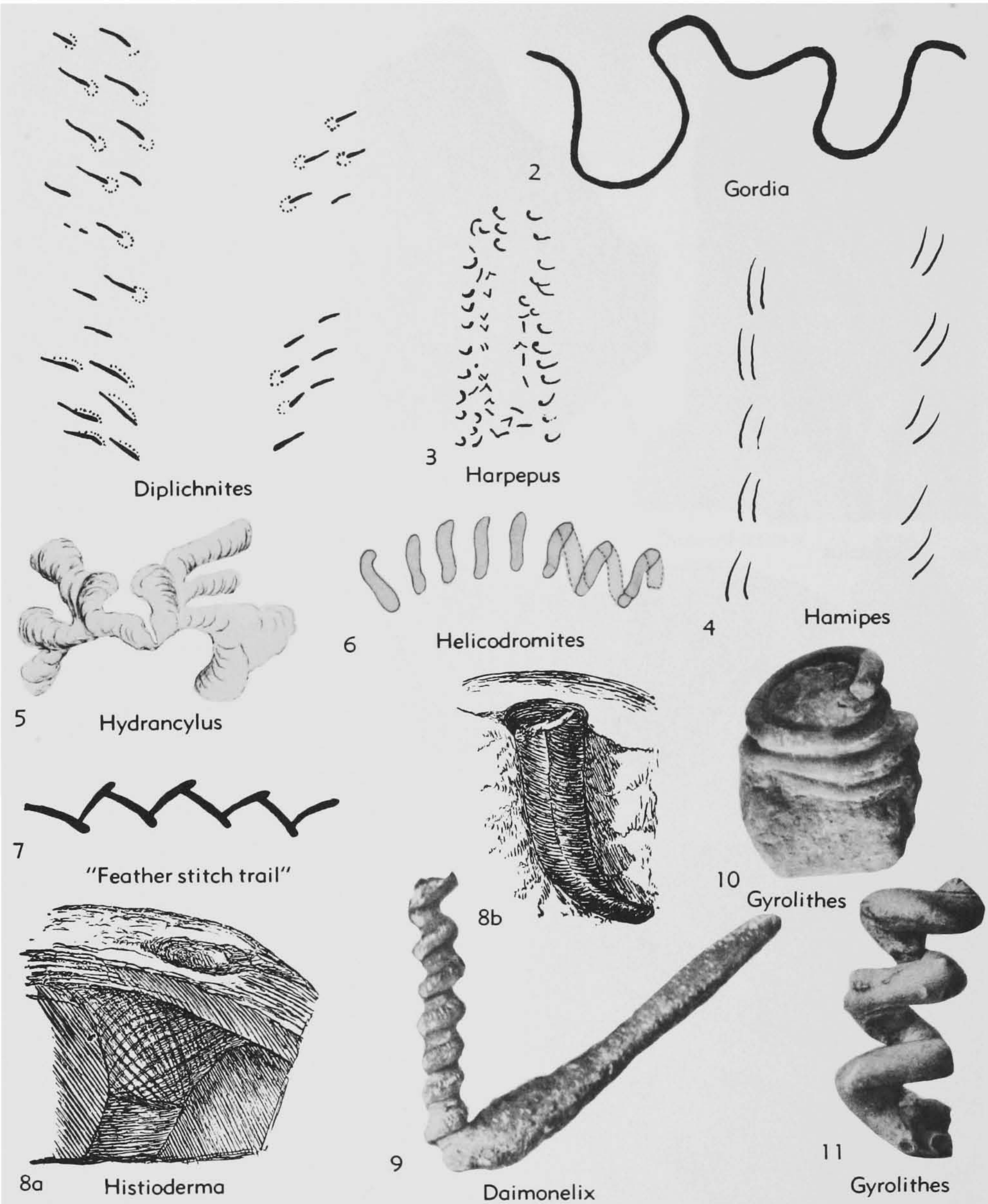


FIG. 121. Trace fossils (p. W191, W194, W196, W200, W220).

but tubes not stuffed (23, 31). *Jur.-Tert.*, Eu.——FIG. 123,*5*. *G. lumbricoides* (HEER), L.Tert.(Alberese), Italy; ×1.25 (109).——FIG. 123,*1*. *G.* sp. cf. *G. arcuata* SCHIMPER, L.Tert.(Alberese), Italy; ×1.25 (109).

Gyrichnites WHITEAVES, 1883 [**G. gaspensis*]. Trails of large size; undulating, slender, rounded furrows of almost equal width throughout and marked transversely by nearly straight, subparallel and subequidistant grooves; name given as "provisional and local" (16). [?Annelid trails.] *?U. Cam.*, USA(N.Y.); *L.Dev.*, Can.——FIG. 124,*4*. **G. gaspensis*, L.Dev., Can.; ×0.3 (139).

Gyrochorte HEER, 1865 [**G. comosa;* SD HÄNTZSCHEL, herein] [=*Gyrochorda* SCHIMPER, 1879; *?Equihenia* MEUNIER, 1886]. *Zopf*-traces of German literature, i.e., ridges on bedding-planes with biserially arranged, obliquely placed transverse

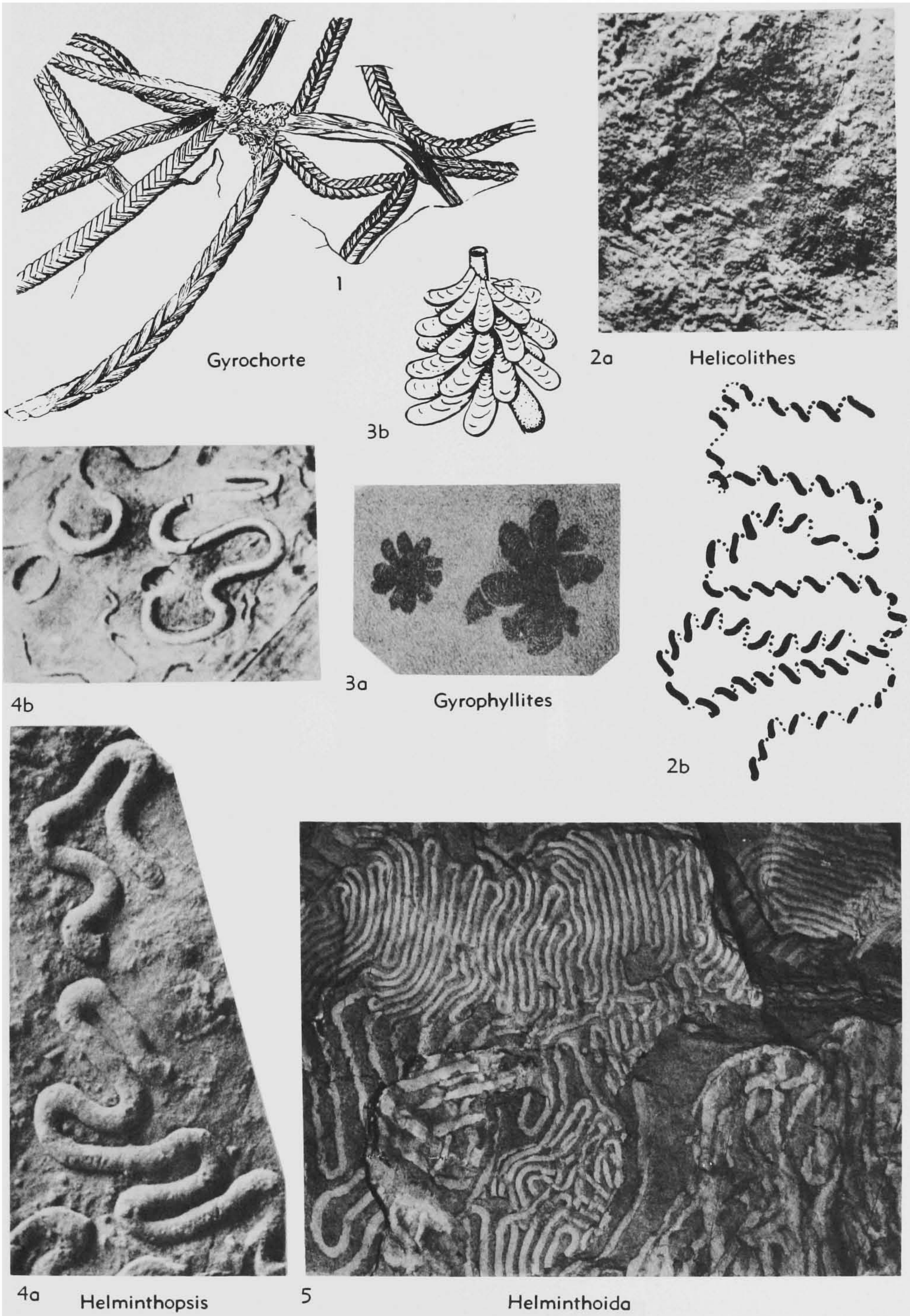


FIG. 122. Trace fossils (p. W196, W200).

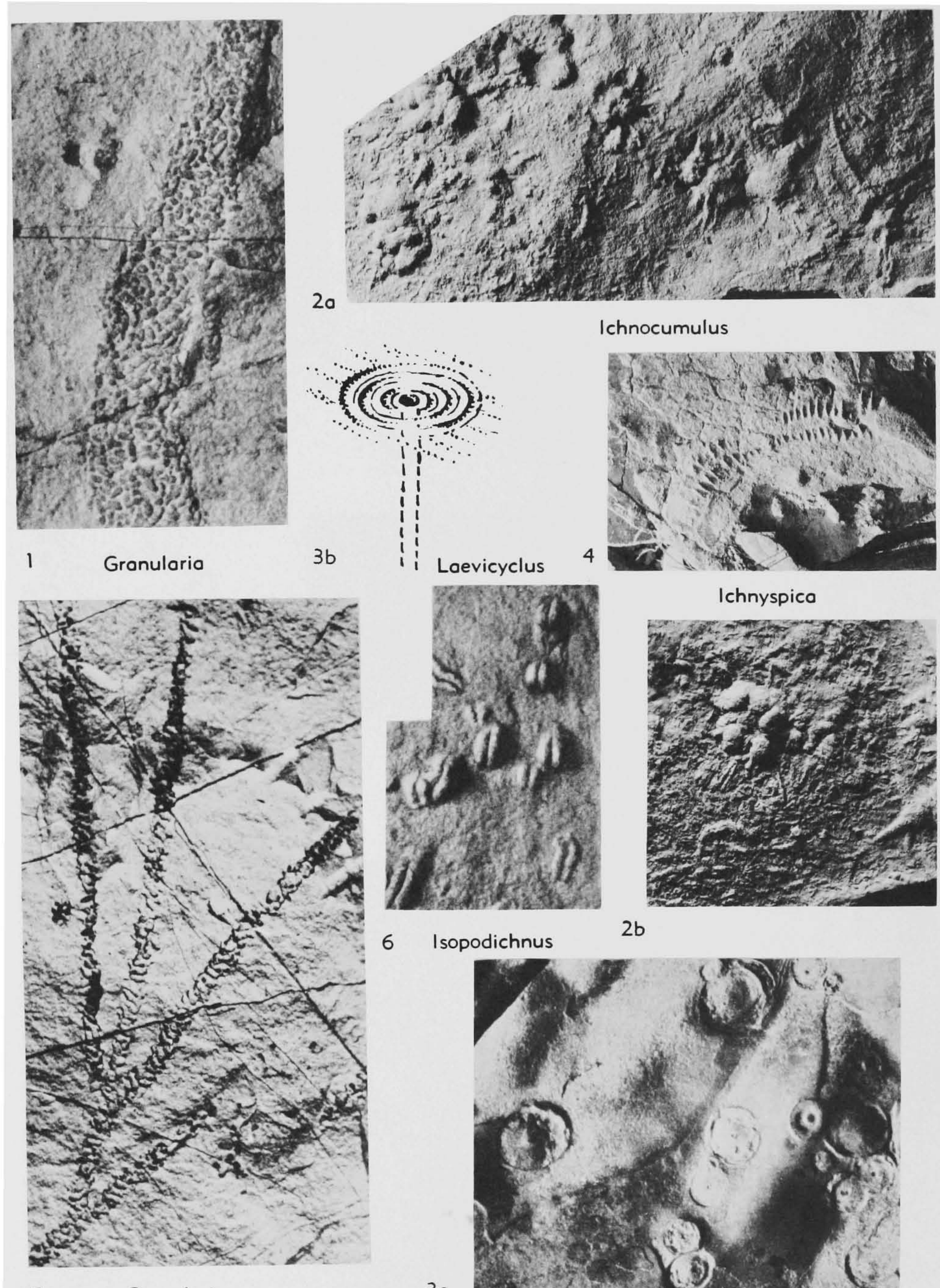


FIG. 123. Trace fossils (p. *W*194, *W*200-*W*201).

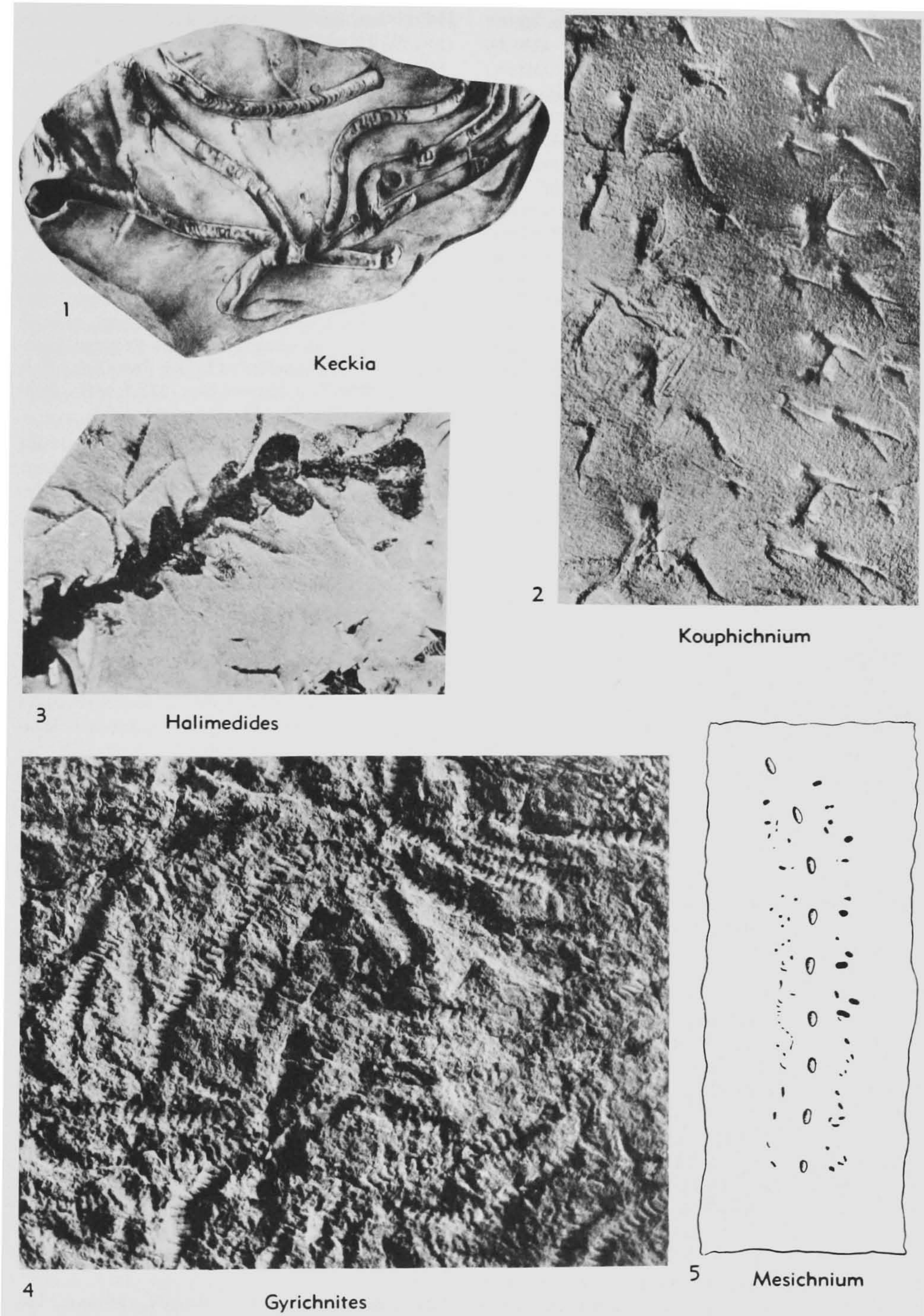


FIG. 124. Trace fossils (p. *W*196,*W*200-*W*201, *W*205).

pads, both series separated by median furrow (46). *Cam.-?Tert.*, Eu.——FIG. 122,*1*. **G. comosa*, M.Jur., Switz.; ×1 (84).

Gyrolithes DESAPORTA, 1884 [**G. davreuxi;* SD HÄNTZSCHEL, herein] [=*"Gyrolithen"* DEBEY, 1849 *(partim); Siphodendron* DESAPORTA, 1884; *Syringodendron* FUCHS, 1895 *(pro Siphodendron); Daemonhelix krameri* VON AMMON, 1900 (*non* BARBOUR, 1892, 1895); *Xenohelix* MANSFIELD, 1927]. Dextrally or sinistrally coiled burrows, upright in deposit; surface with rounded or elongate processes; thin mantle commonly formed by network of small *Chondrites;* diameter of whorls mostly uniform; may branch near upper end (16). [Probably made by Decapoda.] *Jur.-Tert.*, Eu.-USA(Md.-Calif.).——FIG. 121,*11*. *G. marylandicus* (MANSFIELD), ?Mio., Md.; ×? (98).——FIG. 121,*10*. *G. saxonicus* (HÄNTZSCHEL), U.Cret. (Turon.), Ger.; ×0.4 (82).

Gyrophyllites GLOCKER, 1841 [**G. kwassizensis*] [=*?Discophorites* HEER, 1876]. Vertical shaft from which rosettes of short, simple (feeding) tunnels radiate at different levels, as in a mine; "leaves" with sculpture of *Spreiten* burrows; shape of whole structure conical (2). *Dev.-Tert.*, Eu.——FIG. 122,*3*. *G.* sp., U.Cret.(Flysch), Aus.; *3a*, ×1; *3b*, schematic (*3a*, 10; *3b*, 120).

Halimedides LORENZ VON LIBURNAU, 1902 [**Halimeda fuggeri* LORENZ VON LIBURNAU, 1897]. Burrow with bilaterally ("pinnate") arranged, kidney-shaped extensions; morphologically corresponding rather well to Recent alga *Halimeda* LAMOUROUX (2,40). *Cret.-L.Tert.(Flysch)*, Aus. ——FIG. 124,*3*. **H. fuggeri;* ×0.3 (95).

Halopoa TORELL, 1870 [**H. imbricata;* SD ANDREWS, 1955]. Trace fossil, never figured (2). *Cam.*, Swed.

Halysichnus HITCHCOCK, 1858 [**H. laqueatus;* SD HÄNTZSCHEL, herein]. Repeatedly looped, chain-like trail with ridges on each side (17). *Trias.*, USA(Mass.).

Hamipes HITCHCOCK, 1858 [**H. didactylus*]. Two paired, regular, parallel rows of equidistant impressions of steps, curved inward, somewhat hook-shaped; width of trackway 1.6 in.; toes nearly parallel, may be slightly divergent (17). [Arthropod trail.] *Trias.*, USA(Mass.).——FIG. 121,*4*. **H. didactylus;* ×0.7 (17).

Harpepus HITCHCOCK, 1865 [**H. capillaris*]. One or 2 rows of tracks showing slightly curved foot, one end of which forms raised, blunt extremity on track (18). *Trias.*, USA(Mass.).——FIG. 121, *3*. **H. capillaris;* ×0.7 (96).

Helicodromites BERGER, 1957 [**H. mobilis*]. Smooth screw-shaped burrows; horizontal; diameter of tunnels about 2 mm.; interval between spiral turns about 1 cm. (16). *Oligo.(Rupel.)*, S.Ger.——FIG. 121,*6*. **H. mobilis;* ×0.7 (51).

Helicolithus AZPEITIA MOROS, 1933 [**H. sampelayoi,* SD HÄNTZSCHEL, herein]. Small, meandering, screw-shaped burrows; diameter of tunnels 1 mm.; diameter of spiral about 3 mm. (3). *U.Cret.-L. Tert.(Flysch)*, Eu.——FIG. 122,*2*. **H. sampelayoi; 2a,* ×1 (U.Cret., Sp.) (49); *2b,* schematic drawing, ×1.5 (?Cret., Italy) (41).

Helminthoida SCHAFHÄUTL, 1851 [**H. labyrinthica;* SD HÄNTZSCHEL, herein] [=*Helminthoidea* MAILLARD, 1887; *Helminthoides* FUCHS, 1895; *Helmintoidea* VINASSA DEREGNY, 1904 (*non H. mollassica=H. helvetica* HEER, 1865)]. Smooth; numerous, parallel, equidistant concentric furrows, about 2 mm. wide, mostly curved, may be concentric. [According to RUDOLF RICHTER, comprise "guided meanders" (1,2).] *Cret.-Tert.*, Eu.-Alaska-Chile-Trinidad.——FIG. 122,*5*. **H. labyrinthica* U.Cret.(Flysch), Aus.; ×1 (15).

Helminthopsis HEER, 1877 [*non* GROUVELLE, 1906] [**H. magna;* SD ULRICH, 1904] [=*Helmintopsis* VINASSA DEREGNY, 1904; *Magarikune* MINATO & SUYAMO, 1949; *?Serpentinichnus* MAYER, 1956; *Tosahelminthes* KATTO, 1960]. Simple meandering tracks, but not as strictly developed as *Helminthoida* (s.s., RUDOLF RICHTER, 1928); in part with marginal ridges (46). *Ord.-Tert.;* Eu.-Asia-Alaska-Antarct.——FIG. 122,*4*. *H.* sp.; *4a,* U.Cret., Aus.; ×0.75 (1); *4b,* U.Cret., Alaska; ×1 (44).

Herpetonites VON OTTO, 1855 [**H. holothurioides*]. Superfluous, seldom used name for burrows in sandstones, regarded as bodily preserved holothurians. *U.Cret.*, Ger.(Saxony).

Hexapodichnus HITCHCOCK, 1858 [**H. magnus;* SD HÄNTZSCHEL, herein]. Small trails, very probably made by insects (17). *Trias.*, USA(Mass.).

Himanthalites FISCHER-OOSTER, 1858 [**H. taeniatus*] [=*?Taeniophycus* SCHIMPER, 1869]. Differs from *Chondrites* only in size and fewer ramifications (7). *L.Jur.*, ?Ger.; *Cret.-Tert.*, Switz.-Italy.

Histioderma KINAHAN, 1858 [**H. hibernicum*]. Curved tubes, upper extremity trumpet-shaped, lower turned up at right angle to bedding planes; upper portion of tube marked by several ridges crossing each other at irregular intervals (16). [According to RUDOLF RICHTER (1920), a dwelling-burrow.] *Cam.*, Ire.——FIG. 121,*8*. **H. hibernica; 8a, 8b,* ca. ×0.7 (80).

Hydrancylus FISCHER-OOSTER, 1858 [**Münsteria geniculata* STERNBERG, 1833]. Groups of rounded "leaves" arranged irregularly or lyre-shaped; proposed as subgenus of *Münsteria;* feeding-burrow (7). *Cret.-L.Tert.(Flysch)*, Eu.——FIG. 121,*5*. *H. oosteri* FISCHER-OOSTER, ?U.Cret.(Flysch), Switz.; ×1.5 (7).

Ichnocumulus SEILACHER, 1956 [**I. radiatus*]. Little pustule-shaped heaps with straight, radiate appendages; resting traces made by unknown animals which hid temporarily in sand (16). *L.Jur.-*

M.Jur., Ger.——FIG. 123,*2*. **I. radiatus*, L.Lias. (Angulaten-Schichten); *2a*, holotype, ×1; *2b*, ×1 (120).

Ichnyspica LINCK, 1949 [**I. pectinata*] [=*Ichnispica* LESSERTISSEUR, 1955 *(errore)*]. Double track, each composed of numerous "teeth" as in a comb; teeth straight and ending in very sharp points; rows curved, parallel, and equidistant; "type" of "ear-shaped" tracks (*Ichnia spicea* RUDOLF RICHTER) (24). *U.Trias.(M.Keuper)*, Ger.——FIG. 123,*4*. **I. pectinata*, ×0.3 (24).

Ichthyoidichnites AMI, 1903 [**I. acadiensis*]. Two rows of dashlike impressions with small ridges or monticules at posterior ends; believed to have been made by fin or finlike appendages of acanthodians (AMI, 1903) or by arthropods (ABEL, 1) (23). *L.Dev.*, Can.(Nova Scotia).

Incisifex DAHMER, 1937 [**I. rhenanus*]. Two parallel rows of obliquely arranged notches, stemming from 3-membered extremities of an arthropod (*?Homalonotus*); between and outside the rows are smooth strips of sediment; made by sliding ventral side of animal (16). *L.Dev.*, Ger.-Belg.; *?Perm.*, S.Afr.——FIG. 125,*6*. **I. rhenanus*, L. Dev.(Seifener beds), Ger.; ×0.7 (62).

Isopodichnus BORNEMANN, 1889 (*emend.* SCHINDEWOLF, 1928) [*non* BRADY, 1947] [**I. problematicus;* SD SCHINDEWOLF, 1928 (=*Ichnium problematicum* SCHINDEWOLF, 1921)]. Dimorphous trace fossils consisting of small, straight or curved double-ribbon trails, 1 to 6 mm. wide, transversely striated by fine furrows; both "ribbons" separated by median ridge; trail may be intermittent; associated with "coffee-bean"-shaped impressions of corresponding size (16). ["Genus" placed by SEILACHER (40) in synonymy with *Rusophycus*.] *U.Sil.(?Downton.)*, Spitz.; *?L.Dev.*, Ger.; *Carb.*, Austral., Can.(Nova Scotia-N.B.); *Trias;* Ger.——FIG. 123,*6*. **I. problematicus*, L.Trias.(Buntsandstein), Ger.; ×0.75 (117).

Keckia GLOCKER, 1841 [**K. annulata*]. Similar to *Taenidium* HEER, 1877, but with flat ribbons (2, 46). *Cret.-Tert.*, Eu.——FIG. 124,*1*. **K. annulata*, U.Cret.(Cenom.), Ger., ×0.18 (75).

Kirklandia CASTER, 1945 [**K. texana*]. Perhaps a trachylinid (*Treatise*, p. *F*70, Fig. 54); perhaps a trace fossil (feeding burrow). *?M.Jur.*, Ger.; *L. Cret.*, USA.

Kouphichnium NOPCSA, 1923 [**Ichnites lithographicus* OPPEL, 1862] [=*Micrichnum* ABEL, 1924; *Micrichnus* ABEL, 1926; *Artiodactylus* ABEL, 1926; *Hypornithes, Ornichnites* JAEKEL, 1929; *Protornis* JAEKEL, 1929 (*non* MEYER, 1844); *Paramphibius* WILLARD, 1935; *Limuludichnulus* LINCK, 1943; *Limuludichnus* LINCK, 1949]. Trails of great variability; 2 longitudinal series of digitate tracks with 3 or 4 slender, straight or acuminate, or slightly curved rays; length of rays equal or unequal; some with tail track; interpreted as trails of vertebrates (birds, fishlike amphibians, reptiles or mammals) in first descriptions; now recognized as made by limulids (1, 23). *Dev.-Jur.*, Eu.-N.Am.-Greenl.——FIG. 124,*2*. *K. didactylus* (WILLARD), U.Dev.(Chemung), Penn., ×1.5 (56).——FIG. 125,*1*. *K. gracilis* (LINCK), U.Trias.(Schilfsandstein), Ger.; ×0.7 (24).

Kulindrichnus HALLAM, 1960 [**K. langi*]. Stumpy, cylindrical or conical bodies with apex directed downward; oriented subvertically in bed; up to 130 mm. in length and 75 mm. in diameter; composed of shell aggregates, some aligned peripherally to margin; matrix may be phosphatic (16). [Interpreted as burrow (resting trail) produced by cerianthid sea anemone.] *L.Jur.*, Eu.——FIG. 125,*5*. **K. langi*, Blue Lias, Eng.; *5a*, long. sec. with phosphatic sheath; *5b*, long. sec. without phosphatic sheath; *5c*, reconstr. burrow indicating calcite-filled cracks in phosphatic sheath, ±×0.3 (81).

Laevicyclus QUENSTEDT, 1879 [=*Cyclozoon* WURM, 1912 *(partim)*]. Approximately cylindrical bodies standing at right angles to bedding plane; diameter variable in same specimen; perforated by central canal; visible on bedding planes as regular concentric circles with diameter of several cm. (23, 41). [Interpreted by QUENSTEDT (1879) as coral; by PHILIPP (1904) and WURM (1912) as organism of unknown affinities; by M.SCHMIDT (1934) as inorganic, made by gas-exhalations and water under pressure within sediment; by SEILACHER (38, 41) as trace fossil (feeding burrow) comparable with dwelling shaft and scraping circles of Recent annelid worm, *Scolecolepis*.] *L. Cam.*, Pak.; *Trias.-Jur.*, Eu.——FIG. 123,*3*. *L.* sp.; *3a*, U.Trias.(Campiller beds), Italy; ×0.25 (118); *3b*, reconstr., L.Cam., Pak.; ×2.7 (41).

Lapispira LANGE, 1932 [**L. bispiralis*]. U-shaped tunnel with both legs spirally curved in same direction (23). *L.Jur.(L.Lias.)*, Ger.——FIG. 125, *2*. **L. bispiralis;* wire models of burrows, ×0.2 (91).

Lennea KRÄUSEL & WEYLAND, 1932 [**L. schmidti*]. Vertical shaft about 1 cm. in width with numerous narrower lateral tunnels branching off irregularly at right angles along whole length of vertical shaft; lateral branches approximately horizontal, branching dichotomously (16). *Dev.*, Ger.——FIG. 125,*7*. **L. schmidti*, M.Dev.; ×0.3 (104).

Lithographus HITCHCOCK, 1858 [**L. hieroglyphicus;* SD HÄNTZSCHEL, herein]. Insect trail, very similar to or identical with *Copeza* HITCHCOCK but having oblique markings outside longitudinal ones (17). *Trias.*, USA(Mass.).——FIG. 125,*3*. **L. hieroglyphicus;* ×0.7 (96).

Lophoctenium REINHOLD RICHTER, 1850 [**L. comosum* REINHOLD RICHTER, 1851] [=*Criophycus* TOULA, 1906]. Bunches of closely spaced, inwardly bent "twigs" with comblike branches, joining to form main axis; formerly erroneously thought to belong to graptolites, sertularids, or algae (23). [Feeding burrows, according to SEILACHER (41).] *Dev.-Carb.*, Eu. (Ger.-Port.); *U. Cret.-L. Tert. (Flysch)*, Eu.——FIG. 127,7. **L. comosum*, M. Dev. (*Nereites* beds), Ger.; ×1.5 (40).

Lorenzinia GABELLI, 1900 [**L. apenninica*]. Commonly regarded as scyphozoan (*Treatise*, p. F43, Fig. 32,*1-3*); more probably a feeding burrow; some forms resembling *Atollites*. *Cret.-Tert. (Flysch)*, Eu.

