TRACE FOSSILS AND PROBLEMATICA

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CONTENTS

PAGE
INTRODUCTION ........................................................................................................ W177
Definitions ........................................................................................................... W178
Geological occurrence ...................................................................................... W178
Preservation ....................................................................................................... W178
Historical review ............................................................................................... W179
Classification .................................................................................................... W180
NOMENCLATURE OF TRACE FOSSILS ................................................................. W181
Importance of trace fossils for stratigraphy, paleogeography, and paleoecology W182
TRACE FOSSILS .................................................................................................. W183
Systematic Descriptions .................................................................................. W183
Doubtfully Distinguished Trace Fossils ............................................................ W220
BODY FOSSILS .................................................................................................. W223
BORINGS .......................................................................................................... W228
"FOSSILS" PROBABLY OF INORGANIC ORIGIN ............................................... W232
UNRECOGNIZED AND UNRECOGNIZABLE "GENERA" .................................. W238
Acknowledgments ............................................................................................ W243
REFERENCES .................................................................................................... W243
SOURCES OF ILLUSTRATIONS .......................................................................... W245

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 "bioocoenosis."


*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 ("demirelief"s 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 epirelief and hyporelief; 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) Vorseitliche 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 “spread-burrows” (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, Hercorhaph, and Spirorhaph, 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., Spiredosmos).

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 cannot 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 enigmatic area in the kingdom of the problematical fossils”). The difficulties of classifi-
cation, 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,” Parketierung);
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 spicata), 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 otoi 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 PALEOCOLOGY**

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 francoicus 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 subaqueous 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.


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

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 unsatisfactory, owing to the rather casual way that trace fossils have commonly been treated in the literature.
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).

**Artharia** *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.*

**Arthrophyllus** *Hall*, 1852 [*Fucoides alleghaniensis* *Harlan*, 1831 (=Fucoides harlani *Conrad*, 1838; ?Raufalla palmipes *Ulrich*, 1889)] (=*Harlania* *Goepert*, 1852; *Arthropicus* *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 *Klán*, 1932. Poorly founded, rather superfluos „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 Frisch*, 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, auluroïds, 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 star-like 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. W184-W185).

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.); X1 (Howell, n).

*Balanoglossites* Magdefrau, 1932 [*B. triadicus*]
 [=Unciliiferus Hunds, 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 longitudi
nal 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
Gabelle*, 1900; more probably feeding trail than
scyphozoan (*Treatise*, Part F, p. F43, Fig. 32,6).
U.Cret., Greece.
Belorhaphe Fuchs, 1895 [*Cylindrites zickzack Heer, 1877] [=Belorhaphe aucýt]. Sharply zig-zag-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 smooth 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, A. *B. perata*; 4a, casts in overlying sandstone; 4b, original burrow-cavities in underlying shale, ×0.3 (107).

Bifasciculus Volk, 1960 [*B. radius*]. 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. radius*; ×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. (Mecker), Ger.—Fig. 114, 1. *B. insolitus*; 1a, ×0.8; 1b, schematic, ×1 (24).

Bifungites Desio, 1940 [*B. fezzanensis* (?=Bifurcophyes 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 Artharia (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).

Bifurculipes Hitchcock, 1858 [*B. laqueatus*; SD Hantzschel, herein] [=Bifurculipes, Biferculpipes, Bifurculipes Hitchcock, 1865 (error)]. 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. diadema*ta*us*]. According to James (1884), identical to **Triachyphycus**. 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. arbuleiscens** (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 palaeontological collections for trace fossil from the Italian Flysch. [Probably manuscript name.]

**Camptodadus 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 **Ceratocaris** (16). L. Paleoz., Eng.

**Cauerpites Sternberg, 1833** [*Fucoides lycopodioides Bronniart, 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, 1865=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 targinioni Bronniart, 1828; SD Andrews, 1955] [=**Algacites Schlotheim, 1822 (partim); Fucoides Bronniart, 1823 (partim); "Gigartiniter" Bronniart, 1823 (not used as genus); Caulerpites, Sphaerococites Sternberg, 1833 (partim); Bathotrophis Hall, 1847; Phymatoderma Bronniart, 1849; ?Trevisia Zigno, 1856; Phycopsis Fischer-Ooster, 1858; Bythotrephis Eichwald, 1860; Nulliporites Heer, 1865; Chondridites, Leptochondriches Schimper, 1869; ?Theobaldia Heer, 1877 (partim); Palaeochondrites de Saporta, 1882; Chondropogon Squinabol, 1890; ?Prochondrites Frisch, 1908; Labyrinthochorda Weissenbach, 1931; Clematischia 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-
ly built-in ellipsoidal excrement pills; surface pattern commonly very regular, effected by pho­botoxis (43). [Probably made by marine worms.]

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] [=Climactichnites 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 (for 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).

Bifungites

Bifasciculus

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

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

Cochlicluchsia 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, 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.

Conopoides HITCHCOCK, 1858 [·C. larvalis]. Tracks in 3 (?) 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.); X×0.7 (96).

Corrinopsisera Sauer, 1955 [*C. eucadoriensis]. 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 tufts (cangagua). [Probably breeding places of scarabaeid beetles.] Pleist. (guide fossil of 3rd interglacial stage), S. Am.(Ecuador-Colomb.).

Corrophoides Smith, 1893 [*C. polypii] [=Arenicoloides Blanckenhorn, 1916; Arenicolithes Hildegard, 1924 (errose), Corephoides Ovick, 1956 (errose). 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.; la, side, X×0.6; lb, side (somewhat schematic), X×1; lc, lower ends of U-shaped burrows with Spreite, X×0.6 (1).—Fig. 117.2. C. sp. cf. C. rosei Dahmer, L.Cam., Pak.; X×0.6 (41).

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

Cosmoraphhe Fuchs, 1895 [=Cosmoraphhe Fuchs, 1895]. “Free meanders” of extraordinarily regular form in 2 size orders; windings not close to each other; form reminiscent of some spawnstrings of gastropods (10). Cret.-L.Tert. (Flysch), Eu.—Fig. 118.3. C. sp., Low.M.Eoc.(Flysch), Pol.; X×0.6 (89).

Cruziana D'Orbigny, 1842 [*C. furcata; SD Seilacher, herein] [=Bilobites D'Orbigny, 1839 (non Dekay, 1824; nec Rafinesque, 1831); Bilobichnium Krejcigr, 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. 119.3. C. furcata D'Orbigny, Ord., Port.; 5a, 5b, both X×0.3 (63).—Fig. 119, 6. C. sp., Ord., Bol.; X×0.4 (83).

Cylinderichnus Linck, 1949 [*C. gregarium (=Tubifex antiquus Pleninger, 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.Kenper), ?M.Jur., Eu.—Fig.
Chondrites

Climactichnites

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

118.1. *C. gregarium*, U.Trias.(M.Keuper), Ger.; \(\times 1\) (24).

**Cylindrites** Goeppert, 1841 [non Gesner, 1758; nec Gmelin, 1793; nec Sowerby, 1824] [*C. spongoides*; SD Andrews, 1955] [=Spongites Geinitz, 1842 (partim) (non Oken, 1815); *Astrocladia fucata* Gerster, 1881; **Goniophycus** Saporta, 1884]. Like *Palaeophybus*, used as general term for cylindrical and not vertical fillings of burrows (16). [Junior homonym.] **Mesoz., Eu. Dactylophybus** Miller & Dyer, 1878 [*D. tridigita­ tus*]. 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 ROAUXT, 1850 [non REDTENBACHER, 1891] [*Vexillum desiglandi ROAUXT, 1850, SD HANTZSCHEL, herein] [*Vexillum ROAUXT, 1850 (non BOLTEN, 1798); Humiliis ROAUXT, 1850; Vexillum LEBESCONTE, 1892 (erere)]. 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. desiglandi (ROAUXT); 1a,b, Ord., Fr., X0.4 (92); IC, 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; Daemonelix, auctt. (non Daemonelix 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, X0.3 (50).

