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TREATISE ON INVERTEBRATE PALEONTOLOGY, PART W, CONODONTS, CONOIDAL SHELLS, WORMS, TRACE FOSSILS: COMMENTS AND ADDITIONS

By F. H. T. Rhodes, Walter Häntzschel, K. J. Müller, D. W. Fisher, and Curt Teichert

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EDITORIAL PREFACE

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This is the first of a series of papers which it is intended to publish from time to time, containing information supplemental to published volumes of the *Treatise on Invertebrate Paleontology*. Progress in systematic paleontology is more rapid in some areas than in others. Earlier *Treatise* parts are now in the process of being revised. However, it seems desirable to bring up-to-date information on selected fossil groups if an entire volume does not warrant complete revision. Such supplemental information will be published as it comes to hand. More massive contributions will be published as hard cover supplement volumes following *Treatise* style and format. Shorter comments and additions will be published in the Paper series of the University of Kansas Paleontological Contributions.

Part 1

COMMENTS ON CONODONTS

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[In the following text (R) designates comments by Rhodes, (M) by Müller, (T) by Teichert.]

GENERAL COMMENTS ON CLASSIFICATION

One of the striking features of Hass's classification of the conodonts is their division into a substantial number of families, many of them established in the *Treatise*. My own feeling, and I believe this to be one shared by the majority of conodont workers, is that these are of little value, and that some unite conodonts of radically different morphology within the same group. (R)

The utilitarian suprageneric classification of conodonts used in the main part is considered unpractical by most specialists. It does not reflect the natural relationships established by observation of transitional species between genera, and at the same time it is of little help for determinations. For example, the genus *Kockelella* was split off from *Spathognathodus*. According to Hass's system, *Kockelella* belongs to the Idiognathodontidae Harris & Hollingsworth, 1933, while *Spathognathodus* is placed in the Prioniodontidae Bassler, 1925. *Neoprioniodus* was put in the subfamily Neoprioniodontinae Hass, 1959 of the family Coleodontidae Branson & Mehl, 1944, while *Prioniodina*, connected with *Neoprioniodus* by intergrading species and thus closely related, is classified in the family Prioniodinidae Bassler, 1925. At present too little is known to allow establishment of a natural system of the conodonts, although the phylogeny in some of the better-known platform types has been observed. (M)

COMMENTS ON FIGURES (M)

Fig. 35A. Stratigraphic distribution of conodonts (p. *W*58). The following emendations are necessary:

Icriodus: Upper Silurian-Upper Devonian *(Platyclymenia-Stufe)*.
Polygnathus: Lower Devonian-Mississippian, ?Lowermost Triassic (Scythian).
Ancyrodella: early Upper Devonian only.
Palmatolepis: Upper Devonian (?Lower Mississippian).
Ancyrognathus: early Upper Devonian only.
Gnathodus: late Upper Devonian-Pennsylvanian.

Fig. 47. Phylomorphogenesis of *Palmatolepis* (p. *W* 88). After publication of this chart the following changes of names became effective [Helms]:

11. P. (M.) gigas (Miller & Youngquist)
14. P. (M.) delicatula clarki (Ziegler)
19-22. P. (Pand.) glabra (Ulrich & Bassler (4 subsp.)
23. P. (Pand.) glabra acuta Helms
25. P. (Pand.) glabra pectinata (Ziegler)
26. P. (Pand.) distorta distorta (Branson & Mehl)
27. P. (Pand.) distorta manca Helms
37,38. P. (D.) gracilis gracilis (Branson & Mehl)
41,47,48. P. (P.) perlobata Ulrich & Bassler (3 subsp.)
44,45. P. (P.) helmsi Ziegler
49. P. (P.) grossi Ziegler
51. P. (P.) trachytera Ziegler
52. P. (P.) rugosa postera Ziegler
54,59,60,62. P. (Panderoleplis) marginifera (Helms)
58. P. (Pand.) inflexoidea (Ziegler)
61. P. (Pand.) marginifera marginifera (Helms)

COMMENTS ON SELECTED GENERA

Ambalodus Branson & Mehl, 1933 (*p. W*58). Add in synonymy: [=*Ambolodus* Branson & Mehl, 1934 *(nom. null.)*]. (R,M)

Amorphognathus Branson & Mehl, 1933 (p. *W*48). In synonymy replace *Polyplacognathus* Stauffer, 1935, by *Balognathus* Rhodes, 1953; also replace Fig. 37,5 by Fig. 40,2. Emend description as follows: [=*Balognathus* Rhodes, 1953 (p. 284)]. Platform-like dental units consisting of radiating bars, generally up to 6 in number, which tend to be straight or gently curved and of unequal size. Oral surfaces of bars generally bearing node-like denticles, arranged in regular rows along crests; various bars do not diverge from common origin, but one pair, with individuals generally aligned, tends to be longer than others and serves to distinguish main axis. Aboral surface deeply excavated. *M.Ord.-U.Ord.*, N.Am.-Eu.——Fig. 40,2. *A. expansa* (Rhodes), Ord.(Gelligrin Ls.), Wales; *2a-c,* oral, oral, aboral, ×30 (58). (R)

Arcugnathus Cooper, 1943 (p. *W*46). Considered *nom. dub.* [?=*Hindeodella* Bassler, 1925]. (R)

BALOGNATHINAE Hass, 1959 (p. *W*62). Delete. (R)

Balognathus Rhodes, 1953 (p. *W*62). See discussion of *Amorphognathus* Branson & Mehl, 1933, herein. (R)

Belodus Pander, 1856 (p. *W*45). Lindström (1964, p. 176) has stated that the type of *Belodus* is almost cer-

tainly a *Cordylodus*. However, to me *Belodus* seems to be a valid genus and I agree with the synonymy listed for it by HASS (see also p. *W*246). The acceptance of LINDSTRÖM's taxonomy would imply that there exist no true *"Belodus"*-type conodonts. Such forms do exist in the Devonian, however (e.g., *Belodus erectus* RHODES & DINELEY). (R)

Branmehla HASS, 1959 (p. *W*46). Transfer to synonymy of *Spathognathodus* BRANSON & MEHL, 1941. (R)

Cavusgnathus HARRIS & HOLLINGSWORTH, 1933 (p. *W*62). After [**C. alta*] add [=*Idiognathoides* HARRIS & HOLLINGSWORTH, 1933]. (R)

Cervicornoides STAUFFER, 1938 (p. *W*47). Probably a junior synonym of *Angulodus* HUDDLE, 1934. The holotype needs to be restudied, however, before synonymy can be definitely established. (R)

Clavohamulus FURNISH, 1938 (p. *W*65). LINDSTRÖM (1964) regards this as a valid conodont genus. The description, according to FURNISH, is as follows: *Clavohamulus* FURNISH, 1938 (p. 326) [**C. densus*, OD]. Bulbous, pitted basal portion which is not excavated by basal cavity, joined to slender bladelike cusp. *L.Ord.-U.Dev.*, N.Am.-Eu. (R)

Cornuramia SMITH, 1907 (p. *W*63). Should be considered a *nom. dub.* (R)

Ctenopolygnathus MÜLLER & MÜLLER, 1957 (p. *W*5?). Junior synonym of *Polygnathus* HINDE, 1879. (R)

Dichognathus BRANSON & MEHL, 1933 (p. *W*56). In third line of description after "flexed inward slightly" add "and has no secondary denticles." (R)

Diplododella BASSLER, 1925 (p. *W*50). Synonym of *Hibbardella* BASSLER, 1925 (see discussion of *Hibbardella* herein). (R)

Elsonella YOUNGQUIST, 1945 (p. *W*51). To be considered *nom. dub.* until type specimen has been restudied. (R)

Eobelodina SWEET, TURCO, WARNER & WILKIE, 1959 (p. *W*248). Place in synonymy of *Belodina* ETHINGTON, 1959 (p. *W*246). (R)

Eoligonodina BRANSON, MEHL & BRANSON, 1951 (p. *W*52). Transfer to synonymy of *Ligonodina* BASSLER, 1925. (R)

Falodus LINDSTRÖM, 1954 (p. *W*54). Specimen illustrated is *F. extensus* (GRAVES & ELLISON) not *F. prodentatus* (GRAVES & ELLISON). (R)

Gnathodella MATERN, 1933 (p. *W*59). *Nom. dub.* [?=*Polygnathus*.] (R)

Gondolella STAUFFER & PLUMMER, 1932 (p. *W*60). Explanation of Fig. 37,*9* should read as follows: FIG. 37,*9a*. *G. curvata* STAUFFER & PLUMMER, loc. unknown, oral. ——FIG. 36,*9b*. *G. magna* STAUFFER & PLUMMER, *Penn.*(EastMountain Sh.), Texas (see BRANSON, 1963). (M)

Gyrognathus STAUFFER, 1935 (p. *W*54). Junior synonym of *Oulodus* BRANSON & MEHL, 1933 (see p. *W*54). (R)

Hibbardella BASSLER, 1925 (p. *W*50). Description should read as follows: *Hibbardella* BASSLER, 1925, p. 219 [**Prioniodus angulatus* HINDE, 1879] [=*Diplododella* BASSLER, 1925; *Roundya* HASS, 1953; *Ellisonia* MÜLLER, 1956]. Denticles of anterior arch discrete, confluent, alternating or irregular; pulp cavity small. Denticulated posterior bar definitely present. *M.Ord.-M.Trias.*, N.Am.-Eu.-Afr. (R)

Hindeodelloides HUDDLE, 1934 (p. *W*50). Probably junior synonym of *Ligonodina* BASSLER, 1925 (see p. *W*50). (R)

Hindeodina HASS, 1959 (p. *W*46). Junior synonym of *Hindeodella* BASSLER, 1925 (see p. *W*46). (R).