Lumbricaria MÜNSTER, 1831 [**L. intestinum;* SD HÄNTZSCHEL, herein] [=*Vermiculitae, Vermiculites* PARKINSON, 1811 (neither name intended for genus); *Medusites* GERMAR, 1827 (long unused name seemingly intended for this fossil); *?Lumbricites* AUCTT. (*non L. antiqua* PORTLOCK, 1843); (*?non L.? gregaria* PORTLOCK, 1843); *Cololites*

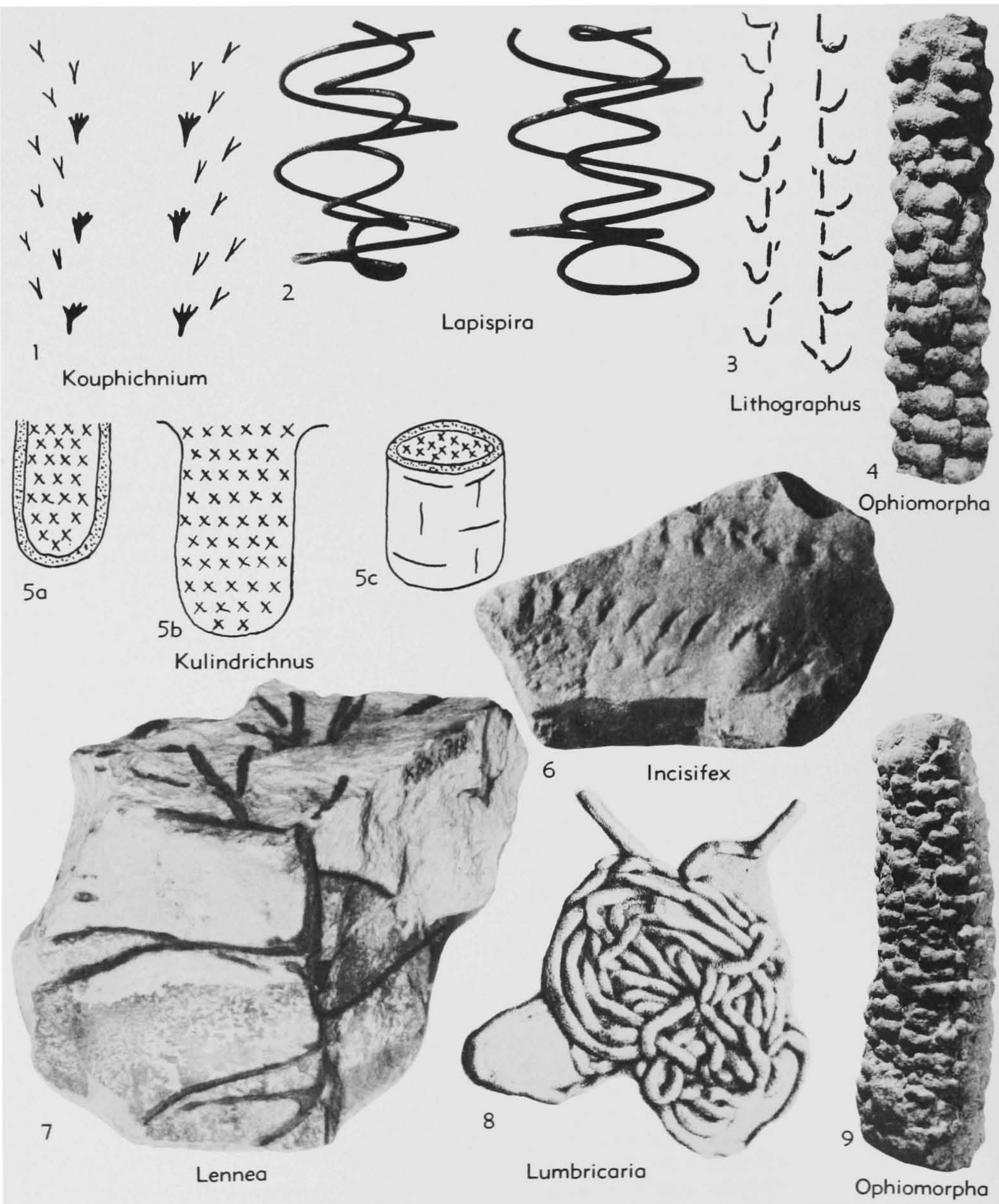


FIG. 125. Trace fossils (p. W201-W202, W205).

AGASSIZ, 1836 (clearly not intended as generic name)]. Entangled intertwined strings, approximately 3 mm. wide (16). [Interpreted as excrement of fish or ejected entrails of holothurians.] [See also *Treatise*, p. F159.] *?U.Trias., Jur.*, Ger. ——FIG. 125,*8*. **L. intestinum*, U.Jur.; ×0.7 (76).

Lunula HITCHCOCK, 1865 [*non* KOENIG, 1825, *nec* LAMARCK, 1812] [**L. obscura*]. Trail consisting of narrow axis, with laterally extended lunate im-

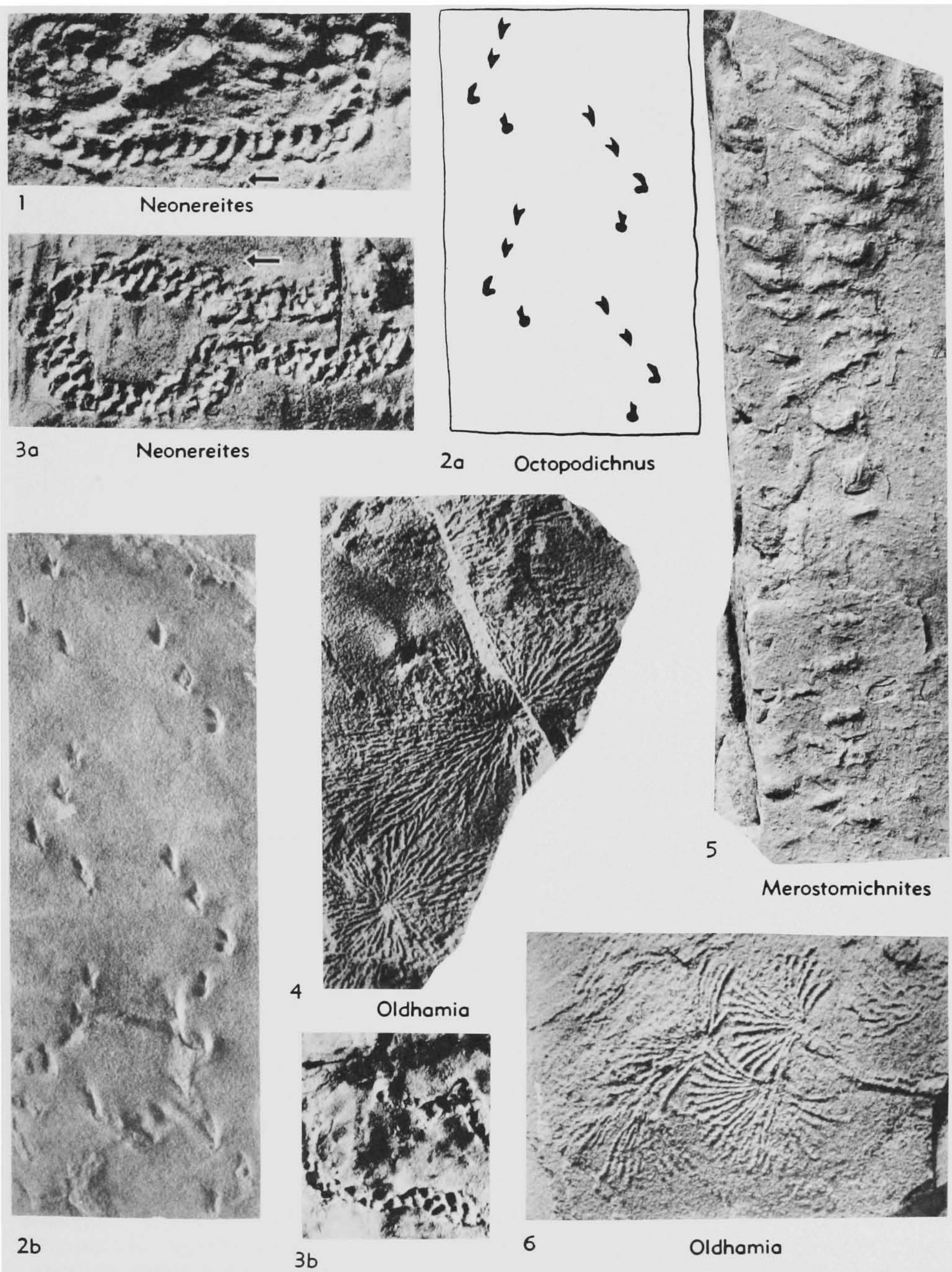


FIG. 126. Trace fossils (p. W205).

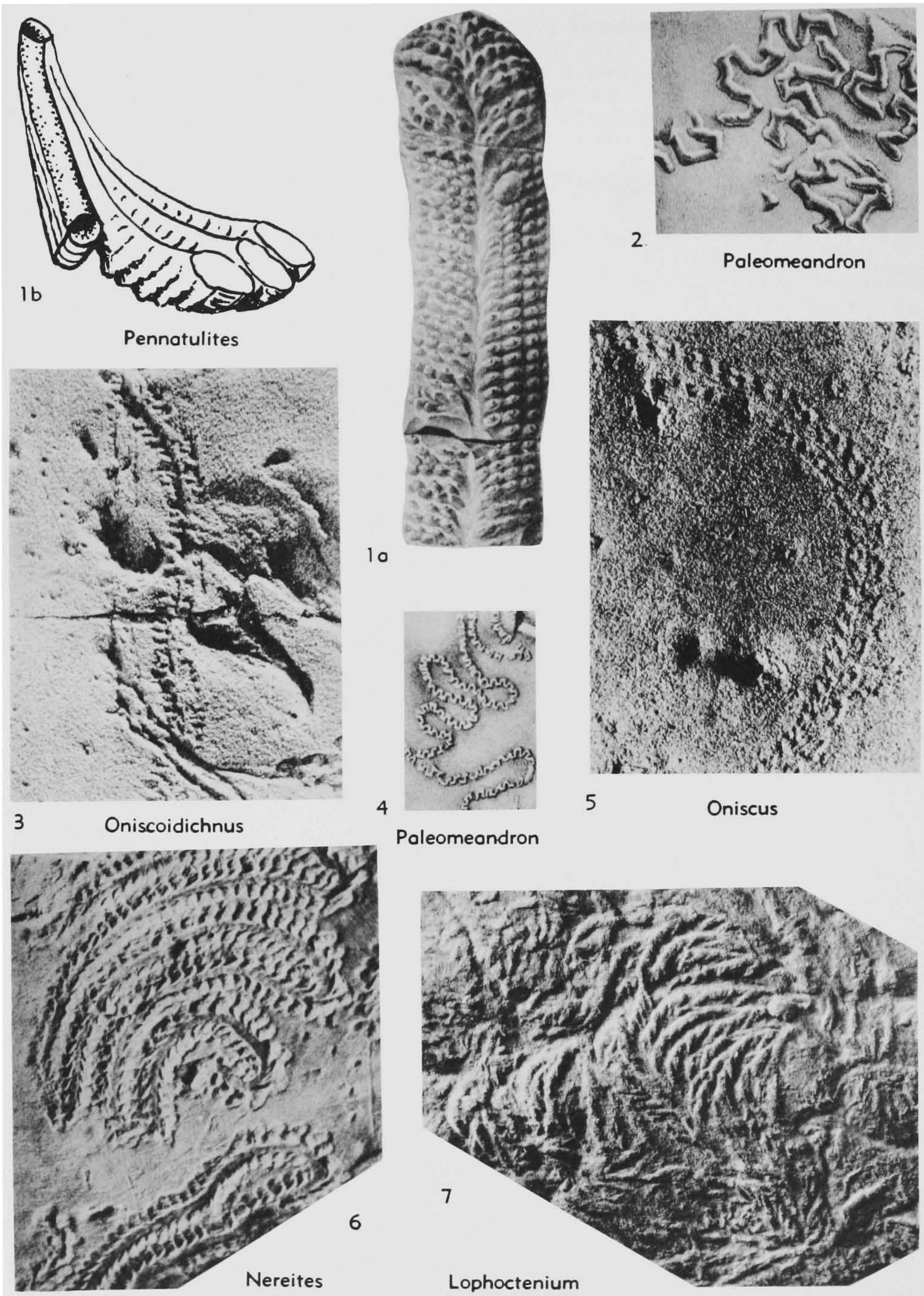


FIG. 127. Trace fossils (p. W201, W205, W208).

pressions on both sides (18). [Possibly made by phyllopod or myriapod; junior homonym.] *Trias.*, USA(Mass.).

Medusina WALCOTT, 1898. "Species" of this "genus" lack valid generic designation. Several species considered to be medusae in the *Treatise* (p. F153, F156-158), as well as "species" of *"Medusites"* (p. F159) and similar forms, probably belong among trace fossils (feeding trails).

Merostomichnites PACKARD, 1900 [**M. beecheri;* SD HÄNTZSCHEL, herein]. Circular, spindle- or bow-shaped, or transversely expanded, rarely ringed; opposite impressions arranged in 2 parallel rows with about 1 cm. interval; Paleozoic forms attributable in part to trilobites, in part to eurypterids, Triassic forms possibly to phyllopods (23). *Cam.-L.Trias.*, Eu.-N.Am.——FIG. 126,*5*. *M. strandi* STØRMER, Downtonian, Nor.(Spitz.); ×1 (126).

Mesichnium GILMORE, 1926 [**M. benjamini*]. Somewhat obscure trail consisting of 2 parallel lines of footprints with median row of suboval regularly spaced depressions; digital formula of producing animal unknown; width about 2 cm.; length of stride (distance between depressions of median row) about 15 mm. (11). *Perm.*, USA (Ariz.).——FIG. 124,*5*. **M. benjamini*, Coconino Ss.; diagram of trackway, ×0.5 (11).

Montfortia LEBESCONTE, 1886 [jr. hom.; *non* RÉCLUZ, 1843]. Small horizontal, oblique, or perpendicular burrows, 1 to 2 mm. wide, occasionally showing annulation; very similar to *Planolites* (42). [Probably worm trails; not a sponge as interpreted by LEBESCONTE.] *Precam.*, Fr.

Muensteria STERNBERG, 1833 [*non* KROGERUS, 1931]. "Genus" based on cylindrical, transversely striped bodies; in part body fossils (?sponges), in part trace fossils (?coprolites, *Taenidium* or other "genera") (7).

Myriapodites MATTHEW, 1903. Two opposite rows of impressions about 6 mm. apart, each row 2 mm. wide; rows consisting of closely set linear prints arranged in double series of elongated scratches or claw-markings, mostly directed from outside to inside of row; tracks commonly only round dots (16). *Carb.*, Can.(Nova Scotia).

Myriodocites MARCOU (before 1880). According to ZITTEL (1880), resembling *Nereites* and like Paleozoic trails; MARCOU's description not found.

Nemapodia EMMONS, 1844 [**N. tenuissima*]. According to RICHTER (1924), very probably track of Recent gastropod feeding in meanders on surface of slabs of slate (as shown by RICHTER for *N. tenuissima*, described by GEINITZ (1854) from L.Carb. slates of Saxony) (32).

Neonereites SEILACHER, 1960 [**N. biserialis*]. Typically (as negative epireliefs) consisting of irregularly curved chains of deep, smooth-walled dimples on upper surface of thin sandstone layers; chains restricted in length, some bordered laterally by flabby structures caused by burrowing; corresponding hyporeliefs (on lower surface of sandstone beds) forming indistinct rows of pustules (one row, *N. uniserialis;* two rows *N. biserialis*); interior with some clay pills corresponding to dimples of epirelief (16). *L.Jur.-M. Jur.*, Ger.——FIG. 126,*3*. **N. biserialis*, M.Jur. (Dogger β); *3a, 3b*, ×0.6 (120).——FIG. 126,*1*. *N. uniserialis* SEILACHER, L.Jur.(Lias α_2); ×0.9 (120).

Nereites MACLEAY, 1839 [*non* EMMONS, 1846] [**N. cambrensis;* SD HÄNTZSCHEL, herein] [=*Myrianites* MACLEAY, 1839 *(partim); Nereograpsus* GEINITZ, 1852; *Myrianytes* MASSALONGO, 1855; *Nereograptus* HALL, 1865]. Meandering feeding trails with narrow central axis and regularly spaced lateral, leaf-shaped or lobelike, commonly with finely striated elevations; width of trail about 1 to 2 cm.; trails highly variable in width and length of lobelike projections (23). [Made by annelids (RICHTER, 35) or gastropods (ABEL, 1).] *Paleoz.*, cosmop.——FIG. 127,*6*. *N. loomisi* EMMONS, M.Dev., Ger.; ×0.3 (35).

Octopodichnus GILMORE, 1927 [**O. didactylus*]. Trail of apparently 8-footed animal; tracks arranged in 4 groups; alternating; 2 anterior impressions of each group didactyle, 2 posterior, unidactyle; probably made by arachnid (ABEL, 1) or scorpionid (BRADY, 1947) (11). *Perm.*, USA (Ariz.).——FIG. 126,*2*. **O. didactylus*, Coconino Ss.; *2a*, ×0.8; *2b*, diagram of trackway, ×0.25 (11).

Oldhamia FORBES, 1849 [**O. antiqua;* SD ANDREWS, 1955] [=*Murchisonites* GOEPPERT, 1860]. Bunches of fine rills, radiating from joints of a sympodial axis; variously explained as actual remains of organisms, small burrows of worms, or inorganic; very probably trace fossils (16). *Cam.*, Eu.-N.Am. ——FIG. 126,*6*. **O. antiqua*, Ire.; ×1.3 (123). ——FIG. 126,*4*. *O. radiata* FORBES, Ire.; ×1.3 (123).

Oncophorus GLOCKER, 1850 [*non* RUDOW, 1870; *nec* EPPELSHEIM, 1885] [**O. beskidensis*]. Sinuous trail resembling *Gyrochorte bisulcata* GEINITZ, 1883 (16). *?U.Cret.*, Czech.

Oniscoidichnus BRADY, 1949 [**Isopodichnus filiciformis* BRADY, 1947] [=*Isopodichnus* BRADY, 1947 (*non* BORNEMANN, 1889)]. Trail with low, sinuous median ridge and forward-pointing bractlike footprints on each side at intervals of about 1 mm.; width of entire trail about 1 cm.; resembles track of Recent isopod, *Oniscus* (16). *M. Perm.*, USA(Ariz.).——FIG. 127,*3*. **O. filiformis* (BRADY), Coconino Ss.; ×0.5 (52).——FIG. 127, *5*. *Oniscus* sp.; track of Recent isopod, ×0.5 (52).

Ophiomorpha LUNDGREN, 1891 [*non* SZEPLIGETI, 1905] [**O. nodosa*] [=*Ophiomorpha* NILSSON, 1836 *(nom. nud.)*; *Cylindrites spongioides* GOEPPERT, 1841; *Spongites saxonicus* GEINITZ, 1842; *Cylindrites tuberosus* EICHWALD, 1865; *Phymatoderma dienvalii* WATELET, 1866; *Halymenites major* LESQUEREUX, 1873; *?Broeckia* CARTER, 1877; *?Halymenidium* SCHIMPER, 1879; *Astrophora* DEECKE, 1895]. Tunnel trails with tuberclelike or wartlike ornamentation of outer wall but smooth inside; width 1 to 2 cm.; may be branched with place of ramification widened in blistered or pear-shaped way (23). *U.Cret.-Tert.*, Eu.-N.Am.-Japan.——FIG. 125,9. **O. nodosa*, ?U.Cret. or L. Tert., S.Swed.(Scania); ×0.4 (82).——FIG. 125, 4. *O. major* (LESQUEREUX), U.Cret., USA (N.Dak.), ×0.5 (82).

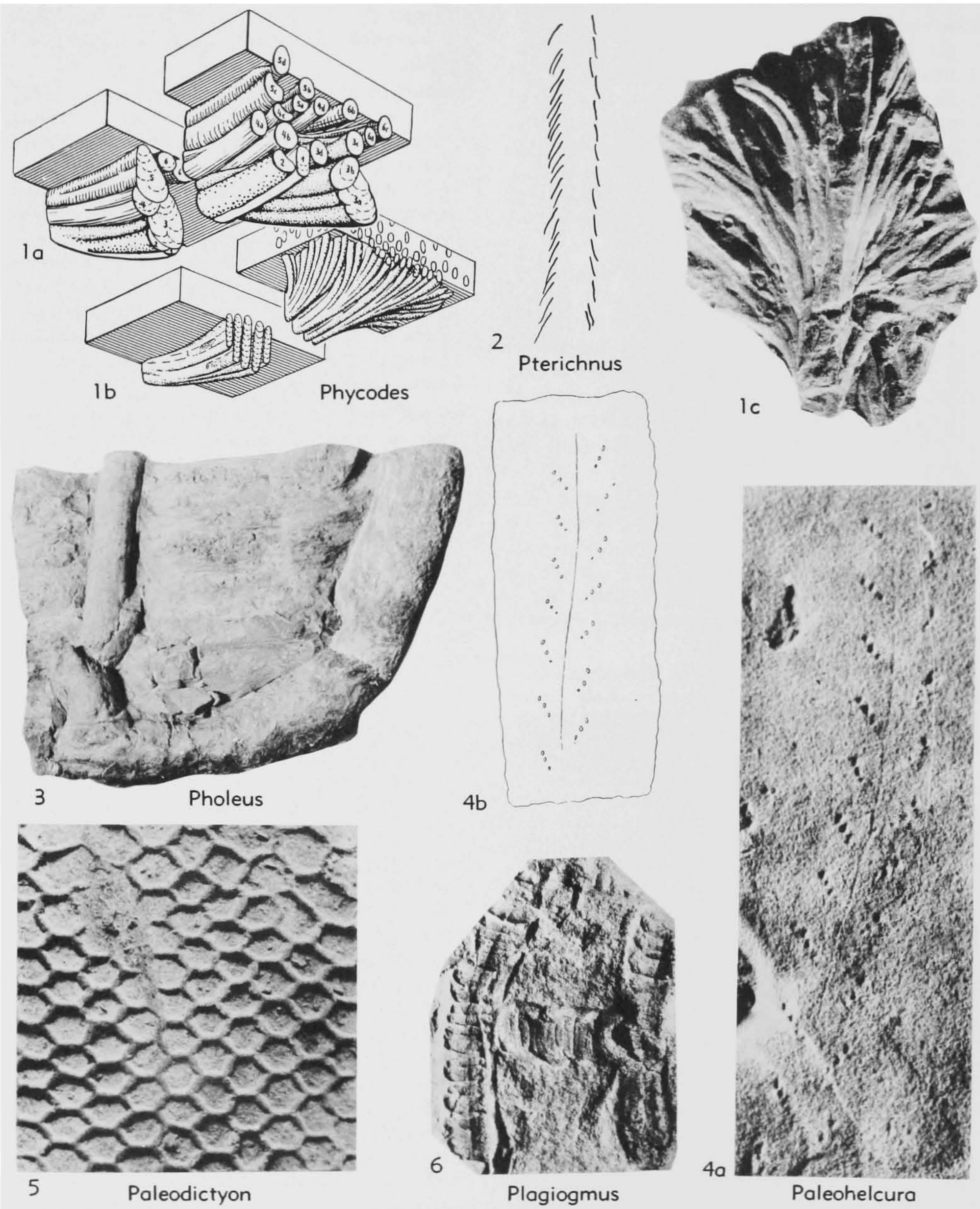


FIG. 128. Trace fossils (p. W208, W210).

Ormathichnus MILLER, 1880 [**O. moniliformis*]. Single, continuous, beaded trail, resembling impression of small column of *Heterocrinus* (16). *Ord.*, USA(Ohio).

Ostrakichnites PACKARD, 1900. Designation for trails described insufficiently by DAWSON (1873) as *Protichnites carbonarius*, according to PACKARD, they do not belong to *Protichnites*, nor were they made by limulids (16). *Carb.*, N.Am.(Nova Scotia).

Palaeocrista HUNDT, 1941 [*nom. nud.;* diagnosis and designation of type-species missing]. (16). *L.Ord.*, Ger.

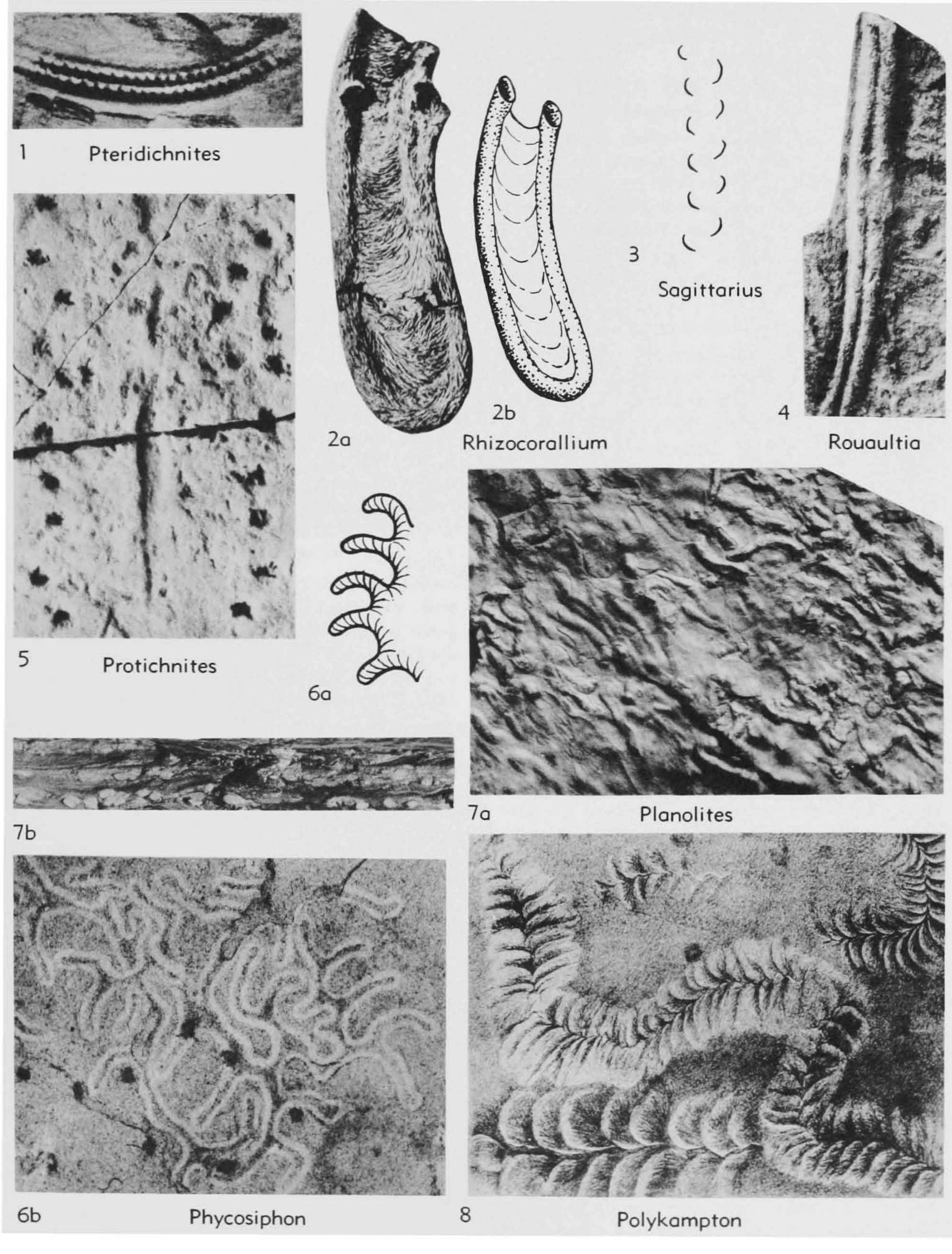


FIG. 129. Trace fossils (p. *W*208, *W*210, *W*212, *W*215).

Palaeophycus HALL, 1847 [**P. tubularis;* SD WILSON, 1948] [=*?Palaeospongia* D'ORBIGNY, 1849 *(partim); Foralites* ROUAULT, 1850; *?Aulacophycus* MASSALONGO, 1859; *?Aulacophycus* EICHWALD, 1860; *Spongillopsis* GEINITZ, 1862; *?Scolecites* SALTER, 1873; *?Aulacophycus* HEER, 1877; *Paleophycus* JAMES, 1879; *?Scoyenia* WHITE, 1929]. Fillings of cylindrical or subcylindrical horizontal galleries, branched and irregularly winding (46). *Paleoz.-Mesoz.*, Eu.-N.Am.

Palaeosemaeostoma RÜGER, 1925 [**Medusina geryonides* VON HUENE, 1901 (=*Medusa gorgonoides* G. WAGNER, 1932]. (See *Treatise*, p. *F*76, Fig. 61,*2*.) Very probably not belonging to the Trachylinida; according to FUCHS (1901) and SEILACHER (41) a feeding burrow resembling *Gyrophyllites* GLOCKER, 1841. *M.Jur.*, Ger.; *Cret.*, Czech.

Paleodictyon MENEGHINI, 1850 [**P. strozii*] [=*Palaeodictyon, Palaeodictyum* AUCTT. (*non* HEER, 1877); *Scyphia maxima* EICHWALD, ?1846; *Reticulipora buzzoni, R. villae, R. quadrata, R. briantea* STOPPANI, 1857; *Glenodictyum* VON DER MARCK, 1863; *Cephalites maximus* EICHWALD, 1865; *Paretodictyon* MAYER, 1878; *Palaeodyction* DE STEFANI, 1879; *Retiofucus* KEEPING, 1882; *Retiphycus* ULRICH, 1904]. Honeycomb-like networks, mostly regularly 6-sided, but also 5- to 8-sided meshes which are commonly open on one side; size variable; in relief on lower surface of beds (1,3). [Interpreted by some authors as organic, by others as inorganic; according to SEILACHER (40), these structures represent feeding trails.] *Ord.-Tert.*, Eu.-Asia-N.Am.——FIG. 128,*5*. *P. regulare* SACCO, L.Tert.(Flysch), Italy; ×0.4 (Seilacher, n).

Paleohelcura GILMORE, 1926 [**P. tridactyla*]. Two parallel rows of tracks with drag of caudal appendage between them; clusters of 3 imprints made by tridactyl, pointed extremities; their longer axis about 45 degrees to line of direction; clusters alternating on 2 sides; greatest width 22 mm.; probably made by scorpionid (11). *Perm.*, USA (Ariz.).——FIG. 128,*4*. **P. tridactyla*, Coconino Ss.; *4a*, ×0.5; *4b*, diagram of trackway, ×0.3 (11).

Paleomeandron PERUZZI, 1881 [**P. rude;* SD ANDREWS, 1955]. [=*Palaeomaeandron* FUCHS, 1895 *(errore)*]. Irregular, wide meanders made up of smaller, rather angular meanders or H-shaped figures (10). *Tert.*, Italy, Sp.——FIG. 127, *2*. **P. rude*, Italy; ca. ×2 (105).——FIG. 127,*4*. *P. elegans* PERUZZI, Italy; ca. ×0.5 (105).

Palmichnium RUDOLF RICHTER, 1954 [**P. palmatum*]. Large, plantlike arthropod track; opposed symmetrical rows of leg impressions; median keel; divided at regular pace intervals; bordered by longitudinally directed club-shaped impressions distinctly set off toward interior, but indistinctly toward exterior (16). *L.Dev.*, Ger.——FIG. 130,*1*. **P. palmatum;* ×0.25 (111).

Parinassa HUNDT, 1941 [**P. pennaeformis*] [*nom. nud.*; diagnosis missing]. (16). *L.Ord.*, Ger.

Pelecypodichnus SEILACHER, 1953 [**P. amygdaloides*] [=*?Lockeia* JAMES, 1879]. Small podlike fossils, tapering to sharp and obtuse points at each end; resting trails of pelecypods (39). *Ord.-Tert.*, Eu.-N.Am.——FIG. 130,*4*. **P. amygdaloides*, M. Jur.(Dogger β, Donzdorfer Ss.), Ger.; (shown with *Asteriacites quinquefolius* (QUENSTEDT), ×0.75 (39).

Pennatulites DE STEFANI, 1885 [**P. longespicata*] [=*Paleosceptron* DE STAFANI, 1885; *Virgularia presbytes* BAYER, 1955 (Tert. forms only)]. Thick cylindrical stalk, followed by a club- or ear-shaped part consisting of biserially arranged overlapping "sawed" leaves divided by deep median furrow (10). [According to SEILACHER (40, 41), a feeding burrow.] *Cret.-L.Tert.(Flysch);* Eu.-W.Indies (Trinidad).——FIG. 127,*1*. **P. longespicata*, U. Cret., Italy; *1a*, ×0.5; *1b*, model, ×0.2 (*1a*, 125; *1b*, 41).

Permichnium GUTHÖRL, 1934 [**P. völckeri*]. Two parallel, equal, and equidistant rows of V-shaped impressions, open to exterior; indicative of equal walking feet with 2 claws each; similar to *Bifurculapes* HITCHCOCK, 1858 (16). [Running trail of insect (?blattoid).]. *L.Perm.(Rotl.)*, Ger.——FIG. 130,*3*. **P. voelckeri;* holotype, ×1.4 (78).

Petalichnus MILLER, 1880 [**P. multipartitus*]. Wide trail, consisting of numerous transversely elongated depressions arranged without distinct order; apparently equivalent to 3 or more interlocking rows (16). [Made by trilobites.] *Ord.*, USA (Ohio).