Delesserites STERNBERG, 1833 [*Fucoides lamourouxii BRONNIART, 1828; SD ANDREWS, 1955] [*=Delesserites BRONNIART, 1853 (non RUDEMANNS, 1925) Delesserella RUDEMANNS, 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 RUDEMANNS, 1925, Ord., N.Y.); Cenozoic "species" under the name of Recent genus Delesseria LAMOUROUX (2).


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; X0.6 (SEILACHER, n).

Dictyodora WEISS, 1884 [*Dictyophyam? liebeanum GEINITZ, 1867] [*=Nematites MACLEAY, 1839 (certainly N. sudeticus ROEMER, 1870); Myriamites gracilis DELGADO, 1910, and very probably several other "new species" of Myriamites in DELGADO, 1910]. Complicated spread (Spreiten) structure, irregularly conical, with its point toward hanging wall; delicately striated exterior surface (=Dictyodora i.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.);

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

Carb., Eu.—Fig. 119.4. *D. liebeanus (GEINITZ), L.Carb., Aus.; X0.3 (1).—Fig. 119.2. D. simplex SEILACHER, L.Cam., Pak., drawing of a model; X0.5 (41).

Dimorphichnus SEILACHER, 1955 [*D. obliquus]. Asymmetrical trails with 2 different types of impressions—thin sigmoidal ones, produced by rak­
ing movement, and blunt ones, similar to impres­
sions 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, X0.16; 1b, X0.8; 1c, X0.4 (41).

Diplichnites DAWSON, 1873 [*D. aenigma] [*=Aeripes MATTHEW, 1910]. Rather nondescri­
berial walking track of arthropods with nu­
erous steps; tracks differently arranged depend­
ing on direction of movement (straight or ob­
**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.--FIG. 121,1. D. sp., L.Cam., Pak.; schematic, X1.3 (41).

**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. nereiforme*]. Oval, patchlike structures on both sides of narrow median ridge; width about 15 mm. (16). *U.Cret.-Oligo., Eu.--FIG. 120,5. *D. nereiforme*, U.Cret.(Campan.), Ger.; X1.3 (Häntschel, 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* Whiteway, 1883; never figured and no specimens
could be located in Canadian collections (16). ?Sil., Can.(N.B.).


*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 *Rosaultia* (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).

*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.*]
Fucusopsis Vassoevitch, 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); Palaeochorda Eichwald, 1855; Herpystezoum Hitchcock, 1848; Helminthoidichnites Pitch, 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 (Hantzschel, n).

Grammepus Hitchcock, 1858 [*G. eriatus*; SD Hantzschel, herein]. Doubtful insect trail (17). Trias., USA (Mass.).

Granularia Pomel, 1849 [non Ploetaeva, ?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),
Trace Fossils

Fig. 120. Trace fossils (p. W191-W194).
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 Hantzschel, herein] (=Gyrochorda Schimper, 1879; *Equihenia Meunier, 1886). Zoof-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. W194, W200-W201).
Fig. 124. Trace fossils (p. W196, W200-W201, W205).
pads, both series separated by median furrow (46). Cam.?Tert., Eu.—Fig. 122,1. *G. comosa, M.Jur., Switz.; X1 (84).

Gyrolithes de saisse, 1884 [*G. daveuxi; SD Hántzschel, herein] [="Gyrolithen" DEBEY, 1849 (partim); Siphondron de saisse, 1884; Syringodendron FUCHS, 1895 (pro Siphodon); Daemonhelic 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.; X> (98).—Fig. 121,10. G. saxonicus (Hántzschel), U.Cret. (Turon.), Ger.; X0.4 (82).

Gyrophyllites GLOCKER, 1841 [*G. kwasiensisii] [=?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. 122,2. G. sp., U.Cret. (Flysch), Aus.; Xa; X1; 3b, schematic (3a, 10; 3b, 120).

Halimedides LORENZ von LIBURNAU, 1902 [*Halimedia 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; X0.3 (95).


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

Hamilipes HITCHCOCK, 1858 [*H. didacynthus]. 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.] Tria., USA (Mass.).—Fig. 121,4. *H. didacynthus; X0.7 (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). Tria., USA (Mass.).—Fig. 121,3. *H. capillaris; X0.7 (96).

Helicodermites 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; X0.7 (51).

Helicolithus AZPEITIA MOROS, 1933 [*H. sampa­leyoi, SD Hántzschel, 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. sampelayo; 2a, X1 (U.Cret., Sp.); X(49); 2b, schematic drawing, X1.5 (?Cret., Italy) (41).

Helminthoida SCHAFHAUFL, 1851 [*H. labirynthica; SD Hántzschel, herein] [=Helminthoida MAILLARD, 1887; Helminthoides FUCHS, 1895; Helminthoidea 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. labirynthica U.Cret. (Flysch), Aus.; X1 (15).

Helminthopsis HEER, 1877 [non GROUVEUIL, 1906] [*H. magna; SD ULRICH, 1904] [=Helminthop­sis VINASSA DEREGNY, 1904; MAGARIKUNE MINATO & SUYAMO, 1949; ?Serpentinichnus MAYER, 1956; Tosakelmimnes 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-Antarctic.—Fig. 122,4. H. sp.; 4a, U.Cret., Aus.; X0.75 (1); 4b, U.Cret., Alaska; X1 (44).

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

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

Himanthalites FISCHER-OOSTER, 1858 [*H. taenia­tus] [=?Taniophycus SCHIMPER, 1869]. Differ from Chondriet only in size and fewer ramifications (7). L.Jur., JGer.; 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. hiberni­cum; 8a, 8b, ca. X0.7 (80).

Hydranctus FISCHER-OOSTER, 1858 [*Ministeria geniculata STERNBERG, 1833]. Groups of rounded "leaves" arranged irregularly or lyre-shaped; proposed as subgenus of Ministeria; feeding-burrow (7). Cret.-L.Tert. (Flysch), Eu.—Fig. 121,5. H. oosteri FISCHER-OOSTER, ?U.Cret. (Flysch), Switz.; X1.5 (?).

Ichnocnusus SEILACHER, 1956 [*I. radius]. Lit­tle pustule-shaped heaps with straight, radiate appendages; resting traces made by unknown ani­mals which hid temporarily in sand (16). L.Jur.-
M. Jurassic, Ger.—Fig. 123, 2. *I. radiatus*, L. Lias. (Angulaten-Schichten); 2a, holotype, ×1; 2b, ×1 (120).

Ichnyspica LINCK, 1949 [*I. pectinata* (=Ichnyspica LESSERTSIEUER, 1955 [error])]. 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 spicae* 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 moniticules at posterior ends; believed to have been made by fin or finlike appendages of anacanthodians (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. SCHIDEWOLF, 1928) [*non BRADY, 1947*] [*I. problematicus*; SD SCHIDEWOLF, 1928 (=*Ichnium problematicum SCHIDEWOLF, 1921)]. Dimorphic 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 LESSERTISSEUR, 1955 (Angulaten-Schichten); 2a, holotype, ×1; 2b, ×1 (120).

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 perpendicularly to margin; matrix may be phosphatic (16). [Interpreted as burrow (resting trail) produced by cerianthid sea anemone.] L. Jurassic, Eu.—Fig. 125, 5. *K. langi*, Blue Liassic, Eng.; 5a, long. sec. with phosphatic sheath; 5b, long. sec. without phosphatic sheath; 5c, reconstr. burrow indicating calcite-filled cracks in phosphatic sheath, ± (120).

Laevicyclus QUENSTEDT, 1879 (=Cyclozoan 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 SELACHER (38, 41) as trace fossil (feeding burrow) comparable with dwelling shaft and scraping circles of Recent annelid worm, *Scoleleptis*.] 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. Jurassic, Ger.—Fig. 125, 2. *L. bispiralis*; wire models of burrows, ×0.2 (91).

