A C T A P A L A E O N T O L O G I C A P O L O N I C A
Vol. X 1965 No. 3

JERZY FEDOROWSKI

LINDSTROEMIIDAE AND AMPLEXOCARINIIDAE (TETRACORALLA) FROM THE MIDDLE DEVONIAN OF SKAŁY, HOLY CROSS MOUNTAINS, POLAND

Abstract. — Six species, of this number 2 new ones, and a new subspecies, all of them belonging to the family Lindstroemiidae Počta, as well as one species of the family Amplexocariniidae Różk., from the Lower-Givetian brachiopod shales from Skały, Holy Cross Mountains (Góry Świętokrzyskie), Poland, are described.

INTRODUCTION

The present elaboration is the second paper, dedicated to Givetian tetracorals from the brachiopod shales from Skały. In the first of them, by Różkowska (1956), the Thamnophyllidae were dealt with.

Corallites with an axial structure are described in the present paper. The material comprises over 300 specimens of simple corallites, assigned to 7 species and one subspecies which belong to 6 genera and 2 families.

The brachiopod shales are a complex of layers, belonging to Sobolev's (1904) classical section, Grzegorzowice-Skały-Włochy, which was investigated by Zeuschner (1869), Gürich (1896), Sobolev (1904), Pajchlowa (1957) and others. The brachiopod shales were not investigated by the present writer and, therefore, he finds it necessary to refer to the authors, mentioned above, as well as to Różkowska's work (1956). In addition to the descriptions of corallites, the history of the investigation and brief outline of the stratigraphy, as well as a map of this region are given by the latter author (Fig. 1).

The material studied comes from the collections of the Museum of Earth (Muzeum Ziemi), in Warsaw and was collected by Prof. Maria Różkowska, the Head of the Poznań Branch of the Palaeozoological Institute of the Polish Academy of Sciences. I would like to express her my gratitude for making this interesting material available, for many discussions as well as for critical remarks on the manuscript.

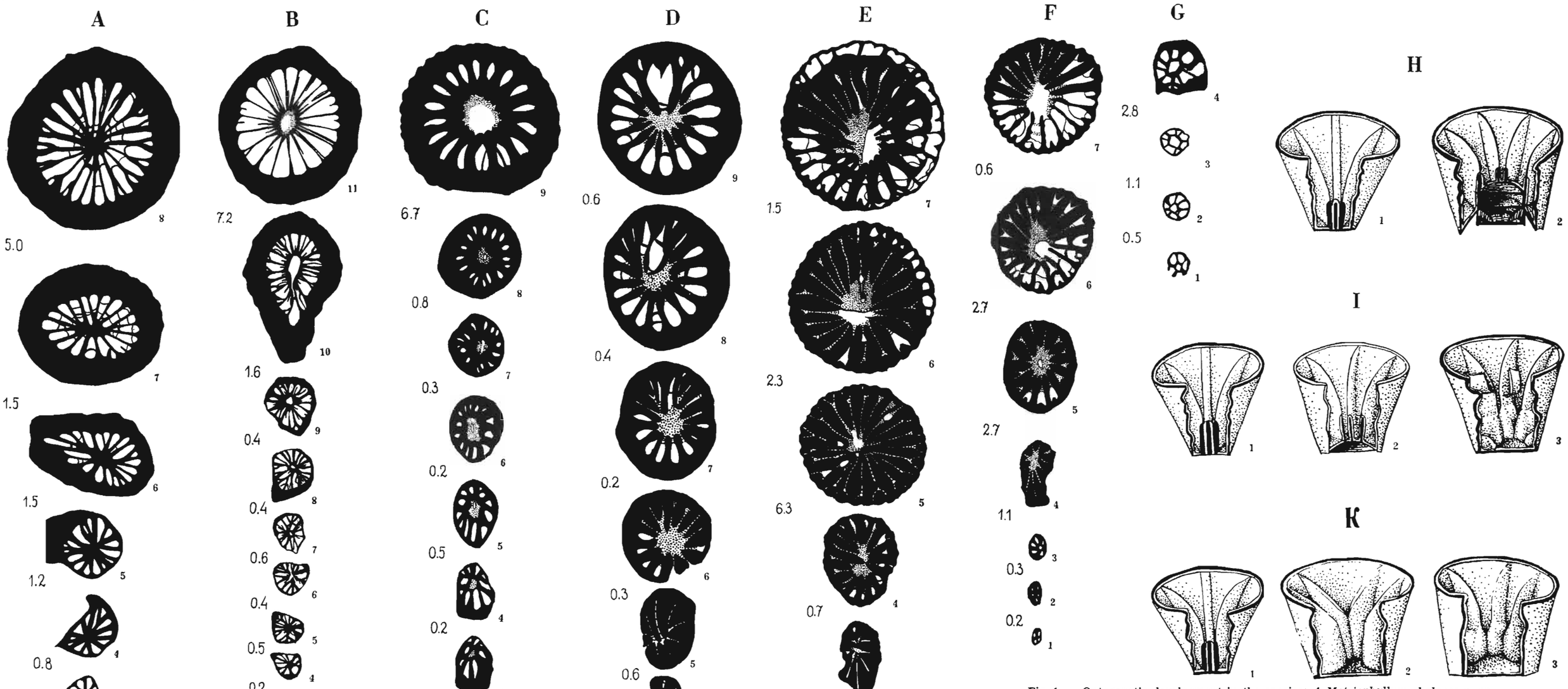


Fig. 1. — Ontogenetic development in the species: *A Metriophyllum skalense* n. sp., *B Metrionaxon accipiter* n.sp., *C Syringaxon bohemica bohemica* (Barrande), *D Stewartophyllum polonicum* (Sobolev), *E Blothrophyllum skalense* Gürich, *F Blothrophyllum skalense vesiculata* n.subsp., *G. Amplexocarinia tortuosa* (Phillips); *H* diagram of the formation of the axial tube in *Amplexocarinia*: H_1 septa connected in axis, H_2 septa reaching only the axial part of a tabula; *I* diagram of the formation of the axial tube in *Metrionaxon*: I_1 septa connected in axis, I_2 septa retreating from the axis but not forming a tube, I_3 septa connecting with each other with their thickened axial ends and forming an axial tube; carinae on septa; *K* diagram of the formation of an axial tube (aulos) in *Syringaxon*: K_1 septa connected in axis, K_2 septa, forming the aulos, by joining each other with their axial ends, K_3 axial parts of septa thickening and contacting each other with their sides.

SYSTEMATIC DESCRIPTIONS

Family **Lindstroemiidae** Počta, 1902

Diagnosis. — The septa, connected in the coral axis by their internal ends, form either a solid and protruding columella, or an elongated tube (Počta, 1902, p. 181, e.p.).