Holodontus RHODES, 1953 (p. *W*48). After [**H. superbus*] [=*Tvaerognathus* BERGSTRÖM, 1961]. (R)

Icriodella RHODES, 1953 (p. *W*62). Junior synonym of *Icriodina* BRANSON & MEHL, 1947 (see discussion of *Icriodina*, herein). (R)

Icriodina BRANSON & MEHL, 1947 (p. *W*62). Replace description by the following: *Icriodina* BRANSON & MEHL, 1947, p. 550 [**I. irregularis*] [=*Icriodella* RHODES, 1953]. Unit elongate; main cusp stout; blade transversely ridged; apex of pulp cavity in middle third of unit. *U.Ord.*, Eu.; *L.Sil.*, N.Am.——FIG. 40,*1a*. *I. superba* (RHODES), *Ord.*(Gelli-grin Ls.), Wales; oral, ×30 (58).——FIG. 40,*1b*. *I. superba acuta* RHODES, Ord.(Gelli-grin Ls.), Wales; lat., ×30 (58). (R)

Idiognathoides HARRIS & HOLLINGSWORTH, 1933 (p. *W*62). Junior synonym of *Cavusgnathus* HARRIS & HOLLINGSWORTH, 1933, since Pl. 1, fig. 14, illustrates the holotype of the type species. (R)

Kladognathus REXROAD, 1958 (p. *W*47). Add in synonymy [=*Cladognathodus* REXROAD & COLLINSON, 1961 (obj.)]. REXROAD & COLLINSON proposed *Cladognathodus* erroneously believing that *Kladognathus* REXROAD, 1958, was a homonym of *Cladognathus* REXROAD, 1957 (*non* BURMEISTER, 1847). (T)

Lonchodus PANDER, 1856 (p. *W*64). The holotype of this genus is almost certainly a broken *Ligonodina* or some similar form. However, there are forms in the Pennsylvanian which fit the generic description and which do not appear to be fragmentary. These constitute a new genus. (R)

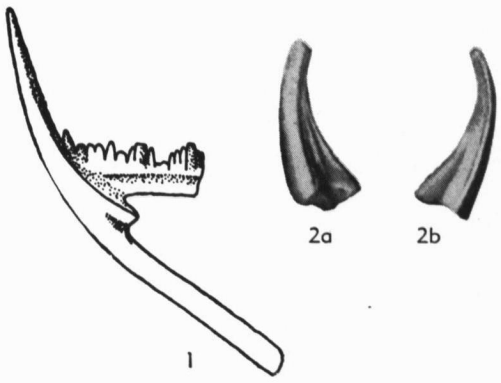

FIG. 1. *Oepikodus smithensis* LINDSTRÖM, L.Ord.(Billingen Stage), Sweden; costate side, ×55.

FIG. 2. *Panderodus unicostatus* (BRANSON & MEHL), *Sil.* (Bainbridge Ls.), USA(Mo.); outer and inner lat. views, ×25.

Loxognathus GRAVES & ELLISON, 1941 (p. *W*50). Junior synonym of *Periodon* HADDING, 1913. (R)

Metaprioniodus HUDDLE, 1934 (p. *W*47). Probably junior synonym of *Hindeodella* BASSLER, 1925. (R)

Neocoleodus BRANSON & MEHL, 1933 (p. *W*64). Considered *nom. dub.* (R)

Nericodus LINDSTRÖM, 1954 (p. *W*64). Considered *nom. dub.* (R)

Nodognathus COOPER, 1939 (p. *W*57). Junior synonym of *Spathognathus* BRANSON & MEHL, 1934. (R)

Oepikodus LINDSTRÖM, 1954 (p. *W*52). Placed in synonymy of *Tetraprioniodus* by HASS, but to be considered as valid genus with following description: [**O. smithensis*; OD]. Compound conodonts with cusp and one anterior, undenticulated process, one posterior denticulate process and lateral undenticulate process to each side, however weak. *L.Ord.-M.Ord.*, Eu.——FIG. 1. *O. smithensis*, L.Ord., Sweden, costate side, ×55. (R)

Oligodus COOPER, 1939 (p. *W*57). Possibly junior synonym of *Bryantodus* BASSLER, 1925 (see p. *W*55). (R)

Oulodus BRANSON & MEHL, 1934 (p. *W*54). Add in synonymy: [=*Tortoniodus* STAUFFER, 1935]. (R)

Pachysomia SMITH, 1907 (p. *W*48). Considered *nom. dub.* (R)

Paltodus PANDER, 1856 (p. *W*44). After removal of *Panderodus* ETHINGTON, 1959, from synonymy, description should be as follows: Asymmetrically curved, simple conodonts, with basal cavity, which is shallow; lateral faces have costae and or grooves developed. (R)

Panderodella BASSLER, 1925 (p. *W*60). Considered *nom. dub.* The type specimen has been studied by three different conodont specialists, each of whom assigned it to a different genus. (R) The distinction between *Palmatolepis* and *Panderodella* was not accepted by subsequent workers. The type specimen of the type species of *Panderodella* [*P. truncata*] is an unidentifiable fragment; therefore, this species should be regarded a *nom. dub.* Species of *Panderodella sensu* HASS are referred to *Palmatolepis.* (M)

Panderodus ETHINGTON, 1959 (p. *W*44). Placed in synonymy of *Paltodus* PANDER, 1856, by HASS, but here considered valid genus with following description: [**Paltodus unicostatus* (BRANSON & MEHL), 1933]. Simple conodonts with basal cavity deeper than wide; base with fine, longitudinal striations, and may bear lateral costae and grooves. In cross section, individual is generally rounded, widest anteriorly, and is commonly asymmetrical. Basal cavity generally extends at least to mid-height. *M.Ord.-M.Dev.*, Eu.-N.Am.-?Australia. ——FIG. 2. *P. unicostatus,* Sil.(Bainbridge Ls), USA (Mo.); *a,b,* outer and inner views, ×25 (R).

Pandorinellina HASS, 1959 (p. *W*57). Considered synonym of *Spathognathodus* BRANSON & MEHL, 1941. (R)

Paracordylodus LINDSTRÖM, 1954 (p. *W*48). Possibly junior synonym of *Cordylodus* PANDER, 1856 (see p. *W*45). (R)

Pinacognathus BRANSON & MEHL, 1934 (p. *W*58). Considered junior synonym of *Ozarkodina* BRANSON & MEHL, 1933 (see p. *W*56). (R)

Plectodina STAUFFER, 1935 (p. *W*49). Considered junior synonym of *Cordylodus* PANDER, 1856 (see p. *W*45). (R)

Polygnathellus BASSLER, 1925 (p. *W*54). Here placed in synonymy of *Bryantodus* BASSLER, 1925 (see p. *W*55) for the following reason. ULRICH & BASSLER (1926) did not select a holotype for the type species and accordingly I hereby select the specimen illustrated in their pl. 1, fig. 3, which I regard as belonging to *Bryantodus* BASSLER, 1925. The specimen figured in their pl. 1, fig. 1, which is identified as *Polygnathellus typicalis,* seems to belong to *Nothognathella* BRANSON & MEHL, 1934. (R)

Polygnathidae BASSLER, 1925 (p. *W*58). In the descriptions of all the genera in this family HASS has reversed the orientation adopted by most conodont workers (see SCOTT, ELLISON, REXROAD & ZIEGLER, 1962). (R)

Polygnathus HINDE, 1879 (p. *W*58). ZIEGLER, KLAPPER & LINDSTRÖM (1964) have prepared an application to the International Commission on Zoological Nomenclature to declare *Polygnathus dubia* HINDE a *nom. dub.* and they have proposed that the Commission exercise its plenary powers to suspend the rules in the case of *Polygnathus* to set aside the designation of *Polygnathus dubia* as type species, and declare *Polygnathus robusticostata* BISCHOFF & ZIEGLER type species in its stead. (M)