Lennna KRÄUSEL & WLEYLAND, 1932 [*L. schmidsi*]. 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). Dec., Ger.—Fig. 125, 7. *L. schmidsi*, M. Dev.; ×0.3 (104).

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

Lophocentrum REINHOLD RICHTER, 1850 [*L. comosum REINHOLD RICHTER*, 1851] (=Criophycus TOUL, 1906). Bunches of closely spaced, inwardly bent “twigs” with comblike branches, joining to...
torm 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).

Lorenzia 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] [=Vermiculites, 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).
Trace Fossils

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. FI59.] ?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 myriopod; junior homonym.] Trias., USA (Mass.).

**M. benjaminii**

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. benjaminii*, Coconino Ss.; diagram of trackway, X0.5 (116).

**Muensteria**

1833 [non KROGERUS, 1931]. "Genus" based on cylindrical, transversely striped bodies; in part body fossils (?sponges), in part trace fossils (?spongodichnites, *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).

**Myriocutes**

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

**Namapodia**

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, 1969 [*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. uniseriatus*; two rows *N. biserialis*); interior with some clay pills corresponding to dimples of epirelief (16). *L.Jur.-M. Jurr.*, Ger.—Fig. 126,3. *N. biserialis*, M.Jurr. (Dogger β); 3a, 3b, X0.6 (120).—Fig. 126,1. *N. uniseriatus* SEILACHER, L.Jur. (Lias a); X0.9 (120).

**Nereites**

MACLEAY, 1839 [non EMMONS, 1846] [*N. cambrensis*; SD HÄNTZSCHEL, herein].—Fig. 126,4. *O. antiqua*, Coconino Ss.; track of Recent isopod, X0.5 (52).—Fig. 126,4. O. radiata FORBES, Ire.; X1.3 (123).—Fig. 126,5. O. filiformis FORBES, Ire.; X1.3 (123).

**Oncomorphus**


**Oniscicithus**

BRADY, 1949 ["Isopodichnus filiformis" BRADY, 1947] [=Isopodichnus filiformis BRADY, 1947 (non BORNEMANN, 1889)]. Trail with low, sinuous median ridge and forward-pointing bract-like 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.; X0.5 (52).—Fig. 127,5. *Oniscus* sp.; track of Recent isopod, X0.5 (52).

**Ophiomorpha**

LUNDGREN, 1891 [non SEELIGETI, 1905] [*O. nodoa*] [=Ophiomorpha NILSON,
1836 (nom. nud.); *Cylindrites spongoides* 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).


*Trace Fossils*
Palaeophycus Hall, 1847 [*P. tubularis; SD Wil- 
son, 1948]: [=?Palaeospengia d’Orbigny, 1849 
(parim)]. Foralites Rouault, 1850; ?Aulacophy 
cus Massalongo, 1859; ?Aulacophycus Eichwald, 
1860; Spongilopsis Geinitz, 1862; ?Scolopites 
Salter, 1875; ?Aulacophycus Heer, 1877; Pale- 
ophycus James, 1877; ?Scoyenia White, 1929).

Fillings of cylindrical or subcylindrical horizontal 
galleries, branched and irregularly winding (46).
Paleos-Mesos, Eu.-N.Am.

Palaeosmecostoma Roeger, 1925 [*Medusina gery- 
onoides von Huenne, 1901 (=Medusa gorgonoides 
G. Wagner, 1932). (See Treatise, p. F76, Fig. 
61.2.) Very probably not belonging to the Trachy- 
linida; according to Fuchs (1901) and Seilacher 
(41) a feeding burrow resembling Gymphyllides 

Paleodictyon Meneghini, 1850 [*P. strozii 
[=Palaeodictyon, Palaeodictyum auct. 
(Heer, 1877)]; Scyphia maxima Eichwald, 
?1846; Reticulopora buszoni, R. villae, R. 
quadra, R. briantae Stoppani, 1857; Gleno- 
dictyum von der Marck, 1863; Cephalidynt 
maxim Eichwald, 1865; Pareodictyon Mayer, 1878; 
Palaeodyction D’Stefani, 1879; Reticofuscus Keep- 
ing, 1882; Retiphycus Ulrich, 1904). Honey- 
comb-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 au-
 thors as organic, by others as inorganic; accord-
ing to Seilacher (40), these structures represent 
feeding trails.] Ord.-Tert., Eu.-Asia-N.Am.— 
Fig. 128.5. P. regulare SACCO, L.Terr.(Flysch), 
Italy; X *0.4 (Seilacher, n).

Paleohelcura Gilmore, 1926 [*P. tridactyla]. Two 
parallel rows of tracks with drag of caudal ap-
 pendage 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, X *0.5; 4b, diagram of trackway, X *0.3 
(11).

Paleomcanon Peruzzi, 1881 [*P. rube; SD 
Andrews, 1955]. [=Palaeomcanon 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. rube, Italy; ca. X *2 (105).—Fig. 127.4. 
P. elegans Peruzzi, Italy; ca. X *0.5 (105).

Palmichnium Rudolf Richter, 1954 [*P. palma-
tum]. 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; X *0.25 (111).

Parinaass Hundt, 1941 [*P. pennaeformis] [nom. 

Pelecyphichnus Seilacher, 1953 [*P. amygdalo-
oides] [=?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. amygdalooides, M. 
Jur.(Dugger β, Donzdorfer Σ.), Ger.; (shown 
with Asteriacites quinquefolius (Quinstedt), 
X *0.75 (39).

Pennatulites de Stefani, 1885 [*P. longetipicata] 
[=Palaeopsectron de Stefani, 1885; Virgularia 
prelbytes Bayer, 1955 (Tert. forms only)]. Thick 
cylindrical stalk, followed by a club- or ear-shaped 
part consisting of biseriately arranged overlapping 
“sawed” leaves divided by deep median furrow 
(10). [According to Seilacher (40, 41), a feed-
ing burrow.] Cret.-L.Tert.(Flysch); Eu.-W.Indies 
(Trinidad).—Fig. 127.1. *P. longetipicata, U. 
Cret., Italy; 1a, X *0.5; 1b, model, X *0.2 (1a, 125; 
1b, 41).

Permichnium Guthörl, 1934 [*P. volckeri]. Two 
parallel, equal, and equidistant rows of V-shaped 
impresions, open to exterior; indicative of equal 
walking feet with 2 claws each; similar to Biur-
culopora Hitchcock, 1858 (16). [Running trail 
of insect (?blattoid)].] L.Perm.(Rotl.), Ger.— 
Fig. 130.3. *P. voelckeri: holotype, X *1.4 (78).

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

Pholeus Fiege, 1944 [*P. abomasiformis]. Large 
compactly cylindrical dwelling burrows; longitu-
dinal 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. abomasiformis, X *0.4 (68).

Phycodes Richter, 1850 [non Guenee, 1852; nec 
Milne-Edwards, 1869] [*P. cirratinum] [=Li-
crophyces Billings, 1865; Vexillum rossiae 
Saporta, 1884; Lycophycites 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 Arthrophyces.] 
L. Cam., Pak.; Ord., Eu.-Am.-AsiaM.—Fig. 128 
1b-c. *P. cirratinum: 1b, model, L.Ord., Ger.; 
X *0.3 (41); 1c, Ord., Galena F., USA(Minn.); 
X *0.7 (97).—Fig. 128.1a. P. cf. palma-
tum (HALL), L.Cam., Pak.; model, X *0.7 (41).

Physocipher Fischer-Ooster, 1858 [*P. incertum] 
[=Palaeodictyon Heer, 1865 (non Meneghini,
Fig. 130. Trace fossils (p. W208, W210, W212).
Phyllodocites Geinitz, 1867 [*Crossopteryx 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.