Remarks. — On the basis of the ontogenetic investigations, this family has been correctly started up again by Glinski (1963) who introduced to it the subfamily Metriophyllinae Hill, 1939 and, consequently, eliminated the family Metriophyllidae Hill, 1939. Besides, he turned attention to the similarity in the taxonomic positions of the genera *Metrionaxon* and *Syringaxon.*

On the basis of an exact analysis of the origin of the axial structure within this family, the present author believes that also the subfamily Blothrophyllinae Stumm, 1949, as well as Syringaxoninae n.subf. (fam. Hill, 1939) should be included in the family Lindstroemiidae Počta, 1902.

Subfamily **Metriophyllinae** Hill, 1939

Type genus: *Metriophyllum* Edwards & Haime, 1850

Diagnosis. — Small, simple Tetracoralla, forming their septa in a zaphrentoid manner. Horizontal carinae are situated on the septa which, in their early ontogenetic stages, are always connected to each other in the axis and, in later growth stages, either connected in a more or less compact pseudocolumella or empty axial tube (stereotheca sensu Grabau), or withdrawn far from the axis. Tabulae with a predominant tendency to the convex shape towards the distal end. Dissepimentarium lacking (Glinski, 1963, p. 323).

Remarks. — In the case when an axial tube occurs, it is formed by a usual retreat of the septa in the axis and a contact of their thickened axial ends which touch each other with their sides. This is the main ontogenetic character of this subfamily, differing it from the Syringaxoninae.

Genus *Metriophyllum* Edwards & Heime, 1850

Metriophyllum skalense n.sp.

(Text-figs. 1 A, 2, 3; Pl. I, figs. 1—4; Pl. IV, fig. 7)

Holotype: Specimen No. 218, Pl. IV, fig. 7.
Type locality: Skały, Holy Cross Mountains.
Type horizon: Brachiopod shales, Lower Givetian.
Derivation of the name: *skalense* — after the locality Skały.

Material. — Sixty eight simple corals.

Diagnosis. — *Metriophyllum* up to 10.5 mm. in diameter and with 22 major septa, arranged in systems. Carinae fairly rare, horizontal and visible mostly only in the longitudinal section. Tabulae almost vertical and turned towards the axis and upwards.

Description. — Corallites simple, conically curved, less frequently, straight, reaching 24 mm. in length. The surfaces of epithecae smooth or with septal grooves and, frequently, with prominent horizontal rings. Talons, sometimes, very strongly developed, sometimes, lacking. The calice to 6.7 mm. in depth, with steep, almost vertical walls, flat bottom and sharp edges. The calice is slightly penetrated by septa.

Transverse section (Text-fig. 1A_8; Pl. I, figs. 1—3; Pl. IV, fig. 7). The major septa are different in length, have thickened bases and axial ends, and are arranged in systems. They are connected in the axis, forming a pseudocolumella which is frequently thickened by an additional layer of stereozone. The cardinal septum, situated on the convex side of the corallite and the counterseptum, are equal to the remaining protosepta. Metasepta are correspondingly ever shorter. Carinae are, in general, rare, attached to the major septa and parallel to them. Minor septa are short, sometimes adhere to the bases of the major septa, or are marked only in the microstructure of the wall. Two minor septa, near the counterseptum, are long and equal to the major septa. The wall consists of the epitheca and of the thick, up to 1.2 mm., layer of stereozone.

Longitudinal section (Pl. I, fig. 4). Near the epitheca, tabulae are horizontal, with few accessory lamellae. Near the axis, they are inflected almost vertically upwards. This is the longest part of tabulae, reaching 3 mm. In the axial part, they are almost indistinguishable among the septa which are very densely disposed and form a pseudocolumella. Few carinae, embedded on the epitheca, serve as bases of the tabulae.

Ontogeny (Text-fig. 1 A_{1-8}). The youngest development stage investigated is 0.7 mm. in diameter and has all protosepta (Figs. 1 $A_{1,2}$) connected with each other in axis. Major septa are formed in such a manner that each alar septum and counterlateral septum has one metaseptum (Fig. 1 A_3). Successive metasepta are laid down unequally, that is, first, in the cardinal quadrants (Fig. 1 A_4) and then, in the opposite ones (Fig. 1 A_5). In this stage, 2 long minor septa appear near the counterseptum.

In the course of the further development (Figs. 1 $A_{6,7}$), metasepta are inserted almost simultaneously in all quadrants and the corallite diameter increases fairly quickly.

At the beginning of the ephebic stage (Fig. 1 A_8), the corallite reaches a full number of major septa and forms minor septa which appear almost simultaneously near all major septa, except for the cardinal septum, and adhere to them.