Pholeus FIEGE, 1944 [**P. abomasoformis*]. Large compactly cylindrical dwelling burrows; longitudinal axis horizontal; anterior and posterior end closed and rounded; 2 or more rounded tubes, running obliquely or vertically, leading to surface; walls lined with flakes (16). [Probably made by decapods.] *M.Trias.(L.Muschelkalk)*, Ger.——FIG. 128,*3*. **P. abomasoformis*, ×0.4 (68).

Phycodes RICHTER, 1850 [*non* GUENEE, 1852; *nec* MILNE-EDWARDS, 1869] [**P. circinatum*] [=*Licrophycus* BILLINGS, 1865; *Vexillum rouvillei* SAPORTA, 1884; *Lycrophycus* TWENHOFEL, 1928]. Bundled cylindrical fillings of tunnels on lower surface of quartzite beds, may show faint regular transverse fluting (41). [According to SEILACHER, 1955, feeding burrow; see also *Arthrophycus*.] *L. Cam.*, Pak.; *Ord.*, Eu.-Am.-AsiaM.——FIG. 128 *1b-c*. **P. circinatum; 1b*, model, L.Ord., Ger.; ×0.3 (41); *1c*, Ord., Galena F., USA(Minn.); ×0.7 (97).——FIG. 128,*1a*. *P.* cf. *palmatum* (HALL), L.Cam., Pak.; model, ×0.7 (41).

Phycosiphon FISCHER-OOSTER, 1858 [**P. incertum*] [=*Palaeodictyon* HEER, 1865 (*non* MENEGHINI,

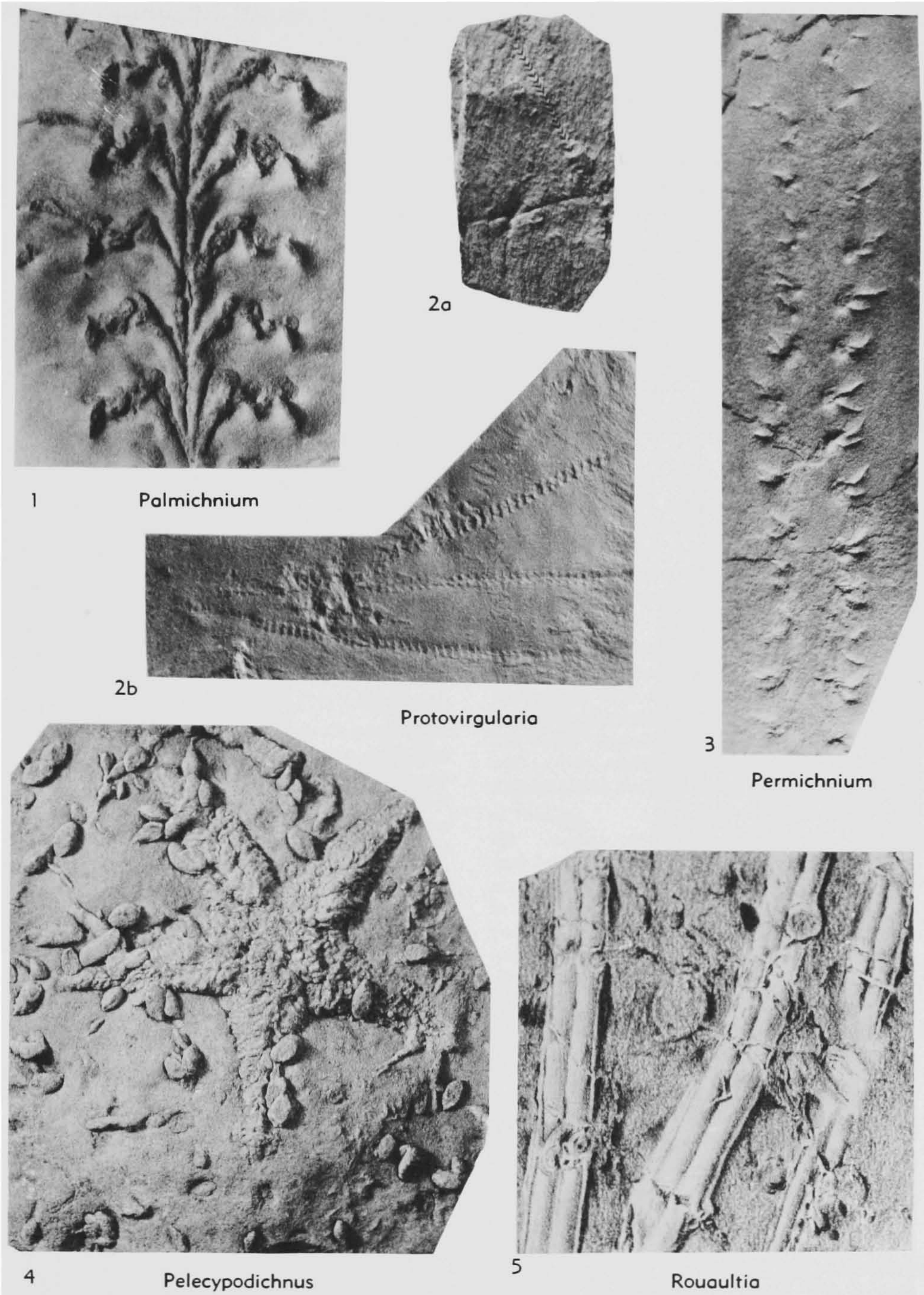


FIG. 130. Trace fossils (p. W208, W210, W212).

1850); *Reticulum* DE STEFANI, 1879; *Eterodictyon* PERUZZI, 1881)]. Elongate, U-shaped loops connected by constructed *Spreite;* frequently branched in large numbers to form antler-shaped systems; similar to *Rhizocorallium* ZENKER, but much smaller and asymmetrical; oblique or parallel to bedding planes (7). *Sil.-L.Dev., ?L.Carb., Jur.-Tert.,* Eu.-?N.Am.——FIG. 129,*6*. **P. incertum; 6a,* Eoc., Italy; ×2 (Seilacher, n); *6b,* U.Cret., Aus.; ×1 (41).

Phyllodocites GEINITZ, 1867 [**Crossopodia thuringiaca* GEINITZ, 1864]. Sinuous trails consisting of overlapping, somewhat irregularly placed oval depressions on either side of median narrow furrow; width of trail about 1 cm.; very similar to *Nereites* (23). *Paleoz.,* Eu.-N.Am.

Phyllonia HUNDT, 1941 [*nom. nud.;* diagnosis and designation of type-species missing.] (16). *L.Ord.,* Ger.

Phytopsis HALL, 1847 [*non* TOWNSEND, 1915] [**Fucoides demissus* EMMONS, 1842]. Inosculating straight or flexuous tubes, nearly circular in section (about 1 cm. in diam.), with diverging and anastomosing branches; pseudonym "birdseye" (2). [Burrows, according to RAYMOND (1931).] *Ord.,* USA(Ky.-Tenn.-N.Y.).

Plagiogmus ROEDEL, 1929 [**P. arcuatus;* SD HÄNTZSCHEL, herein]. Smooth, flat, concave ribbons, 1.5 to 2 cm. wide, slightly curved, with pronounced transverse bulges at irregular intervals or closely crowded; slight longitudinal furrow (16). *?L. Cam., M.Cam.,* Swed.; *Cam.(Pleist.* drift), Ger. ——FIG. 128,*6*. **P. arcuatus,* Cam.(Pleist. drift), Ger.; ×0.4 (112).

Planolites NICHOLSON, 1873 [**P. vulgaris;* SD NICHOLSON & ETHERIDGE, 1875]. Fillings of burrows, about 1 cm. wide, penetrating sediment in irregular course and direction; sand and silt of filling brought in by animals (presumably worms) after passing alimentary canal (16). *Precam.-Mesoz.,* cosmop.——FIG. 129,*7*. *P. montanus,* U. Carb., Ger.; *7a,* ×1; *7b,* transv. sec., ×0.7 (111).

Polykampton OOSTER, 1869 [**P. alpinum*] [*Polycampton* FUCHS, 1895 *(errore)*]. Zigzag-shaped stalk, at angles of which feather-like bunches grow out at both sides with backward directed curvature; externally similar to *Sertularia* (10). [Interpreted by FUCHS as spawn ribbons of prosobranchs; according to SEILACHER (1959), feeding burrow with alternating fanlike feeding fields.] *U.Cret.-L.Tert.,* Eu.——FIG. 129,*8*. **P. alpinum,* Trias., Switz.; ca. ×0.3 (102).

Protichnites OWEN, 1852 [**P. septemnotatus;* SD HÄNTZSCHEL, herein] [=*Protichnides* CHAPMAN, 1878]. Trackways consisting of trifid impressions, with or without median furrow (1, 23, 41). [Some made by trilobites.] *L.Cam.,* Pak.; *U.Cam.,* N. Am.——FIG. 129,*5*. **P. septemnotatus,* U.Cam. (Potsdam Ss.), Can.(Que.); track, ×0.3 (134). ——FIG. 131,*4*. *P. logananus,* U.Cam., USA (N.Y.), trail, ×0.1 (134).

Protopalaeodictyon KSIAZKIEWICZ, 1958 [*nom. nud.,* provisionally published with neither diagnosis nor named species] [=*Protopalaeodictyum* NOWAK, 1959]. Name proposed for initial forms of *Palaeodictyon,* resembling *Belorhaphe* (16). *L. Tert.(Flysch),* Eu.(Pol.).

Protovirgularia M'COY, 1850 [**P. dichotoma* (=?*Cladograpsus nereitarum* REINHOLD RICHTER, 1853)] [*Triplograptus* REINHOLD RICHTER, 1871; *Triplograpsus* GÜMBEL, 1879; *Provirgularia* GÜMBEL, 1879 *(errore)*]. Formerly believed to be octocoral owing to similarity with Recent *Virgularia,* or a graptolite; very probably an earlike trail (group *Ichnia spicea,* RUDOLF RICHTER) (16). [According to NATHORST (28), a trail belonging to the Chordophyceae of SCHIMPER (see *Treatise,* p. *V*95, p. *F*231).] *Ord.,* Eng.; *M.Dev.,* Ger.—— FIG. 130,*2*. **P. dichotoma,* U.Ord.(L. Bala beds), Scot.; *2a, 2b,* ×1 (Brighton, n).

Pterichnus HITCHCOCK, 1865 [**Acanthichnus tardigradus* HITCHCOCK, 1858] [=*Acanthichnus* HITCHCOCK, 1858 *(partim)*]. Two rows of tracks, usually quite numerous, turned outward at angle of 15 to 20 degrees from median line; feet lineate, acuminate (18). [?Myriapod trail.] *Trias.,* USA (Mass.).——FIG. 128,*2*. **P. tardigradus* (HITCHCOCK); ×0.7 (17).

Pteridichnites CLARKE & SWARTZ, 1913 [**P. biseriatus*]. Two rows of small pits bordered by narrow elevated margin; width about 4 mm.; median ridge crenulated; pits nearly equidimensional, alternating in position (16). [Explained as crawling trail of arthropod or annelid.] *U.Dev.,* USA(Md.). ——FIG. 129,*1*. **P. biseriatus,* Jennings F., ×1 (59).

Pyrophyllites. Starlike ?trace-fossil; cited by DAWSON (5); description not found.

Rhizocorallium ZENKER, 1836 [**R. jenense*] [=*Spongia rhizocorallium* GEINITZ, 1846; ?*Lithochela* GÜMBEL, 1861; *Glossifungites* LOMNICKI, 1886; *Lissonites* DOUVILLÉ, 1908 *(nom. nud.); Cavernaecola* BENTZ, 1929; *Upsiloides* BYRNE & BRANSON, 1941; *Rhizocorallum* SULLIVAN & ÖPIK, 1951 (obj.)]. U-shaped tubes with transverse packing (Ger., *Spreite;* Fr., *traverse*) and nearly parallel legs which are distinctly set off from the vertex arch; tubes relatively thick; mostly oblique or parallel to bedding; preponderantly feeding burrows; prolongation of dwelling tube by removal and redeposition of sediment in vertex; may show lateral flaps and at outer side of tubes scratch markings (indicative of crustaceans); ellipsoidal excrement pills may be incorporated (1, 23, 33). *Cam.-Tert.,* cosmop.——FIG. 129,*2*. *R.* sp.; *2a,* U.Cret., Fr.; ×0.5 (1); *2b,* model, L.Cam., Pak.; ×0.4 (41).

Rosselia DAHMER, 1937 [**R. socialis*]. Cylindrical, pencil-thick tubes, oblique to bedding, widening cuplike; opening traversed by peg of equal thickness and filled out by rock lamellae fitted into each other concentrically. [According to DAHMER, dwelling burrows; according to SEILACHER (1955), feeding burrows.] *L.Cam., Perm.,* Asia(Pak.); *L.Dev., ?Jur.,* Ger.——FIG. 131,*2*. **R. socialis,*

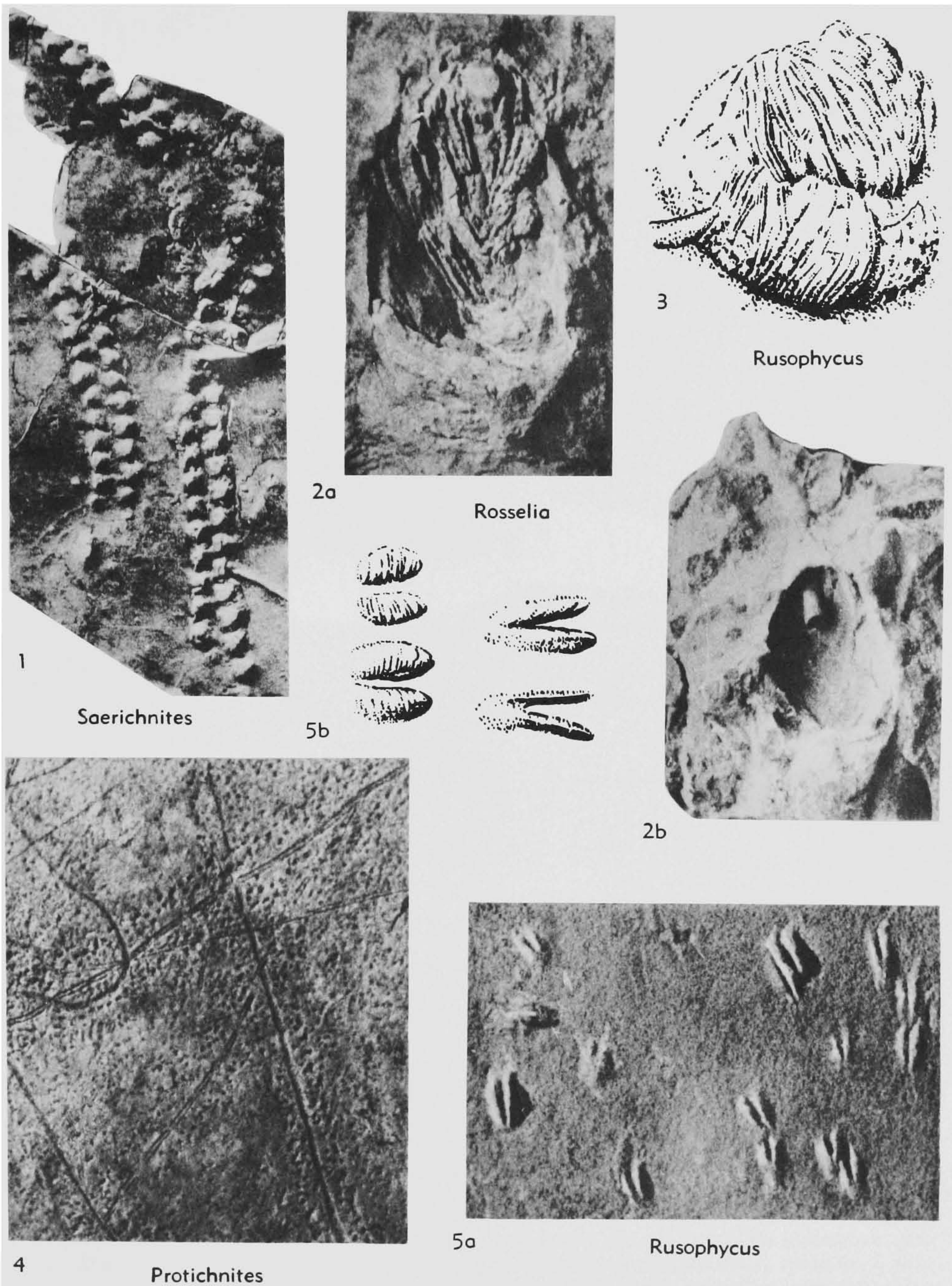


FIG. 131. Trace fossils (p. *W*210-*W*212, *W*215).

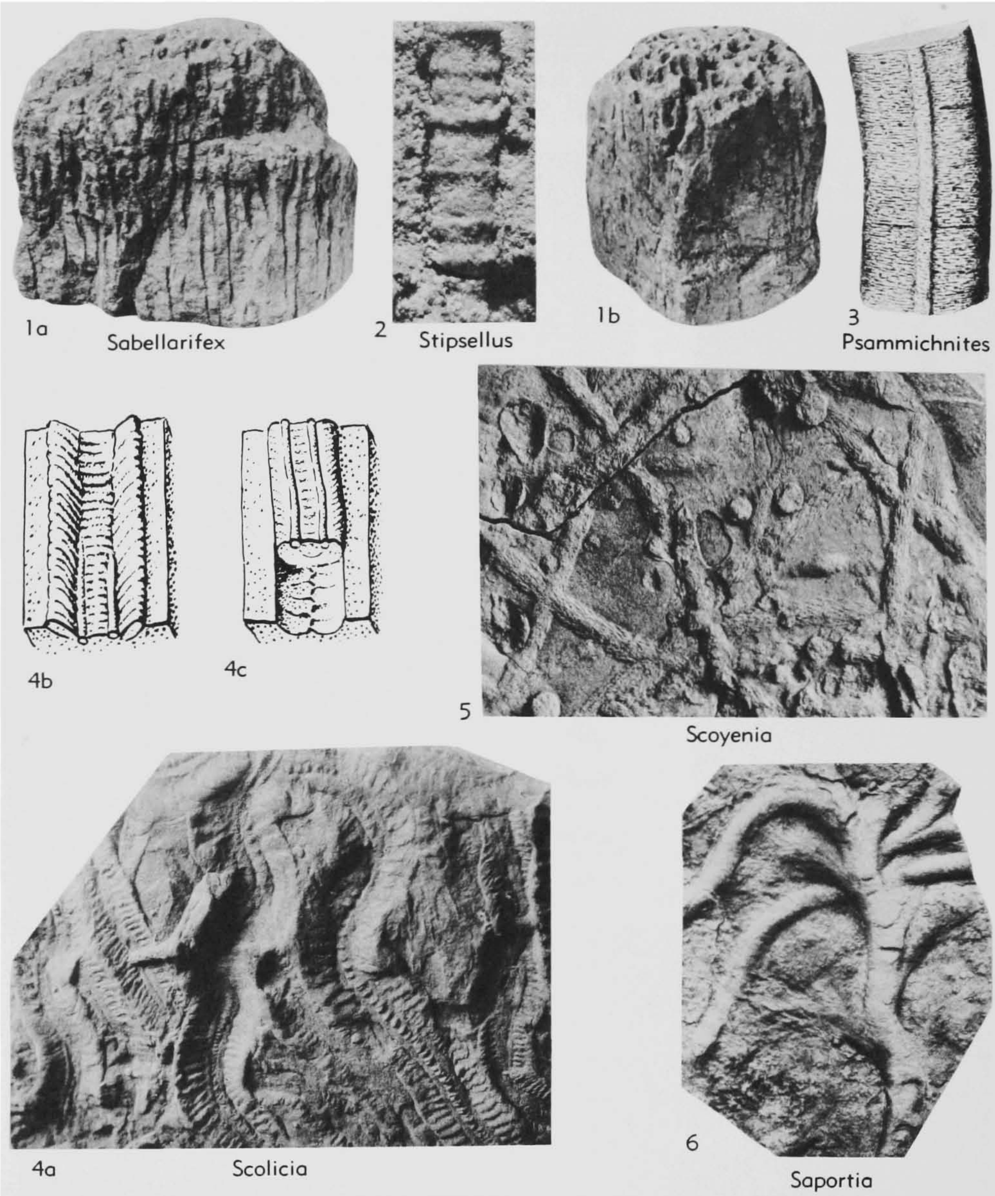


FIG. 132. Trace fossils (p. W214-W215, W218).

L.Dev.(L.Taunus quartzite), Ger.; *2a,* opening, ×0.5; *2b,* upper end of dwelling burrow with opening, ×0.5 (62).

Rouaulita DETROMELIN, 1877 [*non* BELLARDI, 1878] [**Fraena lyelli* ROUAULT, 1850]. Smooth, bilobate crawling trails, up to 1 cm. wide; some with 2 indistinct lateral furrows in addition to median furrow; mostly very long (16, 23). *Ord.,* Fr.-Port.; *?Sil.,* N.Afr.——FIG. 129,*4.* **R. lyelli* (ROUAULT), Ord., Port.; ×0.7 (63).——FIG. 130, *5. R. rouaulti* (LEBESCONTE), L.Ord.(Arenig.), Fr.; ×0.75 (92).

Rusophycus HALL, 1852 [**R. bilobatus*] [=*Rhysophycus* EICHWALD, 1860; *Rusichnites* DAWSON, 1864; *Rysophycus* DETROMELIN & LEBESCONTE, 1876; *Rhysophycus* SCHIMPER, 1879; *Rhizophycus* PENEAU, 1946]. Bilobate forms, resembling shape of coffee beans; transversely wrinkled, with deep median groove; some forming beaded rows of ribbons by horizontal repetition (39). [Typical rest-

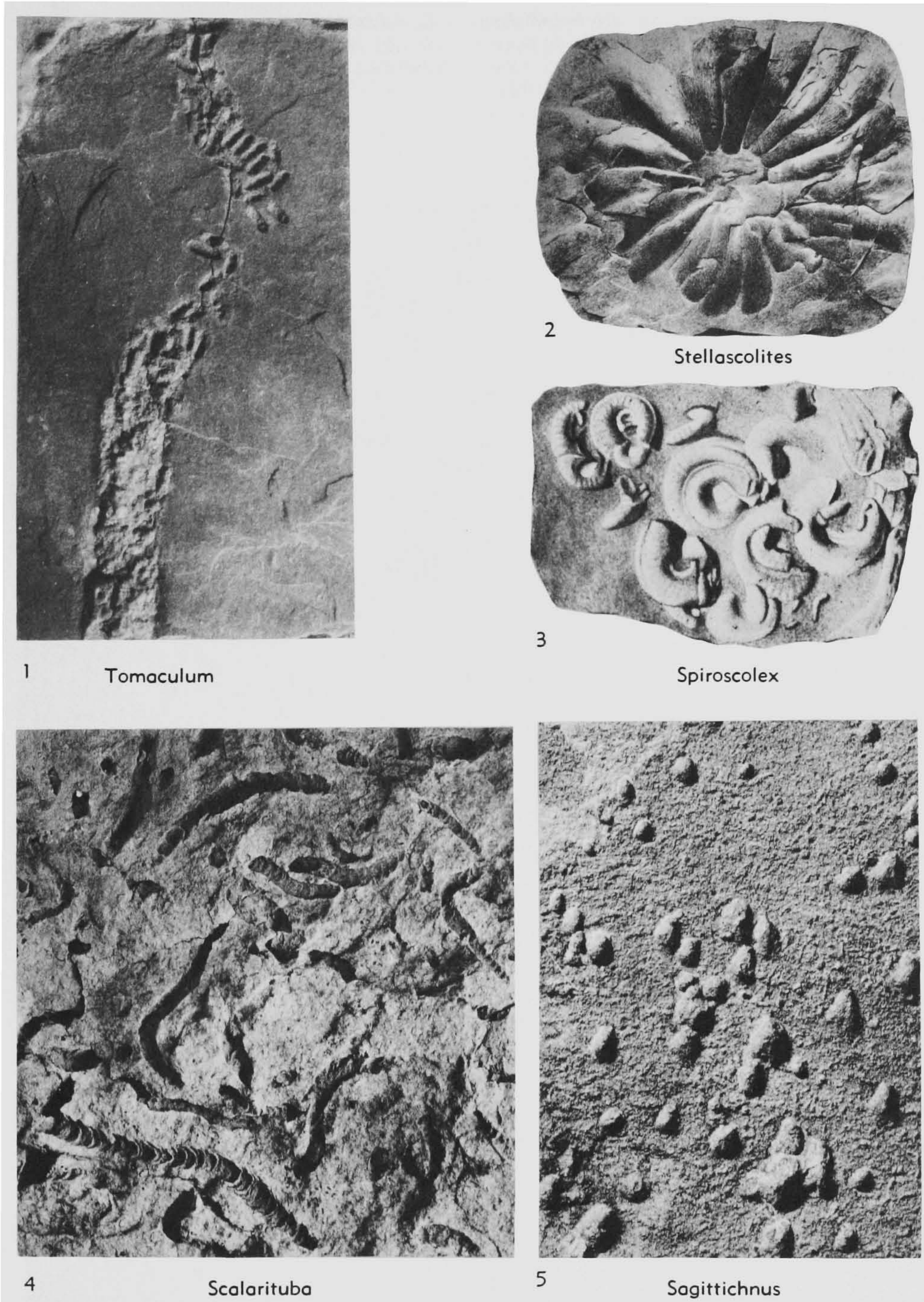


FIG. 133. Trace fossils (p. *W*215-*W*216, *W*218).

ing trail made by trilobites; see also *Isopodichnus* BORNEMANN, 1889.] *Paleoz.*, Eu.-N.Am.-N.Afr.-Asia(Pak.).——FIG. 131,*3*. **R. bilobatus* (VANUXEM), *L.Cam.*, Pak.; ×0.5 (41).——FIG. 131,*5*. *R. didymus* (SALTER), L.Cam., Pak.; *5a*, ×0.5; *5b*, ×1 (41).

Sabellarifex RUDOLF RICHTER, 1921 [**S. eifliensis*] [=*Skolithos* HALDEMAN, 1840; *Sabellarites*

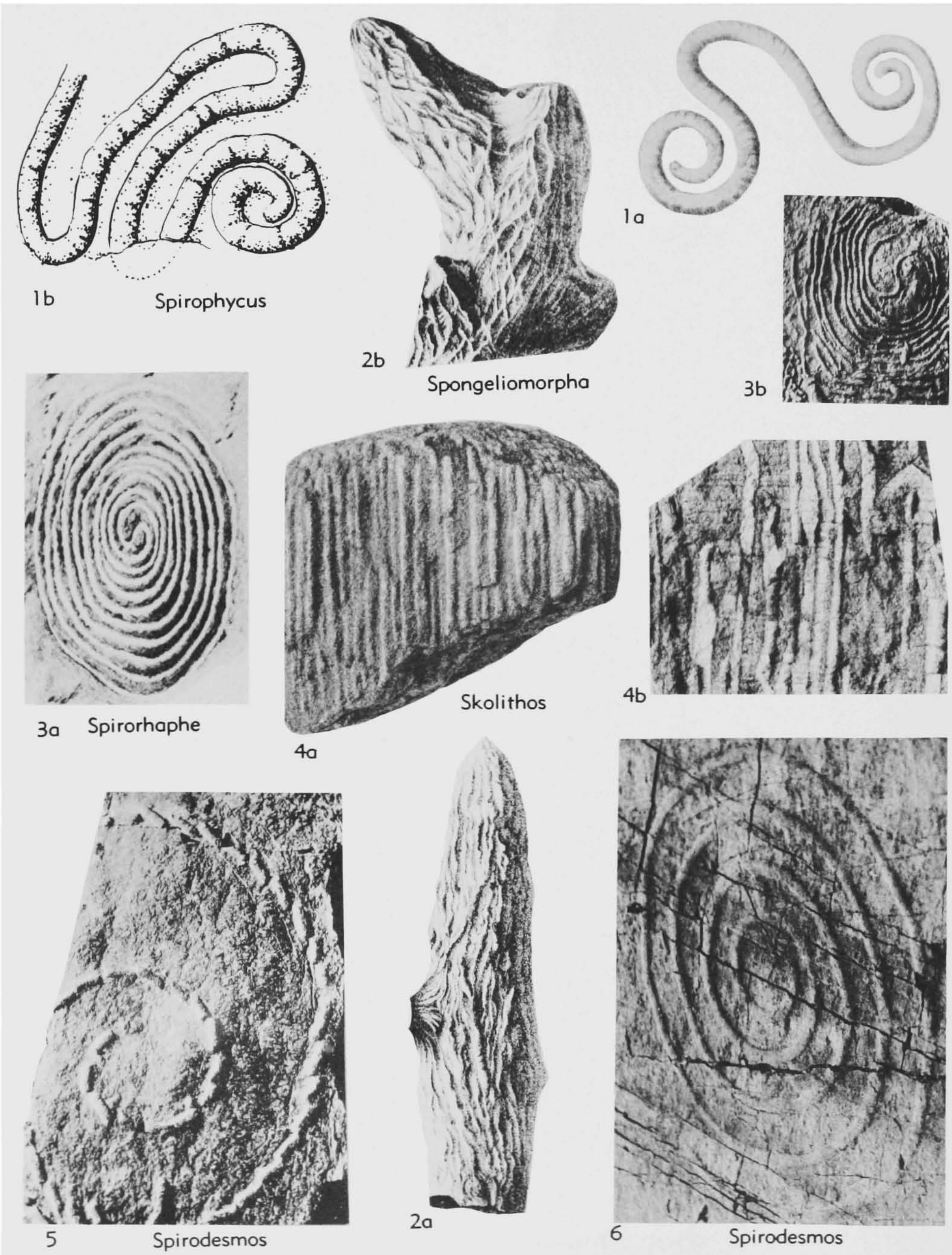


FIG. 134. Trace fossils (p. *W*215-*W*216).

RICHTER, 1920 (*non* DAWSON, 1890)]. Like *Skolithos*, but individual tubes less straight and not as crowded (23). *Cam.-L.Dev.*, Ger.-Swed.-?N.Am.——FIG. 132,*1*. **S. eifliensis*, L.Dev., Ger.; *1a*, ×0.65; *1b*, ×0.6 (111).

Sabellarites DAWSON, 1890 [*non* RUDOLF RICHTER, 1920] [**S. trentonensis;* SD HÄNTZSCHEL, herein]. Tortuous tubes, 1 to 3 mm. in diameter; up to 3 cm. in length; walls thick and composed of fragmental material cemented by organic substance; some in groups of 2 or more attached together (5). *Ord.*, Can.

Saerichnites BILLINGS, 1866 [**S. abruptus*]. Two parallel rows of semicircular or subquadrate pits 0.5 in. in diameter, alternating with each other uniformly, somewhat curved in outline on outer margin; anterior and posterior margins nearly straight; bottom nearly flat (16). *Ord.*, Can. (Anticosti).——FIG. 131,*1*. **S. abruptus*, English Head F.; ×0.14 (131).

Sagittarius HITCHCOCK, 1865 [jr. hom.; *non* VOSMAER, 1767; *nec* HERMANN, 1783] [**S. alternans*]. Two parallel rows of delicately curved tracks, with concave sides toward each other, resembling many small bows alternating with one another (18). [Insect trail.] *Trias.*, USA(Mass.).——FIG. 129, *3*. **S. alternans;* ×0.7 (18).

Sagittichnus SEILACHER, 1953 [**S. lincki*]. Resting trails suggestive of arrowheads with median keel; up to 5 mm. long; occurring in masses and equally oriented rheotactically (39). [Producer unknown, belonging to epipsammonts.] *U.Trias.*, Ger.——FIG. 133,*5*. **S. lincki*, M.Keuper; ×2 (39).

Saportia SQUINABOL, 1891 [**Zonarides striatus* SQUINABOL, 1887]. Large passageways, commonly branching dichotomously; surface with rhombic pattern produced by delicate arched parallel striations in 2 systems (2, 46). *Tert.*, Italy.——FIG. 132,*6*. **S. striata*, Flysch; ×0.3 (124).

Scalarituba WELLER, 1899 [**S. missouriensis*]. Subcylindrical burrows, 2 to 4 mm. in diameter, curving in all directions, marked by transverse ridges situated at distances of 1 to 2 mm. (16). *L.Miss.*, USA(Mo.).——FIG. 133,*4*. **S. missouriensis*, Kinderhook.; ×0.8 (Häntzschel, n).