Polyplacognathus STAUFFER, 1935 (p. *W*58). HASS placed this genus in the synonymy of *Amorphognathus* BRANSON & MEHL, 1933 (see discussion herein). It should, however, be regarded as a separate genus with the following description: [**P. ramosa*; OD]. Individually asymmetrical platform-like conodonts, composed of variable number of lobes or processes (generally fewer than 6) which radiate from common point of origin; aboral surfaces ridged or keeled on either side of slit-like basal cavity located beneath central point on aboral surface of unit and more or less strongly developed, with tendency to extend as slits into each lobe. Oral surface generally bearing irregularly developed denticles. *M.Ord.,* N.Am.-Eu.——FIG. 37,5. **P. ramosa,* Kimmswick Ls., USA(Mo.); *5a,b,* aboral and oral views, ×37 (8). (R)

Pravognathus STAUFFER, 1936 (p. *W*46). Considered *nom. dub.* (R)

Prioniodina BASSLER, 1925 (p. *W*46). Add in synonymy [=*Subbryantodus* BRANSON & MEHL, 1934]. Emend range to *M.Ord.-Trias.* (R)

Ptilognathus ELIAS, 1956 (p. *W*64). Considered *nom. dub.,* [?=*Hibbardella*]. (R)

Pygodus LAMONT & LINDSTRÖM, 1957 (p. *W*248). SWEET & BERGSTRÖM (7), who described specimens with attached basal plates offering the best-preserved material so far known, state that representatives of this genus are true conodonts which "grew in a manner similar to all other conodonts." However, they give no account of the growth lines parallel to the posterior platform margin which are conspicuous on most of their specimens and which are uncommon in other conodonts. This seems to warrant a closer histological investigation of these and similar early conodonts and conodont-like genera. (M)

Rhombocorniculum WALLISER, 1958 (p. *W*248). Replace type species designation by following: [**R. comleyense* (=**Helenia cancellata* COBBOLD, 1921, p. 363)]. (M) (M)

Roundya HASS, 1953 (p. *W*51). Not regarded as valid genus; include in synonymy of *Hibbardella* BASSLER, 1925 (see discussion of that genus herein). (R)

Scaphignathus ZIEGLER, 1960 (p. *W*246). The author of this genus is HELMS, 1959 (4), not ZIEGLER, 1960. (M)

Scotlandia COSSMANN, 1909 (p. *W*65). Considered *nom. dub.* (R)

Stenothecopsis COBBOLD, 1935 (p. *W*138). Belongs to order Paraconodontida (see p. *W*248). (M)

Subbryantodus BRANSON & MEHL, 1934 (p. *W*55). Not regarded as valid genus; include in synonymy of *Prioniodina* BASSLER, 1925 (see discussion of that genus herein). (R)

Subprioniodus SMITH, 1907 (p. *W*48). Considered *nom. dub.* (R)

Tortoniodus STAUFFER, 1935 (p. *W*56). Considered a junior synonym of *Oulodus* BRANSON & MEHL, 1933. (R)

Tetraprioniodus LINDSTRÖM, 1954 (p. *W*52). Add in synonymy: [=*Trapezognathus* LINDSTRÖM, 1954] (R)

Trapezognathus LINDSTRÖM, 1954 (p. *W*65). Considered junior synonym of *Tetraprioniodus.* (R)

Trichonodella BRANSON & MEHL, 1948 (p. *W*53). The holotype of the type species (*Trichognathus prima* BRANSON & MEHL, 1933) is fragmentary, and the genus is at present inadequately defined, especially in comparison to *Roundya.* The entire morphological group requires restudy. (R)

Tripodellus SANNEMANN, 1955 (p. *W*47). Description should be emended as follows: Anterior and lateral bars compressed, denticulated; anterior bar much larger than lateral bars, directed downward; lateral bars joined to front basal portion of main cusp, curved backward and directed slightly downward; main cusp with sharp edge; anterior and posterior sides curved slightly backward; aboral side sharp-edged; pulp cavity fairly small. (R)

Zygognathus BRANSON, MEHL & BRANSON, 1951 (p. *W*49).

Remove *Eoligonodina* BRANSON, MEHL & BRANSON, 1951, from synonymy and transfer to synonymy of *Ligonodina* BASSLER, 1925 (p. *W*50). (R)

ACKNOWLEDGMENTS

It is a pleasure to record my gratitude to the following friends who have given me the benefit of their advice in discussions of various genera: Dr. C. R. BARNES, Mr. E. C. DRUCE, Dr. G. HAMAR, Dr. H. LINDSTRÖM, Mrs. SHIRLEY OSBORN, Miss JOAN ROBINSON and Dr. WILLI ZIEGLER. Needless to say, none of these conodont workers shares all the views represented in this present revision. (R)

REFERENCES (M)

(1) BRANSON, C. C. 1963, *Notes on conodont literature:* Oklahoma Geol. Notes, v. 23, p. 224-226.

(2) COBBOLD, E. S., 1921, *The Cambrian horizons of Comley (Shropshire) and their Brachiopoda, Pteropoda, Gasteropoda, etc.:* Geol. Soc. London, Quart. Jour., v. 76, p. 325-386, fig. 1-4, pl. 21-24.

(3) ETHINGTON, R. L., & CLARK, D. L. 1964, *Conodonts from the El Paso Formation (Ordovician) of Texas and Arizona:* Jour. Paleontology, v. 38, p. 685-704, fig. 1-2, pl. 113-115.

(4) HELMS, JOCHEN. 1959, *Conodonten aus dem Saalfelder Oberdevon (Thüringen):* Geologie, v. 8, p. 634-677, fig. 1-3, pl. 1-6.

(5) ———, 1963, *Zur "Phylogenese" und Taxionomie von Palmatolepis (Conodontida, Oberdevon):* Geologie, v. 12, p. 449-485, fig. 1-3.

(6) MÜLLER, K. J. 1962, *Zur systematischen Einteilung der Conodontophorida:* Paläontol. Zeitschr., v. 36, p. 109-117, fig. 1.

(7) SWEET, W. C., & BERGSTRÖM, S. M. 1962, *Conodonts from the Pratt Ferry Formation (Middle Ordovician) of Alabama:* Jour. Paleontology, v. 36, p. 1214-1252, fig. 1-5, pl. 168-171.

(8) ZIEGLER, WILLI; KLAPPER, GILBERT, & LINDSTRÖM, MAURITS. 1964, *The validity of the name Polygnathus (Conodonta, Devonian and Lower Carboniferous):* Jour. Paleontology, v. 38, p. 421-423.

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Part 2

REVIEW OF CONODONT PUBLICATIONS 1958 TO JULY, 1965

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The article on conodonts prepared by the late Dr. WILBERT H. HASS for Part W of the *Treatise on Invertebrate Paleontology* included literature references up to the year 1958, although the volume itself, published in 1962, included references to 12 additional papers published up to 1961. Therefore, it seems useful to provide a brief review of the more important conodont articles published in the last six years. Only major articles have been included. References to others may be obtained from the bibliographies listed below.

BIBLIOGRAPHIES

ASH (1961, 1963) provided bibliographies of conodont literature for the periods from 1949-1958 and 1959-1963, respectively, together with lists of genera and species, and the formations from which they come. ELLISON (1962, 1963) provided an annotated bibliography of conodont literature, together with a generic and stratigraphic index, which includes literature to the end of 1962.

GENERAL LITERATURE

FAY (1958a, 1958b) published a revised key to conodont genera. LINDSTRÖM (1964) provided an excellent general introduction to conodonts, with a discussion of their morphology and structure, occurrence and nature. He concluded on the basis of their general form and assemblage association that they are internal structures, which probably functioned as supports for a ciliated tentacle apparatus of an unknown plankton-feeding animal, possibly of hemichordate type. LINDSTRÖM's book includes an extensive generic key.

Foss (1960), in a study of the chemical composition of Ordovician and Harding conodonts and associated *Astraspis* scales, concluded that the similar carbonate fluorapatite composition of the two groups suggested an affinity between them, their composition being distinct from that of any other vertebrate studied. FAHLBUSCH (1964) contributed a study of conodont affinities, making detailed comparisons with the hydroxyapatite of invertebrates and an analysis of postdepositional

changes in structure. He argued that the histological and mineralogical structure of conodonts is distinct from that of vertebrates, and that no known animal structures are similar in detailed form to conodonts. FAHLBUSCH preferred to regard conodonts as algal in origin, serving either a sporangial function or as "reserve accumulations." He supported his suggestion by making detailed sections, in which he identified various parts of the conodont with algal structures. He used his conclusions to question the various conodont phylogenies established by other workers.

A detailed reply to FAHLBUSCH has been given by BECKMANN, *et al.* (1965). These authors have shown various defects in FAHLBUSCH's mineralogical and chemical interpretations and they argue that his interpretation of thin sections is unsatisfactory. The specimens in question come from an Upper Devonian bone bed, and the authors have reinterpreted most of FAHLBUSCH's "algal" structures, some being regarded either as inorganic or as misinterpretations.

SCOTT & COLLINSON (1959) reviewed the extent of infraspecific variability in a Devonian species, *Palmatolepis glabra*. GROSS (1960) reviewed the histology of specimens of *Palmatolepis* and *Polygnathus* and their "basal plates."