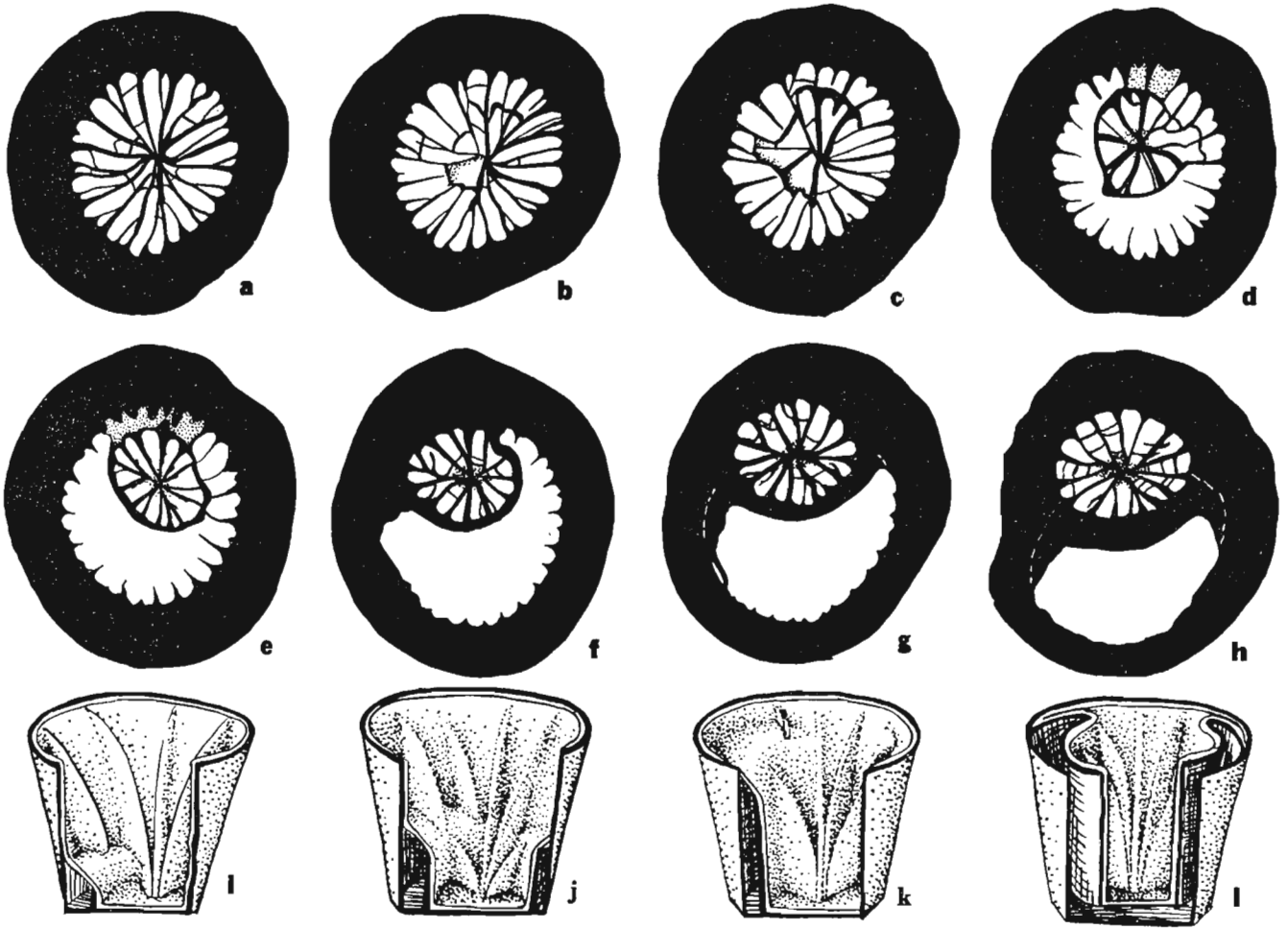


Fig. 2. — Rejuvenescence in *Metriophyllum*: *a—d* hysteronepionic stage with an incomplete development as in the blastogenesis, *e—h* neanic stage with a typical development as in the simple coral ontogeny, *i—l* schematic diagrams showing successive stages of the formation of a new epitheca, of a new septal apparatus and of leaving the old calice by the polyp.

Rejuvenescence (Text-fig. 2). The rejuvenescence is a form of the gemmation, often recorded in simple corallites. It is not the multiplication but a need of a considerable decrease in the dimensions of the body that evokes this phenomenon which is either a reaction to the change in local conditions, deteriorated but still not to such an extent as to cause the death of a given individual, or shedding a part of an overdeveloped skeleton and thus allowing the body for a new, more vigorous development.

The rejuvenescence starts in this species in the axial part of the corallite next to the counterseptum by the formation of a short section of the wall and by the withdrawal of a few septa from the axis (Figs. 2 a, b, i). The wall is laid down by the ectoderm of the body which, it seems, has separated from the epitheca in a similar manner as during the formation of marginal vesicles. At first it is also stretched between the septa (Figs. 2 b, i).

Septa are either separated from the axis, or divided into the disappearing peripheral sections and axial parts which continue to develop in a bud. Of the protosepta, only the counterlateral septa are not parts of the bud; in addition to four protosepta, a few metasepta remain in it. The septa, separated from the axis and the peripheral parts of the septa, separated, by a new wall, from those, developing in the bud, do not grow which — during the observation of successive sections — gives the impression as if they disappear (Figs. 2 e-h).

A new wall, separating the bud, can be fully closed (Fig. 2d) but, finally, it always coalesces, along the short part, with the old one (Figs. 2 e, f). Its microstructure also changes and a layer of stereozone is added to the epitheca. From the length of the septa, decreasing upwards in the old calice, as well as from successive sections of the bud, it seems (Figs. 2 d-h), that the body, lining the old calice, was separating from it gradually upwards. Finally, it was remaining only at the very edge of it in the form of a stretched membrane (Fig. 2k, corresponding with transverse section 2f). At last, it gradually separated from it and withdrew to the new calice-bud (Fig. 2 l, transverse sections 2 g, h). It is testified to by the structure of the wall near the bud in which the new and old epitheca coalescence lines, marked in sections 2 g, h with a dotted line, are visible. In this stage, it was probably only in this place, except, of course, for the new calice-bud (Fig. 2 l), that narrow body folds remained.

Perhaps, in this manner the corallite got rid of a part of the skeleton which, under given conditions, appeared to be overdeveloped and, maybe, resorbed a part of soft tissues, gaining a possibility to continue its existence in decreased dimensions.

It is worth mentioning that, following the comparison of Fig. 1A, showing the successive stages of the ontogenetic development, and Figs.

2 a-d, presenting successive stages of the rejuvenescence, the courses of both these processes are, at first, completely different. It is only since the formation of a new, decreased septal apparatus in the new calice-bud that its development has become identical with that of a normally developing simple corallite.

Individual variation. — Certain morphological differences are displayed by individuals of this species. The specimen No. 79 (Pl. I, fig. 1) differs to the greatest extent from the holotype since although with the same diameter, it has a larger number of major septa, many distinct carinae and incomplete minor septa. Perhaps, it should be excluded from the species under study.

The remaining specimens differ from the holotype in a more or less distinct arrangement of the septa in systems which results in the cardinal fossula being outlined in a different degree of distinctness. The minor septa near the counterseptum may considerably differ in length (Pl. I, figs. 2, 3). The remaining minor septa may be distinctly separated or adhere to major septa. Sometimes, they are visible only in the microstructure of the wall.

Remarks. — The species discussed differs from the remaining representatives of this genus: 1) primarily in very few carinae which, sometimes, are invisible in transverse section, 2) in very steep and highly raised periaxial parts of tabulae, 3) in absolute diameters and number of septa, as well as in a ratio of those values.

Genus *Metrionaxon* Glinski, 1963

Metrionaxon schlueteri Glinski, 1963

(Text-fig. 3; Pl. I, figs. 7, 8; Pl. III, fig. 1)

1904. *Metriophyllum gracile* Schlüter; D. Sobolev, Devonskija otloženija..., pp. 45, 46, Pl. 5, fig. 5; Pl. 7, figs. 2, 3.

1963. *Metrionaxon schlueteri* Glinski; A. Glinski, Neue Gattungen der Metriophyllinae..., pp. 325—328, Text-figs. 1—3, Pl. 45, Figs. 1—2 (cum synon.).

Material. — Sixty eight mostly well-preserved specimens.

Remarks. — The specimens investigated are, both morphologically and in their measurable characters, mostly very similar to the holotype but, in general, they are slightly smaller. Usually, they have 14—15 major septa, this figure only exceptionally reaching 16 (as in the holotype). Minor septa, also near the counterseptum, usually lacking. It seems that these are mostly not quite mature specimens. Their ontogenetic development is identical with that in *M. accipiter* n.sp., described below.

Occurrence. — This species has been identified on the basis of the material from the Eifelian and Lower Givetian of Germany. In Poland, it was erroneously described by Gürich (1896) and Sobolev (1904) as *Metriophyllum gracile* Schlüter from the Givetian of Skały, that is, the same locality which the specimens described here come from.