Scolicia DEQUATREFAGES, 1849 [**S. prisca*]. Used for various trails presumably made by gastropods; typical is flattened ribbon-like shape with peculiar "gill-like" transverse structures produced by repeated displacement of sediment; longitudinal furrows in varied arrangement may occur; some differences may have surface or subsurface origin, as shown by GÖTZINGER & BECKER (1932) (41). [The following "genera" belong to this group but are not classifiable as synonyms: *Nemertilites* MENEGHINI, 1850; *Nereiserpula* STOPPANI, 1857; *Psammichnites* TORELL, 1870; *Cymaderma* DUNS, 1877; *?Phyllochorda* SCHIMPER, 1879; *Bolonia* MEUNIER, 1886; *Tetraichnites* DESTEFANI, 1895; *Curvolithus* FRITSCH, 1908; *Scolithia* KINDELAN, 1919 *(errore); Palaeobullia* GÖTZINGER & BECKER, 1932; *Olivellites* FENTON & FENTON, 1937.] *Cam.-Tert.*, Eu.-N.Afr.-N.Am.-Asia(Pak.).——FIG. 132, *4*. **S. prisca*, Eoc.(Flysch), Aus., Italy; *4a*, ×0.3 (1); *4b, 4c*, models, ×0.4 (41); *4a, 4b*=upper side forms=*Palaeobullia* GÖTZINGER & BECKER; *4c*=lower side form=*Subphyllochorda* GÖTZINGER & BECKER).——FIG. 135,*3*. *Olivellites plummeri* FENTON & FENTON, Penn. (Cisco), Tex.; ×0.6 (Bur. Econ. Geol., Austin).——FIG. 132,*3*. *Psammichnites gigas* (TORELL), L.Cam., S.Swed.; ×0.7 (129).

Scoyenia WHITE, 1929 [**S. gracilis*]. Slender rope-like remains; 2 to 5 mm. in diameter; in half relief or flattened; linear and commonly curved; densely clothed with closely appressed, tapering, acute, bract- or leaflike appendages; resembling lycopod such as *Selaginella;* obviously a trail (16). *Perm.*, Ger.-Fr.-USA(Ariz.).——FIG. 132,*5*. **S. gracilis*, Hermit Sh., Ariz., ca. ×0.7 (138).

Siphonites SAPORTA, 1872 [**S. heberti*]. Tubes about 1 cm. in diameter with sandy lining, mostly washed out and collapsed on bedding planes (2). *U.Trias.(Rhaet.)*, Fr.——FIG. 135,*4*. **S. heberti*, L.Lias.; ×0.35 (Laugier, n).

Skolithos HALDEMAN, 1840 [**Fucoides ?linearis*] [=*Tubulites* ROGERS, 1838 *(nom. nud.)* (*non* GESNER, 1758); *Scolithus* HALL, 1847 (and most later authors dealing with this "genus"); *Scolecolithus* ROEMER, 1848; *Scolecolithus* GOEPPERT, 1852; *Scolites* SALTER, 1857; *?Haughtonia* KINAHAN, 1858; *?Scolecites* SALTER, 1873 *(partim) (?pro Scolites)*]. Tubes or tube fillings standing vertically in sandstones; diameter about 0.2 to 1 cm.; usually straight, never branched; commonly but not always closely crowded; rarely with fine annulations (1, 23). [Made by worms or phoronids.] *Cam.-Ord.*, Eu.-Am.-Greenl.-Tasm.——FIG. 134,*4*. **S. linearis*, L.Cam.; *4a*, Swed.(Öland), ×0.6; *4b*, Swed., ×0.5 (136).

Spirochorda SCHIMPER, 1879 [**Dictyota spiralis* LUDWIG, 1869]. Possibly braided trail (2). *U.Dev.*, Ger.

Spirodesmos ANDRÉE, 1920 [**S. interruptus*]. Large spiral consisting of individual parts which usually are closely packed; individual parts 2 to 3 cm. long and 7 to 8 mm. wide; in outer coils parts are displaced toward interior with respect to each other; possibly part of large double spiral such as *Spirophycus* (16). *L.Carb.*, Ger.——FIG. 134,*5*. **S. interruptus*, Culm; ×0.17 (48).——FIG. 134, *6*. *S. archimedeus* HUCKRIEDE, Culm; ×0.2 (86).

Spirophycus HÄNTZSCHEL, *nom. nov.* [*pro Ceratophycus* SCHIMPER, 1879[1] (*non* FISCHER DE WALD-

[1] SCHIMPER, W. P. in ZITTEL, K. A. VON, 1890: *Handbuch der Palaeontologie*, pt. 2 (Palaeophytologie), p. 59 (München, Leipzig). The section of this work dealing with the Thallophyta was first issued in 1879.

HEIM, 1824)] [*Münsteria bicornis* HEER, 1877; SD HÄNTZSCHEL, herein (=*Münsteria caprina* HEER, 1877; *M. involutissima* SACCO, 1888)]. Transversely folded or rugose cylindrical bulges, curved like horns or bent spirally at the ends; 1 to 2 cm. thick (2, 16). *Cret.-L.Tert.(Flysch),* Eu.——FIG. 134,*1*. **S. bicornis; 1a,* Switz., ca. ×0.3; *1b,* Aus., ca. ×0.4 (*1a,* 84; *1b,* 41).

Spirorhaphe FUCHS, 1895 [=*Gilbertina* ULRICH, 1904 (*non* MORLET, 1888; *nec* JORDAN & STARKS, 1895); *Spiroraphe* ABEL, 1935 (*non* PERNER, 1907)]. Spirally coiled threads, turning in center with loop and running back between primary coils (10). *Cret.-Tert.,* Eu.-Alaska.——FIG. 134,*3*. *S.* sp.; *3a, "Gilbertina,"* U.Cret.(Yakutat F.), Alaska; ×0.7 (44); *3b,* Flysch, Aus.; ca. ×0.3 (1).

Spiroscolex TORELL, 1870 [**Arenicolites spiralis* TORELL, 1868]. Transversely ribbed, strongly curved, spiral structures 2 cm. in diameter; transverse ribs slightly elevated (16). *Cam.;* Swed.-Est.——FIG. 133,*3*. **S. spiralis* (TORELL), Swed.; ×0.5 (134).

Spongeliomorpha DE SAPORTA, 1887 [**S. iberica*] [=*Spongiliomorpha* DARDER, 1945 (*errore*).]

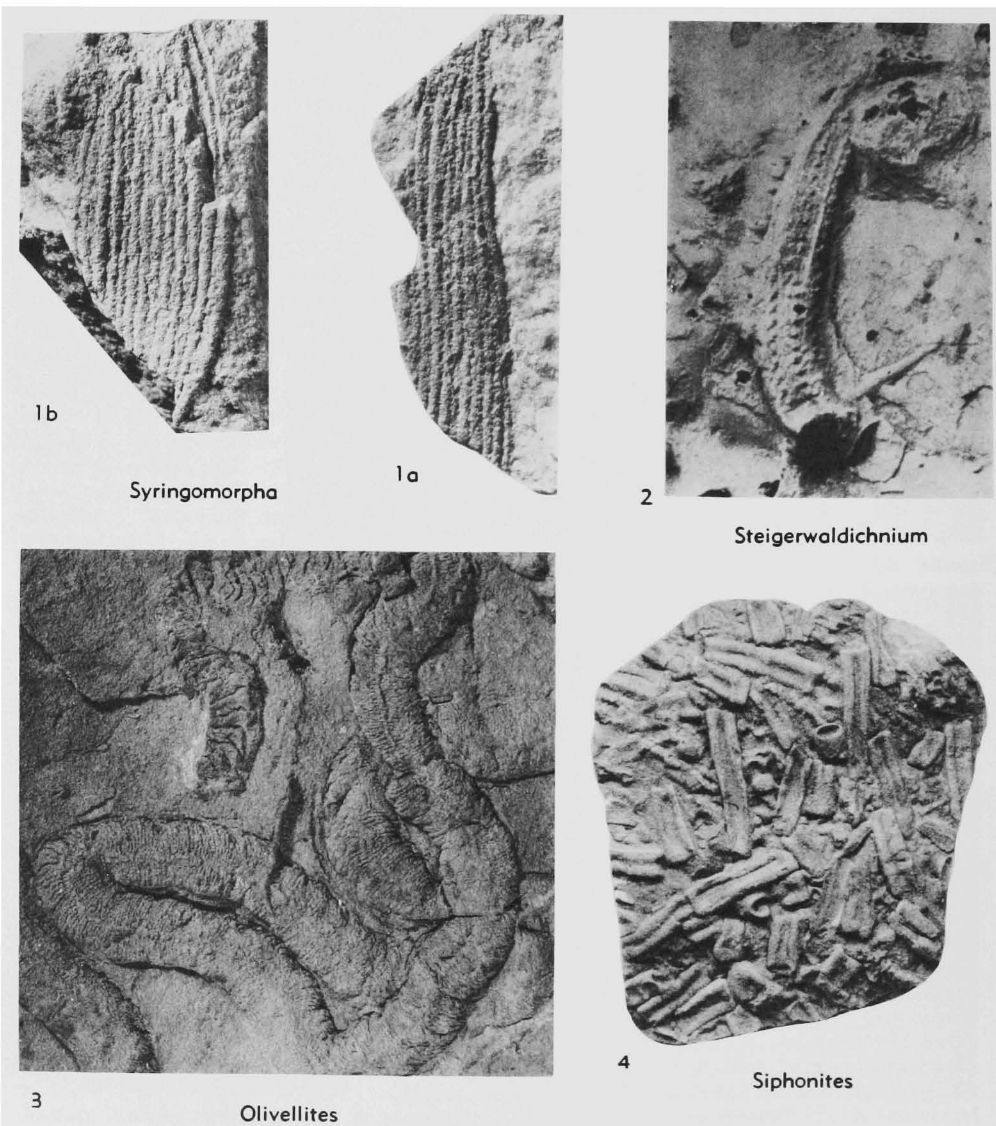


FIG. 135. Trace fossils (p. *W*215, *W*218).

Thick, elongate bodies suggestive of antlers; with ramifications and lateral tapering offshoots; surface with network of scratching traces crossing each other at acute angles (2). [Commonly regarded as sponges (*Treatise*, p. *E*36); burrows according to REIS (1922).] *Trias.-Tert.*, Eu.-?N. Am.——FIG. 134,2. **S. iberica*, ?Tert., Sp.; *2a, 2b*, ×0.7 (114).

"Spongia ottoi" GEINITZ, 1849. Starlike trails with elevated center; about 5 cm. in diameter; gen-

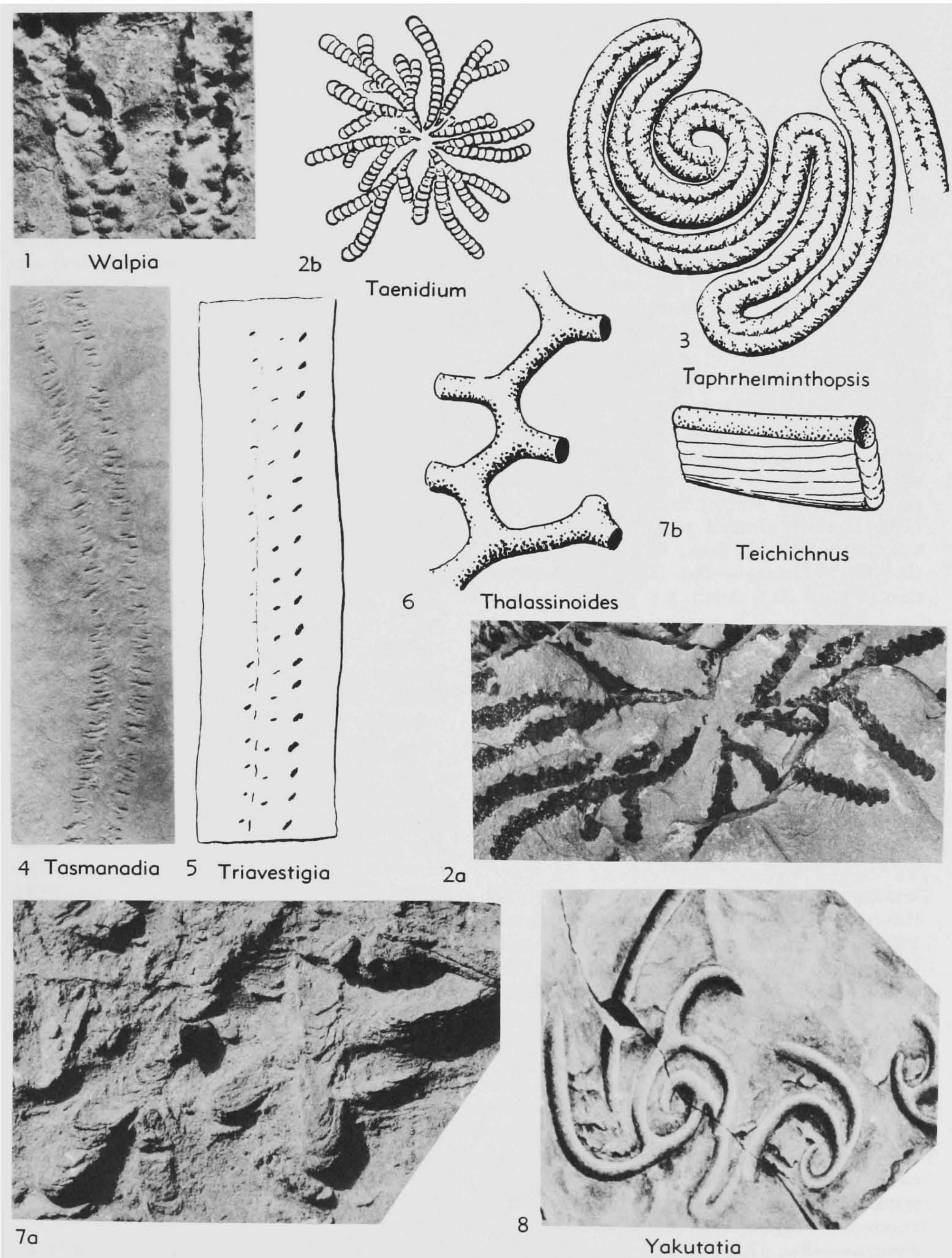


FIG. 136. Trace fossils (p. *W*218-*W*220).

erally 6 to 10 radiating grooves, rather irregularly and commonly only unilaterally developed; formerly described as sponge similar to *Peronidella furcata* (GOLDFUSS) (16). [Surely not belonging to Recent genus *Spongia* LINNÉ; probably feeding burrows made by crustaceans or worms.] *U.Cret. (Cenom.),* Ger.(Saxony).

Steigerwaldichnium KUHN, 1937 [**S. heimi*]. Straight, rarely curved tunnel traces parallel to bedding with distinct longitudinal rows of tiny projections and impressions from doubtful parapodia (16). [Made by a polychaete.] *U.Trias.,* Ger.——FIG. 135,*2*. **S. heimi,* M.Keuper; ca. ×1.5 (90).

Stellascolites ETHERIDGE, 1876 [**S. radiatus*]. Radiate or stellate disclike impression with 16 rays of nearly equal length radiating from central round space, becoming broader at their extremities which are not clearly defined; diameter 20 to 25 cm. (16). *Ord.,* Eng.——FIG. 133,*2*. **S. radiatus;* ×0.17 (67).

Stipsellus HOWELL, 1957 [**S. annulatus*] [=*Stripsellus* HOWELL, 1957 *(errore)*]. Perpendicular, cylindrical burrows, spaced about 2 cm. apart in sediment; differing from *Skolithos* by distinct ringlike expanded belts regularly distributed throughout their length; diameter about 1 cm. (16). [Perhaps identical with *Trachyderma serrata* SALTER, 1864.] *Cam.,* USA(Ariz.); *?Penn.,* USA(Md.)-?Arabia.——FIG. 132,*2*. **S. annulatus,* Cam.(Tapeats Ss.), Ariz.; ×1 (85).

Syringomorpha NATHORST, 1886 [**Cordaites? nilssoni* TORELL, 1868; SD NATHORST, 1886]. Rollerlike sticks several cm. in length and 1 to 2 mm. in thickness lying close together; slightly arched; touching each other along whole length and forming complete slab; occurring in large numbers independent of bedding (2, 23). [Possibly seaweed; work of gregarious worms on flat substratum, according to RUDOLF RICHTER (1927).] *L. Cam.,* Swed.; *Pleist.* (drift), Ger.——FIG. 135,*1*. **S. nilssoni* (TORELL); *1a, 1b,* ×1 (111).

Taenidium HEER, 1877 [**T. serpentinum;* SD HÄNTZSCHEL, herein] [=*Münsteria* STERNBERG, 1833 *(partim); Caulinites catuli* MASSALONGO, 1858; *Eione* TATE, 1859 (*non* RAFINESQUE, 1814; *nec* RISSO, 1826); *?Volubilites* VON LIBURNAU, 1901; *Pseudocrinus* ANELLI, 1935 (*non* GEINITZ, 1846); *Notaculites* KOBAYASHI, 1945; *Scolecocoprus* BRADY, 1947; *Tebagacolites* MATHIEU, 1949; *?Rhizocorallites* MÜLLER, 1955; *Toenidium* LESSERTISSEUR, 1955 *(errore)*]. Cylindrical tunnel fillings with segmentation reminiscent of *Orthoceras;* segmentation may also be indicated on outside by annular constrictions (46). [Interpreted as periodic filling of tunnel in backward direction.] *?Carb., Perm.-Tert.,* Eu.-N.Am.-Jap.-Antarct.——FIG. 136,*2*. *T.* sp., U.Cret. (Flysch), Aus.; *2a,* ×0.7; *2b,* ×0.27 (*2a,* Papp, n; *2b,* 41).

Taphrhelminthopsis SACCO, 1888 [**T. auricularis;* SD HÄNTZSCHEL, herein]. Meandering bilobate trails, similar to *Scolicia* DE QUATREFAGES (41), but in tightly coiled spirals or meanders (2). *Tert.,* Eu.——FIG. 136,*3*. **T. auricularis,* Flysch, Italy; ×0.2 (41).

Tasmanadia CHAPMAN, 1929 [**T. twelvetreesi*]. Double row of very sharp transverse imprints, mostly single but some joined internally or rarely externally to form bifid impression (16). [Sets of imprints explained by CHAPMAN as bristles of polychaete worm, but GLAESSNER (1957) conclusively proved them to be arthropod trails.] *Cam.,* Austral. (Tasm.).——FIG. 136,*4*. **T. twelvetreesi;* part of holotype, ×0.8 (74).

Teichichnus SEILACHER, 1955 [**T. rectus*]. *Spreiten-Bauten* formed by vertical (mostly upward) displacement of horizontal burrows; somewhat flexuous; rarely branched; feeding burrows (41). *L. Cam.,* Asia(Pak.); *M.Trias.-L.Jur.,* Ger.; *Tert.,* Belg.——FIG. 136,*7*. **T. rectus,* L.Cam.(*Neobolus* Ss.), Pak. (Salt Range); *7a,* ×0.7; *7b,* model, ×0.4 (41).

Teratichnus MILLER, 1880 [**T. confertus*]. Trackway of numerous narrow, somewhat rarely bifurcated impressions, arranged in oblique, asymmetrical sets (23). [Probably individual variation of trilobite track.] *Ord.,* USA(Ohio).

Thalassinoides EHRENBERG, 1944 [**T. callianassae*] [=*Spongites saxonicus* GEINITZ, 1842 *(nom. nud.); Cylindrites spongioides* GOEPPERT, 1841 *(nom. nud.); ?Aschemonia* DETTMER, 1915; *Vomacispongites* DE LAUBENFELS, 1955]. Branched burrows and tunnel systems, forkings mostly Y-shaped, without special surface ornamentation, commonly widened to form pear-shaped cavities (16). [Produced by decapod crustaceans.] *Trias.-Tert.,* Eu.-Asia.——FIG. 136,*6*. *T.* sp., Mio. (Meeres-Molasse), Switz.; ca. ×0.07 (41).

Tigillites ROUAULT, 1850 [**T. dufrenoyi;* SD HÄNTZSCHEL, herein] [=*Foralites* ROUAULT, 1850; *Monocraterion* TORELL, 1870; *Lepocraterion* STEHMANN, 1934; *non Tigillites habichi* LISSON, 1904]. Simple vertical burrows without special lining, smooth or regularly annulated; openings may be funnel-shaped, not crowded like *Skolithos* (23). *Cam.-Jur.,* Eu.-N.Am.-Arabia.

Tisoa DE SERRES, 1840 [**T. siphonalis*] [=*?Tissoa* REYNES, 1868 *(errore)*]. Two vertical cylindrical tubes 2 to 30 mm. in diameter, lying about 1 to 15 mm. apart, forming axis of long nodules reaching 1 m. or more in length; not branched; uncertain whether lower ends unite as 2 limbs of U-shaped burrow (23). *Jur.(Lias.),* Fr.-Madagascar; *L.Cret.,* USSR; *Oligo.,* Afr.(Tunisia).——FIG. 137, *4*. **T. siphonalis,* L.Jur.(Lias), Fr.; ca. ×0.7 (121).

Tomaculum GROOM, 1902 [**T. problematicum*] [=*Syncoprulus* RICHTER & RICHTER, 1939].

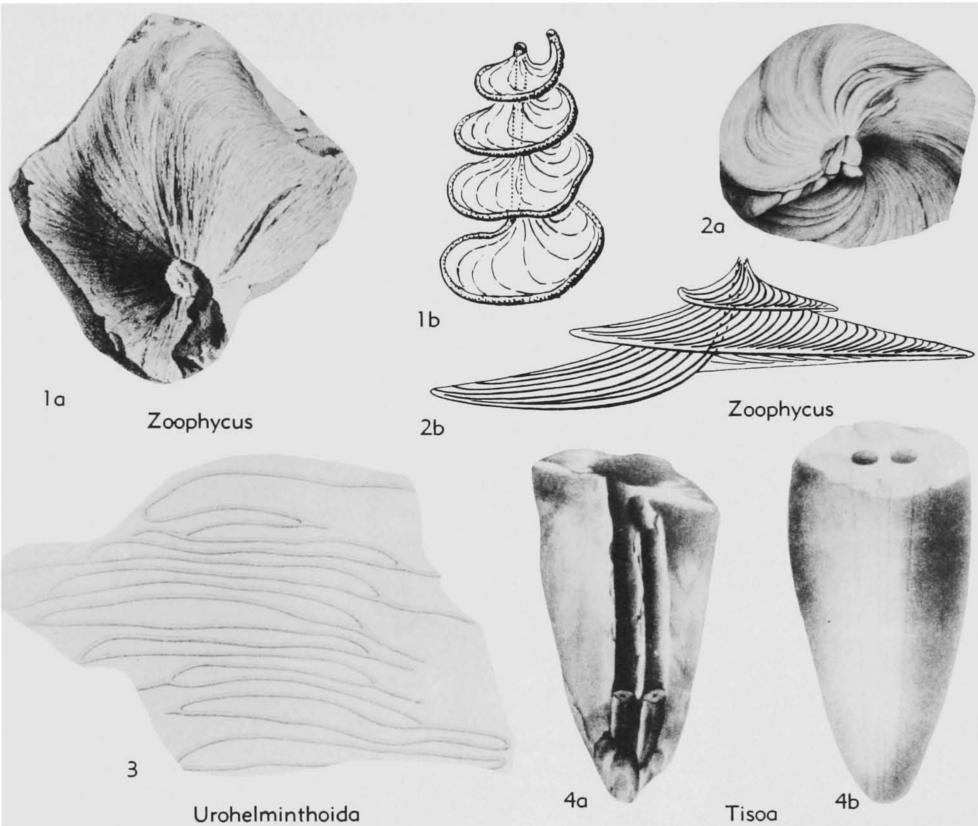


FIG. 137. Trace fossils (p. W218-W220).

Strands of elliptical fecal pellets (=*Coprulus*) up to 10 cm. long and 1 to 2 cm. broad; lying on bedding planes; within strands pellets commonly lumped together in clusters (16). *Ord., Eu.*——FIG. 133,*1*. *T. problematicum*, Herscheid slates, Ger.; ×2.5 (111).

Trachomatichnus MILLER, 1880 [**T. numerosus*; SD HÄNTZSCHEL, herein]. Trackway consisting of 2 rows of numerous, simple or beaded impressions (16). [Believed by some to have been made by cephalopods, but probably one of numerous variations of trilobite tracks.] *Ord.*, USA(Ohio).

Triadonereites MAYER, 1954 [**T. mesotriadica*]. Believed to be burrows of *Triadonereis* MAYER, 1954 (16). *M.Trias.*, Ger.

Triavestigia GILMORE, 1927 [**T. niningeri*]. Continuous trail of 3 parallel rows of footlike impressions, between 2 of which is faintly impressed tail track; longer axes of foot markings placed slightly diagonal to direction of movement, alternating; feet seemingly unidactyl; somewhat similar to *Bifurculapes* HITCHCOCK (11). *Perm.*, USA(Ariz.).——FIG. 136,*5*. **T. niningeri*, Coconino Ss.; ×.3 (11).

Trichophycus MILLER & DYER, 1878 [**T. lanosus*]. According to JAMES (1884), rill marks identical to *Blastophycus* MILLER & DYER, 1878; probably inorganic, according to NATHORST (1881). SEILACHER (personal communication, 1955) holds that they are burrows with delicately scraped walls, a conclusion with which the writer agrees (19). *Ord.*, USA(Ohio).

Trisulcus HITCHCOCK, 1865 [**T. laqueatus*]. Sinuous track, consisting of 3 continuous grooves with intermediate ridges; sometimes showing slight protuberances like those of *Sphaerapus* (18). *Trias.*, USA(Mass.).

Trypanites MÄGDEFRAU, 1932 [**T. weisei*]. Straight bore tunnels, usually vertical, 1 to 2 mm. wide, without ramifications, closely spaced (up to 12 per square cm.); some with excrement of producer (16). *Sil.*, USSR [*Pleist.* drift, Ger.]; *M. Trias.(Muschelkalk)*, Ger.

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

Urohelminthoida SACCO, 1888 [**Helminthoida appendiculata* HEER, 1877; SD HÄNTZSCHEL, herein]

[=*Hercorhaphe* FUCHS, 1895]. Threadlike reliefs forming broad meanders with tail-like appendage at each turn (10). *Cret.-L.Tert.(Flysch)*, Eu.——FIG. 137,*3*. **U. appendiculata* (HEER), Switz.; ×0.3 (84).

Walpia WHITE, 1929 [**W. hermitensis*]. Mined tunnels lined with flattened, lenticular, smooth pellicles of rather leathery texture; irregularly crowded or imbricated; probably representing excrement backed against walls of tunnel; somewhat similar to *Ophiomorpha* (16). [Possibly made by crustaceans.] *Perm.*, USA(Ariz.).——FIG. 136,*1*. **W. hermitensis*, Hermit Sh.; ×0.9 (138).

Yakutatia HÄNTZSCHEL *nom. nov.* [*pro Gyrodendron* ULRICH, 1904 (*non* QUENSTEDT, 1880)] [**Gyrodendron emersoni* ULRICH]. Cylindrical bodies, varying in thickness from 2 to 6 mm.; bifurcating 1 to 3 times, forming 1 to 1.7 volutions about acuminate inner extremity; outer end obtuse (44). *U.Cret.(Yakutat F.)*, Alaska——FIG. 136,*8*. **Y. emersoni* (ULRICH); ×0.5 (44).

Zonarites STERNBERG, 1833 [jr. hom., *non Zonarites* RAFINESQUE, 1831] [**Fucoides flabellaris* BRONGNIART, 1823; SD ANDREWS, 1955] [Probably= *Zonarides striatus* SQUINABOL, 1887 (*Saportia* SQUINABOL, 1891), as well as plants (e.g., *Z. digitatus* STERNBERG, 1833, =*Zonarides* SCHIMPER, 1869)]. "Genus" comprising starlike trace fossils (e.g., *Z. alcicornis* FISCHER-OOSTER, 1858) (2). [According to SEILACHER (1955) branched feeding burrows with faecal pellets stuffed transversely into them.] *?Perm., Tert.*, Eu.

Zoophycos MASSALONGO, 1855 [**Fucoides brianteus*, VILLA, 1844] [=*?Umbellularia longimana* FISCHER DE WALDHEIM, 1811; *Chondrites scoparius* THIOLLIÈRE, 1858; *Taonurus* FISCHER-OOSTER, 1858; *Spirophyton* HALL, 1863; *?Sagminaria* TRAUTSCHOLD, 1867; *Alectorurus, Physophycus, Zoophycus* SCHIMPER, 1869; *Cancellophycus* SAPORTA, 1873; *Glossophycus* SAPORTA & MARION, 1881; *?Flabellophycus* SQUINABOL, 1890; *?Myelophycus* ULRICH, 1904; *Physiophycus* FRITEL, 1925; *Zoophicos* WASSOJEWITSCH, 1953; *Zoophycus* LESSERTISSEUR, 1955]. Variously shaped *Spreiten* structures with thin tube and large but variable radius of curvature; without strict separation of legs and vertex (thus unlike *Rhizocorallium*); *Spreite* comprise thin slab of varied outline, in part screw-shaped (23). [Perhaps made by worms; all forms are feeding burrows.] *Dev.-Tert.*, Eu.-N.Am.-Afr.——FIG. 137,*1*. **Z. brianteus* (VILLA), *1a*, Eoc., Italy; ×0.4 (99); *1b*, schem. drawing after Tert. Ital. specimen (115).——FIG. 137,*2*. *Z. crassus* (HALL) ["*Spirophyton crassum*" HALL], U.Dev., USA; *2a*, ca. ×0.3 (79); *2b*, schem. drawing (41).

DOUBTFULLY DISTINGUISHED TRACE FOSSILS

Algites SEWARD, 1894 [*emend.* STOPES, 1913]. Seldom used, comprehensive generic name given to replace all older generic names of "algae" which suggest relationship with living forms. Generally =*Chondrites* STERNBERG, 1838.

Apodichnites FITCH, 1850 [*non* HITCHCOCK, 1869]. Suggested as "new order" including all sorts of "footless" tracks (e.g., *Helminthoidichnites* FITCH, 1850).

Coprolithus PAREJAS, 1948. Informal name used for coprolites of crustaceans, obviously not thought of as designation of "genus," although several "species" have been erected and described by PAREJAS (16). *U.Jur.*, Eu.(Switz.)-AsiaM.(Turk.)

Coprulus RICHTER & RICHTER, 1939. Mechanical-ecological subsidiary name for excrement in form of isolated, loose pills; not considered generic name, but sometimes used as such (16).

Dipodichnites HITCHCOCK, 1841. Name proposed for an "order" including tracks of biped animals.

"Feather-stitch trail" WILSON, 1948. Straight or curved burrows in form of zigzag feather-stitch pattern (16). *M.Ord.(Trenton)*, Can.; *L.Jur.*, S. Ger.——FIG. 121,*7*. "Feather-stitch trail" WILSON, schem. drawing.

Graphoglypten FUCHS, 1895 [=*Hieroglyphs* s.s., FUCHS, 1895] Trace fossils appearing as reliefs on lower surface of beds (mostly sandstones) and resembling ornaments or letters (e.g., *Paleodictyon, Paleomeandron*), indicative of Flysch sediments. [Explained by FUCHS, 1895, as strings of spawn of gastropods.]

Helminthites SALTER, 1857 [=*Helmintholites* MURCHISON, 1867; *Helmintholithes* ETHERIDGE, 1881]. Name proposed for long, sinuous surface trails or filled-up burrows of marine worms without impressions of lateral appendages; not used as generic name; published without designation of "species" (16).

Ichnites (or **Ichnytes**) VINASSA DA REGNY, 1904. Not a "genus"; general designation for various trails; for instance, applied by OPPEL (1862) and WINKLER (1886) to trails from the Upper Jurassic Solnhofen Limestone (Bavaria).

Ichnium [*non Ichnium* PABST, 1896 (amphib.), *nec* SOLLAS, 1900 (?worm)]. General formal designation of a trail; not a "genus"; used in connection with "species" designations for various vertebrate and invertebrate trails.

Nucleocavia RICHTER & RICHTER, 1930. General name (not generic) for small, usually winding canals which generally occur in form of furrows on surface of *steinkerns*. [Producers are worms, arthropods, and other animal groups.]

Polypodichnites Hitchcock, 1841. Name proposed for an "order" including tracks of animals with more than 4 feet.