CAMBRIAN CONODONTS

KOUCKY, RHODES & CYGAN (1961) recorded conodont faunas of Upper Cambrian to Lower Pennsylvanian age from the Bighorn Mountains, Wyoming.

ORDOVICIAN CONODONTS

BAZOCHE (1960) described Lower Ordovician conodonts from the subsurface of eastern Algeria. BERGSTRÖM (1961) recorded 24 conodont species from limestone boulders from the Ludibundus beds, of the Middle Ordovician of Tvären, Sweden, and reviewed Welsh Ordovician conodont faunas (1964). HAMAR (1964) described Middle Ordovician conodont faunas from Norway. ETHINGTON & FURNISH (1959, 1960) described Upper Ordovician faunas from Manitoba. HARRIS (1962) included three new genera in his description of conodonts from the Middle Ordovician Joins Formation in the Arbuckle Mountains, Oklahoma. SWEET & BERGSTRÖM (1962) described the conodont fauna of the Middle Ordovician Pratt Ferry Formation of Alabama. SWEET, TURCO, WARNER & WILKIE (1959) described the Eden faunas from Ohio and Kentucky. WOLSKA (1961) reported Ordovician conodonts of various ages from erratic boulders near Warsaw, Poland.

SILURIAN CONODONTS

WALLISER (1962, 1964) established a series of detailed Silurian conodont zones. SPASOV & VESELINOVIC (1963) described a Ludlovian conodont fauna from Yugoslavia.

DEVONIAN CONODONTS

BUDUROV (1961) described Middle Devonian conodont faunas from Bulgaria. COLLINSON, SCOTT & REXROAD (1962) produced six summary range charts of Devonian and Mississippian conodont genera (and species of *Gnathodus* and *Siphonodella*) from the Upper Mississippi Valley. They described a sequence of conodont zones and made detailed correlations with the succession in Germany. DVORAK, FREYER & FREYER (1961) described Upper Devonian and Lower Carboniferous conodont faunas from the Moravian area of East Germany, and ETHINGTON & FURNISH (1962) described Silurian and Devonian assemblages from the Spanish Sahara. FREYER (1961) has given detailed ranges of 184 conodont species in the Upper Devonian succession of eastern Thüringen, East Germany. HELMS (1961) described the evolution of Upper Devonian polygnathids from Thüringen, East Germany, and of *Palmatolepis* (1963). KREBS (1959, 1960) described large conodont faunas from the Devonian and Carboniferous of Germany. LYS & SERRE (1957) described Devonian faunas from the Sahara and SPASOV (1960) Silurian and Devonian faunas from southwestern Bulgaria and Yugoslavia.

ZIEGLER (1962a, 1962b) provided a detailed description of the phylogeny of the genera *Palmatolepis*, *Ancyrodella*, *Ancyrognathus* and *Ancyrodina* from the Upper Devonian of Germany, and divided the Upper Devonian into 24 conodont zones.

CARBONIFEROUS CONODONTS

CLARKE (1960) described conodont faunas of Carboniferous age from Scotland and MEISCHNER (1962) reported on the sequence of faunas from the Middle Mississippian *Goniatites Stufe* of the

Rhenish Schiefergebirge, West Germany. Rexroad & Burton (1961) and Rexroad & Liebe (1962) described Mississippian Chester faunas from the Kinkaid and the Paoli Formations of Illinois. Rexroad & Collinson (1963) described conodonts of the Valmeyeran St. Louis Formation.

Higgins (1961) described Namurian conodont faunas from Staffordshire, England. Igo & Koike (1964) described the fauna of the Omi Limestone of central Japan and Higgins (1962) that of the Griotte Limestone of northwestern Spain.

PERMIAN CONODONTS

Ching (1960) described Permian conodont faunas from Nanking Province, China, and mentioned the occurrence of Devonian, Mississippian, and Pennsylvanian conodonts there. Rhodes (1963) described a Lower Permian fauna from the topmost Tensleep Formation of Wyoming.

TRIASSIC CONODONTS

Spasov & Ganev (1960) described conodont faunas from the Lower and Middle Triassic of eastern Bulgaria and Stefanov (1962) reported on faunas from western Bulgaria.

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Part 3

CONOIDAL SHELLS OF UNCERTAIN AFFINITIES

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ADDITION TO CALYPTOPTOMATIDA

Dr. Michael R. House has called my attention to the following genus which was not included in Part W of the *Treatise.*

Pteroconus Hinde in Fox, 1900 (p. 149) [**P. mirum*; SD Fisher, herein]. Shell, conical, compressed, straight; in transverse section round or elliptical, on both sides with small shelly flap or finlike extensions dispersed at regular intervals from basal point to summit aperture. Longitudinal rod or thickening of shell enclosed within

cone. Outer surface with ornamentation of transverse lines of growth following contour of summit, and at intervals with stronger raised lines connected with lateral processes. No operculum has been observed. Shells are 30-72 mm. long, 7-9 mm. wide at aperture. *L.Dev.* ("claret-tinted and bluish shales," Bedruthan Steps), Eng.(North Cornwall). [Name of genus attributed to UPFIELD GREEN by courtesy of HINDE]. [This genus is a member of the hyolithid family Pterygothecidae (Treatise, p. *W*127-*W*128.)]

ADDITION TO REFERENCES

Add on p. *W*141-*W*143:

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(13a) 1900, *Notes on the geology and fossils of some Devonian rocks on the north coast of Cornwall:* Geol. Mag., v. 7, p. 145-152, 239, pl. 7, fig. 1-4.

Lardeux, H.

(28a) 1959, *Les Tentaculoidea du calcaire dévonien de Valet près de Chaudefonds. (M. et. L.):* Soc. des Études Scientifiques d'Angers, Bull., new ser., v. 2, (89, Année), p. 107-110, fig. 1-4 Angers.

(28b) 1961, *Contribution a l'étude des Tentaculitoidea du Zemmour (Mauritanie septentrionale):* Faculté des Sciences de l'Univers. de Dakar 1961, Ann., v. 6, p. 35-44, pl. 53, fig. 1-3, Dakar.

(28c) 1963, *Une intéressante espèce de Tentaculitoidea du Lochkovien de Touchchent (Maroc central):* Service Geol. Maroc, Notes, v. 23, p. 101-104, fig. 1-4.

(28d) 1964, *Nouvelles données sur la morphologie des "Tentaculitida":* Acad. Sci. [Paris], Comptes rendus, v. 258, p. 5939-5942, fig. 1-5.

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(77a) 1962, *Zur Morphologie der Tentaculitengattung Styliolina Karpinsky:* Freiberger Forschungsh., Heft C-151, p. 159-161, pl. 1, fig. 1-4.

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RECENT SIGNIFICANT PUBLICATIONS

VYALOV, O. S., 1962, *Zamechaniya Klassificatsii Tentaculitov:* Visnik L'vivskogo ordena Lenino derzhovnego univesitetu im, Iv. Franka, Seriya geologicheskaya, No. 1, pp. 66-69. [Remarks on the classification of Tentaculites]

VYALOV, after reviewing Lyashenko's classification, proposes a different one in which four families are distinguished based on gross shell geometry; each family is then subdivided into two subfamilies on basis of uniform or nonuniform rings. Genera are distinguished on the basis of presence of ordinary versus compound rings. Species are determined on the basis of regular spacing versus irregular spacing of rings.

POULSEN, VALDEMAR, 1963, *Notes on Hyolithellus Billings, 1871, Class Pogonophora Johannson, 1937:* Biol. Medd. Dansk. Vid. Selsk., vol. 23, no. 12, 15 p., fig.

POULSEN demonstrates that the much disputed "operculum" (*Discinella* HALL, 1871) must be excluded from *Hyolithellus* BILLINGS, 1871. The operculum has possible monoplacophoron affinity. X-ray fluorescence analysis and structure of the tubular skeleton seemingly confirms a pogonophoran relationship. The similarity of the Lower and Middle Cambrian *Hyolithellus* to the modern pogonophore *Galathealinum brunni* KIRKEGAARD is striking.

MAREK, L., & YOCHELSON, E., 1964, *Paleozoic mollusks: Hyolithes:* Science, v. 146, p. 1674-1675, 3 figs.

An unusually well-preserved Ordovician hyolithid (*Hyolithes striatulus* BARRANDE) from Czechoslovakia reveals that the enigmatic paired structures, once thought to be outgrowths of the operculum by YOCHELSON, are actually independent and lie between the operculum and the aperture. This is a unique feature among mollusks and merits a re-evaluation of the evolution of the Mollusca.

BOUČEK, B., 1964, *The Tentaculites of Bohemia:* Czechoslovak. Acad. of Sciences, Prague, 215 p., 40 pl., 36 fig.

A comprehensive monograph on the morphology, ecology, phylogenetic development, and biostratigraphic significance of the Bohemian tentaculitids. BOUČEK proposes one new class, one new order, two new families, one new subfamily, two new genera and 20 new species. Emphasis is placed on the order Dacryoconarida. The new classification, given below, differs from those of LYASHENKO (1955), FISHER (1962), and VYALOV (1962).