Metrionaxon accipiter n.sp.
(Text-figs. 1 B, 1 I, 3; Pl. I, figs. 5, 6; Pl. III, fig. 2; Pl. IV, fig. 1)

Holotype: Specimen 314, Pl. I, fig. 5; Pl. IV, fig. 1.
Type locality: Skały.
Type horizon: Brachiopod shales, Lower Givetian.
Derivation of the name: Lat. *accipiter* — with carinae bent like a hawk's beak.

Material. — Forty six simple corallites.

Diagnosis. — Metrionaxon with a 6.0—8.5 mm. diameter. Eighteen to twenty major septa. Very prominent carinae, hook-like in transverse section, less frequently, parallel to the septa. An incomplete number of short minor septa.

Description. — Corallites small, to 24 mm. in length, conical and slightly bent near the proximal end. The ornament of the epitheca slight or lacking at all. Talons poorly developed. Calice with vertical walls, flat bottom and sharp edge, 4—6 mm. in depth depending on a corallite's dimensions.

Transverse section (Pl. I, fig. 5; Pl. III, fig. 2). Owing to a mostly strong, oval elongation of the axial tube, the bilateral symmetry is distinct. Major septa equalling each other in length, usually S-shaped, thin, only in the wall of the axial tube and at the base slightly thickened. No systems. Sometimes, even the cardinal- and counterseptum cannot be distinguished from the metasepta. The cardinal septum is usually situated in the extension of the longitudinal axis of the axial tube. Many, very prominent carinae, mostly bent in a hook-like manner towards the axial tube, sometimes connected with it. Now and then, they are parallel to the septa, equalling them in length and thickness, and run from the epitheca to the axial tube which results in the number of septa being sometimes difficult to settle. Minor septa very short, incomplete in number and without carinae. Axial tube mostly thickened by a stereozone layer.

Longitudinal section (Pl. I, fig. 6; Pl. IV, fig. 1). It is very similar to the longitudinal section of the type species, being characterized by: 1) a strong, thick-walled axial tube with equally thickened, axial parts of tabulae, and 2) thickened axial parts of major septa and their carinae. Peripheral parts of tabulae, few, very thin, slanting upwards and towards the corallite axis.

Ontogeny (Text-figs. 1 B, 1 I). Protosepta are formed successively (Fig. 1 B_{1-3}), similarly as metasepta whose growth, in the younger neanic stage, is very quick. At first, septa are disposed radially and connected with each other in axis (Fig. 1 B_{1-5}). At the end of this stage carinae appear (Fig. 1 B_5), blurring the picture of the process during which new metasepta are formed.

An axial tube is formed by two stages: 1) First, septa are parting in axis (become shorter). This is the only stage (except for the initial

ones) in which the protosepta may be distinguished and in which it may be found that in principle only these protosepta were connected with each other in axis (Fig. B_6). 2) The wall of the axial tube is formed by thickening and by the connection of the axial ends of the septa and their carinae around a fissure in axis, formed in the previous stage (Figs. 1 B_{7-12}, 1 I_3). Clearly, then, in this place, septa contact each other by their sides.

A further development consists in a harmonious increase in the calice diameter and in the number of septa, with a bilateral system of septa being retained.

Individual variation. — The amplitude of the variation of measurable characters is not very high (Fig. 3 also comprises the dimensions of the late-neanic stage), fluctuating within limits of 2—3 major septa and 3 mm. diameter of the calice. The morphological differences are mostly expressed in the quantitatively different ratio of hook-like carinae and those, parallel to the septa. Hook-like carinae are usually more abundant. The more or less oval shape of the axial tube, the thickness of the epitheca and number of major septa are also variable.

Remarks. — This species is similar to *M. schlueteri* Glinski from which it only differs in: 1) larger absolute dimensions and greater number of septa, 2) very strongly developed, hook-like carinae, 3) frequent, S-shaped bend of major septa. Both these species are most similar to each other in their longitudinal section.

Subfamily **Syringaxoninae** Hill, 1939
[nom. transl. Fedorowski, herein (ex Syringaxonidae Hill, 1939)]

Type genus: *Syringaxon* Lindström, 1882.

Diagnosis. — Simple corals with their septa connected to each other in axis in the early-neanic and nepionic stages. In the further ontogeny, the axial tube is formed by the axial ends of major septa bent towards each other. In the ephebic stage, the axial tube is closed, or it may be open towards the cardinal fossula and formed by thickened axial ends of major septa, touching each other with their sides. The dissepimentarium lacking.

Remarks. — This is a subfamily which, until recently, has been considered an independent family. In its morphology, microstructure and general ontogenetic development trend (cf. also Glinski, 1963), it is closely associated with the Metriophyllinae from which it differs mostly in the manner of forming the axial tube, that is, the aulos. In the first stage, its septa do not retreat simply from the axis as is the case, for instance, in *Metrionaxon* Glinski but they are bent to each other and connected by axial ends (Fig. 1 K_2). *Paralleynia* Soshkina, 1936, from the Lower

Permian of the Ural Mountains, still remains in this stage. In the next ontogenetic stage, the septa become rhopaloid and join each other, forming the aulos which may be open towards the cardinal fossula as, for instance, in the genus *Stewartophyllum* (Fig. 1 D_9).

Genus *Syringaxon* Lindström, 1882

Syringaxon bohemica bohemica (Barrande, 1865)

(Text-figs. 1 C, 1 K, 3; Pl. II, figs. 1—8)

1938. *Syringaxon bohemica bohemica* (Barrande); F. Prantl, Some Laccophyllidae..., pp. 23—26; Text-fig. 1; Pl. 1, fig. 1, Pl. 3, figs. 1—4 (cum synon.).

Material. — Thirty two specimens. Simple corals, mostly deprived of calices and proximal parts. A detailed macroscopic description has been given by Prantl (1938).

Discription. — The *Syringaxon* 5.5—8.5 mm. in diameter and with 17—18 long major septa. Two considerably elongated minor septa, $^1/_3$—$^1/_2$ of the length of major septa, are situated near the counterseptum. The aulos with mostly small inside diameter, thick wall, oval in shape.

Affinities and differences. — a) *Morphology*: Plate II presents different morphological types which, despite their considerable variability, are assigned to the same species because they occur in the same layer and in the same region, as well as because of the existence of transitory forms between them. The greatest differences between them are recorded: 1) in the length of minor septa which may occur only in the wall (Pl. II, fig. 3) or reach to $^3/_4$ of the length of major septa; 2) in the thickness of axial ends of major septa — from very thick (Pl. II, figs. 1, 2, 7) to only slightly rhopaloid (Pl. II, fig. 6) in which it is even difficult to distinguish the aulos since septa are connected with each other not directly but through the stereozone; 3) in stereozone which may fill up the aulos tube almost completely (Pl. II, figs. 2,6), or it is lacking at all (Pl. II, figs. 4, 5). In view of the variability observed, it seems that many species of this genus, described in literature, make up only one of the manifestations of the individual variation.

b) *Ontogeny* (Text-fig. 1): The ontogeny has been investigated by Butler (1935), Prantl (1939), Flügel & Free (1962). Two ontogenetic stages are differentiated by these authors, that is: 1) the brephic and early-neanic stage in which septa join each other in axis, similarly as in the *Metriophyllum* (Figs. 1 $C_{1,2}$, 1 K_1), and 2) the late-neanic and ephebic stage in which the aulos is formed (Figs. 1 C_{3-9}, 1 $K_{2,3}$).