Rhabdoglyphen Fuchs, 1895. General and informal name for nearly straight bulges, mostly on undersurface of sandstone beds of Flysch and similar sediments; greatest diameter several centimeters; *Rhabdoglyphus* used by Wassojewitsch

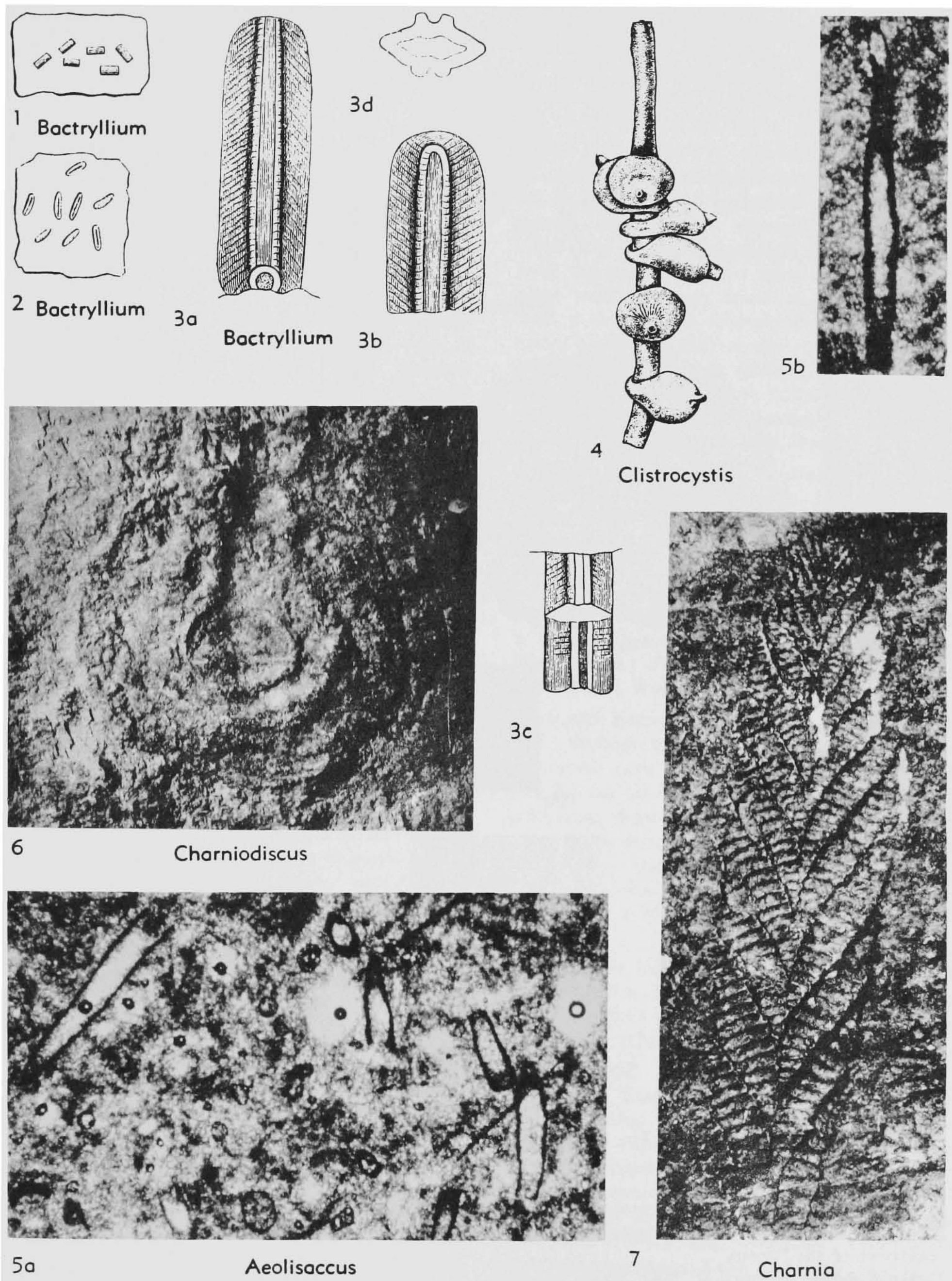


Fig. 138. Body fossils (p. W223).

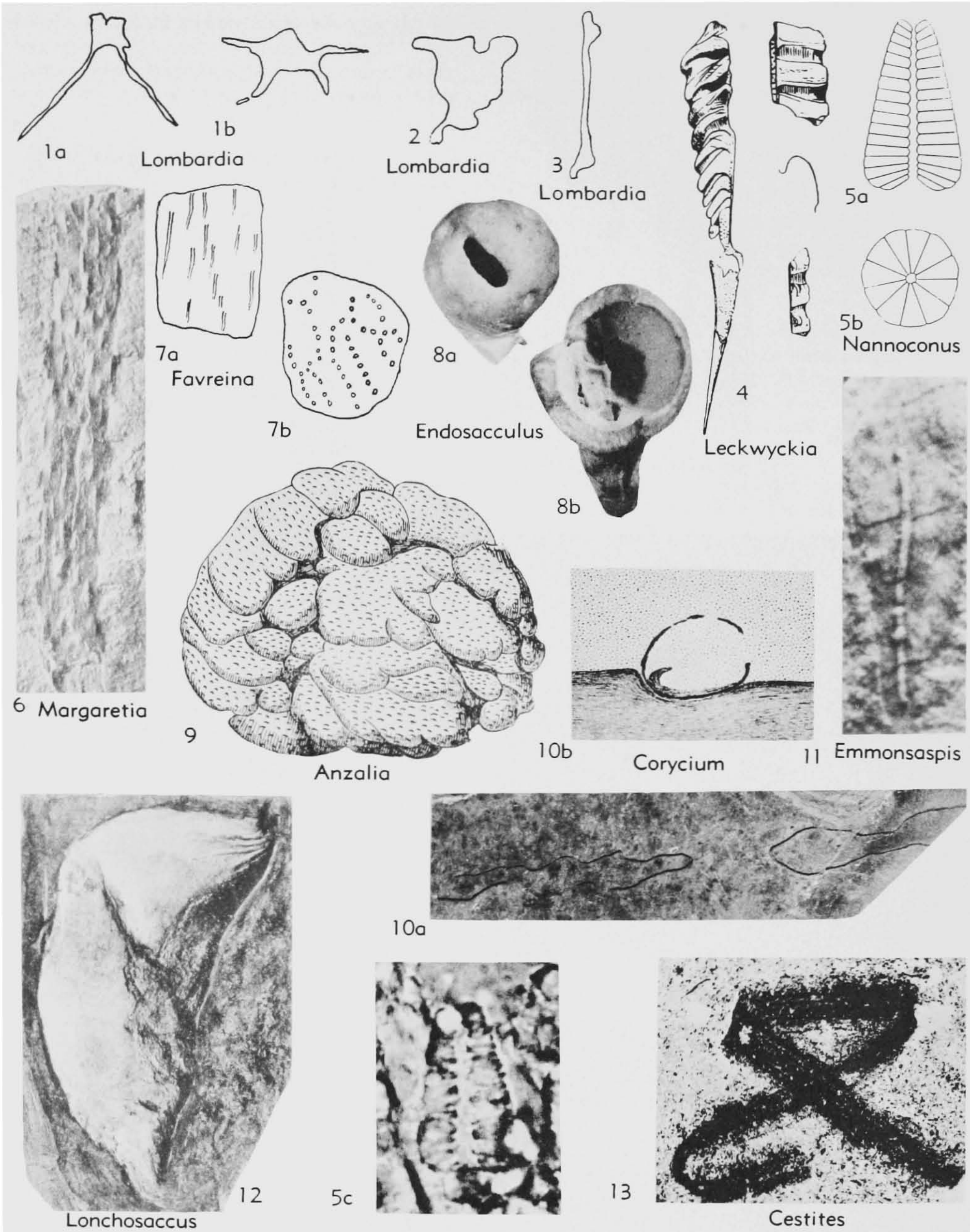


FIG. 139. Body fossils (p. W223-W225).

(1933), with the "species" *R. grossheimi* from the Flysch of USSR, is invalid owing to absence of diagnosis of the "genus."

Tetrapodichnites HITCHCOCK, 1841. Name proposed for "order" containing tracks of quadruped animals.

Vermiglyphen FUCHS, 1895. Collective name for threadlike, straight or variously winding reliefs on undersurface of sandstone beds in Flysch and similar sediments; mostly unbranched; width usually only a few mm.

BODY FOSSILS

This chapter contains "genera" of doubtful or completely uncertain classificatory status. Frequently they have been described only once and have never been discussed again. Additional "genera" of this type may be found in the sections on "unrecognizable genera" in this and in other parts of the *Treatise*. The forms listed in the parts of the *Treatise* published before this manuscript was finished have generally not been listed here again. The larger groups of doubtful affinities such as conodonts and hyolithids, have been dealt with by other authors.

Aeolisaccus ELLIOTT, 1958 [**A. dunningtoni*]. Small thin-walled tubes, gently tapering, open at both ends, maximum length 1.7 mm., diameter 0.1 mm.; wall structure of crystalline calcite, walls irregularly annular (16). [Doubtfully inferred to be shells of small extinct pteropod.] *Perm.-Low. M.Jur.*, Middle East.——FIG. 138,*5*. **A. dunningtoni*, U.Perm., Arabia; *5a*, sec. showing numerous individuals; *5b*, approx. long. sec. of irregular elongate tube; both ×50 (66).

Anzalia TERMIER & TERMIER, 1947 [**A. cerebriformis*]. Reef-forming organisms of brainlike aspect, with large central cavity and very numerous small apertures resembling oscula of sponges (16). *Cam.*, Morocco.——FIG. 139,*9*. **A. cerebriformis;* ×.04 (128).

Armelia ?LEBESCONTE, ?1891. Description missing. [According to SEILACHER (personal communication, 1956) problematic body fossil.] *Ord.*, Fr.

Bactryllium HEER, 1853 [**B. canaliculatum;* SD ANDREWS, 1955]. Small rounded or flat bacilliform bodies, a few mm. to 1 cm. in length, about 0.6 mm. wide; smooth or mostly with delicate transverse striations and 1 or 2 longitudinal furrows; ends rounded; material siliceous (2). [Interpretation as diatoms very improbable; ?pellets.] *Trias.-Jur.*, Eu.——FIG. 138,*1*. **B. canaliculatum*, U.Trias., Switz., Italy; ×1 (116).——FIG. 138, *2*. *B. schmidi* HEER, U.Trias., Italy, Switz.; ×1 (116).——FIG. 138,*3a-d*. *B. striolatum* HEER, U. Trias., Switz., Italy; (*3c*, transv. sec.), ca. ×8 (116).

Bovicornellum HOWELL, 1934 [**B. vermontense*]. Small horn-shaped tube; about 1.5 cm. long; walls smooth (16). [May be worm or mollusk. Index fossil of Highgate Shale.] *U.Cam.*, USA(Vt.).

Ceramites LIEBMANN (in FORCHHAMMER), 1845 [*non* MASSALONGO, 1859] [**C. hisingeri*]. This fossil, described from alum shales (U.Cam.) of Scandinavia as a fucoid, represents a species of *Dictyonema* HALL, 1851, probably *D. flabelliforme* EICHWALD.

Cestites CASTER & BROOKS, 1956 [**C. mirabilis*]. Fringed ribbon reduced to carbonaceous film, with longitudinal lines (16). [Regarded as lobe of fossil cestid ctenophoran, but identification questionable.] *Ord.*, USA(Tenn.).——FIG. 139, *13*. **C. mirabilis;* ×2 (56).

Charnia FORD, 1958 [**C. masoni*] [=?*Rangea* sp. GLAESSNER, 1959]. Frondlike organisms, 10 to 25 cm. in length, 4 to 5 cm. wide; composed of segmented oblique lobes, diverging alternately on either side of sinuous median axial line, whole fossil tapering to pointed apex at one end and blunt stalk at other; frond possibly grown up from a disc named *Charniodiscus* (16). [Interpreted by FORD (1958) as algal frond or primitive colenterate of unknown affinities, and by GLAESSNER (1959) as coelenterate related to the Pennatulacea.] *Precam.*, Eng.-S.Austral.——FIG. 138,*7*. **C. masoni*, Woodhouse beds, Eng.; ×0.4 (70).

Charniodiscus FORD, 1958 [**C. concentricus*]. Disclike structures, possibly organic, 5 to 30 cm. in diameter; central area rough-surfaced; smooth flange with or without concentric corrugations; possibly associated with frondlike fossil *Charnia* (16). [Interpreted by FORD (1958) as basal part of the "alga" *Charnia*, and by GLAESSNER (1959) as medusa-like base of coelenterate related to the Pennatulacea.] *Precam.*, Eng.——FIG. 138,*6*. **C. concentricus*, Woodhouse beds; ×0.7 (70).

Clistrocystis KOZLOWSKI, 1959 [**C. graptolithophilius*]. Padlock-like chitinous forms bearing a very small cone about 0.5 mm. long; individual side by side on stipes of *Mastigograptus* sp. and embracing them; longitudinal axis perpendicular to graptolite stipes (16). [Possibly cysts of aquatic invertebrate; systematic position unknown.] *M. Ord.*(drift), Pol.——FIG. 138,*4*. **C. graptolithophilius*, on a stipe of *Mastigograptus* sp.; ×25 (88).

Coelenteratella KORDE, 1959 [**C. antiqua*]. Small cuplike bodies; height about 7 mm., wall thickness about 0.15 mm.; fixed by foot about 8 mm. long (16). [Questionable coelenterate]. *M.Cam.*, USSR(Sib.).

Conostichus LESQUEREUX, 1876 [**C. ornatus*] [=*Conostychus* LESQUEREUX, 1880]. Cone with flattened or cup-shaped top; showing a series of several successive layers; diminishing in diameter from base toward top; wrinkled lengthwise; somewhat similar to feeding burrow, *Rosselia* (10). [BRANSON (1961) has designated *Conostichus* (=*Duodecimedusina* KING, 1955) as type of n. fam. Conostichidae of the Scyphozoa, Order Coronatida.] *?Dev.*, S.Am.(Bol.), *Penn.*, USA.

——FIG. 116,*2*. **C. ornatus;* ×0.3 (69).——FIG. 116,*3*. *C.* sp., Ohio; ×0.3 (69).

Corycium SEDERHOLM, 1911 [**C. enigmaticum*] [=*Corycinium* C. L. FENTON, 1946]. Saclike structures with carbonaceous walls occurring in sandy beds; filling mass commonly shows concentric internal structure (37). [Regarded as alga by SEDERHOLM, but considered to be inorganic by VAN STRAATEN (1949); carbonaceous material proved by isotope investigation to be of organic origin.] *Precam.*, Fin.——FIG. 139,*10*. **C. enigmaticum; 10a,* ×0.2; *10b,* vert. sec., ×0.7 (*10a,* Geol. Survey Finland; *10b,* 119).

Curculionites KOLBE, 1888 [jr. hom.; *non* HEER, 1847; *nec* GIEBEL, 1856] [**C. senonicus*] [=*Curculidium* HANDLIRSCH, 1907]. Name proposed for burrow of curculionid, presumably in wood; recognized by W. QUENSTEDT (1932) as belonging to *Doratoteuthis syriaca* WOODWARD (16). *U. Cret.(Senon.)*, AsiaM.(Syria).

Emmonsaspis RESSER & HOWELL, 1938 [**Phyllograptus? cambrensis* WALCOTT, 1890]. Oval shape, blunter at one end than other, with rod beginning about a third of way back and extending almost to posterior end, mostly with ribbing beginning at about center line and extending to outer margins (16). [Possibly a chordate.] *L.Cam.*, USA (Vt.).——FIG. 139,*11*. **E. cambriensis* (WALCOTT), Rome F.(*Olenellus* Z.); mag. unknown (110).

Endosacculus VOIGT, 1959 [**E. moltkiae*]. Globular, gall-like swellings in internodes of octocoral *Moltkia minuta* NIELSEN; diameter about 5 mm.; with narrow ventral slitlike opening, length about 2.5 mm.; interior of "cyst" smooth (16). [Possibly made by barnacles (Ascothoracida).] *U.Cret. (Camp.-U.Maastr.)*, Netherl.-Swed.——FIG. 139, *8*. **E. moltkiae,* Maastricht., Neth.; *8a,* cyst with somewhat damaged opening; *8b,* cyst opened, showing the thin walls; both ×3 (132).

Favreina BRÖNNIMANN, 1955 [**F. joukowskyi*] [="Organisme B" JOUKOWSKY & FAVRE, 1913; *Coprolithus salevensis* PAREJAS, 1948; "Characé primitive(?)" CUVILLIER, 1951]. Subtriangular and rounded dark organic remains of apparently homogeneous texture; 0.5 to 1.5 mm. in length, 0.2 to 0.4 mm. in width; 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 (16). [Explained by PAREJAS (1948) as coprolites of crustaceans, by CUVILLIER (1951) as primitive Charophyta, by BRÖNNIMANN (1955) as microfossils *incertae sedis,* and by BRÖNNIMANN & NORTON, 1960, as coprolites of crustaceans.] *L.Jur. (Infra.-Lias.)-L.Cret.(Apt.),* Eu.(Switz.-Fr.)-W. Indies(Cuba) - USA(Tex.) - C.Am.(Guatemala)-Trinidad.——FIG. 139,*7*. **F. joukowskyi,* U.Jur. (M.Portland.), Cuba; *7a, 7b,* long. sec., transv. sec., ×22 (54).

Halysium SWIDZINSKI, 1934 [**H. problematicum*]. [=*?Hormosira moniliformis* HEER, 1877; *Halimeda saportae* FUCHS, 1894; *Arthrodendron* ULRICH, 1904 (*non* SEWARD, 1898 *nec* SCOTT, 1900)]. Ovate capsules, commonly flattened, smooth or minutely granulated, with consistency differing from matrix; some specimens with carbonaceous lining; capsules forming branching rows (16, 44). *U.Cret.-L.Tert.*, Eu.-N.Am.(Alaska).——FIG. 141, *4*. **H. problematicum,* Italy; ×0.6 (Seilacher, n).

Hensonella ELLIOTT, 1960 [**H. cylindrica*]. Calcareous tubes, hollow, cylindrical, straight, slightly tapering, length up to 2.5 mm. (?incomplete); diameter 0.1 to 0.5 mm.; walls consisting of very thin dark inner layer and thick outer layer of aragonite with radiate structure (16). [Affinities doubtful; according to ELLIOTT not a dasyclad alga; perhaps a small scaphopod.] *L.Cret.*, AsiaM. (Iraq-Iran)-N.Afr.(Algeria)-E.Indies(Borneo).————FIG. 141,*5*. **H. cylindrica,* NE.Iraq; ×30 (66).

Leckwyckia TERMIER & TERMIER, 1951 [**L. aenigmatica*]. Smooth, sharply pointed, acutely conical tube; upper end widening regularly and showing transverse units separated by constrictions (16). *Ord.*, Morocco.——FIG. 139,*4*. **L. aenigmatica;* ×0.9 (128).

Lenaella KORDE, 1959 [**L. reticulata*]. Cylindrical calcareous organisms, about 1 mm. long and 0.5 mm. wide; wall perforated by very fine holes (16). [Systematic position unknown (?hydrozoan).] *L.Cam.*, USSR(Sib.).

Lombardia BRÖNNIMANN, 1955 [**L. arachnoidea*] [="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 about 1.5 mm. (16). [Interpreted by LOMBARD (1945) as algae, by PAREJAS (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.(Fr.-Switz.)-W.Indies(Cuba).——FIG. 139,*1*. **L. arachnoidea,* Portland., Cuba, *1a, 1b,* ×62 (54).——FIG. 139, *2*. *L. perplexa* BRÖNNIMANN, Portland., Cuba; ×62 (54).——FIG. 139,*3*. *L. angulata* BRÖNNIMANN, Portland., Cuba; ×62 (54).

Lonchosaccus RUEDEMANN, 1925 [**L. uticanus*]. Formed like bent bag, length more than twice width, with thick, substantial wall, now carbonized; 2 "extremities" drawn into apertures (16).

[Systematic position unknown.] *Ord.*, USA(N.Y.). ——FIG. 139,*12*. **L. uticanus,* Utica Sh.; holotype, ×? (113).

Margaretia WALCOTT, 1931 [**M. dorus*]. Thin membranous sheet with elongate oval perforations arranged on longitudinal and obliquely transverse lines; tegument presumably leathery (16). [Compared with algae and alcyonarians.] *M.Cam.*, Can.(B.C.)-USA(Idaho). —— FIG. 139,*6*. **M. dorus,* Burgess Sh., B.C.; holotype, ×0.7 (134).

Nannoconus KAMPTNER, 1931 [**Lagena colomi* DE LAPPARENT, 1931; SD BRÖNNIMANN, 1955]. Micro-

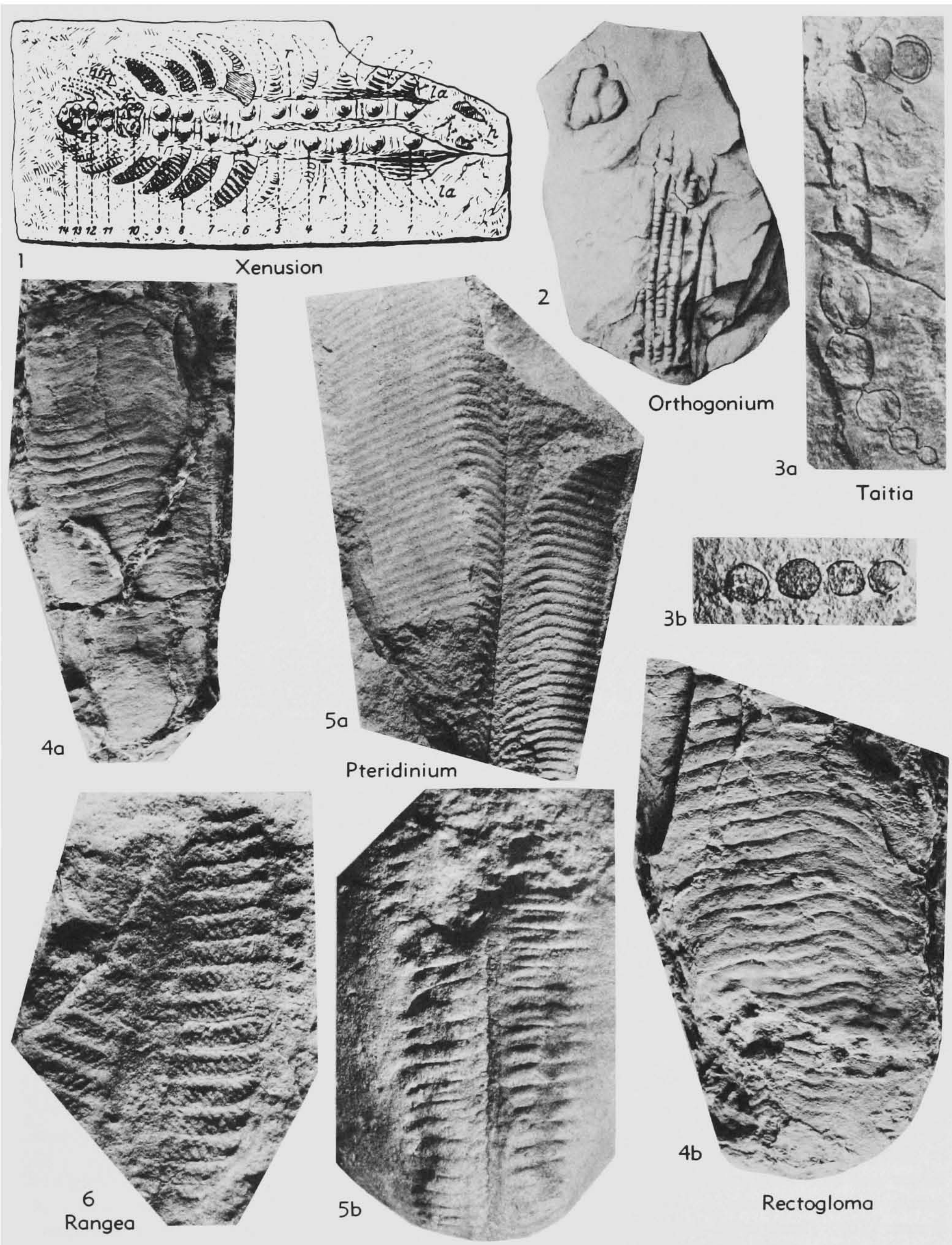


FIG. 140. Body fossils (p. *W*226, *W*228).

scopically small, peg-shaped structures with axial canal, 5 to more than 50 microns (mostly 15 to 20 microns) long, 5 to 15 microns wide; composed of numerous wedge-shaped individual elements (16). [?Skeletal remains of planktonic Protozoa (*Treatise*, p. D170-171).] *U.Jur.-L.Cret.*, S.Eu.-N.Afr.-Carib.——FIG. 139,*5*. *N. steinmanni* KAMPTNER, U.Tithon, Italy; *5a*, schem. drawing of "cone," long. sec., ×1333; *5b*, transv. sec., ×2000; *5c*, single "cone," long. sec.; ×1250 (87).

Orthogonium GÜRICH, 1930 [**O. parallelum*]. Problematical body fossil consisting of several articulated rows suggestive of crinoid arms; width of a row 3 or 4 mm., length about 6 cm.; sponge-like body similar to dictyospongiids (16). *?Precam.-?L.Paleoz.* (*Nama* F., *Kuibis Quartzite*), S.Afr.——FIG. 140,*2*. **O. parallelum*, L.Paleoz. (Nama F., Kuibis Quartzite); ×0.4 (77).

Palaeobalanus VON SEEBACH, 1876 [*nom. nud.*] [**P. schmidi*]. Name given for little bodies found on *Lima*, recognized by POHLIG (1888) as *Discina*, which allegedly occupy the opening of little bore holes (16). *M.Trias.(Muschelkalk)*, Ger.

Palaxius BRÖNNIMANN & NORTON, 1960 [**P. habanensis*]. Coprolites of oval to sub-pentagonal or subrectangular shape; width 0.5-2 mm., breadth ±0.5 mm.; pierced by crescent or hook-shaped longitudinal canals (length 45-140 meters, width 15-35 meters), arranged in two symmetric groups; coprolites structurally closely related to those of the Recent thalassinid *Axius stirhynchus* (16). *Eoc.*, C.Am.(Guatemala); *Mio.*, W.Indies(Cuba)-Libya.

Paramedusium GÜRICH, 1930 [**P. africanum*]. ?Medusa; ?inorganica (*Treatise*, p. F154, Fig. 125). *?Precam.-?L.Paleoz.* (*Nama* F., *Kuibis Quartzite*), S.Afr.

Parvancorina GLAESSNER, 1958 [**P. minchami*]. Small shieldlike body with oval outline; length up to 25 mm.; ?front margin curved in low arc and gently tapering to rounded end; center formed by prominent smooth anchor- or T-shaped unsegmented and undivided ridge; this ridge separated from ?anterior rim by distinct furrow; 2 lateral areas divided by 7 or more fine oblique lines (?traces of appendages) (16). [Systematic position and affinities unknown; possibly a larval form.] *Precam.(Ediacara Quartzite, Adelaide Syst.)*, S.Austral.——FIG. 141,*3*. **P. minchami*; *3a*, ×1.2; *3b*, ×1 (74).

Porocystis CRAGIN, 1893 [**Siphonia globularis* GIEBEL, 1853 (=*Araucarites? wardi* HILL, 1893)]. Spheroids, generally prolate, with flattened, slightly protuberant area; whole surface covered with ridges and oval or circular depressions; arranged mostly rather irregularly in rows; diameter about 2 cm. (16). [Interpreted by GIEBEL (1853) as alga, by HILL (1889-93) as fruit of *Goniolina*, *Parkeria* or *Araucarites*, by CRAGIN (1893) as cheilostomatous byrozoan, by RAUFF (1895) as calcareous alga, and by JARVIS (1905) as gigantic monothalamnian foraminifer.] *L.Cret.*, USA (Tex.).——FIG. 141,*1*. *P. pruniformis* CRAGIN, L. Alb.(large specimens)-M.Alb.(small specimens); *1a-d*, ×1 (Geol. Staatsinst. Hamburg).

Pteridinium GÜRICH, 1933 [**Pteridium simplex* GÜRICH, 1930] [=*Pteridium* GÜRICH, 1930 (*non* SCOPOLI, 1777)]. Long, thin, bilaterally symmetrical "leaves" with transverse ribs (16). [According to RUDOLF RICHTER (1955) belongs to Gorgonaria (together with *Rangea* GÜRICH, 1930); according to GLAESSNER (1959) (together with *Rangea*) probably closely related to Pennatulacea.] *Precam.(Ediacara Quartzite)*, S.Austral., *?Precam.-?L.Paleoz.*, S.Afr.——FIG. 140,*5*. **P. simplex*, ?L.Paleoz.(Kuibis Quartzite), S.Afr.; *5a*, ×0.8; *5b*, ×0.7 (111).

Rangea GÜRICH, 1930 [**R. schneiderhöhni*]. Leaf-shaped main body with median field (axis); lateral branches separated by transverse lateral furrows and subdivided by secondary furrows arising from their proximal margins (pinnae correspondingly) (16). [Interpretations: GÜRICH (1930, 1933), compared with the Ctenophora; RICHTER (1955), placed (together with *Pteridinium*) in Gorgonacea; GLAESSNER (1959), near Pennatulacea.] *Precam.(Ediacara Quartzite)*, S.Austral.; *?Precam. or L.Paleoz.(Kuibis Quartzite, Nama* F.), S.Afr.——FIG. 140,*6*. **R. schneiderhoehni*, ?L. Paleoz.(Kuibis Quartzite), S.Afr.; holotype, ×0.7 (111).

Rectogloma VAN TUYL & BERCKHEMER, 1914 [**R. problematica*]. Cephalopod-like fossil, elliptical in transverse section; apex terminating in spiral coil, closely placed sinuous sutures on surface which disappear completely on apical coil (16). *U.Dev.*, USA(Pa.).——FIG. 140,*4*. **R. problematica; 4a, 4b*, ×1.2 (Am. Mus. Nat. Hist.).

Stromatolite KALKOWSKY, 1908 [=*Coenoplase* TWENHOFEL, 1919]. General name for variously shaped, finely stratified calcareous crusts and calcareous bodies (also called stromatoliths); obviously formed by lime-precipitating algae; commonly associated with oolites or ooid-grains. Many "genera" belong here (e.g., *Anomalophycus* FENTON & FENTON, 1937; *Aphrostoma* GÜRICH, 1906; *Archaeozoon* MATTHEW, 1890; *Chondrostoma* GÜRICH, 1906; *Codonophycus* FENTON & FENTON, 1939; *Collenia* WALCOTT, 1914; *Cryptozoon* HALL, 1884; *Conophyton* MASLOV, 1937; *Dolatophycus* FENTON & FENTON, 1937; *Gouldina* JOHNSON, 1940; *Gymnosolen* STEINMANN, 1911; *Malacostroma* GÜRICH, 1906; *Osagia* TWENHOFEL, 1919 (only pisoids or ooids?) *Ottonosia* TWENHOFEL, 1919; *Pycnostroma* GÜRICH, 1906; *Spongiostroma* GÜRICH, 1906; *Stylophycus* JOHNSON, 1940; *Tetonophycus* FENTON & FENTON, 1939; *Weedia* WALCOTT, 1914, etc.) (37). [Genera named above are differentiated only on basis of general form. According to HOLTEDAHL (1919) and SCHINDEWOLF (37), they are pseudofossils (inorganic structures), and should not be accorded generic and specific names]. *Precam.-Rec.*, cosmop.