Classification of Tentaculitids by Bouček (1964)

Tentaculita BOUČEK, nov. *(class)* [=*Cricoconarida* FISHER, 1962)
- Tentaculitida LYASHENKO, 1955 *(order)*
  - Tentaculitidae WALCOTT, 1886
  - Uniconidae LYASHENKO, 1955
- Homoctenida BOUČEK, *(order)* nov.
  - Homoctenidae LYASHENKO, 1955
- Dacryoconarida FISHER, 1962 *(order)*
  - Nowakiidae BOUČEK & PRANTEL, 1960
  - Styliolinidae LYASHENKO, 1955
  - Striatostyliolinidae BOUČEK, nov.
- Coleolida BOUČEK, *(order)* nov.
  - Coleolidae FISHER, 1962
- Cornulitida BOUČEK, *(order)* nov.
  - Cornulitidae FISHER, 1962

The following new genera were described:

Viriatellina BOUČEK, 1964 (p. 94) [**V. hercynica*]. Similar to *Nowakia* but the external surface is covered

with broad, ripple-like rings or undulations. Longitudinal ribbing present. According to BOUČEK, rings in *Nowakia* are more acute. *L.Dev.-M.Dev.* (L. Ems.-L.Eifel.), Ger.-Czech.-N.Am. [BOUČEK assigns HALL's *Tentaculites gracilistriatus* from the Hamilton Group to *Viriatellina* but the Hamilton beds are Givetian; re-examination of this assignment is necessary.]

Paranowakia BOUČEK, 1964 (p. 110) [**Tentaculites intermedius* BARRANDE, 1867]. "Very similar to . . . . *Viriatellina* from which it differs practically only by having an elongated [embryonic chamber] and with tubular projection terminating initial chamber." *U.Sil.* (Lochkovian) (=zone of *Monograptus hercynicus*). Bohemia-Ger.-S.Eu.-N.Afr.-C.Asia-Australia.

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Part 4

ANNELID SERPULOIDES SOWERBY

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On p. *W*163 the paragraph under *Campylites* EICHWALD should be replaced by the following:

Serpuloides SOWERBY in MURCHISON, 1839, p. 200 [**S. longissima*, M] [=*Serpulites* SOWERBY in MURCHISON, 1839, obj., *non* BLUMENBACH, 1803; *Campylites* EICHWALD, 1856, obj., *non* ROLLIER, 1822]. Tube large, curved, flat, composed of numerous thin layers, tapering very gradually. *Sil.-Perm.*, Eu.-Asia-Australia.——FIG. 105,*1*. **S. longissima* SOWERBY, U.Sil.(U.Ludlov.), Eng., ×0.3 (142).

[The name *Serpulites* SOWERBY in MURCHISON, 1839, is clearly a junior homonym of *Serpulites* BLUMENBACH, 1803. In the stratigraphic part of his work, in the description of the Upper Ludlow rocks, MURCHISON (1839, p. 200) referred to occurrence of "*Serpuloides? longissima*," introducing the name, apparently on a conditional basis, for the first time. In the paleontological part, SOWERBY (in MURCHISON, 1839, p. 605) named the same fossil *Serpulites longissimus*. In a footnote he explained that "In the description of the Upper Ludlow Rock this fossil has been inadvertently named *Serpuloides longissima*." *Serpuloides* thus being a synonym of *Serpulites*, it becomes the valid name of the genus, when the latter name is found to be preoccupied. Since MURCHISON cited the name with a query it cannot be credited to him. The genus, under the name *Serpulites*, has been reported from the Permian of Pakistan (WAAGEN, 1886) and of Western Australia (TEICHERT, 1950).

BOUČEK (1939) erected the family Serpulitidae, based on "*Serpulites* MURCHISON, 1839," with which he grouped as synonyms a number of conical shells of uncertain affinities.]

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(*4*) WAAGEN, WILLIAM, 1885, *Salt Range Fossils. v. 1. Productus Limestone Fossils, pt. 5, Bryozoa-Annelida-Echinodermata:* Palaeontologia Indica, ser. 13, v. 1, p. 771-834, pl. 87-96.

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Part 5

RECENT CONTRIBUTIONS TO KNOWLEDGE OF TRACE FOSSILS AND PROBLEMATICA

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NEW AND OVERLOOKED "GENERA" OF TRACE FOSSILS AND PROBLEMATICA

Since the appearance of Part W of the *Treatise on Invertebrate Paleontology* (1962) a number of new ichno-genera and "genera" of problematic fossils have been published. Also, I have detected several names of such fossils previously overlooked by me. All of these have been combined in the following supplement. Not all were suitable for illustration, partly because figures published by authors were deficient in quality, partly because forms lacked characteristic features, or it was impossible to obtain good photographs of the fossils.

Meanwhile, the index and bibliography of trace fossils and Problematica written by the author have been issued as Part 108 of the *Fossilium Catalogus* (HÄNTZSCHEL, 1965). Here every "genus" ever described (including syno-

FIG. 3. *Acanthoraphe* sp. L.Cret., Pol., ×0.6 (24).

nyms, invalid names, etc.) is described and nearly 900 references are listed.

Acanthoraphe KSIAZKIEWICZ, 1961 (published as "nova forma" without species names). Narrow trail, fairly regular winding, with short lateral thornlike branches on both sides (24). *L.Cret.*, Pol. (Fig. 3).

Aggregatella ELLIOTT, 1962 (**A. pseudohieroglyphicus*). Microcoprolites forming clusters or tangles of pellets, 0.5-1 mm. in length similar to but smaller than those of Recent ophiuroids or brittle stars (12). *U.Jur.*, Iraq.

Archaeichnium GLAESSNER, 1963 (**A. haughtoni*). Fillings of cylindrical burrows with external longitudinal striation (10-12 striae) and faint transverse sculpture inside; diameter (max.) ±5 mm.; thickness of walls 1 mm.; erroneously described as Archaeocyatha by S. H. HAUGHTON (1956, 1959), certainly belonging to the trace fossils (15). *Uppermost Precam.* or *?L.Paleoz.* (Kuibis quartzite, base of the Nama Series), S.Afr. (Fig. 4)

Beaconites VIALOV, 1962 (**B. antarcticus*). Tubes with thin walls and thick transverse walls; uncertain if trace fossils or body fossils (39). *?Carb.*, Antarct.

Benjaminichnus BOEKSCHOTEN, 1964, [*nom. subst. pro Batrachoides* HITCHCOCK, 1858 (=*nom. inval.*, preoccupied by *Batrachoides* LACEPÈDE, 1800)] proposed for possible fossil (and Recent!) tadpole "nests" (3, 19).

Bicornifera LINDENBERG, 1965 [**B. alpina*]. Microproblematicum, *incertae sedis*, calcareous shells consisting of 2 chambers of different size which are separated by double wall; outer end of chambers consisting of small round tubes of unknown original length; walls of shells hyaline, externally smooth; length 0.5 mm., height 0.30 mm. (25). *L.Tert. (Low.M.Olig.)*, North Tyrol (Austria)-Yugosl.-Turkey. (Fig. 5)

Birrimarnoldia HOVASSE & COUTURE, 1961 [**B. antiqua*] [=*Arnoldia* HOVASSE, 1956, *non Arnoldia* MAYER, 1887, *nec* KIEFFER, 1895, *nec* VLASENKO, 1931]. Siliceous microfossil, length 35-800μ; obviously articulated in chambers; interpretation as foraminifer doubted by DEFLANDRE, 1957 (21). *Precam.*, Afr.(Côte-d'Ivoire).

Brancichnus DOUGHTY, 1965 (**B. dudleyi*). Horizontal cylindrical and branching structures, maximal length 60 cm.; main cylindrical portion ("stem") fairly straight; reducing in diameter distally; burrow systems or, according to DOUGHTY, more probably "remains of a branching marine algae or some form of branching porifera." [Name perhaps superfluous; resembling *Saportia* SQUINABOL, 1891, from the Eocene flysch of Italy; see *T. eatise*, Part W, p. *W*215] (9). *Lias.*, Eng.

Capodistria VIALOV, 1964 [**C. vettersi*]. Starlike trace fossil; "genus" founded only on one specimen observed in a stone wall and described by VETTERS, 1910, from the Eocene flysch of Capodistria (Istria) (40).

Claviradix FERGUSON, 1961 [**C. ashi.*] Small cone-shaped bodies with small central elevations on upper surface; size ±2 mm.; 8 to 10 tapering radii growing from edge; stem projecting from underside of body and terminating in root which may be hollow; whole finely striated and pitted; similar to *Palaeocoryne* DUNCAN & JENKINS, 1869, emend. FERGUSON; neither hydrozoan nor algal nor bryozoan in origin (13). *U.Carb.(L. Namur.)*, Eng. (Fig. 6).