Phytopsis Hall, 1847 [non Townsend, 1915] [*Fucusoides demissus Emmons, 1842]. Inoculating straight or flexible tubes, nearly circular in section (about 1 cm. in diam.), with diverging and anastomosing branches; pseudonym "birdseye" (2). [Burrows, according to Raymond (1931).] Ord., Eng.; M.Dev., Ger.—Fig. 130.2. *P. dichotoma, U.Ord.(L. Bala beds), Scot.; 2a, 2b, ×1 (Brighton, n).
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.Car., Perm., Asia(Pak.); L.Dev., ?Jur., Ger.—Fig. 131.2. *R. socialis,

Fig. 131. Trace fossils (p. W210-W212, W215).
L.Dev. (L.Taunus quartzite), Ger.; 2a, opening, X0.5; 2b, upper end of dwelling burrow with opening, X0.5 (62).

Rouaulita detromelin, 1877 [non Bellardi, 1878] [*Praena 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.; X0.7 (63).—Fig. 130, 5. R. rouaulti (Lebesconte), L.Ord.(Arenig.), Fr.; X0.75 (92).

Rusophycus Hall, 1852 [*R. bilobatus*] [=Rhy sop/ycus Eichwald, 1860; Rusichnites Dawson, 1864; Rysophy cus detromelin & Lebesconte, 1876; Rysophy cus Schimper, 1879; Rhizophy cus Penneac, 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-
Trace Fossils

ing trail made by trilobites; see also Isopodichnus Bornemann, 1889. I Paleoz., Eu.-N.Am.-N.Afr.-Asia (Pak.).—Fig. 131.3. *R. bilobatus (Vanuxem), L.Cam., Pak.; ×0.5; 5b, ×1 (41).—Fig. 131.5.

Sabellarifex Rudolf Richter, 1921 [*S. efliani] (= Skolithos HaldeMan, 1840; Sabellarites

Fig. 134. Trace fossils (p. W215-W216).
Richter, 1920 (non Dawson, 1890). Like Skolithos, but individual tubes less straight and not as crowded (23). Cam.-L.Dev., Get.-Swe.-N.Am.--Fig. 132, 1. *S. eiffeniensis, L.Dev., Get.; 1a, ×0.65; 1b, ×0.6 (111).

Sabellariites Dawson, 1890 [non Rudolf Richter, 1920] (*S. trentonensis, prisca, *S. Missouriensis, prisca). Leipzig). The section of this work dealing with the heberti, *S. gracilis, abraptus. *S. alternans; *S. trentonensis...

Scalarituba Well, 1899
Scolicia de Quatrefages, 1849
Saportia Squinabol, 1891
Sagittichnus Seilacher, 1953 (Anticosti).--Fig. 131, J. *S. abruptus, English Head F.; ×0.14 (131).

Sagittarius Hitchcock, 1865 [jr. hom.; non Vosmer, 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; interestingly oriented rheotactically (39). [Producer unknown, belonging to epipsammonts.] U. Trias., Ger.--Fig. 133, J. *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, Flisch; ×0.3 (124).

Sclarituba Weller, 1899 (*S. missourienensis). 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, A. *S. missourienensis, Kinderhook; ×0.8 (Häntzschel, n).

Sclicia de Quatrefages, 1849 (*S. priscia). 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; Nerioerispula Stoppani, 1857; Pramamichites Torell, 1870; CymADERMA Duns, 1877; Phylochorda Schimper, 1879; Bolonia Meunier, 1886; Tetraichnites de Stefani, 1895; Curviscolithus Freisch., 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. priscia, Loc. (Fletsch), Aus., Italy; 4a, ×0.3 (1); 4b, 4c, models, ×0.4 (41); 4a, 4b = upper side form = Palaeobullia Götzinger & Becker; 4c = lower side form = Subphylochorda Götzinger & Becker.)--Fig. 135, 3. Olivellites plummeri Fenton & Fenton, Penn. (Cisco), Tex.; ×0.6 (Buc., Econ., Goe., Austin).--Fig. 132, 3. Pramamichites gigas (Torell), L. Cam., S. Swe.; ×0.7 (129).

Scotenia 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 leaf-like 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, A. *S. heberti, L. Lias.; ×0.35 (Laugier, n).

Skolithos Halde, 1840 [*Fucoides ?linearis] [=Tubulites Rogers, 1838 (nom. nud.) (non Gesner, 1758); Skolithus Hall, 1847 (and most later authors dealing with this "genus"); Scoleco­ lithus Römer, 1848; Scolocithus Goepert, 1852; Scoleiter Salter, 1857; ?Haughtonia Gian­ na, 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 phoronsids, Cam.-Ord., Eu.-Am.-Greenl.-Tasm.--Fig. 134, 4. *S. linearis, L. Cam.; 4a, Swe. (Öland), ×0.6; 4b, Swe.; ×0.5 (136).


Spireidosmos 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 Spirophus (16). L. Carbo, Ger.--Fig. 134, 5. *S. interruptus, Culn; ×0.17 (48).--Fig. 134, 6. S. archimedus Huckriede, Culn; ×0.2 (86).

Spirophus Hänzschel, nom. nov. [pro Cero­ phus Schimper, 1879] (non Fischer de Walb...
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. X0.3; 1b, Aus., ca. X0.4 (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; X0.7 (44); 3b, Flysch, Aus.; ca. X0.3 (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.; X0.5 (134).

Spongeliomorpha de Saporta, 1887 [*S. iberica] [=Spongiliomorpha Darder, 1945 (errore)].

Fig. 135. Trace fossils (p. W215, W218).
Trace Fossils

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. E36); burrows according to Reiss (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. W218-W220).
Steigerwaldichnium Kuhn, 1937 [*S. heimi]. Straight, rarely curved tunnel traces parallel to bedding with distinct longitudinal rows of tiny projections and impressions from doubtful para-podia (16). [Made by a polychaete.] U.Triás., Ger.—Fig. 135.2. *S. heimi, M.Keuper; ca. ×1.5 (90).

Stellacolites Etheridge, 1876 [*S. radiatus]. Radiate or stellate dislike 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] [=Strip-sellus 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.(Tapes)., Ariz.; ×1 (85).

Syringomorpha Natherst, 1886 [*Cordaites? nilsoni Torell, 1868; SD Natherst, 1886]. Roller-like 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. nilsonii (Torell); 1a, 1b, ×1 (111).

Taenidium Heer, 1877 [*T. serpen tinum]; SD HantzscHEL, herein] [=Münsteria Sternberg, 1833 (partim); Caulinites catuli Massalongo, 1858; Eione Tate, 1859 (non Rafinesque, 1814; nec Risso, 1826); ?Volubilites von Liburnau, 1901; Pseudocirrus Anelli, 1935 (non Geinitz, 1846); Notaculites Kobayashi, 1945; Scelecorcorpus Brady, 1947; Tegbagacites Mathieu, 1949; ?Rhizocorallites Müller, 1955; Toenidium Lessertisseur, 1955 (errore)]. Cylindrical tunnel fillings with segmentation reminiscent of Orthocerat; 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.-Antarc.—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 HantzscHEL, herein]. Meandering bilobate trails, similar to Scicilia de Quatrefages (41), but in tightly coiled spirals or meanders (2). Tert., Eu.—Fig. 136.3. *T. auricularis, Flisch, Italy; ×0.2 (41).

Tasmanidea Chapman, 1929 [*T. twelvetreesii]. Double row of very sharp transverse impressions, 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 tracks.] Cam., Austr. (Tas.).—Fig. 136.4. *T. twelvetreesii; 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. conjectus]. Track-way of numerous narrow, somewhat rarely bifurcated impressions, arranged in oblique, asymmetrical sets (23). [Probably individual variation of trilobite track. ] Ord., USA(Ohio).