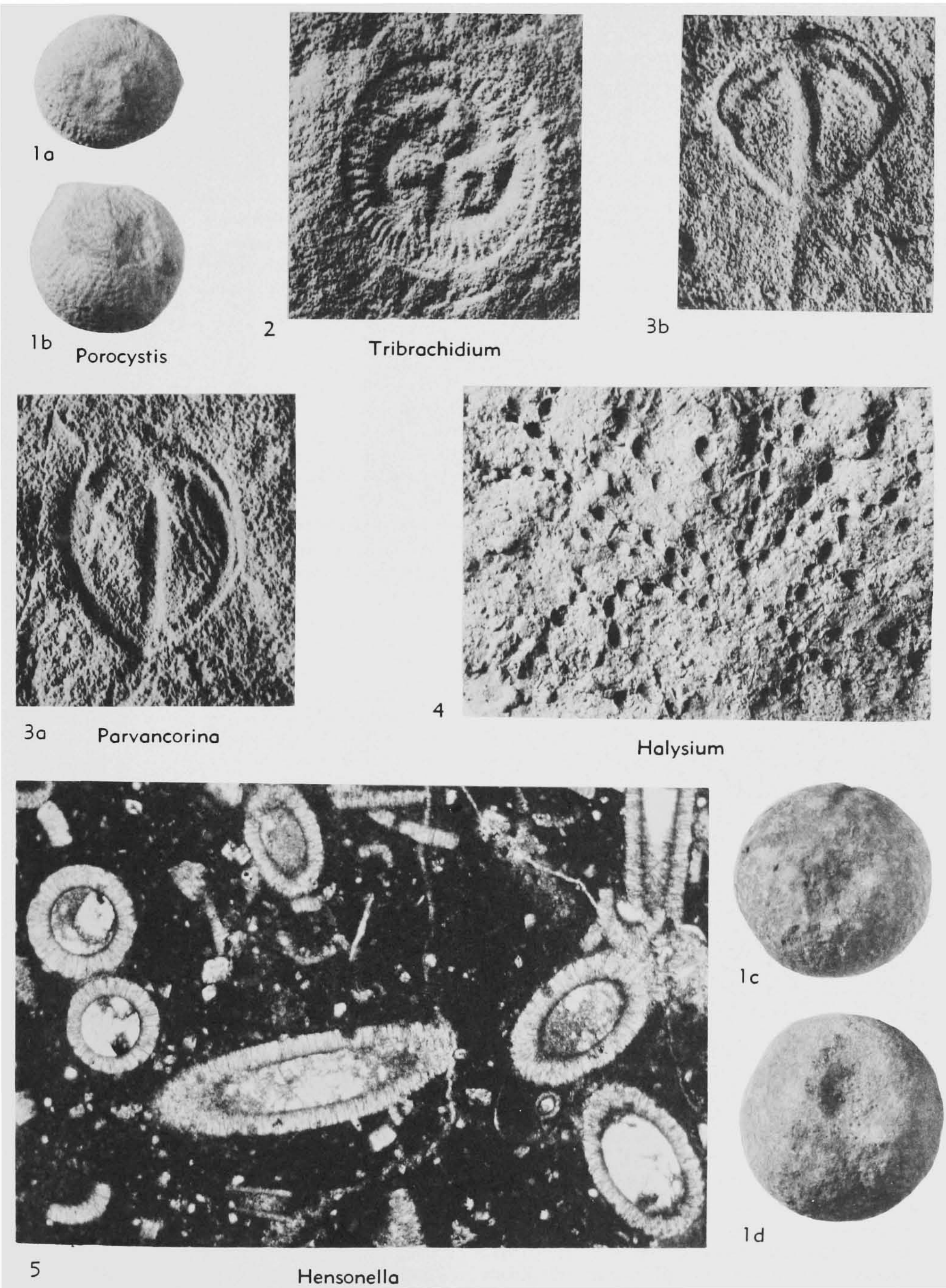


FIG. 141. Body fossils (p. W224, W226, W228).

Taitia Crookall, 1931 [*T. *catena*]. Little chains commonly composed of 6 to 7 (maximum, 11) circular or oval bodies; adjacent bodies united by thin isthmus 1 mm. long and 1 mm. wide; bodies generally constant in size (diameter 1 cm.), some with progressive diminution in size toward extremity; characteristic but problematical body fossil of Scottish Downtonian rocks (2). *U.Sil.*, Scot. ——Fig. 140,*3*. **T. catena*; *3a*, ×1; *3b*, ×0.7 (61).

Tribrachidium Glaessner, 1959 [*T. *heraldicum*]. Subcircular impressions up to 26 mm. in diameter; rim sharply impressed, with distinct sculpture consisting of 3 hooked ridges of similar size and shape radiating from the center, ending along periphery in fringe of tentacular projections; all known specimens seemingly external molds; excluded from all known major groups on basis of its 3 tentaculate arms (16). [Perhaps an aberrant coelenterate.] *Precam.(Ediacara Quartzite)*, S. Austral.——Fig. 141,*2*. **T. heraldicum*; ×1 (impression) (74).

Xenusion Pompeckj, 1927 [*X. *auerswaldae*]. Bilaterally symmetrical; length 8.5 cm.; central field divided into segments, with median longitudinal furrow; segments separated by broad transverse furrows; each segment supporting a bosslike elevation; finely fluted marginal stripes along central field; transversely ringed, slightly curved, delicately striped lateral appendages along both sides (16). [Affinities unknown, although some have regarded it as a ctenophore (*Treatise*, p. F478).] *Precam.* [more probably *Cam.* (drift)], N.Ger. ——Fig. 140,*1*. **X. auerswaldae*, ?L.Cam.(Pleist. drift); ×0.7 (106).

BORINGS

Borings or, more properly, etching traces in shells, bones, or other hard parts of invertebrates and vertebrates occupy a special position among the trace fossils which entitles them to a chapter of their own. Of the few papers on this subject that of Mägdefrau (26) deserves mention. Boring traces are known as far back as Early Paleozoic. They may be produced by plants or by animals. Those produced by plants are made by algae or fungi, but the cavities left by them do not allow conclusions as to a definite producer. Within the animal kingdom certain sponges, worms, bryozoans, and barnacles bore into shells; the last mentioned especially leave very characteristic cavities. The cavities made by the others often leave uncertainty as to the producer. Boring ctenostome Bryozoa (Terebriporidae) have not been dealt with in this chapter, inasmuch as Bassler has already described them in Part G of the *Treatise*.

Abeliella Mägdefrau, 1937 [*A. *riccioides*; SD Häntzschel, herein]. Dichotomously branching borings in fish scales; width of individual borings 4 to 8 microns, of the whole system 0.25 to 0.5 mm. (26). *U.Cret.-Oligo.*, Eu.(Ger.-Eng.).—— Fig. 142,*1*. **A. riccioides*, Oligo., Ger.; (in fish scale), ×110 (26).

Anobichnium Linck, 1949 [*A. *simile*]. Smooth cylindrical perforations in fossil wood, 1 to 1.5 mm. in diameter, with numerous openings to each gallery; very similar to the borings of Recent beetles of the genus *Anobium* (16). *U.Trias.*, Ger. ——Fig. 144,*2*. **A. simile*, Keuper; in wood, ×0.7 (94).

Brachyzapfes Codez, 1957 [*B. *elliptica*]. Borings of barnacles; short and broad; cross section elliptical; depth half the length; observed in belemnoids and pelecypods (16). *L.Cret.*, Fr.——Fig. 142,*2*. **B. elliptica*; schem. drawings; *2a*, opening; *2b*, tang. sec. (max.); *2c*, long. sec.; *2d*, chamber (60).

Calcideletrix Mägdefrau, 1937 [*C. *flexuosa*; SD Häntzschel, herein]. Cavity systems in belemnoids; one or more openings, shrublike, ramified; diameter of branches 0.02 to 0.1 mm. (26). *U. Cret.*, Ger.——Fig. 142,*4*. **C. flexuosa*; in *Belemnitella*, ×8 (26).——Fig. 142,*5*. *C. breviramosa* Mägdefrau; in *Actinocamax*, ×8 (26).

Calciroda Mayer, 1952 [*C. *kraichgoviae*]. Cylindrical boring tunnels up to 1 mm. wide; usually built parallel to outer surface in shells of mollusks or in stalk members of *Encrinus*; may be ramified, cutting through or crossing each other (16). [According to A. H. Müller (1956), probably identical with *Trypanites* Mägdefrau.] *M.Trias. (Trochiten-Kalk)*, Ger.

Caulostrepsis Clarke, 1908 [*C. *taeniola*] [=*Polydorites* Douvillé, 1908 (*according to* Bather, 1910, not intended as an independent generic name)]. U-shaped boring tunnels with constructed *Spreite*, corresponding to a tiny *Rhizocorallium*; up to 2 cm. long and 5 mm. wide; mostly in shells of brachiopods, mollusks, and echinoids (23). *L.Dev.*, Ger.; *U.Trias.-?L.Jur.*, Eng.; *Tert.*, Austral.-Port.——Fig. 142,*3*. **C. taeniola*; L.Dev., Ger.; in shell of *Stropheodonta*, ×0.75 (58).

Chaetophorites Pratje, 1922 [*C. *gomontoides*]. Ramifying tunnels in rostra of belemnoids and

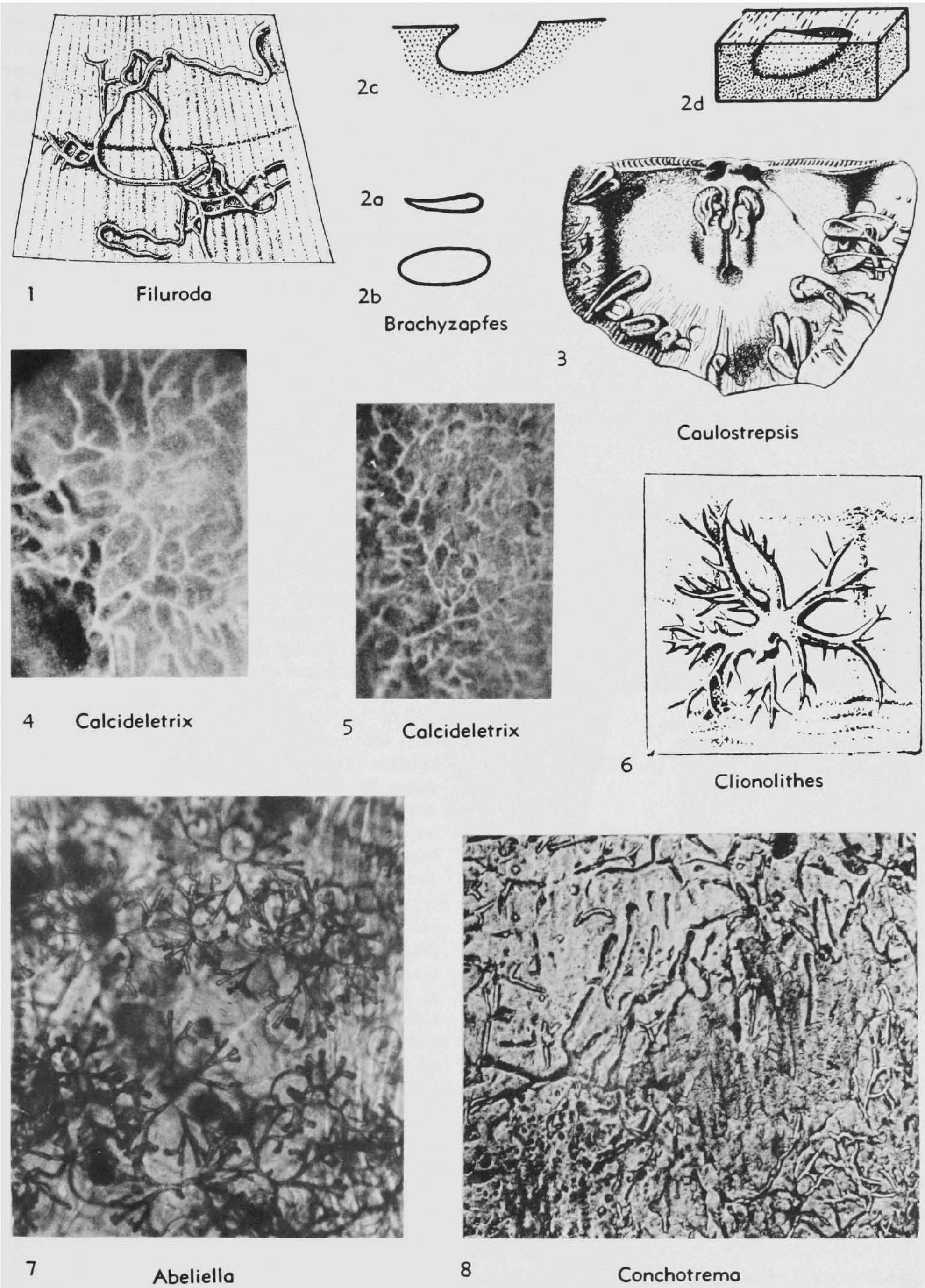


FIG. 142. Borings (p. *W*228, *W*230).

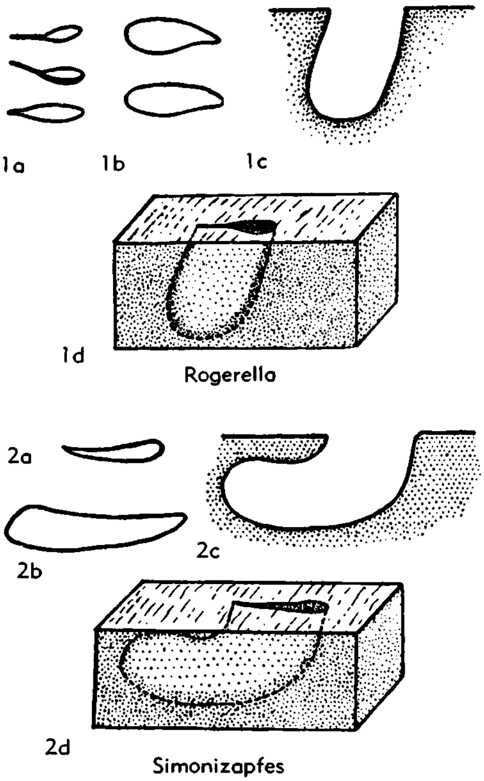


FIG. 143. Borings (p. *W*231).

shells of brachiopods and mollusks; usually straight; diameter less than 0.02 mm.; located close to surface of shell (26). *Jur.-Plio.*, Eu.——FIG. 144,*4*. **C. gomontoides*, L.Jur.(Lias. δ), Ger.; in pelecypod shell, ×106 (108).

Cliona GRANT, 1826 (see *Treatise*, p. *E*40).

Clionoides FENTON & FENTON, 1932 (see *Treatise*, p. *E*40).

Clionolithes CLARKE, 1908 [**C. radicans;* SD FENTON & FENTON, 1932] [=*Pyritonema? gigas* FRITSCH, 1908 (*non* M'COY, 1850); *Olkenbachia* SOLLE, 1938]. Bent or cracked borings of sponges, generally radiating in one plane to all sides from very small, central cavity; commonly branching dichotomously; diameter several mm.; always etched into shell of some host animal (see *Treatise*, p. *E*40) (16). *Ord.*, Czech.; *Dev.-Carb.*, Ger.-USA-China.——FIG. 142,*6*. **C. radicans*, U.Dev. (Chemung Ss.), USA; in *Atrypa* shell, ×6 (58).

Conchotrema TEICHERT, 1945 [**C. tubulosa*]. Narrow tubular borings in shells (diameter about 0.2 mm.), communicating with the surface, straight or gently curved; branching (16). [Probably made by worms; observed in brachiopods.] *L.Carb.*, Scot.; *Perm.*, W.Austral.——FIG. 142,*8*. **C. tubulosa*, Wandagee Ser.; in *Taeniothaerus* valve, ×2 (127).

Dendrina QUENSTEDT, 1848 [**Talpina dendrina* MORRIS, 1851]. 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. (26). *Ord.-U.Cret.*, Eu.(Ger.-Eng.-USSR.).——FIG. 144,*6*. *D. belemniticola* MÄGDEFRAU, U.Cret., Ger.; in *Belemnitella*, ×5 (26).

Dictyoporus MÄGDEFRAU, 1937 [*non* HOULBERT, 1934] [**D. nodosus*]. Borings in rostra of belemnoids; without exterior aperture; distinctly netlike; width of canals about 0.07 mm. (26). *U. Cret.*, Eu.(Ger.).——FIG. 144,*5*. **D. nodosus;* in *Belemnitella*, ×5 (26).

Entobia BRONN, 1838 [**E. cretacea* PORTLOCK, 1843; SD HÄNTZSCHEL, herein]. Borings consisting of small cavities connected by processes nearly hairthin; occurring in belemnoids and in shells of pelecypods, particularly *Inoceramus;* similar forms also in trilobites (16). [Possibly made by boring sponges.] *?Sil.*, Ire.; *U.Cret.*, Eng.-Ire.

Filuroda SOLLE, 1938 [**Clionolithes reptans* CLARKE, 1908] [=*Clionolithes* CLARKE, 1908 *(partim)*]. Threadlike, strongly curved borings in shells, running closely below surface of shell (16). [Possibly made by boring sponges (*Treatise*, p. *E*40).] *L.Dev.-M.Dev.*, N.Am.-Eu.(Ger.).——142,*1*. **F. reptans* (CLARKE), L.Dev.(Oriskany Ss.), USA; in *Leptostrophia*, ca. ×2 (58).

Mycelites ROUX, 1887 [**M. ossifragus*]. General name for various irregularly branching tunnels about 2 to 6 microns wide in hard parts (shells, bones, teeth, scales) of invertebrates and vertebrates (26). [Caused by algae and/or fungi.] *?Sil.*, *Rec.*, cosmop.

Nygmites MÄGDEFRAU, 1937 [**Talpina solitaria* VON HAGENOW, 1840; SD HÄNTZSCHEL, herein] [=*Talpina* VON HAGENOW, 1840 *(partim)*]. Simple, unbranched tunnels in rostra of belemnoids; oblique to surface; leading from outside inward (26). *L.Jur.-U.Cret.*, Eu.(Ger.-Fr.-USSR.).

Palaeachlya DUNCAN, 1876 [**P. perforans*]. Small tubes of parasitic algae in fossils; diameter 0.008 inch; usually straight, rarely curved; not varying much in size; running more or less inward at different angles to surface; some branched (2). *Sil.-Dev.*, Eu.-Austral.-N.Am.(Can.).

Palaeosabella CLARKE, 1908. [See *Treatise*, p. *E*41.] (16).

Paleobuprestis WALKER, 1938 [**P. maxima;* SD HÄNTZSCHEL, herein]. Channels under bark of *Araucarioxylon arizonicum;* diameter 2 to 10 mm.; recognizable all around tree; channels resembling work of Recent buprestids (16). *Trias.*, USA(Ariz.).

Paleoipidus WALKER, 1938 [**P. perforatus;* SD HÄNTZSCHEL, herein]. Tunnels and burrows penetrating heart-wood of *Araucarioxylon arizonicum* (see also *Paleobuprestis* and *Paleoscolytus*); diameter 2 to 5 mm.; boring near bark or through wood (16). *Trias.*, USA(Ariz.).

Paleoscolytus WALKER, 1938 [**P. divergus*]. Channels under bark of *Araucarioxylon arizonicum;* diameter 5 mm.; running in all directions; not filled with castings; resembling channels of Recent bark beetles or engraver beetles of family Scolytydae (16). *Trias.*, USA(Ariz.).

Rogerella DE SAINT-SEINE, 1951 [**R. lecointrei*]. Very deep borings of barnacles; cross section short and broad; observed in shells of echinoids, pelecypods, belemnoids and corals (16). *M.Jur.-U.Cret.*, Fr.-Eng.; *Mio.*, Fr.; *Plio.*, Morocco.——FIG. 143,*1*. *R. mathieui* DE SAINT-SEINE; schem., *1a, 1b*, various kinds of openings and tang. secs.; *1c*, long. sec., *1d*, chamber (60).

Simonizapfes CODEZ, 1957 [**S. elongata*]. Long, narrow borings of barnacles; length (max.) 4.5 mm.; width (max.) 1.1 mm.; shallow; observed in shells of oysters, gastropods, belemnoids, crinoids, corals, etc. (16). *Jur.*, Fr.-Eng.——FIG. 143, 2. **S. elongata;* schem.; *2a*, opening; *2b*, tang. sec. (max.); *2c*, long. sec.; *2d*, chamber (60).

Talpina VON HAGENOW, 1840 [**T. ramosa;* SD HÄNTZSCHEL, herein]. Tunnels in rostra of belemnoids; width about 0.2 mm.; numerous circular or oval openings toward exterior; commonly branched (26). *U.Cret.*, Eu.(Ger.-Fr.-USSR.).

Tarrichnium WANNER, 1938 [**T. balanocrini*]. 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 (16). [Made by ?hydrozoan

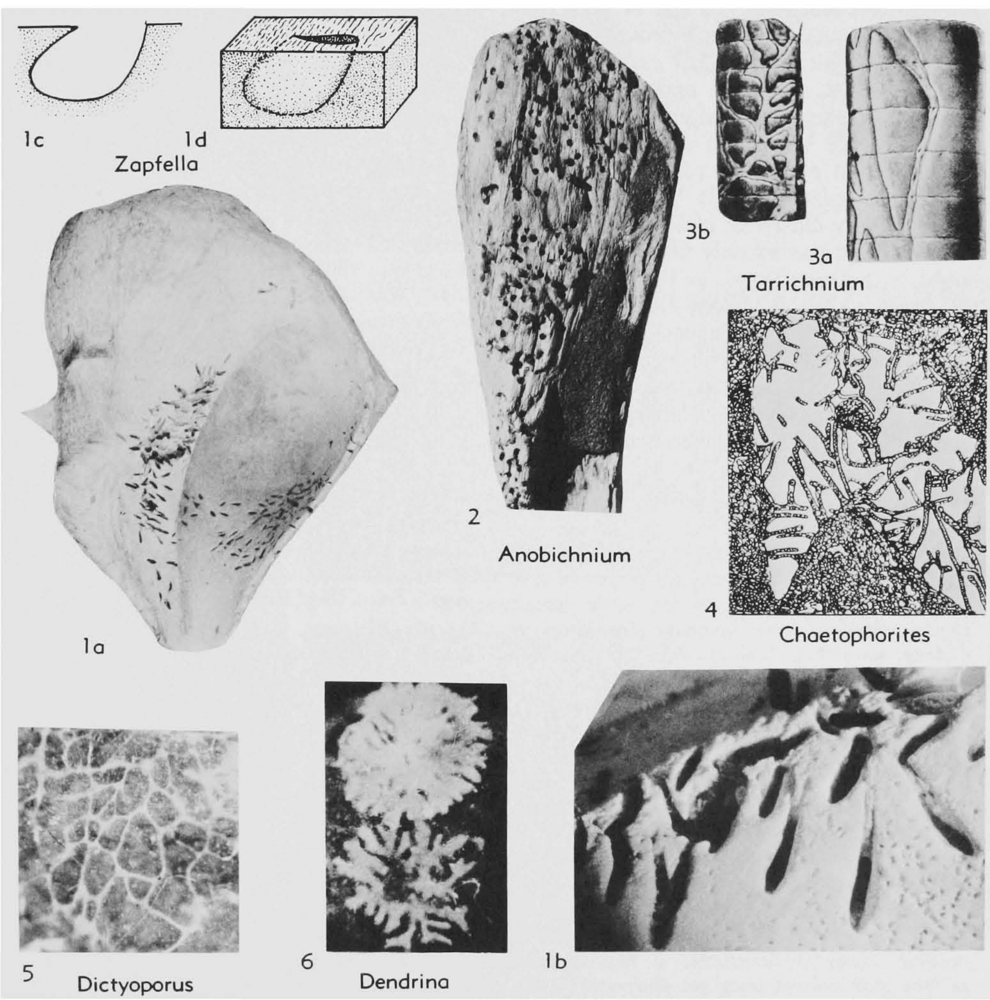


FIG. 144. Borings (p. W228-W232).

(*Treatise*, p. *F*88).]. *Mio.*, E.Ind.——FIG. 144,*3*. **T. balanocrini; 3a*, ×2.2; *3b*, ×1.2 (135).

Topsentopsis deLAUBENFELS, 1955 [*pro Topsentia* CLARKE, 1921 (*non* BERG, 1899)] [**Topsentia devonica* CLARKE, 1921]. (See *Treatise*, p. *E*41.)

Zapfella DE SAINT-SEINE, 1955 [**Z. pattei*]. Saclike bore holes, 1 to 4 mm. long, 0.5 to 1 mm. wide and up to 5 mm. deep; slitlike opening (23). [Made by barnacles *(Acrothoracica)*; found in mollusks, brachiopods, corals, and solid rock.] *Tert.*, Eu.-N.Afr.——FIG. 144,*1*. Borings of *Zapfella* in *Galeodes (Volema) cornuta* AGASSIZ, Mio., Hung.; *1a*, ×.08; *1b*, ×4; *1c*, schem. long sec.; *1d*, schem. chamber (*1a, 1b*, 142; *1c, 1d*, 60).

"FOSSILS" PROBABLY OF INORGANIC ORIGIN

Concretions, clay galls, various trail-like markings and even mud cracks and structures of diagenetic origin have sometimes been described and named as plant or animal fossils. One of the best-known examples is *Eozoon canadense*. Errors of this type occurred frequently when paleontology was a new field, but more recent examples may be found (e.g., markings and structures of tectonic or diagenetic origin described by FUCINI in the Verrucano of Florence, also described and named in voluminous books with many plates). The "arthropod" remains in very old rocks of South Australia, described and named only two decades ago, ought to be mentioned in this connection too. Naturally, all names listed here are worthless and have no right to exist. 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, they have been cited.

Aenigmichnus HITCHCOCK, 1865 [**A. multiformis*]. 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) (18). *Trias.*, USA (Mass.).

Antholithina CHOUBERT, TERMIER & TERMIER, 1951 [**A. rosacea*]. Almost circular cross sections with radially disposed structures ("septa"), observed in thin sections; regarded by authors as calcareous algae. [According to SCHINDEWOLF (37) oolitic grains with outer cover of iron-oxyhydrate which in part has penetrated radially into the interior.] *Precam.*, Morocco.

Archaeophyton BRITTON, 1888 [**A. newberryanum*]. Thin films of graphite lying parallel to bedding planes of limestones; at first regarded as "the most ancient plant yet discovered" (16). *Precam.*, USA(N.J.).

Aristophycus MILLER & DYER, 1878 [**A. ramosus*]. ?Rill markings (19). *Ord.*, USA(Ohio).

Aspidella BILLINGS, 1872 [**A. terranovica*]. Small, ovate, narrow ringlike border; having general aspect of small *Patella* flattened by pressure (37). [Regarded by MATTHEW (1898) as slickensided mud concretion striated by pressure; somewhat similar to *Guilielmites* GEINITZ.] *Precam.*, Can. (Newf.).——FIG. 145,*3*. **A. terranovica*, Etchemin Gr.; *3a, 3b*, mag. unknown (134).

Atikokania WALCOTT, 1912 [**A. lawsoni*]. Compared at first with sponges and Archaeocyathinae; now considered inorganic by RAYMOND (1935) and other authors (*Treatise*, p. *E*20, *E*33 and *E*103). *Precam.*, Can.

Batrachoides HITCHCOCK, 1858 [jr. hom.; *non* LACEPÈDE, 1800] [**B. nidificans*] [=*Batrachioides* WEIGELT, 1927; *Batracoides* ILIE, 1937]. Shallow contiguous pits on bedding planes; about 2.5 cm. in width, depth about 1 cm.; compared with similar Recent excavations made by small fishes and tadpoles (SILLIMAN, 1850; HITCHCOCK, 17). [Reasonably explained by KINDLE (1914) as interference ripples.] *Sil.*, USA(N.Y.); *Trias.*, USA(Mass.).——FIG. 145,*10*. **B. nidificans*, U. Trias. (New Red Ss.), Mass.; ×0.2 (1).

Bisulcus HITCHCOCK, 1865 [**B. undulatus*]. Continuous paired grooves separated by single ridge (18). [According to BROWN (1912), drag markings.] *Trias.*, USA(Mass.).

Camasia WALCOTT, 1914 [**C. spongiosa*]. Cross sections showing spongioid appearance; originally regarded as algae. [According to SCHINDEWOLF (37), probably of inorganic origin (diagenetic structure).] *Precam.*, USA(Mont.).——FIG. 145, *6*. **C. spongiosa*, Belt Ser. (Newland Ls.); vert. sec., ×0.4 (45).

Chloephycus MILLER & DYER, 1878 [**C. plumosum*]. Rill marks or, according to SEILACHER (personal communication, 1955), drag marks (19). *Ord.*, USA(Ohio).

Chuaria WALCOTT, 1899 [**C. circularis*]. Disclike bodies resembling compressed conical shells of discinoid or patelloid shape; 2 to 5 mm. in diameter; concentrically wrinkled; dark bituminous matter covering surface. Certainly inorganic.

[According to SCHINDEWOLF (37), possibly small, wrinkled clay galls or concretions. *C. wimani* BROTZEN (1941) has been variously regarded as trilobite eggs (WIMAN, 1894); ?chitinous foraminifers (BROTZEN); and hystrichosphaerids (EISENACK, 1951). May be inorganic.] *Precam.*, USA-USSR-Swed. —— FIG. 145,5. **C. circularis*, Algonk., Ariz.; *5a, 5b*, ×12 (134).

Copperia WALCOTT, 1914 [**C. tubiformis*] [=*Cooperia* CHOUBERT, TERMIER & TERMIER,

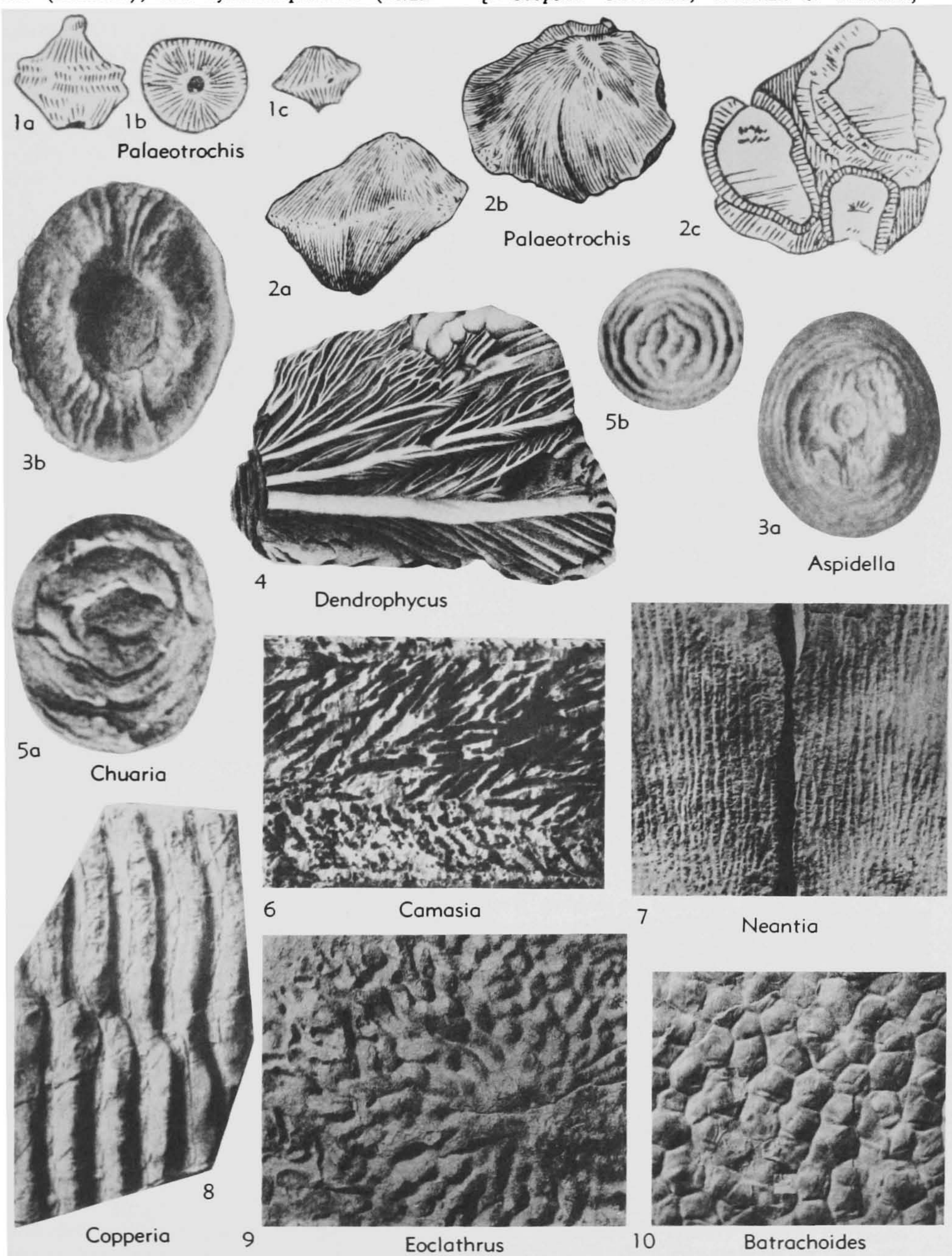


FIG. 145. "Fossils" of inorganic origin (p. *W*232-*W*234, *W*236).

1951]. Differs from *Greysonia* WALCOTT, 1914 (45), 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; according to SCHINDEWOLF (37), partly resembling ripplemarks deformed by diagenetic and tectonic processes.] *Precam.*, USA(Mont.)-?N.Afr.——FIG. 145,*8*. **C. tubiformis*, Belt Ser. (Newland Ls.), Mont.; surface of group of tubes formed in horiz. position, ×0.7 (45).