The attention has been paid to a detail which, in the present writer's opinion, is important, that is to the formation of the aulos which is different than, for instance, in *Metrionaxon*. In this case, septa do not simply retreat from the axis, but their axial ends first bend to each other and then connect (Figs. 1 C_{3-6}, 1 K_2). It is only at the end of the neanic

stage, that septa become fully rhopaloid and connected in the axial part by their sides (Figs. 1 $C_{8,9}$, 1 K_3). The differences, observed in the formation of the aulos in *Metrionaxon* and in *Syringaxon* are shown in diagrams, presented in Figs. 1 F and 1 K.

Occurrence. — This species has been so far known from the Hlubočepy Limestone, Czechoslovakia.

Genus *Stewartophyllum* Busch, 1941
Stewartophyllum polonicum (Sobolev, 1904)
(Text-fig. 1 D; Pl. III, figs. 3—8)

1904. *Zaphrentis polonica* Sobolev; D. Sobolev, Devonskija otloženija..., pp. 46, 47, Pl. 6, figs. 6, 7, 7a.

Material. — Six mostly incomplete specimens, deprived of calices and proximal ends. The surface of the epitheca smooth, sometimes, with thick transverse rings.

Description. — Corallites 7—9 mm. in diameter, with 18 rhopaloid major septa, forming an axial tube open towards the cardinal fossula. At the end of the ontogeny, an incomplete number of minor septa in the wall.

Transverse section (Pl. III, figs. 4, 7). Major septa, strong, with thickened peripheral and axial ends, form a large, oval axial tube, thickened by a layer of the stereozone and open towards the cardinal fossula. The cardinal septum strongly shortened. In the latest ontogenetic stages, minor septa appear in the wall. They do not penetrate to the inside of the corallite. The septotheca is thick.

Longitudinal section (Pl. III, figs. 5, 8). Tabulae are incomplete, with accessory plates, raised in a domelike manner, reaching the stereotheca and thickened within the axial tube (Pl. III, fig. 8 — section in a plane parallel to the cardinal septum). The tabular fossula occurs here.

Ontogeny. — The first development stages do not differ at all from those, described here in other genera (Text-fig. 1 $D_{1,2}$). Hereafter, the protosepta become very thick, fill up the entire interior of the corallite and connect with each other by their axial ends and by their sides. In this stage (Fig. 1 D_{3-5}), the growth of the metasepta is very slow. The cardinal septum elongates, which is a character of the neanic stage. During the subsequent development, there occurs a rapid shortening of the septa whose axial ends simultaneously incline to each other, or thicken and join, forming a tube, filled up with the stereozone (Figs. 1 $D_{6,7}$). Unfortunately, due to a complete development, the coalescence of the septa into an axial tube by bending of the axial ends, which also is characteristic of the genus *Syringaxon,* does not occur in the sections presented here as distinctly as in other ones, available to the present author.

At the end of the neanic stage, a deep cardinal fossula is formed, bordered by shortened and coalescent axial ends of the major septa (Figs. 1 $D_{7,8}$; Pl. III, fig. 6). The ephebic stage begins together with shortening of the cardinal septum (Fig. 1 D_9 and, particularly, Pl. III, fig. 3).

Individual variation. — A species with a stabilized morphology. The most important difference is manifested in the fact that the minor septa appear not in all the corallites.

Remarks. — A species, described by Sobolev (1904) from the crinoid limestone from Skały, overlying the brachiopod shales. One of the specimens, cited by him, is 2 mm. bigger and has 5 more septa than the corallite, described in the present paper. Another — is identical. The transverse section, presented by Sobolev (Pl. VI, fig. 7a) is very similar. The longitudinal section is drawn not in the axis and, therefore, it is different (Pl. VI, fig. 7).

In the occurrence of short minor septa in the wall, observed in the ephebic stage, *S. polonicum* (Sobolev) approaches slightly *S. intermittens* (Hall) from the Middle Devonian of North America. It differs from it in considerably smaller diameters, lower number of septa and stronger thickening of septa in the stereotheca. They are distinctly rhopaloid.

So far, representatives of this genus have not been described from Europe.

Subfamily **Blothrophyllinae** Stumm, 1949

Type genus: Blothrophyllum Billings, 1859.

Diagnosis. — Simple corallites with repeatedly occurring contractions. In the early ontogeny, septa are connected in axis and, later on, connected with each other by their thickened axial ends, forming an axial tube (stereotheca sensu Grabau, 1922). In the ephebic stage, the axial tube disappears. The dissepimentarium, consisting of dissepiments and marginal vesicles, appears. There are major and minor septa. On the convex side, the cardinal septum may be shortened. The tabulae are trapezoid-convex in shape.

Remarks. — A subfamily, assigned by Stumm (1949) to the family Bethanyphyllidae, erected by him (1949) and, by Hill (1956) to the family Spongophyllidae Dybowski (1873). However, since the Blothrophyllinae have a completely different structure and development than Zaphrentidae Milne-Edwards & Haime, 1850 (according to Hill, 1956 = ?Bethanyphyllidae Stumm), these assignments seem to be erroneous. Since, between these families and subfamilies, there are no common characters in the ontogeny, the morphological characters common with

the Spongophyllidae such as, for instance, marginal vesicles, seem to be only convergent.

The ontogenetic development, investigated by the present author in *Blothrophyllum* (Figs. 1 E, 1 F), distinctly indicates a close affinity of the subfamily Blothrophyllinae to the Syringaxoninae from which it differs only in having the dissepimentarium. It is worth mentioning that the nepionic and almost the entire neanic stage are here nearly identical as those in *Syringaxon* or in *Stewartophyllum*.

It is a firm belief of the present writer that the genus *Nicholsoniella* Soshkina, 1952, having almost identical ontogenesis, should be also assigned to the subfamily Blothrophyllinae. However, the development of *Nicholsoniella* Soshkina, 1952, is stopped in the stage of one row of dissepiments which corresponds with the older neanic stage of *Blothrophyllum skalense* Gürich.