Thalassinoides Ehrenberg, 1844 [*T. cal lianassae] [=Spongiae tus saxonicus Geinitz, 1842 (nom. nud.)]; Cylindrites spongoides Goepfert, 1841 (nom. nud.); ?Achenconia Dettmer, 1915; Vomacispongites de Laubenfels, 1955]. Branched burrows and tunnel systems, forking 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 HantzscHEL, herein] [=Foralites Rouault, 1850; Monocration Torell, 1870; Lepocration Stehman, 1934; non Tigillites habichi Lissi on, 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] [=Tisoa 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].
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, T. problematicum, Herscheid slates, Ger.; X2.5 (111).

Trachomatichnus MILLER, 1880 [*T. numerosus; SD HANTZSCHEL, 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).


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 Bifurculipes HITCHCOCK (11). Perm., USA (Ariz.).—Fig. 136,5. *T. niningeri, Coconino Ss.; X.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 MAGDEFRAU, 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 HANTZSCHEL, herein]
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.]

Zonarites Sternberg, 1833 [jr. hom., non Zonarides Rafinesque, 1831] [*Fucoides flabellaris Brongniart, 1823; SD Andrews, 1955*] [Probably=Zonarides striatus Squinabol, 1887 (Saportia Squinabol, 1891), as well as plants (e.g., Z. digitatius Sternberg, 1833, =Zonarides Schimper, 1869)]. "Genus" comprising starlike trace fossils (e.g., Z. alicornis Fischer-Ooster, 1858) (2). [According to Seilacher (1955) branched feeding burrows with faecal pellets stuffed transversely to them.]

Zoophycos Massalongo, 1855 [*Fucoides brianteus, Villa, 1844*] [=Umbellularia longimana Fischer de Waldheim, 1811; Chondrites scoparius Thiollière, 1858; Taonurus Fischer-Ooster, 1858; Spirohyton Hall, 1863; ?Sagminaria Trautschold, 1867; Alectorurus, Phytophyton, Zoophyton Schimper, 1869; Cancellophyton Squinabol, 1873; Glossophycus Squinabol, 1890; ?Flabellophycus Squinabol, 1890; ?Myelophycus Ulrich, 1904; Physiophycus Fritsch, 1925; Zoophycos Wasootjeswitsch, 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 Risocorallium); Spreite comprise thin slab of varied outline, in part screw-shaped (23). [Perhaps made by worms; all forms are feeding burrows.]

Doubtfully Distinguished Trace Fossils

Algitae 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 Hitchcock, 1850 [non Hitchcock, 1869]. Suggested as "new order" including all sorts of "footless" tracks (e.g., Helminthoidichnites Hitchcock, 1850).

Coprolithes 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. (Swa.-Asi.A.M. Turku).

Coprulites 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.]

Helminhites Saltier, 1857 [=Helmintholithes 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 Paret, 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 channels 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 underside of sandstone beds of Flysch and similar sediments; greatest diameter several centimeters; Rhabdoglyphus used by Wassojevitsch.
(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). [Dubiously 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*; ×0.04 (128).


Bactryllum 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).

Bovicorncillum 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 fusid, 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. GLAESNER, 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 coelenterate of unknown affinities, and by GLAESNER (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*]. Disc-like 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 "algæ" Charnia, and by GLAESNER (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. graptolithophilus*]. 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. graptolithophilus*, 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*] [=Conostichus 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; X0.3 (69).---Fig. 116,3. C. sp., Ohio; X0.3 (69).

Corycium Sederholm, 1911 [*C. enigmaticum*] (=Corycinium C. L. Fenton, 1946). Sacklike structures with carbonateous 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); carbonateous material proved by isotope investigation to be of organic origin.] Precam., Fin.---Fig. 139,10. *C. enigmaticum;* 10a, X0.2; 10b, vert. sec., X0.7 (10a, Geol. Survey Finland; 10b, 119).

Curculionites Kolbe, 1888 [ir. hom.; *non Heer, 1847; nec Giebel, 1856* [*C. senonius*] (=Curculidium Handlirsch, 1907). Name proposed for burrow of curculionid, presumably in wood; recognized by W. Quenstedt (1932) as belonging to Doratotethys syriaca Woodward (16). U. Cret.(Senon.), AsiaM. (Syria).

Emmonsitis Resser & Howell, 1938 [*Phyllograpthus cambriensis* 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).

Endosaccus Vogt, 1959 [*E. molktiae*]. Globular, gall-like swellings in internodes of octocoral Molitka minuta Nielsen; diameter about 5 mm.; with narrow ventral slitlike opening, length 2.5 mm.; interior of "cyst" smooth (16). [Possibly made by barnacles (Ascothoracida).] U.Cret. (Camp.-U.Maasr.), NetherL.-Swed.---Fig. 139,8. *E. molktiae*, Maastricht., Neth.; 8a, cyst with somewhat damaged opening; 8b, cyst opened, showing the thin walls; both X3 (132).

Favreina Brönning, 1955 [*F. joukowski*] (="Organisme B" Joukowski & Favre, 1913; Coprolithus taluensis 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 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; X30 (66).

Leckwyckia Termer & Termier, 1951 [*L. aenigmatica*]. Smooth, sharply pointed, acutely conical tube; upper end widening regularly and showing transverse units separated by constriction (16). Ord., Morocco.---Fig. 139,4. *L. aenigmatica;* X0.9 (128).

Lenaelia 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 (?hydrozoa).] L.Cam., USSR (Sib.).

Lombardia Brönning, 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 Brönning (1955) as sections of microscopic symmetrical holothurian remains or microscopic planktonic crinoids or ophiuroids.] U.Jur., Eu.(Fr.-Switz.)-W.Indies(Cuba).---Fig. 139,J. *L. arachnoidea*, Portland., Cuba, 1a, 1b, X62 (54).---Fig. 139, 2. L. perplexa Brönning, Portland., Cuba; X62 (54).---Fig. 139,3. L. angulata Brönning, Portland., Cuba; X62 (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.).

**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 coloni de Lapparent*, 1931; SD Brönnimann, 1955]. Micro-

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Fig. 140. Body fossils (p. W226, W228).
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). [2 Skeletal remains of planktonic Protopora (Treatise, p. D170-171), J. Mar. L. Cret., S. Eul.-N.Afr.-Carib. — Fig. 139.5. N. steinmanni KAMPF Ney, U. Tithon, Italy; 5a, schem. drawing of "cone," long. sec., X 1333; 5b, transv. sec., X 2000; 5c, single "cone," long. sec.; X 1250 (87).

Orthognathus Gürich, 1930 [*O. parallellum]. Problematical body fossil consisting of several articulated rows suggestive of crinoid arm; width of a row 3 or 4 mm., length about 6 cm.; spongelike body similar to dictyospongiids (16). ?Precam.-?L. Paleoz. (Nama F., Kuibis Quartzite), S. Afr.—Fig. 140.2. *O. parallellum, L. Paleoz. (Nama F., Kuibis Quartzite); X 0.4 (77).

Palaeobalanus von Seebach, 1876 [nom. nud.] [*P. schmidtii]. Name given for little bodies found on Lima, recognized by Pohlig (1888) as Discina, which allegedly occupied the opening of little bore holes (16). M. Trias. (Muschelkalk), Ger.

Palaxius Brönnimann & Norton, 1960 [*P. habanensis]. Coprolites of oval to sub-rectangular or subcircular 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.


Parvarcorina 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, X 1.2; 3b, X 1.7 (74).

Porocythis Cracin, 1893 [*Siphonia globularis Giebel, 1853 (=Aracaritae wardi Hill, 1893)]. Spheroids, generally prolute, 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 Aracaritae, by Cracin (1893) as cheilostomatous byrozoan, by Rauff (1895) as calcareous alga, and by Jarvis (1905) as gigantic monothalamian foraminifer.] L. Cret., USA (Tex.). — Fig. 141.1. P. pruniformis Cracin, L. Alb. (large specimens)-M. Alb. (small specimens); la-d, X 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, X 0.8; 5b, X 0.7 (111).