Corticites FUCINI, 1938 [*nom. nud.*] [jr. hom.; *non* ROSSMAESSLER, 1840]. ?Inorganic (16). *?L.Perm. (Verrucano)* Italy.

Cupulicyclus QUENSTEDT, 1879. Pressure cone, recognized as inorganic by QUENSTEDT (16). *Dev.-Tert.;* Ger.

Cyathospongia? eozoica MATTHEW, 1890. "Fossils" interpreted as skeletal fragments of sponges (37). [Recognized by RAUFF (1893) as inorganic in origin.] *Precam.*, Can.(N.B.).

Dendrophycus LESQUEREUX, 1884 [**D. desorii*]. Branched rill marks?, described as algae (2).——FIG. 145,*4*. *D. triassicus* NEWBERRY, U.Trias., Conn.; ?ca. ×0.2 (101).

Dictuolites CONRAD, 1838 [**D. beckii*]. Mud cracks regarded by HALL with some doubt as plants (2). *L.Sil.*, USA(N.Y.).

Dinocochlea WOODWARD, 1922 [**D. ingens*]. Large horizontal bodies, spirally twisted to right or left; erroneously described as gastropod *steinkerns;* now interpreted as concretions (23). *L.Cret.*, Eng.

Eoclathrus SQUINABOL, 1887 [**E. fenestratus*]. Irregular, elongate, ridgelike structures nearly parallel with each other; probably inorganic (6). *L.Dev., Tert.*, Italy-N.Afr.——FIG. 145,*9*. *E. balboi* DESIO, L.Dev., N.Afr.; ×0.3 (6).

Eophyton TORELL, 1868 [**E. linneanum*] [=*Rabdichnites* DAWSON, 1873 *(partim); Taonichnites* MATTHEW, 1890 *(partim); Medusichnites, Eoichnites, Ctenichnites* MATTHEW, 1891; *Aspidiaria* VLCEK, 1902 (*non* PRESL, 1838)]. Straight, parallel or curved drag markings on bedding planes; produced by organisms or comprising inorganic objects (2, 46). *Cam.-Rec.*, cosmop.——FIG. 147, *1*. *E.* sp., Cam.(*Mickwitzia* Ss.), Swed.; ×0.3 Regnéll, n, Paleont. Coll., Paleont. Inst. Lund).

Eopteris DE SAPORTA, 1878 [**E. andegavensis;* SD ANDREWS, 1955]. *Cardiopteris*-like "fossil." According to GOTHAN (1909), *E. morierei* DE SAPORTA comprises ferric sulphide dendritic marking (16). *Ord.*, Fr.

Eospicula DELAUBENFELS, 1955 [**E. cayeuxi*]. Doubtful "fossils" resembling spicules of calcisponge; lumpy and crooked. [Believed by CAYEUX (1895) to be sponge; regarded as inorganic in origin by RAUFF (1896)] (*Treatise*, p. E33). *?Precam.*, Fr.

Eozoon DAWSON, 1865 [**E. canadense*]. Banded structures of coarsely crystalline calcite and serpentine; originally interpreted as gigantic Foraminifera (16). *Precam.*, Can.

Flabellaria johnstrupi HEER, 1883. Regarded by SCHENK, 1890 as ripple marks rather than palm leaf (16). *Tert.*, Greenl.

Forchhammera GOEPPERT, 1860 [**F. silurica*]. According to POULSEN and ROSENKRANTZ (personal communication, 1956), inorganic; probably dendritic markings (2). *L.Ord.*, Den.(Bornholm).

Gallatinia WALCOTT, 1914 [**G. pertexa*]. Septarian concretions (RAYMOND, 1935) (30, 45). *Precam.*, USA(Mont.).——FIG. 146,*4*. **G. pertexa*, Belt Ser. (Newland Ls.); upper surface, ×0.3 (45).

Gloeocapsomorpha tazenakhtensis CHOUBERT, TERMIER & TERMIER, 1951. "Organisms" observed in thin sections of limestones; interpreted as calcareous algae (37). [According to MOSEBACH (1956), certainly inorganic structures produced by combination of tectonic movements and metamorphic recrystallization.] *Precam.*, Morocco.

Gothaniella FUCINI, 1936 [**G. sphenophylloides*]. Small rosettes, occurring together with bigger and more pronounced ones called *Sewardiella* FUCINI (16). [Interpreted by FUCINI (1936) as algae; by SACCO (1940) as *?Sphenophyllum*; and by PIA (1937) as probably inorganic.] *?L.Perm., Trias.*, Italy.——FIG. 147,*4*. **G. sphenophylloides*, ?U.Trias.(Verrucano); ×2 (71).

Grammichnus HITCHCOCK, 1865 [**G. alpha*]. [According to BROWN (4) and LULL (25), probably roll or drag markings (18).] *Trias.*, USA(Mass.).

Greysonia WALCOTT, 1914 [**G. basaltica*]. Shrinkage cracks (RAYMOND, 1935) or results of segregation of $CaCO_3$ and dolomite by percolating waters (FENTON & FENTON, 1936). [According to SCHINDEWOLF (37), partly resembling ripple marks transformed by tectonic and diagenetic processes.] *Precam.*, USA(Mont.).——FIG. 146,*2*. **G. basaltica*, Belt Ser. (Newland Ls.); *2a*, sec. of mass of basaltic-like columns, *2b*, view of end of tubes; both ×0.7 (45).

Guilielmites GEINITZ, 1858 [=*Calvasia* sp. STERNBERG, 1820; *Carpolites umbonatus* STERNBERG, 1825; *Cardiocarpum umbonatum* BRONN, 1837; *Carpolites clipeiformis* GEINITZ, 1856; *?Gaussia* CHACHLOF, 1934 *(partim); ?Gaussia* NEUBURG, 1934; *Verrucania* FUCINI, 1936]. Ellipsoidal bodies, 1 or 2 cm. in diameter; originally thought to be seeds; most authors (CARRUTHERS, SCHENK, POTONIÉ, GOTHAN) consider them to be of inorganic origin (concretions or similar diagenetic structures); PRUVOST (1930) interpreted them as burrows of lamellibranchs (2, 23). *Carb.-Perm., ?Jur.*, Eu.-Am.-Asia.——FIG. 147,*2*. *G. umbonatus* (STERNBERG) L.Perm., Ger.; *2a, 2b*, ×1 (72).

Halichondrites graphitiferus MATTHEW, 1890. Long, thin spicules in graphitic shales and graphite lenses (37). [Interpreted as remains of sponges; recognized by RAUFF (1893) as inorganic (?systems of striae on graphite flakes).] *Precam.*, Can. (N.B.).

Halleia Fucini, 1936 [**H. penicillata*]. Probably very slender flow markings; inorganic (16). *?L. Perm.(Verrucano)*, Italy.

Hirmeria Fucini, 1936 [**H. notabilis*]. Small parallel wrinkles, resembling *Eoclathrus* Squinabol, 1887; inorganic (16). *?L.Perm.(Verrucano)*, Italy.

Interconulites Desio, 1941. Suggestion for an international name for cone-in-cone structures.

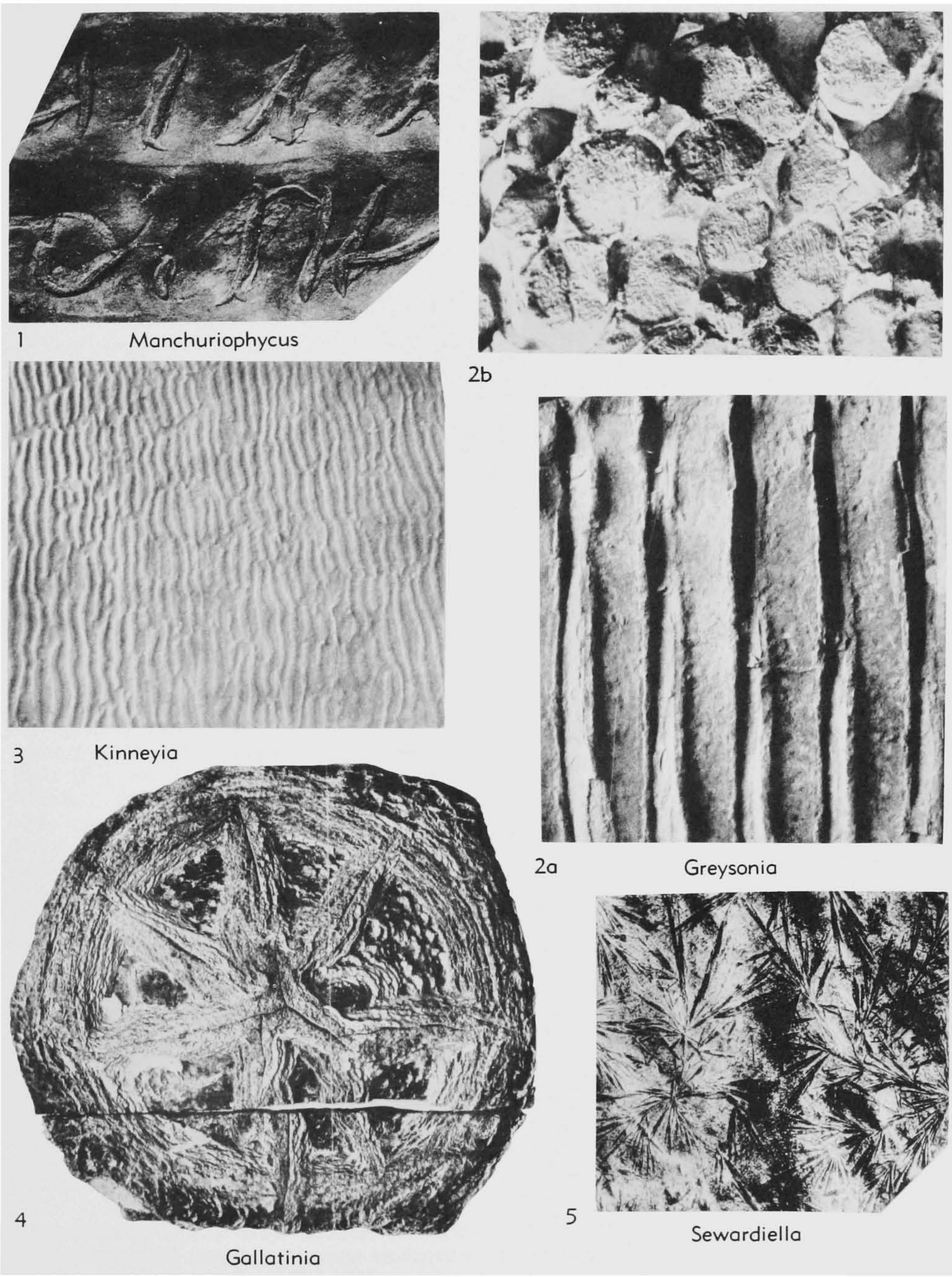


Fig. 146. "Fossils" of inorganic origin (p. *W*234, *W*236).

Kinneyia WALCOTT, 1914 [**K. simulans*]. Reliefs reminiscent of very small ripple marks; 1 to 3 mm. wide, approximately parallel; similar to or identical with *Furchensteine* (furrow-stones) or corroded limestone flags; perhaps inorganic (37, 45). *Precam.*, USA; *Sil.*, N.Afr.——FIG. 146,*3*. **K. simulans*, Precam. Belt. Ser., (Newland Ls.), Mont.; upper surface, ×0.7 (45).

Kräuselia FUCINI, 1936 [**K. verrucana*]. Narrow, long, tapering swellings, apparently screw-shaped, twisted; inorganic (16). *?L.Perm.(Verrucano)*; Italy.

Lithodictuon CONRAD, 1837 [**L. beckii*]. Very probably mud cracks (2). *Sil.*, USA(N.Y.).

Manchuriophycus ENDO, 1933 [**M. yamamotoi*]. Mud cracks, in part in normal form of polygons (*M. yamamotoi*), in part curved in valleys of simple or interference ripples (*M. sawadai*) (37). [Interpreted by ENDO as algae; by LEE (1939) as worm burrows; recognized by HÄNTZSCHEL (1949) as inorganic.] *Precam.-Trias.*, Eu.-Asia-Can.-Greenl.——FIG. 146,*1*. *M. sawadai* YABE, Precam., Asia; ×0.4 (141).

Membranites FUCINI, 1938. Very probably inorganic (16). *?L.Perm.(Verrucano)*, Italy.

Neantia LEBESCONTE, 1886. Wrinkle-like structures very closely resembling rill marks and other markings (42, 46). [Certainly not sponges, as LEBESCONTE thought.] *Precam.*, Fr.——FIG. 145,*7*. *N. rhedonensis* LEBESCONTE; ca. ×0.7 (92).

Newlandia WALCOTT, 1914 [**N. frondosa*]. Irregular hemispherical or frondlike bodies; diameter up to 80 cm.; built of concentric, subparallel, subequidistant layers; similar to *Collenia* or *Cryptozoon* (45). [Very probably inorganic.] *Precam.*, USA(Mont.).——FIG. 147,*5*. **N. frondosa*, Belt Ser. (Newland Ls.); upper surface, large frond, ×0.5 (45).

Osagia TWENHOFEL, 1919 [**O. incrustata*]. Resembling *Fusulina* in size and shape; with thin concentric lamellae and with nucleus comprising fragment of rock or shell; forming thin beds of limestone. [Regarded by TWENHOFEL as algal "coenoplases" of small size; according to SCHINDEWOLF (37) perhaps only simple ooids or pisoliths.] *Penn.*, USA(Kans.-Okla.).

Palaeotrochis EMMONS, 1856. Double cone, with grooved surface; cones juxtaposed base to base (37). [Formerly regarded by EMMONS as coral; determined by HALL (1857), MARSH (1868), HOLMES & DILLER (1899) as inorganic; possibly concretions or cone-in-cone structures; according to WALCOTT (1899) spherolite of an acidic magmatic rock. *Precam.*, USA(N.Car.).——FIG. 145,*1*. *P. minor; 1a-c*, mag. unknown (137).——FIG. 145,*2*. *P. major; 2a-c*, mag. unknown (137).

Palmacites martii HEER, 1855 [=*Palmanthium martii* SCHIMPER, 1870]. "Fossil" interpreted as flower or fruit of a palm; according to SCHENK, possibly inorganic (16). *U.Tert.(Molasse)*, Switz.

Panescorsea DE SAPORTA, 1882 [=*Panescorea* ANDREWS, 1955 (*errore*)]. Long parallel ridges on bedding planes. [Erroneously explained by DE SAPORTA as seaweed.] Resembling ripplemarks or mud flow markings (2). *Cret.-Tert.*, Fr.-Italy.

Phyllitites FUCINI, 1936 [**P. rugosus*]. Inorganic (16). *?L.Perm.(Verrucano)*, Italy.

Phytocalyx BORNEMANN, 1886 [**P. antiquus*]. Structureless conical or hemispherical bodies originally regarded as algae (2). [Probably concretionary bodies.] *Cam.*, Italy(Sardinia).

Piaella FUCINI, 1936 [**P. biformis*]. Inorganic (16). *?L.Perm.(Verrucano)*, Italy.

Polygonolites DESIO, 1941. Suggested as international designation for mud cracks.

Protadelaidea TILLYARD, 1936 [**P. howchini*]. Fragments in form of ochreous to black crusts in quartzites, with rather regular angular outlines (37). [Erroneously believed to represent body segments of giant arthropods. According to GLAESSNER (1959), possibly formed by pyritized soft plant tissue. Very similar forms described by HUPÉ (1952) from the Precambrian of Morocco as inorganic (mud flakes or flattened clay pellets).] *Precam.(Adelaide System)*, S.Austral.

Pseudopolyporus HOLLICK, 1910 [**P. carbonicus*]. Concretion, closely resembling fungus (especially *Polyporus*) and originally described as such (16). *Carb.*, USA(W.Va.).

Reynella DAVID, 1928 [**R. howchini*]. Problematical small fragments of exceedingly irregular shape (16). [Erroneously explained by DAVID as belonging to the crustaceans; according to GLAESSNER (personal communication, 1956, 1959) not recognizable as animal remains, perhaps inorganic (16). *Precam.(Brighton Ls., Sturtian)*, S.Austral.

Rivularites FLICHE, 1905 [**R. repertus*]. Explained by FLICHE and D. WHITE (1929) as algal colonies (?Cyanophyceae). American "species," *R. permiensis* WHITE, is very similar to mud flow markings on bedding planes; compared by C. L. FENTON (1946) with small ripple marks (2). *Perm.*, Ariz.; *U.Trias.*, Fr.——FIG. 147,*3*. *R. permiensis* WHITE, Perm., (Hermit Sh.), Ariz., ×0.4 (138).

Schafferia FUCINI, 1938 [**S. verrucana*]. Inorganic (16). *?L.Perm.(Verrucano)*, Italy.

Sewardiella FUCINI, 1936 [**S. verrucana*] [=*Baieropsis* FUCINI, 1928 (*non* FONTAINE, 1889)]. Sharply stamped impressions resembling palm branches, fans, or rosettes on bedding planes (16). [Evidently molds of radiate crystal aggregates (gypsum or ice), not algae as believed by FUCINI.] *?L.Perm.(Verrucano)*, Italy.——FIG. 146,*5*. **S. verrucana*; ca. ×0.7 (71).

Sickleria MÜLLER, 1846 [**S. labyrinthiformis*]. Shrinkage cracks in sandstone; originally regarded as plants (16). *L.Trias.*, Ger.

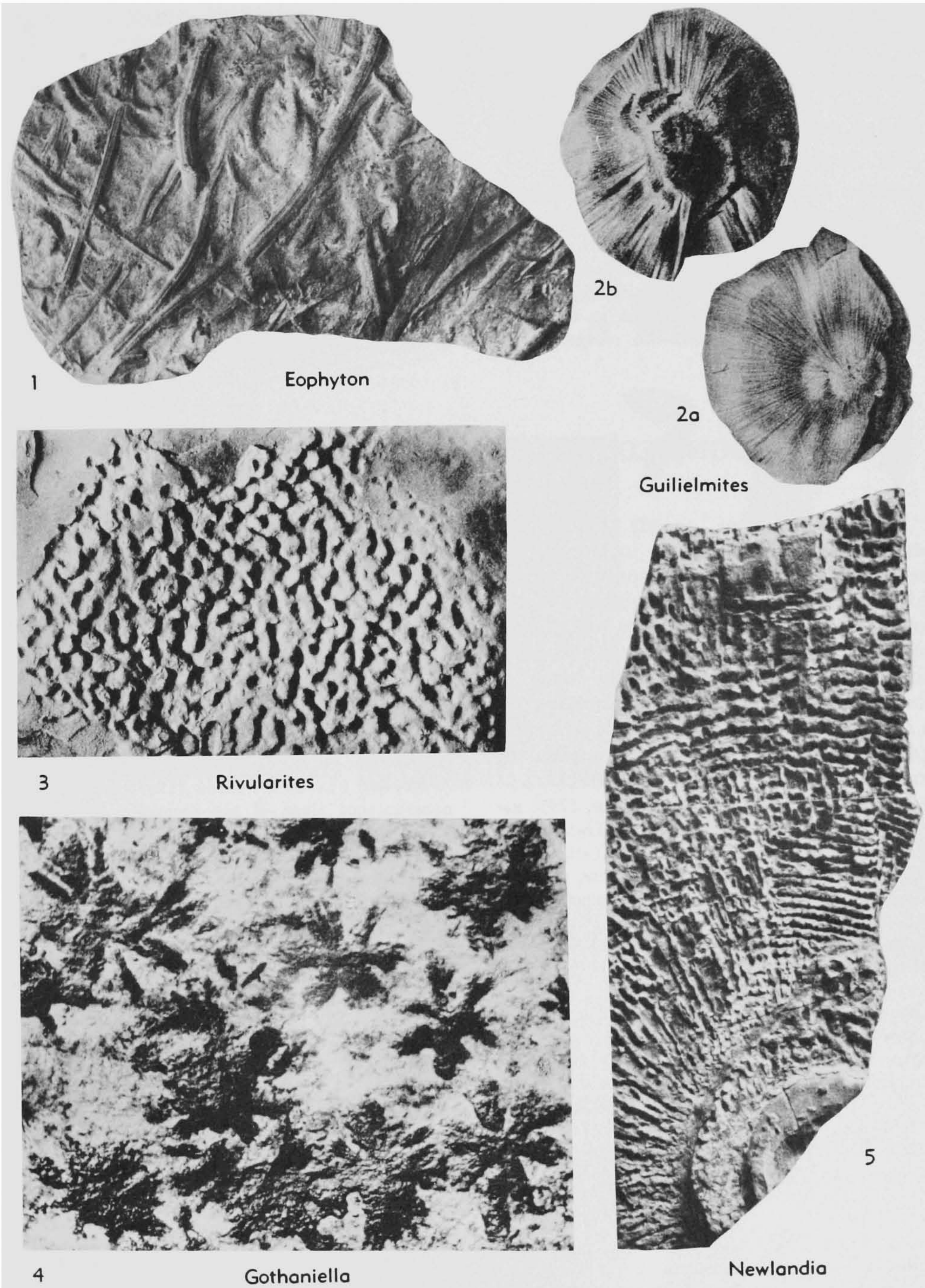


FIG. 147. "Fossils" of inorganic origin (p. W234, W236).

Sidneyia groenlandica CLEAVES, 1935. Not abdominal segments of poorly preserved arachnid, as originally believed according to EHA (1953), more probably group of ripple marks partly removed by erosion (37). *Precam.*, Greenl.

Squamopsis FUCINI, 1938 [**S. modesta*]. Inorganic (16). *?L.Perm.(Verrucano)*, Italy.

Stylolithes KLÖDEN, 1828 [**S. sulcatus*]. Regarded by KLÖDEN as problematical fossil; actually stylolites (16). *M.Trias.(Muschelkalk)*, Ger.

Tazenakhtia CHOUBERT, TERMIER & TERMIER, 1951 [**T. aenigmatica*]. "Organisms" observed in thin sections of limestones, interpreted as of animal origin (?Foraminifera), but also compared with calcareous algae (*Nubecularites* MASLOV); according to MOSEBACH (1956) certainly inorganic structures due to combination of tectonic movements and metamorphic recrystallization (37). *Precam.*, Morocco.

Tubiphyton CHOUBERT, TERMIER & TERMIER, 1951 [**T. taghdoutensis*]. "Organisms" observed in thin sections of limestones, interpreted as calcareous algae; according to MOSEBACH (1956), certainly inorganic structures due to combination of tectonic movement and metamorphic recrystallization (37). *Precam.*, Morocco.

Vesicolithus FRITSCH, 1908 [*nom. nud.*] [**V. guttalis*]. Very probably inorganic (?raindrop impressions) (9). *Ord.*, Czech.

UNRECOGNIZED AND UNRECOGNIZABLE "GENERA"

Numerous "genera," mostly of badly preserved fossils, are included in this group, because of insufficient descriptions and inadequate illustrations. The majority of them are so nondescript that they do not deserve to be named, and under no circumstances should their names be revived. Many of these fossils will remain unexplainable for a long time. In only a few cases are investigations of new and better material likely to clarify their systematic position.

Acanthus GROSSHEIM, 1946 [*non* BLOCH, 1795; *nec* DUMONT, 1816; *nec* GISTL, 1834; *nec* LOCKINGTON, 1876)] [**A. dodecimanus*] (16). *L.Tert.*, USSR.

Aequorfossa NEVIANI, 1925. See *Treatise*, p. F159.

Agarites DE SAPORTA, 1890 [*non* AGASSIZ, 1841] [**A. fenestratus*] (16). *U.Jur.*, Fr.

Amanlisia LEBESCONTE, 1891 [**A. simplex*]. Nondescript (?) trail; somewhat similar to *Palaeophycus* HALL (16). *Precam.*, Fr.

Amansites BRONGNIART, 1849 [**Fucoides dentatus* BRONGNIART, 1828]. ?Graptolites (16). *?Ord.*, Can.

Ampelichnus HITCHCOCK, 1865 [**Grammepus uniordinatus* HITCHCOCK, 1858] [=*Grammepus* HITCHCOCK, 1858 *(partim)*] (18). *Trias.*, USA (Mass.).

Archaeorrhiza TORRELL, 1870 [**A. tuberosa*]. "Plant" *("Radicibus similis")*; never figured (16). *Cam.*, Swed.

Archaeoscolex MATTHEW, 1889 [**A. corneus*]. Dubious fossil interpreted as insect larva; no specimens could be located in Canadian collections (16). *U.Carb.*, Can.(N.B.).

Beaumontia DAVID, 1928 [*non* EDWARDS & HAIME, 1851; *nec* EUDES-DESLONGCHAMPS, 1856] [**B. eckersleyi*] [=*Beaumontella* DAVID, 1928]. Nodular bodies (16). [Interpreted by DAVID as various parts of eurypterids; according to GLAESSNER (personal communication, 1956, 1959) not recognizable as animal remains, perhaps inorganic.] *Precam.(Beaumont Dol., Adelaide System)*, S. Austral.

Beltina WALCOTT, 1899 [**B. danai*]. Angular fragments of thin, commonly much distorted and compressed tests without distinctive surface ornamentation (42). [Regarded by WALCOTT as fragmentary remains of Merostomata, and by WHITE (1929) and FENTON & FENTON (1937) as probably noncalcareous algae, if not inorganic (37, 42). *Precam.*, USA(Mont.).——FIG. 148,2. **B. danai*, Belt Ser.(Greyson Sh.); *2a*, body segment, ×?; *2b*, portion of jointed appendage, ×3; *2c*, unidentified fragment with terminal curved spine, ×4; *2d*, appendage with two large basal? joints and two smaller terminal joints, ×2 (134).

Bipezia MATTHEW, 1910 (?1909) [**B. bilobata*] [=*Bipesia* MATTHEW, 1910 *(errore)*]. Spindle-shaped "footprints," pointed at both ends, in pairs opposite each other, coalescing laterally; length 10 mm., width 3 mm. (23). [Interpretation very doubtful, but certainly not of vertebrate origin, as MATTHEW believed; according to GLAESSNER (1957), possibly synonymous with *Isopodichnus* BORNEMANN, 1889.] *Dev.*, Can.(N.B.).

Bitubulites BLUMENBACH, 1803 [**B. problematicus*]. This "genus" (especially the "species" *B. irregularis* VON SCHLOTHEIM, 1820) possibly synonymous with *Rhizocorallium;* name not used for more than 100 years (16). *M.Trias.*, Ger.

Boliviana SALTER, 1861 [**B. melocactus;* SD ANDREWS, 1955]. (16). *Ord.*, Bol.

Bucinella FUCINI, 1936 [**B. verrucana*] (16). *?L.Perm.(Verrucano)*, Italy.

Carelozoon METZGER, 1924 [**C. jatulicum*]. Irregularly ramifying and 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; possibly coelenterate, calcareous alga or inorganic (42). *Precam.*, Finl.——FIG. 149,*1*. **C. jatulicum*; cross sec., ×1.1 (Geol. Survey Finland).

Chauviniopsis DE SAPORTA, 1872 [**C. pellati*] (16). *U.Jur.*, Fr.

Chordophyllites TATE, 1876 [or YOUNG & BIRD,

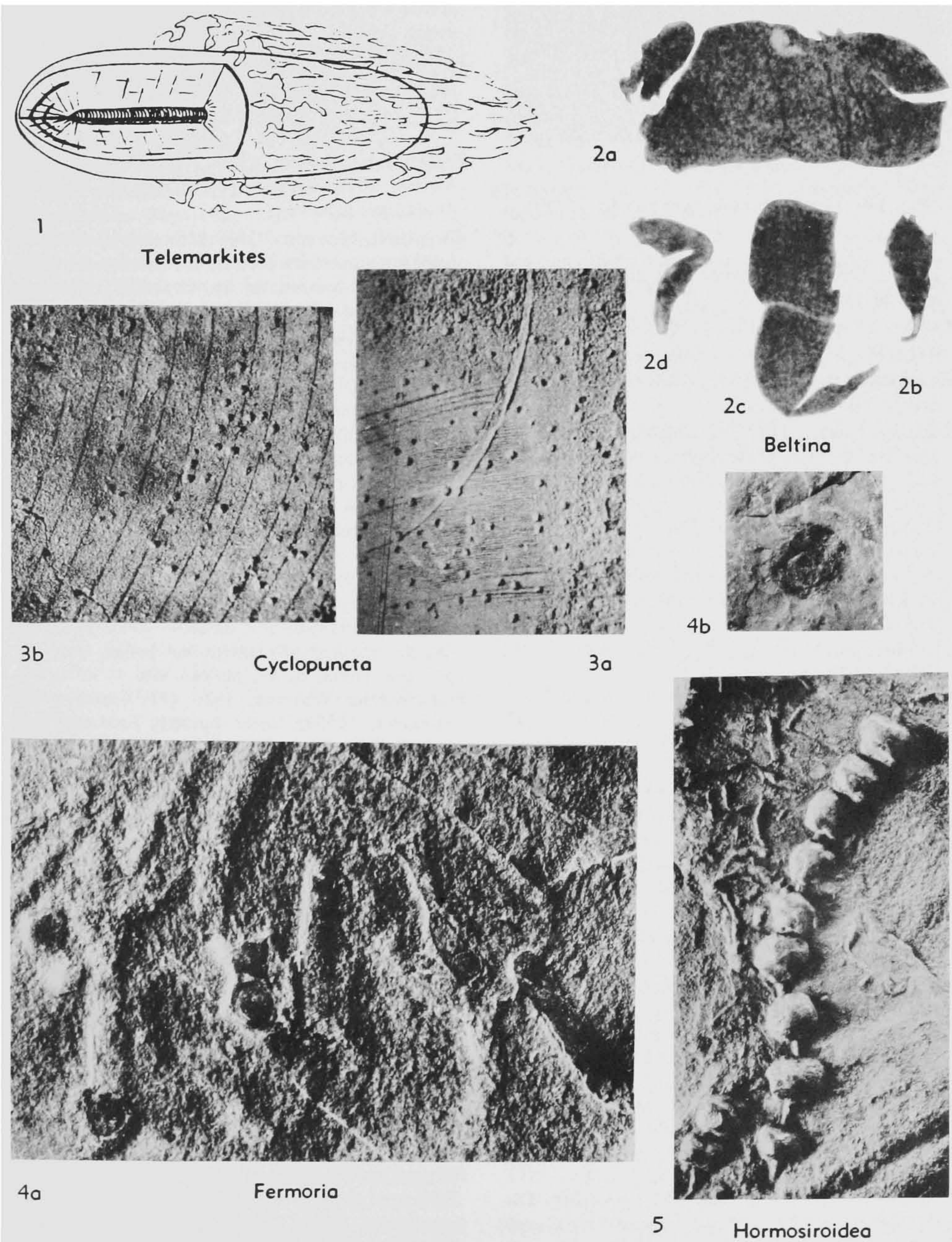
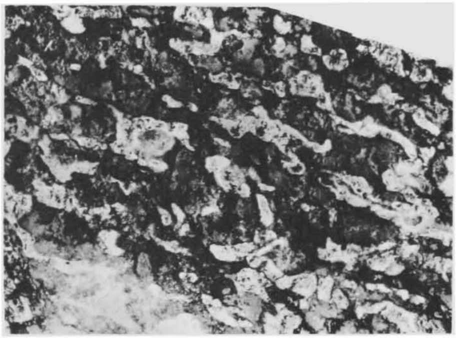


FIG. 148. Unrecognizable "genera" (p. *W*238, *W*240-*W*242).



Carelozoon

FIG. 149. Unrecognizable "genera" (p. W239).

1822]. Cylindrical "stems" of great length on bedding planes; "fucoid" (16). *L.Jur.*, Eng.

Codites STERNBERG, 1833 [**C. serpentinus;* SD ANDREWS, 1955]. ?Sponge (16). *U.Jur.*, Fr.

Conchyophycus DE SAPORTA, 1872 [**C. marcignyanus*] (16). *U.Trias.*, Fr.

Cophinus KOENIG, 1839 [**C. dubius*]. Problematical structure resembling an inverted 4-sided pyramid with column-like rounding at each corner; always found in vertical position; tentatively explained by SOWERBY and SALTER (Murchison, 1859) as impressions of rooted crinoid stems which produced observed pattern by wavy and somewhat rotatory motion; possibly inorganic (16). *U.Sil.(Ludlov.)*, Eng.

Crenobaculus FRITSCH, 1908 [**C. draboviensis*] (9). *Ord.*, Czech.