Genus *Blothrophyllum* Billings, 1859
Blothrophyllum skalense Gürich, 1896
(Text-figs. 1 E, 3; Pl. V, figs. 1—5)

1896. *Blothrophyllum skalense* Gürich; G. Gürich, Das Paläozoicum..., pp. 173—176, Pl. 4, figs. 1a-c, 7a-b, 8a-b.
1948. *Blothrophyllum skalense* Gürich; M. Różkowska, Korale Dewońskie..., p. 202, fig. 11.

Material. — Thirty three specimens of simple corallites, mostly without proximal ends and calices and with damaged epithecae.

Description. — *Blothrophyllum* 10—12.5 mm. in diameter and with 20—26 major septa, thickened in tabularium. Cardinal septum shortened. Marginal vesicles met with only rarely.

Transverse section (Pl. V, figs. 1, 2). Epitheca undulate, thin. Major septa long, undulate, do not reach the axis of the corallite. In the tabularium, particularly in cardinal quadrants, they are more conspicuously thickened, sometimes, separated from the epitheca. Major septum short, thickened, counter septum equalling all remaining major septa. Minor septa short, sometimes incomplete, do not penetrate the tabularium. Sometimes they are divided into sections or, in the form of ridges, occur on the epitheca.

Dissepimentarium broader on the side of the cardinal septum. Near the counterseptum mostly only one ring of dissepiments. Marginal vesicles small, occur seldom.

Longitudinal section (Pl. V, figs. 4, 5). Dissepiments and marginal vesicles are steeply or even vertically disposed, slightly convex. In the young part of the corallite, the tabularium's structure approaches that of *Syringaxon*, that is the axial ends of septa form the axial tube in which the axial part of tabulae are horizontally disposed. The peripheral parts of tabulae are slanting upwards to the axial tube (Pl. V, fig. 5).

In the mature part of the corallite where septa do not connect with each other, tabulae are complete, trapezoid-convex, with few accessory plates in axis and in periphery. The tabular fossula is indistinct.

Ontogeny (Text-fig. 1 E). — The first stage investigated (Fig. 1 E_1) has 6 thickened protosepta, connected in axis, and a talon. It is in a very early stage that protosepta retreat from the axis, joining the axial ends, bent towards them, and form a distinct axial tube (Fig. 1 E_2). This is also a short-lasting stage since, together with the appearance of the first metasepta, septa become wedge-shaped and coalesce with each other by

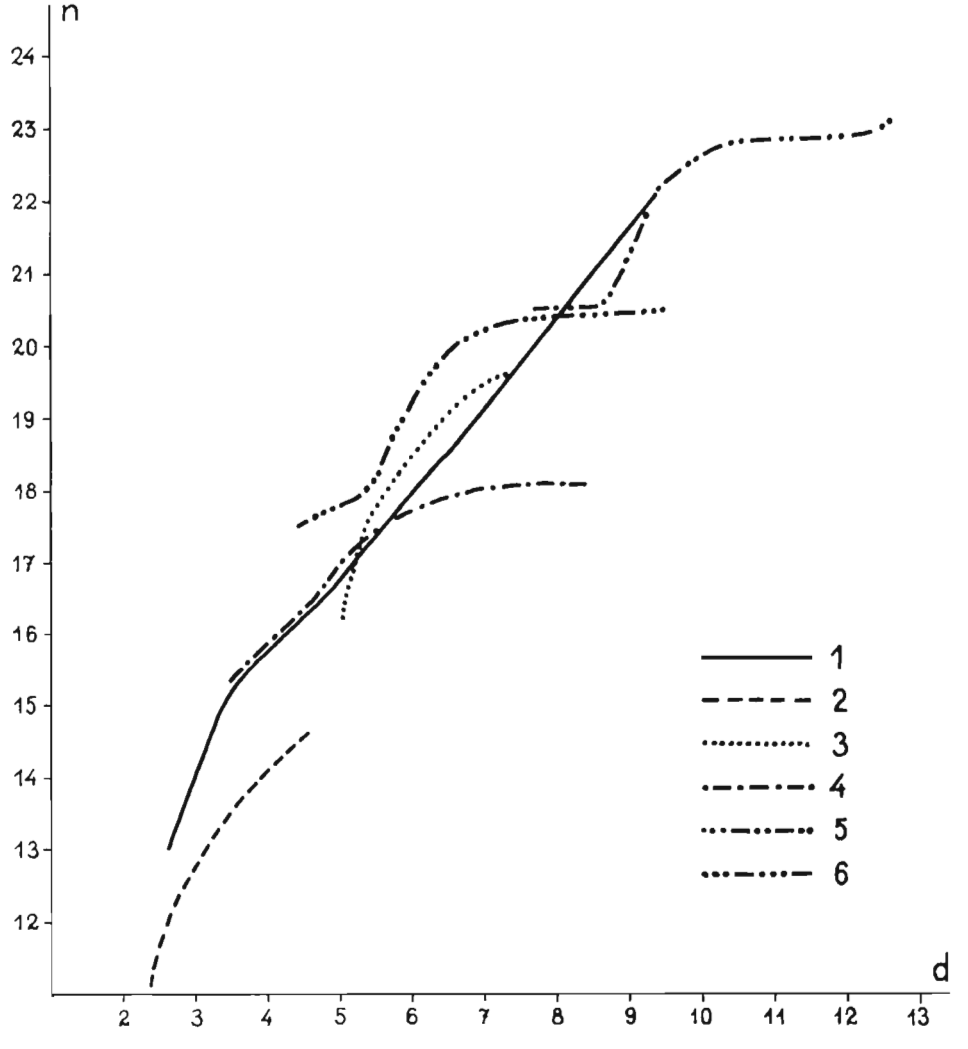


Fig. 3. — Curves of correlation of the number of septa (*n*) and of the diameter of the calice (*d*) for the species *Metriophyllum skalense* n.sp. (*1*), *Metrionaxon schlueteri* Glinski (*2*), *Metrionaxon accipiter* n.sp. (*3*), *Syringaxon bohemica bohemica* (Barrande) (*4*), *Blothrophyllum skalense* Gürich (*5*) and *Blothrophyllum skalense vesiculata* n.subsp. (*6*).

their sides, while the axial part of the corallite is being filled up by the stereozone (Fig. 1 $E_{3,4}$).

In the course of a further development (Fig. 1 E_5), all minor septa appear simultaneously and new major septa are observed to grow quickly. The previously compact mass of stereozone, filling up the axial part of the corallite, now retracts and forms only thickened, axial parts of tabulae (Fig. 1 E_{5-7}).

At the end of the neanic stage (Fig. 1 $E_{6,7}$), a dissepimentarium appears, first in the cardinal quadrants. It may also happen that some minor septa become subject to breaking or shortening. The thickness of major septa is differentiated. In cardinal quadrants they may be thicker even in the ephebic stage.