Rangea Gürich, 1930 [*R. schneiderihoehmi]. 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. schneiderihoehmi, L. Paleoz. (Kuibis Quartzite), S. Afr.; holotype, X 0.7 (111).

Rectoglooma 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, X 1.2 (Am. Mus. Nat. Hist.).

Stromatolite Kalkowsky, 1918 [= Coenoplate 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., Anomalophybus Fenton & Fenton, 1937; Aphrostroma Gürich, 1906; Archaeozoon Matthew, 1890; Chondrostoma Gürich, 1906; Codonophybus Fenton & Fenton, 1939; Collenia Walcott, 1914; Cryptozoan Hall, 1884; Conophyton Maslov, 1937; Dolphycus Fenton & Fenton, 1937; Gouldina Johnson, 1940; Gymnosolen Steinmann, 1911; Malacostroma Gürich, 1906; Osagia Twenhofel, 1919 (only pisoids or ooids?) Ottoniaia Twenhofel, 1919; Pycnostroma Gürich, 1906; Spongiosotoma Gürich, 1906; Stylophybus Johnson, 1940; Tetophycus Fenton & Fenton, 1939; Weedia Walcott,
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.

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 MAGDEFRAU (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 ctenostomes 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; length 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. 142,7. *A. riccioides, Oligo., Ger.; (in fish scale), X110 (26).

Anobichythum 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, X0.7 (94).

Brachyzaephes Codez, 1957 [*B. elliptica]. Borings of barnacles; short and broad; cross section elliptical; depth half the length; observed in belemnoids and pelecypods (16). U.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 Belemninitella, X8 (26).—Fig. 142,5. C. breviramosa MÄGDEFRAU; in Actinocamax, X8 (26).

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

Caulostrepis Clarke, 1908 [*C. taeniola] [=Polydorites DOUVILLE, 1908 (according to BATHER, 1910, not intended as an independent generic name)]. U-shaped boring tunnels with constructed Spreite, corresponding to a tiny Rhisocorallium; up to 2 cm. long and 5 mm. wide; mostly in shells of brachiopods, mollusks, and echinoids (23). L.Dev., Ger.; U.Trias.—Fig. 142,3. *C. taeniola; L.Dev., Ger.; in shell of Strophopoda, X0.75 (58).

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

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W230  

Miscellanea—Trace Fossils and Problematica

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. belemnito­lica Magdefrau, U.Cret., Ger.; in Belemnitella, X5 (26).

Dicytoperus Magdefrau, 1937 [non Houlbert, 1934] [*D. nodosus*]. Borings in rostra of belemnoids; without exterior aperture; distinctly net-like; width of canals about 0.07 mm. (26).

Dictyoporus Magdefrau, 1937 [non Houlbert, 1934] [*D. nodosus*]. Borings in rostra of belemnoids; without exterior aperture; distinctly net-like; width of canals about 0.07 mm. (26).

Entobia Bronn, 1838 [*E. cretacea Fortlock, 1843; SD Hantzschel, herein*]. Borings consisting of small cavities connected by processes nearly hair-thin; occurring in belemnoids and in shells of pelecypods, particularly Inoceramus; similar forms also in trilobites (16). [Possibly made by boring sponges?]

Mycelites Roux, 1887 [*M. mossifragus*]. 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?]

Nygmites Magdefrau, 1937 [*Talpina solitaria von Hagenow, 1840; SD Hantzschel, herein*] [*Talpina von Hagenow, 1840 (partim)*]. Simple, un­branched tunnels in rostra of belemnoids; oblique to surface; leading from outside inward (26).

Palaeacarya Duncans, 1870 [*C. perforans*]. Small tubes of parasitic algae in fossils; diameter 0.008 inch; 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, X10 (108).

Clionos Fenton & Fenton, 1932 (see Treatise, p. E40).

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.]

Conchostraca Optimalis, 1908 [*C. radicans*; SD Fenton & Fenton, 1932] [*Pyriionema? 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. E40) (16). Ord., Czech.; Dev.-Carb., Ger.-USA-China.—Fig. 142.6. *C. radians*, U.Dev. (Cheumug Ss.), USA; in Atrypa shell, X6 (58).

Palaechyda Selie, 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.).

Palaescabella Clarke, 1908. (See Treatise, p. E41.)

Paleobuprestis Walker, 1938 [*P. maxima*; SD Hantzschel, 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 Hantzschel, herein]. Tunnels and burrows pene-

Fig. 143. Borings (p. W231).
tating 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 Scolytidae (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, J. *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 Hantzschel, 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

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**Fig. 144. Borings (p. W228-W232).**
"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). *Triass.*, *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.

Archaeophytum 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 Billing, 1872 [*A. terranotica*]. Small, ovate, narrow ringlike border; having general aspect of small *Patella* flattened by pressure (37). [Regarded by Mathieu (1898) as slickensided mud concretion striated by pressure; somewhat similar to *Guiulielmites Grinditz*.] *Precam.*, Can. (Newf.).—*Fig. 145,3.* *A. terranovica*, Etchegoin 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. E20, E33 and E103). *Precam.*, Can.

Batrachoides Hitchcock, 1858 [j. hom.; *non Lacinghe*] 1800] [*B. nidificans*] (==Batrachioideis Weigelt, 1927; Batrachoides 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 Kindl (1914) as interference ripples.] *Sil.*, USA (N.Y.); *Trias.*, *USA* (Mass.).—*Fig. 145,10. *B. nidificans*, U. *Trias.* (New Red Ss.), Mass.; *X* 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 Hitchcock, 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., *X* 0.4 (45).

Chloephycus Miller & Dyer, 1878 [*C. pluomorum*]. Kill marks (8), according to Seilacher (personal communication, 1955), drag marks (19). *Ord.*, USA (Ohio).

Chuaria Walcott, 1899 [*C. circularis*]. Dislike bodies resembling compressed conical shells of discinoid or patellloid 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 Brotnen (1941) has been variously regarded as trilobite eggs (Wiman, 1894); chitinous foraminifers (Brotnen); and hystrichospheraids (Eisenack, 1951). May be inorganic.] Precam., USA-USSR-Swed. — Fig. 145.5. *C. circularis, Algonk., Az.; 5a, 5b, X12 (134).

Copperia Walcott, 1914 [*C. tubiformis] (=Cooperia Choubert, Termier & Termier,

Fig. 145. "Fossils" of inorganic origin (p. W232-W234, W236).
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.)-TN.Afr.—Fig. 145,8. *C. tubiformis, Belt Ser. (Newland Ls.), Mont.; surface of group of tubes formed in horizon position, X0.7 (45).


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


Dendrophyclus Lesquereux, 1884 [*D. desorii]. Branched rill marks?, described as algae (2).—Fig. 145,4. D. triassicus Newberry, U.Trias., Conn.; ?ca. X0.2 (101).

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

Dinococclea 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.

Eocladathrus Squinabol, 1887 [*E. jenestriatus]. 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.; X0.3 (6).

Eophyton Torrell, 1868 [*E. linneanum] [=Rab dichnites Dawson, 1873 (partim); Taonichnites Matthew, 1890 (partim); Meduschnites, Eochonetes, Cienmethnites Matthew, 1891; Aspidaria VLck, 1902 (non Prell, 1838)]. Straight, parallel or curved drag markings on bedding planes; produced by organisms or comprising inorganic objects (2, 46). Cam.-Rec., cosmom.—Fig. 147, 1. E. sp., Cam.(Mickwitzia Ss.), Sweden; X0.3 Regnell; n, Paleont. Coll., Paleont. Inst. Lund).


Eospicula de laubenfels, 1955 [*E. cayeuixi]. 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.


Gallatina Walcott, 1914 [*G. pertensa]. Septarian concretions (Raymond, 1935) (30, 45). Precam., USA(Mont.).—Fig. 146,4. *G. pertensa, Belt Ser. (Newland Ls.); upper surface, X0.3 (45).