Chomatichnus DONALDSON & SIMPSON, 1962 [**C. wegberensis*]. Small circular mounds looking like miniature mole hills, about 5 to 7 cm. high, with central burrow; interpreted as piles of worm castings (8). *L.Carb.*, Eng.

Chotecella OBRHEL, 1964 [**Ch. leiotheca*]. Small hollow globules with smooth surface, diameter 500 to 800μ; wall 85 to 170μ thick; formed by several very thin irregularly adjacent layers; globules showing organic structure consisting of carbonaceous matter; somewhat similar to *Leiosphaeridia* EISENACK, 1958, and *Tasmanites* NEWTON, 1875; unknown if of plant or animal origin (30). *Low.M.Dev.*, Czech.

Diorygma BIERNAT, 1961 [**D. atrypophilia*]. Small borings of parasitic organisms in pedicle valves of *Desquamatia subzonata* (BIERNAT), consisting of minute, smooth, nearly V-shaped tubes, burrowed through all

FIG. 4. **Archaeichnium haughtoni* GLAESSNER, *U.Precam.* (?L.Paleoz.) (Kuibis Quartzite, Nama Ser.), S.Afr.; ×1.5 (15).

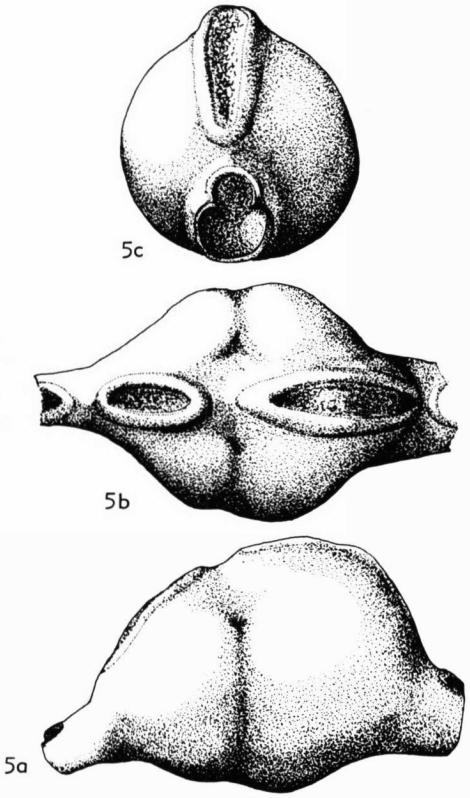

FIG. 5. **Bicornifera alpina* LINDENBERG (*a-c*, different views), *L.Tert.(Oligo.)*, Austria, ×100 (25).

shell substance, placed in lateral sides of pedicle muscle area (2). *M.Dev.*, Pol. (Fig. 7).

Gakarusia HAUGHTON, 1964 [**G. addisoni*]. Central disc of 2 cm. diameter, somewhat elevated, with 10 or 11 short "rays" of different width and trapezoidal cross section, beginning in some distance from margin of disc; interpretation "medusoid" (HAUGHTON) (20). *?U.Precam.* (Transvaal Syst., Pretoria Ser.), S.Afr. (Fig. 8).

Haentzschelinia VYALOV, 1964 [**Spongia ottoi* GEINITZ, 1849]. For description of type species *"Spongia ottoi"* see *Treatise*, p. *W*217-*W*218; new occurrences: *Trias.*, USSR(NE Siberia) (19, 40) (Fig. 9).

Haplotichnus S. A. MILLER, 1889 [**H. indianensis*]. Simple trail, running straight or curved, some bent sharply, made by larva of ?palaeodictyopterid (27). *L. Carb.*, USA(Ind.).

Helicoraphe KSIAZKIEWICZ, 1961 [published as "nova forma" without species names]. Very narrow trails resembling horizontal spiral spring with narrow turns (15/1 cm.); similar to *Helicolithus* AZPEITIA, 1933, but not meandering (24). *L.Tert.*, Pol. (Fig. 10).

Herpichnites GÜMBEL, 1879. General term for crawling trails (Repichnia), not used as "genus" (18).

Ladinosphaera OBERHAUSER, 1960 [**L. geometrica*]. Microfossil, *incertae sedis* (?plant, ?animal); small globules (6 or 9) linked in one plane to regular geometric figures; size ±0.5 mm.; surface of globules obviously perforated or retiform (29). *M.Trias.* (Ladin.), Austria (Fig. 11).

Linotolypa EISENACK, 1962 [**L. arcuata*]. Problematical microfossil, *incertae sedis*, consisting of thin ?chitinous threads arranged as links or meshes which form minute hollow globules; ?planktonic organism. *Ord.-L.Cret.*, Eu.-USA-Va.-Australia. (Fig. 12).

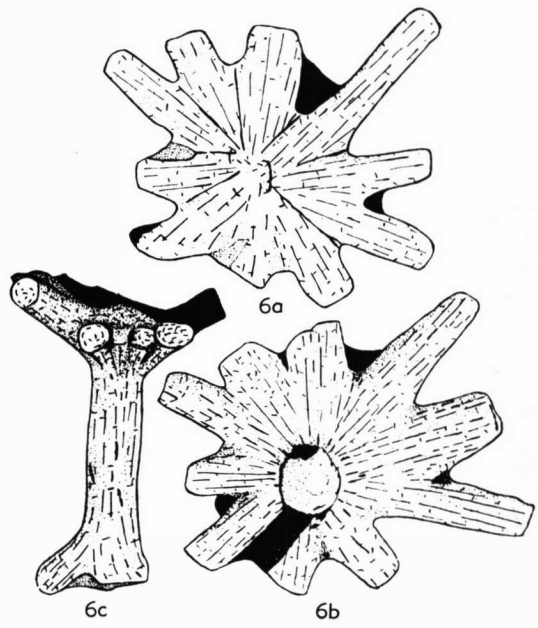

FIG. 6. **Claviradix ashi* FERGUSON, *U.Carb.(L.Namur)*, Eng.; *a,b*, upper and lower surfaces, body, stem, and roots, ×25 (13).

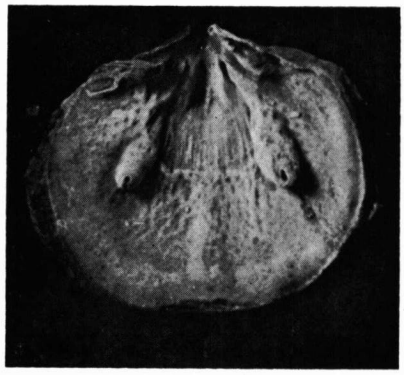

FIG. 7. **Diorygma atrypophilia* BIERNAT in *Desquamatia subzonata* (BIERNAT), *M.Dev.*, Pol.; ×2 (2).

Maeandropolydora VOIGT, 1965 [**M. decipiens*]. Long, meandering furrows sunk into outer or inner side of shells of Cretaceous oysters and pectinids; width 0.5-1.2 mm.; resembling U-shaped tubes of *Polydora* but without *Spreite*; probably made post-mortem by polychaete worm of family Spionidae (44). *U.Cret.(Santon.-U.Maastricht.)*, W.Ger.-Netherl.-Sweden. (Fig. 13).

Megagrapton KSIAZKIEWICZ, 1961 [published as "nova forma" without species names]. Graphoglyptic trails, straight or slightly curved, branching at rather regular intervals at nearly right angles and thus forming network with rectangles never closed (24). *L.Tert.*, Pol. (Fig. 14).

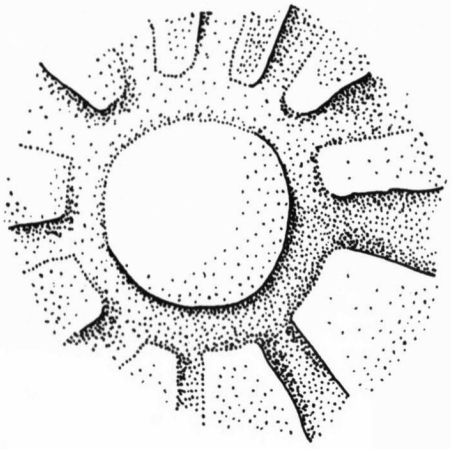

FIG. 8. *Gakarusia addisoni* HAUGHTON, *?U.Precam.* (Transvaal Syst., Pretoria Ser.), S.Afr.; ×1.1 (20). (Through kindness of the Director of the Geol. Survey S.Afr. and with permission of Government Printer, S.Afr.)