Cyclopuncta ELIAS, 1958 [**C. girtyi*]. Shallow subhemispherical holes; diameter 0.1 to 0.3 mm.; generally irregularly scattered on cephalopod shells, in some specimens tending to follow growth lines (16). [Explained by GIRTY (1909) as perforations in shells, probably made by small gregarious animals (e.g., the lorica-secreting infusorian *Folliculina*), the scars being produced by a prolonged passive attachment.] *Miss.*, USA(Okla.).——FIG. 148,*3*. **C. girtyi; 3a,* on *Bactrites? smithianus*, ×4.6; *3b*, on *Cravenoceras* sp., ×8 (*3a*, 73; *3b*, 65).

Dactyloidites HALL, 1886 [**D. bulbosus* (=*Buthotrephis? asteroides* FITCH, 1850)]. Probably an alga, a medusoid, or rosette-shaped burrows (*Treatise*, p. F159, Fig. 130,*3*) (16). *L.Cam.*, USA(N.Y.); ?M.Cam., USA(Vt.).

Dasycladites FUCINI, 1936 [**D. subclavaeformis*]. (16). *?L.Perm.(Verrucano)*, Italy.

Digitolithus FRITSCH, 1908 [**D. rugatus*]. (9). *Ord.*, Czech.

Discophycus WALCOTT, 1883 [**D. typicalis*]. Discoid, slightly convex bodies; diameter 4 to 12 cm.; outline varying from circular to orbicular, substance ?coriaceous (2). [Interpreted by JAMES (19) as inorganic (fossil mud bubbles); by RUEDEMANN (1925) as fossils of very diverse kinds (seaweeds, sponges, eurypterids).] *Ord.*, N.Am.

Dryalus BARRANDE, 1872 [**D. obscurus*] (9). *Sil.*, Czech.

Duovestigia BUTTS, 1891 [**D. scala*]. Described as amphibian footprint, but obviously of invertebrate origin (16). *U.Carb.*, USA(Mo.).

Dystactophycus MILLER & DYER, 1878 [**D. mamillanum*]. According to JAMES (19), impression of coral base that left its mark in concentric rings. *Ord.*, USA(Ohio).

Eocladophora FUCINI, 1936 [**E. fibrata*]. Long, narrow, threadlike pads or ridges (16). *?L.Perm. (Verrucano)*, Italy.

Eurypterella MATTHEW, 1889 [**E. ornata*]. Dubious fossil interpreted as peculiar crustacean; no specimens could be located in Canadian collections (16). *U.Carb.*, Can.(N.B.).

Fengtienia ENDO & RESSER, 1937 [**F. peculiaris*]. According to ÖPIK (1959) perhaps "only a *Rusophycus*" (p. W212); see also *Treatise*, p. O102 (16). *M.Cam.*, Manchur.

Fermoria CHAPMAN, 1935 [**F. minima*] [=*Protobolella* CHAPMAN, 1935]. Small disc-shaped carbonaceous structures, 2 to 4 mm. in diameter, concentrically wrinkled (37). [Interpreted as ?atremate brachiopod (CHAPMAN, 1935); compared with algae (SAHNI & SHRIVASTAVA, 1954, HOWELL, 1956, and others); probably inorganic, according to MISRA & DUBE (1952).] *Precam.* or *Cam.(Vindhyan F.)*, India.——FIG. 148,*4*. *F.* sp.; *4a*, attached to filament-like bodies, ×2; *4b*, ×4 (*4a*, Sahni, n; *4b*, Howell, n).

Fruticristatum WEBSTER, 1920 [**F. iowense;* SD ANDREWS, 1955]. Never figured; first described as alga (2). [Obviously represents fillings of nondescript burrows.] *Dev.*, USA(Iowa).

Furca FRITSCH, 1909 [BARRANDE MS] [**F. bohemica*]. Possibly pluteus larva of crinoid (9). *Ord.*, Czech.

Gleichenophycus MASSALONGO, ?date [?**G. granulosus* (=*?Caulerpa lehmanni* HEER, 1877)] (16). *Cret.*, Italy-Switz.

Gordioides FRITSCH, 1908 [*nom. nud.*] [**G. spiralis*] (9). *Sil.*, Czech.

Gracilerectus WEBSTER, 1920 [**G. hackberryensis*]. Nondescript straight or curved, cylindrical "stems" (2). [Originally regarded as algae ("fucoids"), but obviously burrows.] *U.Dev.*, USA(Iowa).

Granifer FRITSCH, 1908 [**G. stolatus*] (9). *Ord.*, Czech.

Guttolithus FRITSCH, 1908 [**G. strasseri*] (9). *Ord.*, Czech.

Harpagopus HITCHCOCK, 1848 [**H. dubius;* SD HÄNTZSCHEL herein]. Obliquely placed elliptical impressions (25). *?M.Dev.*, USA(N.Y.); *Trias.*, USA(Mass.).

Helviensia DE LIMA, 1895 [**H. delgadoi*] (16). *Cam.*, Port.

Hippodophycus HALL & WHITFIELD, 1872 [**H. cowlesi*]. Described as marine plants with swelling roots, which are laterally expanded in form of subcircular disc, with one edge truncate; known only from impressions; holotype (single described specimen) probably lost; perhaps inorganic (2). *U.Dev.*, USA(N.Y.).

Hoplichnus HITCHCOCK, 1848 [**H. quadrupedans* (?=*Chelichnus gigas* JARDINE, 1850)]. Hoof-shaped, semioval reliefs resembling impressions of horseshoes; diameter about 2 inches; perhaps markings or (particularly the "species" *H. equus* HITCHCOCK, 1858) belonging to *Spreiten-bauten* (17). *Penn.-Trias.*, N.Am.-?Eng.-?Ger.

Hormosiroidea SCHAFFER, 1928 [**H. florentina*] [=?*Corallinites rosarium* MASSALONGO, 1851; *C. tuna* MASSALONGO, 1855; ?*Halimedopsis* MASSALONGO, 1859]. Spherical or hemispherical bodies arranged on thin strings like pearls; diameter of hemispheres about 0.5 to 1 cm.; surface of some specimens coarsely granulose (16). [Regarded by HEER (1877) and SCHAFFER (1928) as an alga, by SEILACHER (1959) as a rosary-like trail of unknown origin.] *Cret.-L.Tert.(Flysch)*, Eu.——FIG. 148,5. **H. florentina*, U.Cret., Italy; ×0.7 (Naturhist. Mus. Wien).

Hydrocytium (?) silicula MATTHEW, 1890. Minute oval bodies; length 0.5 mm., width 0.25 mm.; with strong cuticle and pedicle-like knob at one end (2). *Cam.*, Can.(Nova Scotia).

Hylopus? variabilis MATTHEW, 1910. Very doubtful "footprints," referred to vertebrates; according to ABEL (1) not a vertebrate track, but an unrecognizable form. *Dev.*, Can.(N.B.).

Ichnophycus HALL, 1852 [**I. tridactylus*]. Doubtful tridactyl impressions (16). *Sil.*, USA(N.Y.).

Itieria DE SAPORTA, 1872 [jr. hom.; *non* MATHERON, 1842]. (2). *U.Jur.*, Fr.

Krishnania SAHNI & SHRIVASTAVA, 1954 [**K. acuminata*]. Acutely ovate discs, superficially resembling *Lingula*, with deep marginal furrow; longest axis 7.5 mm., maximum width 4 mm.; probably belonging to the Fermoriidae SAHNI (16). *Precam.* or *Cam.?*(*Vindhyan* F.), India.

Laminarites STERNBERG, 1833 [**Fucoides tuberculosus* BRONGNIART, 1828; SD ANDREWS, 1955]. "Genus" comprising very heterogenous "species," similar to *Laminaria;* straight and parallel structures on bedding planes (2). [Seemingly in part of plant origin (e.g., *L. antiquissimus* EICHWALD), in part certainly ripples or flow casts (e.g., *L. langrangei* DE SAPORTA & MARION), in part (e.g., *L. pseudoichnites*, according to MESCHINELLI & SQUINABOL, 1892) also trails.] *Cret.*, Fr.

Laminopsis FUCINI, 1938 [**L. insignis*] (16). *?L. Perm.(Verrucano)*, Italy.

Lepidotruncus FRITSCH, 1908 [**L. fortis*] (9). *Ord.*, Czech.

Leptophycus FRITSCH, 1908 [**L. venosus*, SD ANDREWS, 1955] (9). *Ord.*, Czech.

Leuconoe BOGATSCHEW, 1930 [jr. hom.; *non* BOIE, 1830] [**L. paradoxa*]. Larva of arthropod of unknown systematic position (16). *L.Eoc.(Flysch)*, USSR.

Lithodictyon TORELL, 1870 [**L. fistulosum*]. Possibly small mud cracks (16). *Cam.*, Swed.

Lithostachys FISCHER-OOSTER, 1858 [**L. alpina*]. ?Plant (7). *Jur.*, Switz.

Macrocystites FUCINI, 1936 [**M. similis*]. Trail or inorganic (16). *?L.Perm.(Verrucano)*, Italy.

Mastocarpites ZIGNO, 1956 [*non* TREVISAN, 1849 *(nom. nud.)*] [**Algacites crucaeformis* STERNBERG, 1833]. ?Coprolite (2). *U.Jur.*, Ger.

Micrapium TORELL, 1870 [**M. erectum*]. Never figured (16). *Cam.*, Swed.

Naites GEINITZ, 1867 [**N. priscus*]. Rather valueless name for a trail somewhat resembling that of the Recent genus *Nais* (16). [Interpreted by GEINITZ as a bodily preserved annelid.] *L.Carb.*, Ger.

Nanopus? vetustus MATTHEW, 1910. Very doubtful "footprints," referred to vertebrates; according to ABEL (1) not a vertebrate track, but an unrecognizable form. *Dev.*, Can.(N.B.).

Nematolites KEEPING, 1882 [**N. edwardsii;* SD ANDREWS, 1955]. Poorly preserved, "curious irregular branching structures" (2). *Sil.*, Eng.

Nereitopsis GREEN, 1899 [**N. cornubicus*]. ?Trail, somewhat similar to *Nereites;* poorly described and figured (16). *L.Dev.*, Eng.

Nimbus BOGATSCHEW, 1930 [jr. hom.; *non* MULSANT & REY, 1870] [**N. helianthoides*]. Starlike? trace fossil, somewhat resembling *Atollites* or similar forms (16). [Explained as belonging to Trachymedusae or Narcomedusae.] *L.Eoc.(Flysch)*, USSR.

Nisea DE SERRES, 1840 [*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 (16). [Interpreted as annelids, mollusks, or coelenterates.] *L.Cret.*, S.Fr.

Orthocaris FRITSCH, 1908 [**O. splendens*] (9). *Ord.*, Czech.

Palaeonereis EICHWALD, 1856 [*non* HUNDT, 1940] [**P. prisca*]. Poorly based "genus" interpreted as a bodily preserved polychaete worm, but obviously a trail, possibly related to *Nereites*; in one paper of EICHWALD (1856) described as "*P.* mihi"; in a later one (1860) as "*Palaeonereis* SOWERBY"; no description given by SOWERBY was to be found (16). *?Ord.*, USSR.

Papilionata SPRIGG, 1947 [**P. eyrei*]. According to GLAESSNER (1959), possibly a poorly and incompletely preserved specimen of *Dickinsonia* SPRIGG, (1947), and perhaps belonging to the Annelida. *Precam.*, Austral.

Phycoidella MATTHEW, 1890 [**P. stichidifera*]. Strap-shaped "fronds" showing irregular rows of dark spots or granules transversely arranged on "stem"; some "fronds" with enlarged extremity "like a *stichida*"; according to MATTHEW, related to *"Fucoides circinnatus"* BRONGNIART and belonging to algae; perhaps trace fossil (2). *Cam.*, Can.

Platyrhynchus GLOCKER, 1850 [jr. hom.; *non* LEUCKART, 1816; *nec* SWAINSON, 1820; *nec* CUVIER, 1826; *nec* WAGLER, 1830; *nec* AGASSIZ, 1846; *nec* VAN BENEDEN, 1876; *nec* CHEVROLÂT, 1882] [**P. problematicus*] (16). *?U.Cret.*, Ger.

Portelia BOURSAULT, 1889 [jr. hom.; *non* DE QUATREFAGES, 1850] [**P. meunieri*]. Nondescript, branched cylindrical fillings of tunnels; very poorly figured (2). *U.Jur.*, Fr.

Ptilichnus HITCHCOCK, 1858. Finlike impressions, arranged in rows; others consisting of parallel, slightly curved grooves (17). [According to HITCHCOCK, swim trails of fishes; more probably markings of rolling or dragging objects.] *Trias.*, USA(Mass.).

Ptychoplasma FENTON & FENTON, 1937 [**P. excelsum*] (23). *Penn.*, USA(Tex.).

Pucksia SOLLAS, 1895 [**P. machenryi*]. Long, narrow, threadlike markings in slate (16). *Cam.*, Ire.

Punctatumvestigium BUTTS, 1891 [**P. circuliformis*]. Described as amphibian footprint, but obviously of invertebrate origin (16). *U.Carb.*, USA (Mo.).

Quallites FRITSCH, 1908 [**Q. graptolitarum* (=*Q. problematicus* FRITSCH, 1908)] (9). *Sil.*, Czech.

Radicites FRITSCH, 1908 [**R. rugosus*]. Name used only in explanation of figure; in text FRITSCH calls same fossil *Radix corrugatus* (9). *Ord.*, Czech.

Radicopsis FUCINI, 1938. Probably inorganic (16). *?L.Perm.(Verrucano)*, Italy.

Radiophyton MEUNIER, 1887 [**R. sixii*]. Tetraradiate, probably accidental structure (2). *U.Jur.*, Fr.

Radix FRITSCH, 1908 [jr. hom.; *non* DE MONTFORT, 1810] [**R. corrugatus*]. In explanation of figure same fossil named *Radicites rugosus* (9). *Ord.*, Czech.

Rauffella ULRICH, 1889 [**R. filosa*] [=*Raufella* SARDESON, 1896 *(errore)*]. Possibly trace fossils (16). [See *Treatise*, p. *E*107]. *Ord.*, USA.

Rhizomorpha HERNANDEZ-PACHECO, 1908 [**R. calderoni*]. Bulging structures on bedding planes; 3 to 12 mm. in diameter; irregularly branched; curved (16). *Sil.*, Sp.

Saccophycus JAMES, 1879 [**S. inortus*]. Possibly burrows, smooth or striated longitudinally; never figured (2, 19). *Ord.*, USA(Ohio).

Saltator HITCHCOCK, 1858 [jr. hom.; *non* VIEILLOT, 1816]. Inorganic markings or tracks made by animals moving by leaps; 2 "species" having little in common (17). *Trias.*, USA(Mass.).

Scotolithus LINNARSSON, 1871 [**S. mirabilis*] (16). *Cam.*, Swed.

Solicyclus QUENSTEDT, 1879. Elliptical reliefs, smooth internally; marginal seam divided by numerous radial rays (16). *L.Jur.*, Ger.

Sphaerapus HITCHCOCK, 1858. ?Trackway consisting of 2 rows of small (diameter 3 to 5 mm.) hemispherical impressions (17). *Trias.*, USA(Mass.).

Sphenopus FRITSCH, 1908 [jr. hom.; *non* STEENSTRUP, 1856] [**S. pectinatus*] (9). *Ord.*, Czech.

Spongia paradoxica WOODWARD, 1833 [=*Siphonia paradoxica*, AUCTT.]. "Ramifying zoophyte, resembling the roots of trees, about an inch thick, branching and interweaving in every direction, fragments not unlike the horns of a stag" (16). [According to MCKENNY HUGHES (1884), not sponges, but of inorganic (concretionary) origin.] *L.Cret.*, Eng.

Spongolithus FRITSCH, 1908. Very heterogenous group of ridgelike and tracklike structures (9). *Ord.*, Czech.

Squamularia ROTHPLETZ, 1896 [*non* GEMMELLARO, 1899] [**Caulerpa cicatricosa* HEER, 1877; SD HÄNTZSCHEL, herein]. Possibly small fucoids (2, 23). *Tert.*, Eu.

Staurophyton MEUNIER, 1891 [**S. bagnolensis*]. Similar to *Radiophyton* MEUNIER, 1887 (16). [See *Treatise*, p. *F*23, Fig. 12,*2*.] *Ord.*, Fr.

Stratipes HITCHCOCK, 1858 [**S. latus*]. Very large trail, about 20 inches between 2 rows of impressions, doubtful if made by invertebrate (17). *Trias.*, USA(Mass.).

Striocyclus QUENSTEDT, 1879. Reliefs on bedding planes with radial, wormlike ornament and central hollow (16). *L.Jur.*, Ger.

Telemarkites DONS, 1959 [**T. enigmaticus*]. Ellipsoidal nodules; long axis parallel to bedding planes; 2 to 4 cm. in length; 1 to 2 cm. across; composed of fine-grained quartz, with central tube filled with coarse-grained quartz, lying parallel to the long axis (16). [According to DONS, organic or organic-controlled origin (primitive sponges or concretions formed by intervention of algae).] *Precam.*, S.Norway.——FIG. 148,*1*. **T. enigmaticus*, simpl. reconstr. showing internal structures, ×1.5 (64).

Thinopus antiquus MARSH, 1896. Single "footprint" with 3 "toe-impressions," described as earliest record of a terrestrial vertebrate; according to ABEL (1) and others, not a vertebrate footprint; in ABEL's opinion a "fossil" allowing of various explanations; possibly only a fish coprolite (1). *U.Dev.*, USA(Pa.).

Trianisites RAFINESQUE, 1821 [**T. cliffordi*]. See *Treatise*, p. *F*159.

Trichoides HARKNESS, 1855 [**T. ambiguus*]. Hair like bodies; generally straight, some slightly curved; length irregular, about 1 inch; never figured (2). *Ord.(Llandeil.)*, Scot.

Tropidaulus FENTON & FENTON, 1937 [**T. magnus*] (23). *Penn.*, USA(Tex.).

Truncus Fritsch, 1908 [**T. ramifer*] (9). *Ord.*, Czech.

Valonites Sordelli, 1873 [**V. utriculosus*] (16). *Plio.*, Italy.

Vermiculites Rouault, 1850 [jr. hom.; *non* Bronn, 1848] [**V. panderi*]. Poorly described and never figured (2). *Ord.*, Fr.

Walcottia Miller & Dyer, 1878 [**W. rugosa*]. "Genus" including 3 different "species" of long, tapering, rugose, flexuous impressions of worm-like shape (16). [The 3 "species" explained by James (1886) as a burrow, an impression of a crinoid, and an imprint of a starfish arm, respectively.] *Ord.*, USA(Ohio).

Zearamosus Webster, 1920 [**Z. elleria*]. (2). *Dev.*, USA(Iowa).

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The number of paleontologists in all parts of the world who have helped me in such friendly ways in the often difficult task of finding and procuring type specimens and literature is so large that it is impossible to name them individually. My sincere thanks are due to all who aided and promoted my work by frequent painstaking, time-consuming search for identification of often-neglected Problematica. Special thanks are due to my colleague Dr. Ulrich Lehmann (Hamburg) for the difficult translation of the German text.

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The included papers represent only a very small selection from the widely scattered literature on palichnology. As far as could be ascertained, at least 900 publications dealing exclusively with the fossil *Lebensspuren* of invertebrates and with the Problematica had been published up to 1957. Commonly, however, the descriptions and interpretations of these sorts of fossils are contained in purely stratigraphic or faunistic texts where they easily can be overlooked. Altogether more than 1,100 publications have been consulted.

The best and most complete bibliographies on palichnology are found in Wilckens (46) and especially Lessertisseur (23). Those of Nathorst (28) and Winkler (47) are older. A bibliographical index of all "genera" treated here (including synonyms), to be published by the author in 1962 (16), will make it possible to find their original descriptions.

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(122) *See* **Glocker (75)**
(123) **Sollas, W. F.**
(124) **Squinabol, S.**
(125) **Stefani, Carlo de**
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SUPPLEMENT TO SYSTEMATICS OF CONODONTS

By Klaus J. Müller

Dr. W. H. Hass, author of the main *Treatise* article on conodonts, including systematic descriptions, unfortunately died prior to publication of this volume. Shortly before his death he made revisions and last additions to his typescript, which therefore was well up to date until the middle part of 1959. This chapter provides information for the period extending from mid-1959 to August, 1961.

CONODONT TAXA CLASSED AS VALID

Belodina Ethington, 1959 [**Belodus grandis* Stauffer, 1935]. Family Belodontidae Huddle, 1934. Anteriorly directed horizontal cusp with series of prominent denticles and upward-bowed main denticle; unit longitudinally asymmetrical, with prominent heel posterior to first denticle and 2 conical basal cavities. *M.Ord.-U.Ord.*, N.Am. (USA-Can.).——Fig. 150,*1*. **B. grandis* (Stauffer), U.Ord.(Galena F.), USA(Iowa); lat., ×60 (2).

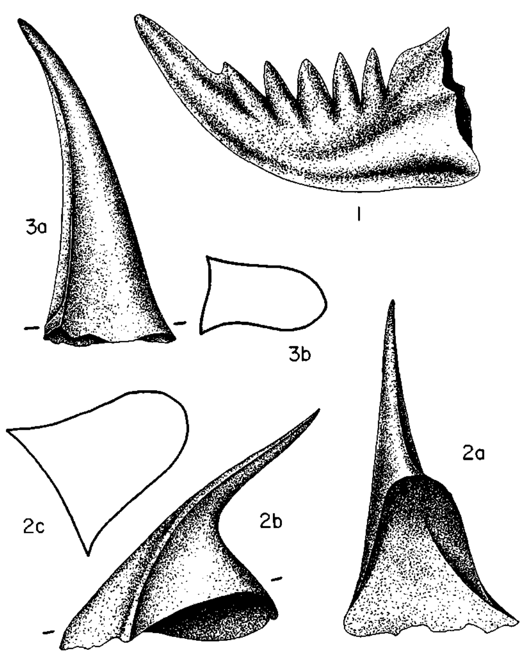

Fig. 150. Conodonts (p. W246).——*1. Belodina. 2. Furnishina. 3. Hertzina.*

Furnishina Müller, 1959 [**F. furnishi*]. Family Distacodontidae Ulrich & Bassler, in Bassler, 1925. Unsymmetrical, with very large, triangular-pentagonal basal cavity; anterior side with broad flat area, corresponding to greatest width of fossil. *U.Cam.*, Eu.(Swed.-N.Ger.)- N.Am.(S.Dak.-Wyo.-Utah-Nev.).——Fig. 150,*2*. **F. furnishi*, Gallatin Ls., USA(Wyo.); *2a-c*, post., lat., transv. sec., ×80 (7).

Hertzina Müller, 1959 [**H. americana*]. Family Distacodontidae Ulrich & Bassler, in Bassler, 1925. Subsymmetrically elongated, with narrow, extremely long basal cavity, with flat area on posterior side limited laterally by carinae. *U.Cam.*, Eu.(Swed.-N.Ger.)-N.Am.(Nev.).——Fig. 150,*3*. **H. americana*, Elvinia Z., USA(Nev.); *3a,b*, lat., transv. sec., ×80 (7).

Plegagnathus Ethington & Furnish, 1959 [**P. nelsoni*]. Family Belodontidae Huddle, 1934. Laterally compressed, with cusp; posterior denticulated bar, and aboral process; deep thin-walled cavity opens posteriorly and tapers to sharp point beneath cusp. *U.Ord.*, N.Am.(N.Man.-Wyo.).——Fig. 151,*1*. **P. nelsoni*, Shamattawa Ls., Man.; lat., ca. ×110 (3).

Proacodus Müller, 1959 [**P. obliquus*]. Family Distacodontidae Ulrich & Bassler, in Bassler, 1925. Asymmetrical, with large basal cavity which is rounded anteriorly and posteriorly and bears stretched-out carina on one side. *U.Cam.*, Eu. (Swed.-N.Ger.).——Fig. 151,*2*. **P. obliquus*, 5d Zone, N.Ger.; *2a*, ant. view with transv. secs.; *2b*, post.; all ×80 (7).

Scaphignathus Ziegler, 1960 [**S. velifera*]. Family Polygnathidae Ulrich & Bassler, in Bassler, 1925. Long, narrow platform with peg-shaped or rounded lower surface, small basal cavity at anterior end; blade short and high laterally, as in *Cavusgnathus*. *U. Dev.(Prolobites - Platyclymenia Z.)*, Eu.(Ger.).——Fig. 152,*1*. **S. velifera; 1a,b*, upper and outer lat. views, ×35 (12).

Family WESTERGAARDODINIDAE Müller, 1959

Lamellar, with 2 lateral denticles produced by upwardly bowed flanges of main denticle; lower side smooth and undifferentiated. *M.Cam.-L.Ord.*

Westergaardodina Müller, 1959 [**W. bicuspidata*]. Bilaterally symmetrical; lateral denticles may be larger than middle one; large basal cavity, in some forms divided into 2 lateral cavities. [Little balls associated with the type species prob-

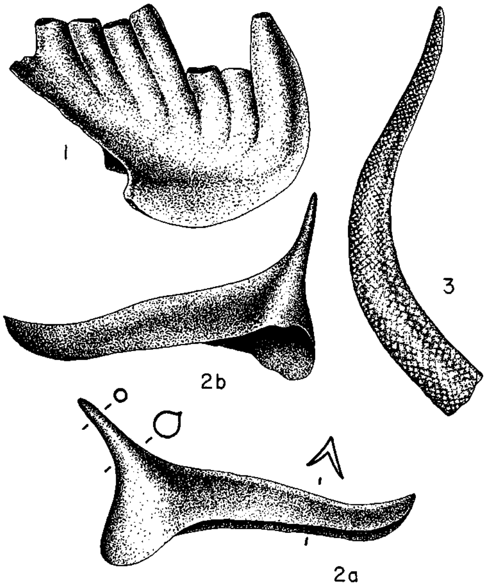

Fig. 151. Conodonts and paraconodont (p. *W*246, *W*248).——*1. Plegagnathus. 2. Proacodus. 3. Rhombocorniculum.*

ably belong to the same conodont taxon (?static organ)]. *M.Cam.-L.Ord.,* Eu.(Swed.-N.Ger.)-N. Am.(S.Dak.-Wyo.).——Fig. 152,*2*. **W. bicuspidata,* U.Cam. (5b Zone), N.Ger.; ca. ×55 (7).

Conodont Assemblage Classification UNCERTAIN

Westfalicus Schmidt in Moore & Sylvester-Bradley, 1957 (p. 21) [*pro Gnathodus* Schmidt, 1934 (*non* Pander, 1856)] [**Gnathodus integer* Schmidt, 1934]. This generic name was proposed for designation of conodont assemblages named *Gnathodus integer* by Schmidt, the gnathodid element of which was (and still is) considered to be congeneric with *G. mosquensis* Pander, 1856, type-species of *Gnathodus.* Müller, supported by Schmidt (personal communication), judges that *Westfalicus* should be cited as a junior subjective synonym of *Gnathodus,* despite the fact that *Westfalicus* is a name based on conodont assemblages and *Gnathodus* was defined on the basis of discrete conodonts.

[*Editorial Note.* It should be observed that because *Westfalicus* as a generic designation for conodont assemblages was premised on acceptance of *Gnathodus* and other names based on discrete conodonts as parataxa, which the XVth Zoölogical Congress (London, 1958) denied, the standing of *Westfalicus* as a zoological name is not affected. The Rules (new Art. 6, Sec. 5c) provide: "The fact that the name of a taxon published prior to 1958 was originally established conditionally does not prevent its name from being available." Also, as is well recognized (Art. 6, Sec. 5e), "A name is not made unavailable because it is based on any part of an animal. . . ." Thus, *Gnathodus* is available for application to assemblages of conodonts, as well as to discrete conodonts, and *Westfalicus* (by no means rejectable on the ground of its provisional first-published status) is also available for assemblages, subject only to considering the name to be a junior subjective synonym of *Gnathodus.*—Moore]

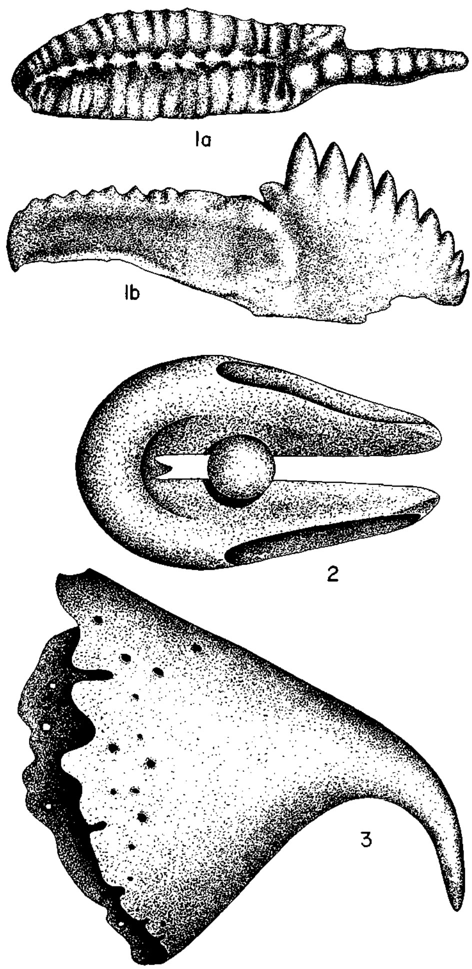

Fig. 152. Conodonts and paraconodont (p. *W*246, *W*248).——*1. Scaphignathus. 2. Westergaardodina. 3. Problematoconites.*

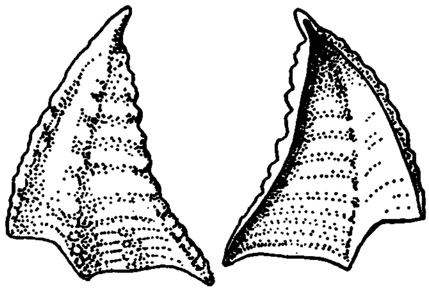

FIG. 153. Paraconodontida (p. W248).——1. *Pygodus*.

CONODONT TAXA CONSIDERED INVALID

SYNONYMS

Ancyrolepis ZIEGLER, 1959 [**A. cruciformis*]. Junior subjective synonym of *Ancyroides* MILLER & YOUNGQUIST, 1947.

Cornudina HIRSCHMANN, 1959 (Dec.) [**Ozarkodina breviramulis* TATGE, 1956]. Junior subjective synonym of *Parachirognathus* CLARK, 1959 (March).

Ctenognathodus FAY, 1959 [*pro Ctenognathus* PANDER, 1856 (*non* FAIRMAIRE, 1843)] [**Ctenognathus murchisoni* PANDER, 1856]. Junior subjective synonym of *Spathognathodus* BRANSON & MEHL, 1941.

Eobelodina SWEET, TURCO, WARNER & WILKIE, 1959 [**Oistodus fornicalis* STAUFFER, 1935]. Junior subjective synonym of *Oistodus* PANDER, 1856.

Gnamptognathus ZIEGLER, 1958 [**G. walliseri*]. Junior subjective synonym of *Scutula* SANNEMANN, 1955.

Order PARACONODONTIDA Müller, n. order

Phosphatic microfossils, which may contain organic matter and which, though resembling conodonts in size range and partly in general appearance, grow by accretion of the lower rim in a manner clearly distinct from the mode of growth in conodontophorids (*see* Fig. 48), are grouped under the name Paraconodontida. It is believed that the paraconodontids, now represented by a few described forms and several undescribed ones, will be useful in stratigraphic studies of early Paleozoic rocks. The presently recorded genera come from pre-Silurian strata. *L.Cam.-M.Ord.*

Problematoconites MÜLLER, 1959 [**P. perforata*]. Conical toothlike forms with large basal cavity; flanges perforated by numerous small oval holes, which demonstrate mode of growth unlike that of conodonts. *U.Cam.*, Eu.(Swed.-N.Ger.).——FIG. 152,*3*. **P. perforata*, 5d Zone, N.Ger.; lat., ×80 (7).

Pygodus LAMONT & LINDSTRÖM, 1957 [**P. anserinus*]. Sheathlike, triangular, flat, with point on one extremity; on reverse side sheath folded down like doublure of trilobite pygidium; accretion on rim opposite to point. *M.Ord.(Llandeil.)*, Eu.(Swed.-Scot.).——FIG. 153,*1*. **P. anserinus* LAMONT & LINDSTRÖM, *1a,b*, lat. obverse and reverse sides, Swed.; ×60 (6).

Rhombocorniculum WALLISER, 1958 [**R. comleyense*]. Conical, slender, laterally compressed, bowed or twisted, with deep basal cavity; surface with regular facet-like sculpture. *L.Cam.*, Eng.——FIG. 151,*3*. **R. comleyense*, Shrops.; lat., ×35 (9).

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