Individual variation. — A considerable variation of this species is manifested: 1) by the rate of the development since different degrees of advancement in the morphological development are shown with the same diameter; 2) by the structure of the dissepimentarium which may be different in width and may be built either with the participation of the marginal vesicles and dissepiments or dissepiments only; 3) by the structure of major septa whose axial parts, in different individuals, are thickened to a different degree, sometimes this thickening is distinct in cardinal quadrants as, for instance, in the Carboniferous genus *Caninia* M'Coy; 4) by the structure of minor septa which may slightly penetrate the dissepimentarium, reach its boundary or occur as ridges on the epitheca; they are complete or broken. The amplitude of the variation of measurable characters is represented by a curve, drawn in Fig. 3.

Remarks. — This species differs from the type species (*B. decorticatum* Billings) in only slightly emphasized specific characters. Morphologically it is rather nearer the Frasnian representatives of the genus *Tabulophyllum* Fenton & Fenton from which, as it has been found by the present author who compared serial sections, it differs in a completely dissimilar ontogeny.

Occurrence. — This species, described by Gürich (1896) from the Givetian of Skały, is, thus far, known only from this locality. Apart from Gürich's species, this genus is known only from North America.

Blothrophyllum skalense vesiculata n.subsp.
(Text-figs. 1 F, 3; Pl. V, fig. 6; Pl. VI, figs. 1—7)

Holotype: Specimen No. 102, Pl. VI, fig. 1, Text-fig. 1 F.
Type locality: Skały, Holy Cross Mountains.
Type horizon: Brachiopod shales, Lower Givetian.
Derivation of the name: Lat. *vesiculatus* — having vesicles.

Material. — Eighty one specimens. Corallites conical, straight or curved. Transverse growth rings and vertical septal grooves distinctly

visible on the epitheca. Specimens without calices and, mostly, without proximal ends. Epitheca frequently weathered.

Diagnosis. — *Blothrophyllum* 6.5—10 mm. in diameter and with 19—20 major septa, frequently separated from the epitheca. Cardinal septum frequently not shortened. Minor septa vanishing. Dissepimentarium narrow.

Transverse section (Pl. V, fig. 6; Pl. VI, figs. 1 and 3—6). Epitheca thin, undulate. Major septa sinuous, not reaching the axis, dilated in the tabularium and, yet more, in the cardinal quadrants. They may have thickened bases and rhopaloid axial ends. Frequently, they are separated from the epitheca. Cardinal septum shortened or equalling other major septa. Minor septa short, always incomplete, only in exceptional cases, slightly penetrate the tabularium.

Dissepimentarium, somewhat broader near the cardinal septum, consists of 1—3 rings of dissepiments and marginal vesicles which may comprise more than a half of the corallite's circumference.

Longitudinal section (Pl. VI, figs. 2, 7). Dissepiments and marginal vesicles are disposed steeply or vertically and are flat-convex in shape. Tabulae mostly complete, trapezoid-convex in shape, with very few accessory plates, sometimes, form a tabular fossula. In the young part, similarly to *B. skalense,* described above, the structure of the tabularium is identical as that in *Syringaxon.*

Ontogeny (Fig. 1 F). — Protosepta are inserted by pairs and connect each other in axis (Fig. 1 $F_{1,2}$). The axial tube is formed as early as in the protoseptal stage. A further development is quite like that, described above in *B. skalense* Gürich. The fact that, in this subspecies, the dissepimentarium appears only in the mature form, makes up the main difference.

Individual variation. — A great morphological differentiation is displayed by this subspecies: 1) dissepimentarium different in width, without marginal vesicles, with fine vesicles only, or with huge and flat vesicles; 2) major septa complete or separated from the epitheca, uniformly thickened in the tabularium, or thicker in cardinal quadrants, rhopaloid or wedge-shaped; 3) cardinal septum shortened or equalling the remaining major septa; 4) minor septa in various stages of reduction, complete, divided into sections or in the form of spines setting on the epitheca.

Remarks. — The subspecies described is related with the species *B. skalense* through a few individuals with intermediary morphological characters and dimensions. It differs from it in: 1) absolute dimensions of most specimens and in the ratio of the number of septa to the diameter of the calice (Fig. 3); 2) in a considerably more frequent occurrence of the marginal vesicles which, sometimes, are big; 3) in a stronger reduction of minor septa; 4) in the dissepimentarium which, in general, is nar-

rower and appears only in mature specimens, while, in *B. skalense,* it is observed as early as in the neanic stage.

Family **Amplexocariniidae** Różkowska (in MS)

Diagnosis. — Solitary corallites, less frequently budding, with a structure in the axial part, formed by axial parts of the tabulae (Cyathotheca sensu Grabau, 1922).

Remarks. — In this family, the axial tube is formed in a quite different manner than in Lindstroemiidae Počta, 1902. In its representatives, it is already the protosepta that part from the axis and connect with the box-like axial parts of the tabulae which, subsequently, are also joined by the metasepta. Thus, the axial tube is made up not by the septa but only by the tabulae (Fig. 1 $H_{1\,2}$).

Subfamily **Amplexocariniinae** Soshkina, 1941
Genus *Amplexocarinia* Soshkina, 1928
Amplexocarinia tortuosa (Phillips, 1841)
(Text-figs. 1 G, 1 H; Pl. IV, figs. 2—6)

1841. *Amplexus tortuosus* Phillips; J. Phillips, Descriptions of the fossils..., p. 8, Pl. 3, fig. 8.
1896. *Diphyphyllum intermedium* Gürich; G. Gürich, Das Paläozoicum..., pp. 188—190, Pl. 2, figs. 4 a—c.
1963. *Amplexocarinia tortuosa* (Phillips); S. Smith & H. D. Thomas, On Amplexus coralloides Sowerby..., pp. 165—167, Pl. 8, figs. 1 a-c (cum synon.).

Material. — Twenty seven solitary corallites. Specimens damaged, without the calices and proximal parts.

Description. — *Amplexocarinia* with corallites 5—7 mm. in diameter and to 24 major septa. Septa not always reaching the axial tube. Sometimes, minor septa in the wall.

Transverse section (Pl. IV, figs. 2—5). The external wall consists of the epitheca and septotheca or it may be only the epitheca with a different thickness, more frequently, thin and mostly, smooth. Major septa amplexoid, mostly undulate. Sometimes, in particular when not connected with the axial tube, they are slightly rhopaloid.

Minor septa occur only in specimens with a thicker external wall and are, always, incomplete in number. Sticking in the wall, they are visible only as small protuberances. The axial tube not always complete, particularly so in ontogenetically older individuals. Near the calice, its line is broken.

Longitudinal section (Pl. IV, fig. 6). Tabulae are divided into two distinct zones, a peripheral zone, slanting upwards, sometimes with accessory plates and an axial zone. Axial parts of the tabulae are dis-

posed in a box-like manner one upon another. They are flat and have a form, characteristic of this genus.