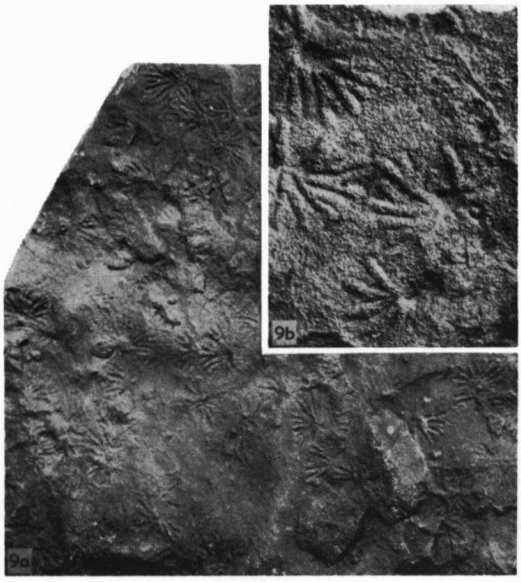

FIG. 9. *Haentzschelinia ottoi* (GEINITZ), *U.Cret.(Cenoman.)*, Ger.(Saxony); *a*, ×12.5, *b*, ×0.33 (from HÄNTZSCHEL, 1930).

Microtubus FLÜGEL, 1964 [**M. communis*]. Very small cylindrical tubes, mostly curved, seldom straight; diameter 0.05-0.2 mm., length 0.2-2 mm. (commonly 0.3-0.5 mm.); walls 0.02-0.04 mm. thick and smooth, obviously not agglutinated or built in layers; tubes probably articulated transversely, perhaps belonging to worms (?Serpulidae). (14). *U.Trias.(Rhaet.*, reef limestones); S.Ger.-Austria-Yugosl.-Greece-?Italy.

Mystichnis VYALOV & ZENKEVICH, 1961 [**M. pacificus*]. Recent creeping trails on bottom of Pacific at depth of 3.000 m.; width 10 cm.; producer unknown (42).

Ostreoblabe VOIGT, 1965 [**O. perforans*]. Tubes in shells of Cretaceous oysters, sunk into shell material; straight or slightly curved; directed centripetally toward muscle scar, proceeding from round external opening perforating shell; resembling mud blisters of Recent oysters; obviously made by parasitic polychaete worms and representing *intra vitam* deformations of shell (44). *U.Cret.(Turon.-Santon.)*, W.Ger. (Fig. 15).

Palaeohelcura BRADY, 1961 [*nom. null.* for *Paleohelcura* GILMORE, 1926 (see *Treatise*, p. *W*208)] (5).

Palaeomycelites BYSTROW, 1956 [**P. lacustris*]. Small borings in hard parts of animals like *Mycelites* (see *Treatise*, p. *W*230), but restricted to fossils in Paleozoic fresh-water sediments (e.g., *Holoptychius, Psammosteus, Dev.*, USSR) (6, 19).

FIG. 10. *Helicoraphe* sp., *L.Ter.(Eoc.*, Flysch), Pol.; ×1.5 (24).

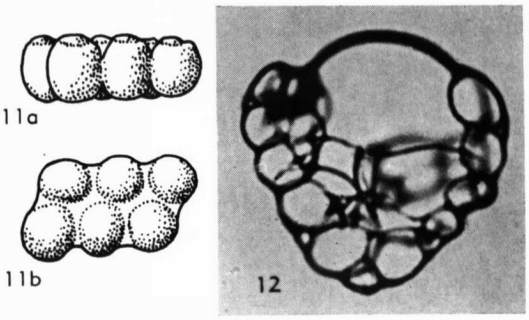

FIG. 11. **Ladinosphaera geometrica* OBERHAUSER, *M.Trias.(Ladin.)*, Austria; ×50 (26).

FIG. 12. **Linotolypa arcuata* EISENACK, *M.Trias.*, Ger., ×500 (11).

FIG. 13. *Maeandropolydora sulcans* VOIGT in *Neithea quinquecostata* (SOWERBY), *U.Cret.(L.Santon.)*, W.Ger., (Gross-Bülten), ×1.8 (44).

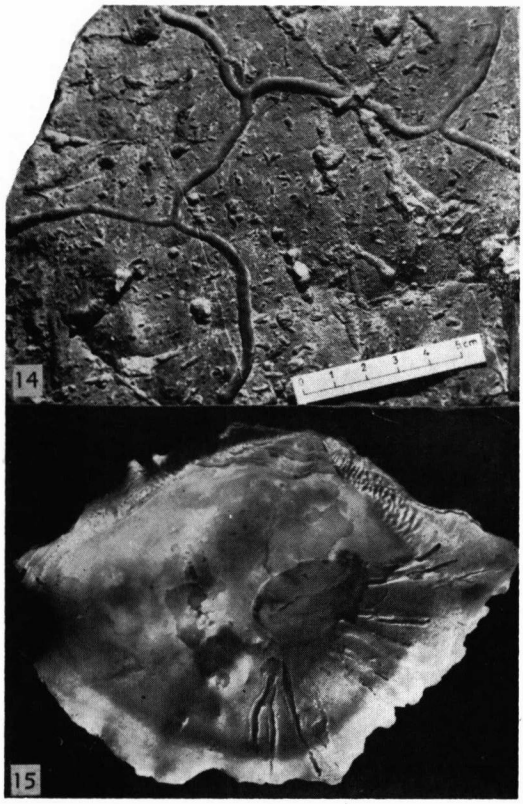

FIG. 14. *Megagrapton* sp., *L.Tert.(Eoc.,* Flysch), Pol.; ×0.43 (24).

FIG. 15. **Ostreoblabe perforans* VOIGT in *Ostrea (Lopha) semiplana* SOWERBY, *U.Cret.(M.Turon.)*, W.Ger. (Mühlheim-Broich), ×1.4 (44).

Palaeopiscovum BÁNYAI, 1939. Synonym of *Paleodictyon* MENEGHINI, 1850, interpreted as impressions of roe (1).

Palaeospirographis PLIČKA, 1962 [**P. hraběi*]. Burrows with *Spreite*; identical, and therefore it is synonymous with the trace fossil *Zoophycos* MASSAL., here interpreted as impressions of the prostomium with a crown of tentacles belonging to a polychaete worm, resembling the Recent genus *Spirographis* (32). *L.Tert.* (Magura-Flysch), Czech.

Palaeotenia CRIÉ, 1883 [**P. guilleri*]. Trail; name proposed for *Fraena goldfussi* ROUAULT, but obviously never used since 1885 (7).

Papillomembrana SPJELDNAES, 1963 [**P. compta*]. Compressed bodies of primarily probably cylindrical or spherical shape, 0.4-0.5 mm. in diameter; having a thin outer (?carbonaceous) membrane with dense papilla-like protuberances, thin-walled and hollow; systematic position unknown, somewhat resembling dasycladacean algae (36). *U.Precam.(Esmarkian)*, Norway. (Fig. 16).

Petaloglyphus VYALOV, GORBACH & DOBROVOLSKAYA, 1964 [**P. krimensis*]. Starlike trace fossil (grazing trail); insufficiently figured and described only in Ukrainian language (43). *L.Cret.*, USSR(Crimea).

Plangtichnus S. A. MILLER, 1889 [**P. erraticus*]. Simple narrow trail, smooth, irregularly zigzag, running in any and every direction, made by larva or pupa of palaeodictyopterous insect (27). *L.Carb.*, USA(Ind.).

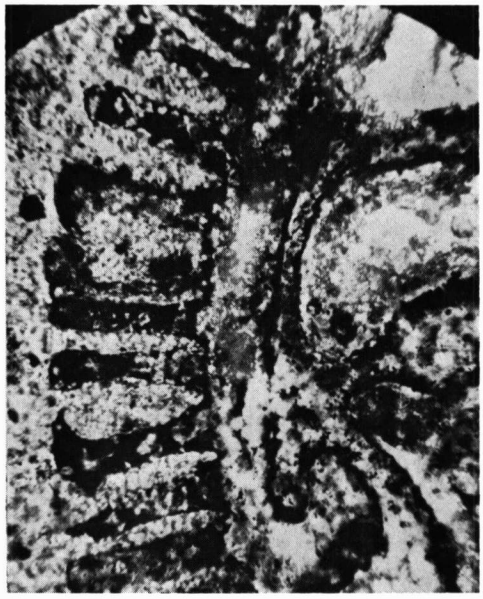

FIG. 16. **Papillomembrana compta* SPJELDNAES; *Precam.*, Norway; ×500 (36).

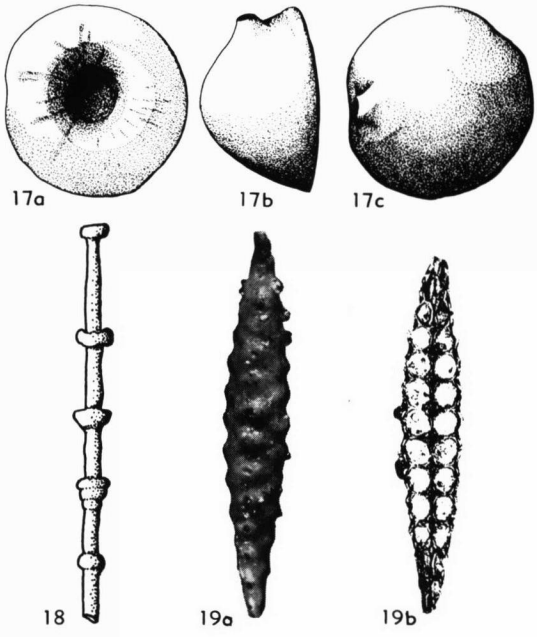

FIG. 17. **Pseudarcella rhumbleri* SPANDEL (*a-c*, different views), *L.Tert.(Oligo.)*, Austria; ×73 (25).