Gotheanella Fucini, 1936 [*G. sphenophyloides]. 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 PA (1937) as probably inorganic.] ?L.Perm., Tria., Italy.—Fig. 147,4. *G. sphenophyloides, ?U.Trias.(Verrucano); X2 (71).

Grimmicnus Hitchcock, 1865 [*G. alpha]. [According to Brown (4) and Lull (25), probably roll or drag markings (18).] Tria., USA(Mass.).

Greysonia Walcott, 1914 [*G. basaltica]. Shrinking cracks (Raymond, 1935) or results of segregation of CaCOs 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 X0.7 (45).

Guillelmities Geinitz, 1858 [=Calvaia sp. Sternberg, 1820; Carpolites umbonatus Sternberg, 1825; Cardiocarpus umbonatum Bronn, 1837; Carpolites cipelloformis Geinitz, 1856; ?Gautia Chachelof, 1934 (partim); ?Gautia Neuburg, 1934; Verrucania Fucini, 1936]. Ellipsoidal bodies, 1 or 2 cm. in diameter; originally thought to be seeds; most authors (Carruthers, Schenk, Pononie, Gothan) consider them to be inorganic origin (concretions or similar diagenetic structures); Provost (1930) interpreted them as burrows of lamellibranchs (2, 23). Carb.-Perm., ?Jur., Eu.-Am.-Asia.—Fig. 147,2. G. umbonatus (Sternberg) L.Perms., Ger.; 2a, 2b, X1 (72).

Halichondrites graphiteformus Matthew, 1890. Long, thin spicules in graphic shales and graphite lenses (37). [Interpreted as remains of sponges; recognized by Rauff (1893) as inorganic (??sys-
tems 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. W234, W236).
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; S.I., N.Afr.—Fig. 146,3. *K. simulans*, Precam. Belt. Ser., (Newland Ls.), Mont.; upper surface, x>0.7 (45).

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

Lithodictyon CONRAD, 1837 [*L. beckii*]. Very probably mud cracks (2). S.I., USA (N.Y.).

Manchuriophysycus ENDO, 1933 [*M. yamamotoi*]. Mud cracks, in part in normal form of polygons (*M. sawadai*) 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 HANTZSCHEL (1949) as inorganic.] Precam.-Trias., Eu.-Asia-Can.-Green.—Fig. 146.1. *M. sawadai Yabe, Precam., Asia; X>0.4 (141).


Neantia LEBESCONTE, 1886. Wrinkle-like structures *Neantia LEBESCONTE, 1886*. Wrinkle-like structures [Similarly resemble rill marks and other marks (42, 46). [Certainly not sponges, as LEBESCONTE thought.] Precam., Fr.—Fig. 145.7. *N. rhedonensis LEBESCONTE; ca. X>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, X>0.5 (45).

Osagia TWENHOEFEL, 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 TWENHOEFEL as algal *“cono-planes” of small size*; according to SCHINDEWOLF (37) perhaps only simple ooids or pisoliths.] Penn., USA (Kans.-Okla.).

Palaenotrichis 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) spherite of an acidic magmatic rock. Precam., USA (N.Ca.)—Fig. 145.1. P. minor; 1a-c, mag. unknown (137).—Fig. 145.2. P. major; 2a-c, mag. unknown (137).

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

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

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

Phyltycaux 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.

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

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

Reynella DAVID, 1928 [*R. howchinii*]. Problematical small fragments of exceedingly irregular shape (16). [Erroneously explained by DAVID as belonging to the crustaceans; according to GLAESNER (1959), possibly formed by pyritized soft plant tissue. Very similar forms described by Huve (1952) from the Precambrian of Morocco as inorganic (mud flakes or flattened clay pellets).] Precam. (Brighton Li., Sturtian), S.Austral.

Rivularites FLICHE, 1905 [*R. repertus*]. Explained by FLICHE and D. WHITE (1929) as algal colonies (?Cyanophyceae). American *“species,” R. permieni­si 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. permienisi WHITE, Perm., (Hermits Sh.), Ariz., X>0.4 (138).


Sewardiella FUCINI, 1936 [*S. verrucana*] [=Bairopsis 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. X>0.7 (71).*

Sickleria MULLER, 1846 [*S. labyrinthisformis*]. Shrinkage cracks in sandstone; originally regarded as plants (16). Trias., Ger.
Inorganic “Fossils”

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 Ema (1953), more probably group of ripple marks partly removed by erosion (37). Precam., Greenl.


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

Tazenakhia Choubert, Termier & Termier, 1951 [*T. aenigmatica]. “Organisms” observed in thin sections of limestones, interpreted as calcareous algae; 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. taghoutensis]. “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 Gistel, 1834; nec Lockington, 1876] [*A. dodecimanus*] (16). L.Tert., USSR.

Aequor fossa Neviani, 1925. See Treatise, p. 1519.


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


Ampelichnus Hitchcock, 1865 [*Grammepus unordinatus Hitchcock, 1858*] (18). Trias., USA (Mass.).


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


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, X 7; 2b, portion of jointed appendage, X 3; 2c, unidentified fragment with terminal curved spine, X 4; 2d, appendage with two large basal joints and two smaller terminal joints, X 2 (134).

Bipezia MATTHEW, 1910 (1909)*B. bilobata* [=Bipedia Matthew, 1910 (error)]. 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 GLAESNER (1957), possibly synonymous with Isopodichnus Bornemann, 1889.] Rev., 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.


Bucinella Fucini, 1936 [*B. verrucana*] (16). ?L. Perm.(Verrucano), Italy.
Unrecognizable "Genera"  

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, I. *C. jatulicum*; cross sec., X1.1 (Geol. Survey Finland).


Chordophyllites Tate, 1876 [or Young & Bird]
Carelozoa

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

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


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 wave and somewhat rotary 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 fusorian Follculina), 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 (=Bushothrophis? 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.).


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

Discophycus Walcott, 1883 [*D. typicus]. Dishaped, slightly convex bodies; diameter 4 to 12 cm.; outline varying from circular to orbicular, sub-

stance ?coriaceous (2). [Interpreted by James (19) as inorganic (fossil mud bubbles); by Rudemann (1925) as fossils of very diverse kinds (seaweeds, sponges, eurypterids).] Ord., N.Am.


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

Dystactophycus Miller & Dyer, 1878 [*D. mammilatum]. According to James (19), impression of coral base that left its mark in concentric rings. Ord., USA (Ohio).

Eoeladophora Fucini, 1936 [*E. fibrata]. Long, narrow, threadlike pads or ridges (16). ?L.Perms. (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 Ópik (1959) perhaps "only a Rusophycus" (p. W212); see also Treatise, p. O102 (16). M.Cam., Manchur.

Fernoria Chapman, 1935 [*F. minima] [=Proto­bolella Chapman, 1935]. Small disc-shaped carbonaceous structures, 2 to 4 mm in diameter, concentrically wrinkled (37). [Interpreted as ?atebrate 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).

Fruticistatum Webster, 1920 [*F. iowense; SD Andrews, 1955]. Never figured; first described as algae (2). [Obviously represents fillings of non-descript burrows.] Dev., USA (Iowa).


Gleichenophybus Massalongo, ?date [*G. graneous (=Caulerpa lehmanni Heer, 1877)] (16). Cret., Italy-Switz.


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

Granifer Fritsch, 1908 [*G. stilatus] (9). Ord., Czech.

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

Harpagopus Hitchcock, 1848 [*H. dubius; SD Hantschel herein]. Obliquely placed elliptical impressions (25). ?M.Dev., USA (N.Y.); Trias., USA (Mass.).
Helvien sia de Lima, 1895 [*H. delgadoi*] (16). Cam., Port.

Hippodophycus Hall & Whitfield, 1872 [*H. cowlesii*]. 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 organic (2). U.Dev., USA (N.Y.).

Hoplicnthus 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.-Triss., N.Am.-?Eng.-?Ger.