FIG. 18. **Rhabdoglyphus grossheimi* VASSOEVICH, *L.Tert.* (Flysch), Czech.; ×0.6 (4).

FIG. 19. **Skylonia mirabilis* THOMAS, *U.Ter.(L.Mio.)*, Afr. (Kenya); *a*, surface view, ×25; *b*, long, thin section, ×23 (37).

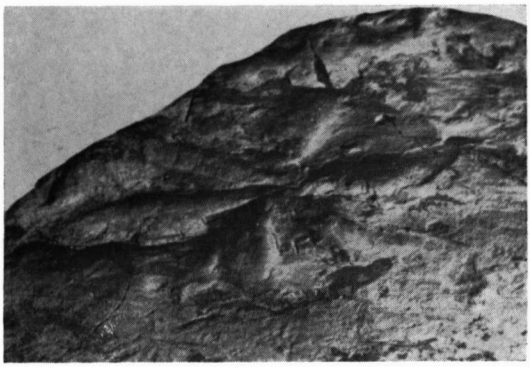

FIG. 20. *Volkichnium volki* PFEIFFER, *L.Ord.(Phycodes* beds), Ger.; ×1 (31).

Polyupsilon HOWELL, 1957 [**Tigillites habichi* LISSON, 1904]. U-shaped burrows with retrograde *Spreite*; according to GOLDRING (1962), synonym of *Diplocraterion* TORELL (16, 22). *U.Cret.*, USA(Colo.).

Prethocoprolithus ELLIOTT, 1962 [**P. centripetalus*]. Microcoprolites of cylindrical shape, resembling those of Recent gastropod genera *Patina, Trochus,* and *Gibbula* (12). *U.Jur.*, Iraq.

Priodictyon VYALOV & GOLEV, 1960 [no type species named]. Proposed for small honeycomb-like networks (=*Paleodictyon* MENEGHINI, 1850) on surfaces of strata, particularly of flysch (41).

Pseudarcella SPANDEL, 1909 [emend. LINDENBERG, 1965] [**P. rhumbleri*]. See LOEBLICH & TAPPAN in *Treatise,* p. C522; according to new investigations of LINDENBERG, 1965, p. 28, no protozoan (25). *L.Tert.(Oligo.)*, Ger.-Aus. (Fig. 17).

Rhabdoglyphus VASOEVICH, 1951 [**R. grossheimi*]. Straight strings encircled by ringlike knots in ± regular intervals; difficult to interpret as trace fossil (4, 19, 38). *U.Cret.-L. Tert.* (Flysch), USSR-Czech. (Fig. 18).

Sabellastartites DUDICH, 1962 [**S. arenaceus*]. Sandy tubes of sabellid polychaete worm resembling Recent genus *Sabellastarte* (10). *Tert.(Mio.)*, Hung.

Schaderthalis HUNDT, 1931 [**S. bruhmii* (*nom. van.*, no description, no diagnosis, figure only; trail)]. According to SEILACHER, 1960, identical with *Lophoctenium globulare* GÜMBEL, 1879 (23, 33). *Low.M.Dev.*, Ger. (Thüringen).

Skylonia H. D. THOMAS, 1961 [**S. mirabilis*]. Small spindle-shaped fossil, chambered, 2 mm. in length; systematic position unknown (37). *Tert.(L.Mio.)*, Afr. (Kenya) (Fig. 19).

Squamodictyon VYALOV & GOLEV, 1960 [**S. squamosum*]. Name proposed for a special form of *Paleodictyon* MENEGHINI reminiscent of overlapping fish scales (41). *L.Cret.* (Flysch), Pol.

Stelloglyphus VYALOV, 1964 [**S. turkomanicus*]. Large rosette-like trace fossils (grazing trails) consisting of about 25 very close "rays," without central smooth field, diameter about 7 cm. (33). *Perm.*, S.Afr.; *U.Cret. (Turon.)*, USSR(Turkmenistan-Crimea) (19, 40).

Treptichnus S. A. MILLER, 1889 [**T. bifurcus*]. Trail in form of zigzag feather-stitch pattern (see "feather-stitch trail" WILSON, 1948, in *Treatise*, p. *W*220, fig. 121,7) (27, 45). *L.Carb.*, USA(Ind.).

Tubotomaculum RUD. RICHTER [=*nom. nud.*, used in title of announced but never published paper (see GOMEZ DE LLARENA, 1949; p. 117, 127) (17).

Volkichnium PFEIFFER, 1965 [**V. volki*]. Starlike feeding burrows, about 5 cm. in diameter, consisting of

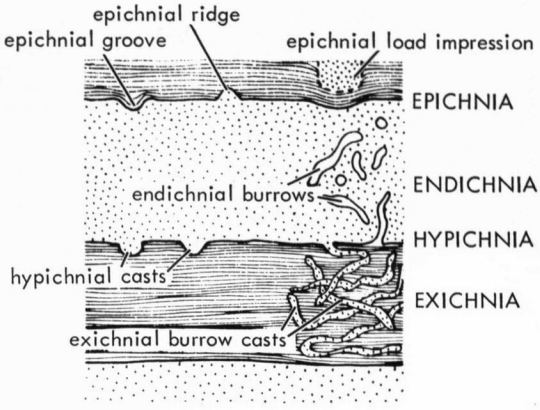

FIG. 21 "Stratinomic" classification of trace fossils proposed by A. MARTINSSON (1965) (26).

6 to 8 tunnel-shaped "rays"; vertical shaft not observed; very similar to *Bifasciculus* VOLK, 1960; obviously no surface trails but made inside sediment (31). *L.Ord.(Phycodes* beds), Ger. (Fig. 20).

COMMENTS ON NEWLY INTRODUCED TERMINOLOGIES

Most trace fossils are preserved in coarse clastic sediments and commonly are restricted to interfaces between pelitic (clayey) sediments and psammitic (coarser clastic) sediments. Terms representing a *"stratinomic" classification* have recently been proposed by MARTINSSON (1965, p. 202-203). They seem to be useful in defining any trace fossil from morphological and topographical viewpoints. These terms may be used in combination with common descriptive geological and ecological terms. They may also be used as adjectives and in the singular (Fig. 21).

Epichnia: Traces on surface of hard, usually coarse-grained bed.
Endichnia: Traces inside sediment (in German, *Innen-Spuren*).
Hypichnia: Traces on lower surface of psammite beds (sole trails).
Exichnia: Mainly burrows in pelitic sediments filled with psammitic sediment which has been introduced from outside.

MÜLLER (28) proposed the following ecological classification of trace fossils, offering synonyms for some categories previously named by SEILACHER (see *Treatise*, p. *W*181). They are:

Cibichnia: Eating (feeding) trails, subdivided into Fodinichnia SEILACHER, Mordichnia MÜLLER, and Pascichnia SEILACHER.
Cursichnia: Running trails; subgroup of the Movichnia.
Mordichnia: Biting and gnawing trails; subgroup of the Cibichnia.

Movichnia: Moving trails, including Repichnia SEILACHER, Cursichnia, Natichnia, and Volichnia.
Natichnia: Swimming trails, subgroup of the Movichnia.
Quietichnia: Resting trails, including Cubichnia SEILACHER and Domichnia SEILACHER.
Volichnia: Flying trails, subgroup of the Movichnia.

As recently shown by SEILACHER (34) ichnological interpretations must consider the taxonomic, the behavioral, and the preservational aspects. He has made some proposals to the "Committee for the Nomenclature of Sedimentary Structures" for a classification from the aspects of preservation and genetic interpretations. Among "biogenic sedimentary structures" (=trace fossils) he distinguishes:

1) *Semireliefs:* Either *"epireliefs"* on the top of a sandstone bed or *"hyporeliefs"* on the sole of a sandstone bed; both forms may be concave or convex.
2) *Full reliefs:* Either *"fills"* comparable to internal molds of shells or *"cavities"*=open burrows.
3) *Biodeformational structures:* Biogenic structures in sediments appearing as interruptions or deformations of the primary bedding.

Owing to the complexity of the trace fossil preservation these descriptive terms need to be qualified by additional words such as "exogene," "endogene," etc. In the paper mentioned above SEILACHER has given a chart of the relations between preservational processes and genetic and descriptive terminology. It contains all the genetic and descriptive terms proposed by him which seem necessary to distinguish the known preservational types.

In another recent paper on "biogenic sedimentary structures" SEILACHER (35) gave a short, but very good summary of trace fossils as paleontological objects, and as paleoecological guides. He also distinguishes three universal types of marine ichnofacies, named *Nereites-*, *Zoophycos-*, and *Cruziana*-Facies, representative of a sequence from deeper-water to shallow-water environment.

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