Hormosiroidea Schaffer, 1928 [*H. florentina*] [=?Corallinites rosarium Massalongo, 1851; *C. tunda 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 unrecognizable form. *Cret.*-L.Tert. (Flisch). Eu.—Fig. 148, 5. *H. florentina*, U.Cret., Italy; >X 0.7 (Naturhistor. Mus. Wien).

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


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

Iheria de Saporeta, 1872 (16). [Explained as belonging to the *Fermoriidae Sahni (16). Precam. or Cam.? (Vindhyan F.)], India.

Laminarites Sternberg, 1833 [*Pleucoconites 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, 1847*), in part certainly ripples or flow casts (e.g., *L. langrangei de Saporeta & 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.

Leptodarncus Frisch, 1908 [*L. fornis*] (9). *Ord.*, Czech.


Macrocystites Fucini, 1936 [*M. similis*]. Trail or inorganic (16). *L. Penn.* (Verrucano), Italy.


Micrarium Torell, 1870 [*M. erectum*]. Never figured (16). *Cam.*, Swed.

Nautes 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.


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


Nisea de Serres, 1840 [non Rafinesque, 1815 (nom. nud.)] [=Nemascina 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 Frisch, 1908 [*O. splendidus*] (9). *Ord.*, Czech.

Palaeconeris Eichwald, 1856 [non Hundt, 1940] [*P. priscus*]. 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 “Palaeconeris Sowerby”; no description given by Sowerby was to be found (16). ?Ord.*, USsr.


Phyocodium 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
glae; perhaps trace fossil (2). Cam., Can.

Platyrrhynchus Glocker, 1850 [jr. hom.; non
Leuckart, 1816; nec Swainson, 1820; nec Couvier, 1826; 
nec Wagler, 1830; nec Agassiz, 1846; nec
van Beneden, 1876; nec Chevrélat, 1882] [*P.

Portella Boursault, 1889 [jr. hom.; non de Quat-
refages, 1850] [*P. meunieri]. Nondescript, 
branchcd cylindrical fillings of tunnels; very poorly 
figured (2). U.Jur., Fr.

Ptilichnus Hitchcock, 1858. Finlike impressions, 
aranged 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. excel-
sum] (23). Penn., USA(Tex.).

Pucksia Sollas, 1895 [*P. machenryi]. Long, nar-
row, threadlike markings in slate (16). Cam., Ire.

Punctatumvestigium Butts, 1891 [*P. circuli/or-
formis]. Described as amphibian footprint, but ob-
viously of invertebrate origin (16). U.Carb., 
USA(Mo.).

Qualites Fritsch, 1908 [*Q. graptolitarum (=Q.
problematicus Fritsch, 1908)] (9). Sil., Czech.

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

Radioplys Fritsch, 1908 [*R. sphericus]. Probable inorganic (16). 
?L.Perm.(Verrucano), Italy.

Radix Fritsch, 1908 [jr. hom.; non de Montfort, 
1810] [*R. corrugatus]. In explanation of figure same fossil named 
Radiates rugosus (9). Ord., Czech.

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 ani-
imals moving by leaps; 2 "species" having little 
in common (17). Trias., USA(Mass.).

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

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

Sphaerops Hitchcock, 1858. Trackway consisting 
of 2 rows of small (diameter 3 to 5 mm.) hemi-
uplications (17). Trias., USA(Mass.).

Sphenopus Fritsch, 1908 [jr. hom.; non Steen-

Spongia paradoxa Woodward, 1833 [=Siphonia 
paradoxa, Auctt.]. "Ramifying zoophyte, re-
ssembling 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.

Spongodithus Fritsch, 1908. Very heterogeneous 
group of ridgelike and tracklike structures (9). 
Ord., Czech.

Squamularia Rothpletz, 1896 [non Gemmellaro, 
1899] [*Caulerpa cicatrixica Heer, 1877; SD 
Hantzschel, herein]. Possibly small fuscoes (2, 
23). Tert., Eu.

Staurophyton Meunier, 1891 [*S. hagnoleensis]. 
Similar to Radioplys Meunier, 1887 (16). 
[See Treatise, p. F23, Fig. 12,2.] Ord., Fr.

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

Striocycles Quenstedt, 1879. Reliefs on bedding 
planes with radial, wormlike ornament and cen-

Telemarkites Dons, 1959 [*T. enigmaticus]. Ellip-
soidal nodules; long axis parallel to bedding 
planes; 2 to 4 cm. in length; 1 to 2 cm. across; 
composed of fine-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,l.*T. enigmati-
cus, simpl. reconstr. showing internal structures, 
X1.5 (64).

Thinopas antiquus Marsh, 1896. Single "footprint" 
with 3 "toe-impressions," as described earliest 
record of a terrestrial vertebrate; according to 
Abel (1) and others, not a vertebrate foot-
print; in Abel’s opinion a "fossil" allowing of 
various explanations; possibly only a fish copro-
lite (1). U.Dev., USA(Pa.).

Trianisites Rafinesque, 1821 [*T. clifordi]. See 
Treatise, p. F159.

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

Tropidaulus Fenton & Fenton, 1937 [*T. mag-
nus] (23). Penn., USA(Tex.).

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Truncus Fritsch, 1908 [*T. ramifer] (9). Ord., Czech.
Valonites Sordelli, 1873 [*V. utriculosus] (16). Plio., Italy.
Walcottia Miller & Dyer, 1878 [*W. rugosa]. "Genus" including 3 different "species" of long, tapering, rugose, flexuous impressions of wormlike 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.

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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., X60 (2).

Furnishina MÜLLER, 1959 [*F. furnishi]. Family Distacodontidae ULRICH & BASLER, in BASLER, 1925. Unsymmetrical, with very large, triangular-pentagonal basal cavity; anterior side with broad flat area, corresponding to greatest width of fossil. U.Cam., Eu.(Swe.-N.Ger.)- N.Am.(S.Dak.-Wyo.-Utah-Nev.).——Fig. 150.2. *F. furnishi, Gallatin Ls., USA (Wyo.); 2a-c, post., lat., transv. sec., X80 (7).

Hertzina MÜLLER, 1959 [*H. americana]. Family Distacodontidae ULRICH & BASLER, in BASLER, 1925. Subsymmetrically elongated, with narrow, extremely long basal cavity, with flat area on posterior side limited laterally by carinae. U.Cam., Eu.(Swe.-N.Ger.)-N.Am.(S.Dak.-Wyo.-Utah-Nev.).——Fig. 150.3. *H. americana, Elvinia Z., USA (Nev.); 3a,b, lat., transv. sec., X80 (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. X110 (3).

Proacodus MÜLLER, 1959 [*P. obliquus]. Family Distacodontidae ULRICH & BASLER, in BASLER, 1925. Asymmetrical, with large basal cavity which is rounded anteriorly and posteriorly and bears stretched-out carina on one side. U.Cam., Eu. (Swe.-N.Ger.).——Fig. 151.2. *P. obliquus, 5d Zone, N.Ger.; 2a, ant. view with transv. secs.; 2b, post.; all X80 (7).

Scaphignathus ZIEGLER, 1960 [*S. velifera]. Family Polygnathidae ULRICH & BASLER, in BASLER, 1925. Long, narrow platform with peg-shaped or rounded lower surface, small basal cavity at anterior end; blade short and high laterally, as in Cavaugnathus. U.Dev.- Prolobites - Platyclymenia Z.), Eu.(Ger.).——Fig. 152.1. *S. velifera; 1a,b, upper and outer lat. views, X35 (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-
ably belong to the same conodont taxon (?static organ]. M.Cam.-L.Ord., Eu.(Swed.-N.Ger.)-N. Am.(S.Dak.-Wyo.).—Fig. 152. *W. bicuspidata, U.Cam. (5b Zone), N.Ger.; ca. X55 (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 Zoological 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]
CONODONT TAXA

CONSIDERED INVALID

SYNONYMS


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


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