Ontogeny. (Text-figs. 1 G, 1 H). — No complete specimen could be found in the material elaborated. The youngest stage investigated, 0.7 mm. in diameter, although having only the protosepta, has already the axial tube. One may only state, therefore, that the axial tube appears in this genus in an exceptionally early stage of its ontogeny.

Individual variation. — The presence or absence of major septa and the thickness, as well as the structure of the external wall, related with them, are the most important differences between particular individuals. In the case of the existence of minor septa, this wall consists of the epi- and septotheca. The number of septa, although slightly different in particular specimens, is correlated with the calice diameter. Likewise, the length of the septa depends on the width of the axial part of the tabularium.

Remarks. — The corals described do not differ, in their principal characters, from the holotype of Phillips (1841, Pl. 3, fig. 8). From other species, in particular from *A. muralis* Soshkina, related to them, they differ mostly in larger dimensions and considerably higher number of septa.

These corallites are in conformity with the specimens, described by Gürich (1896) from Skały as *Diphyphyllum intermedium* Gürich. He mentions a slightly lower number of septa and, erroneously, describes the peripheral parts of the tabulae as the dissepiments. The specimens, illustrated by Gürich (1896, Pl. 2, figs. 4 a—c) as *D. intermedium* should, in the present writer's opinion, be assigned to *A. tortuosa* (Phillips).

Sobolev (1904) identified this form similarly as Gürich. He describes it from the crinoid and *Calceola* limestones from Skały, that is the limestones directly over- and underlying the brachiopod shales the specimens from which are described in the present paper.

This species is known from the Middle Devonian of Plymouth and Newton Abbot, Devon, South England, and from Skały.

GENERAL CONCLUSIONS

A rich tetracoral fauna from the Skały brachiopod shales consists mostly of small forms which do not exceed 3 cm. in length and have very thick epithecae, provided with talons. The specimens are mostly undamaged, without any traces of rolling and, therefore, they probably occur in situ. A relatively solid structure with small dimensions of individuals, as combined with the pelitic fraction of the sediment, allow one to guess a very quiet living condition. The formation of the

sediment was bound to be slow since, otherwise, the structure of the corallites would be lighter and their length greater.

A complete lack of the colonial tetracorals and stromatoporoids may testify to crossing of a certain depth limit. Thus, this environment seems to be a quiet, averagely deep sea with a slow sedimentation and without colonial forms which require better ecological conditions.

The corallites, discussed in the present paper, are known either from Skały only, or from previous elaborations in which their age has not been accurately determined. It is difficult, therefore, to base on them any exact stratigraphic consideration. It is only the age of *Metrionaxon schlueteri* Glinski 1963 that has been strictly given as the Eifelian and Lower Givetian of Germany. The *Macgeea*, elaborated by Różkowska (1956) from Skały, is a genus that has been known only since the Givetian. Perhaps, a supposition may, therefore, be accepted that the brachiopod shales are of the Lower Givetian age.

Palaeozoological Institute
of the Polish Academy of Sciences
Poznań Branch,
Poznań, December, 1964

REFERENCES

BUSCH, D. A. 1941. An ontogenetic study of some rugose corals from the Hamilton of Western New York. — *J. Paleont.*, **15**, 4, 392—411, Menasha.

BUTLER, A. J. 1935. On the Silurian coral Cyathaxonia siluriensis M'Coy. — *Geol. Mag.*, **72**, 116—123, London.

DEMBIŃSKA-RÓŻKOWSKA, M. 1949 (1948). Korale dewońskie Gór Świętokrzyskich (Les Zoanthaires dévoniens du massif de Ste-Croix). — *Wiad. Muz. Ziemi*, **4**, 187—220, Warszawa.

EDWARDS, H. M. & HAIME, J. 1851. Monographie des polypiers fossiles des terrains paléozoïques. — *Arch. Mus. Hist. Nat.*, **5**, 1—502, Paris.

FLÜGEL, H. & FREE, B. 1962. Laccophyllidae (Rugosa) aus dem Greifensteiner Kalk (Eifelium) von Wiede bei Greifenstein. — *Palaeontographica*, **119**, A, 222—247, Stuttgart.

GLINSKI, A. 1963. Neue Gattungen der Metriophyllinae (Rugosa) aus dem Devon des Rheinlandes. — *Senckenberg. Lethaea*, **44**, 321—339, Frankfurt a.M.

GÜRICH, G. 1896. Das Paläozoicum im Polnischen Mittelgebirge. — *Verh. Russ. K. Min. Ges.*, **32**, 1—539, St. Petersburg.

HALL, J. 1843. Geology of New York, Pt. IV, Survey of the fourth geological district, Albany. 209—210.

HILL, D. 1939. Western Australian Devonian corals in the Wade collection. — *J. Roy. Soc. West. Australia*, **25** (8), 141—151, Brisbane.

— 1956. Rugosa. *In*: Moore, R. C. Treatise on Invertebrate Paleontology, Pt. F: Coelenterata. — *Geol. Soc. Amer. Univ. Kansas Press*, 233—327, Lawrence.

LINDSTRÖM, G. 1882. Anteckningar on silurlagren pa Carlsoarne. — *Offers. K. Vet. Akad. Förhandl.*, **39**, 5—30, Stockholm.

PAJCHLOWA, M. 1957. Dewon w profilu Grzegorzowice-Skały. Z badań geologicznych regionu świętokrzyskiego, II (The Devonian in the Grzegorzowice-Skały section). — *Inst. Geol., Biul.*, **122**, 2, 145—254, Warszawa.

PHILLIPS, J. 1841. Figures and descriptions of the Palaeozoic fossils of Cornwall, Devon and West Somerset. — *Geol. Surv. Gt. Britain a. Ireland*, XII + 1—231, London.

POČTA, F. 1902. Anthozoaires et Alcyonaires, T. II, VIII. *In:* J. Barrande, Système silurien du centre de la Bohême. Pt. I, Recherches paléontologiques. Prague.

PRANTL, F. 1938. Some Laccophyllidae from the Middle Devonian of Bohemia. — *Ann. Mag. Nat. Hist.*, **11**, 2, 18—41, London.

RÓŻKOWSKA, M. 1956. Pachyphyllinae from the Middle Devonian of the Holy Cross Mts., Pt. I (Pachyphyllinae ze środkowego dewonu Gór Swiętokrzyskich, Cz. I). — *Acta Palaeont. Pol.*, **1**, 4, 271—330, Warszawa.

— 1965. Korale fameńskie Gór Świętokrzyskich (in MS).

SCHOUPPÉ, A. & STACUL, P. 1959. Säulchenlose Pterocorallia aus dem Perm von Indonesisch Timor (mit Ausnahme der Polycoelidae). Eine morphogenetische und taxonomische Untersuchung. — *Palaeontographica, Suppl.* **4**, 4, 197—359, Stuttgart.

SMITH, S. & THOMAS, H. D. 1963. On Amplexus coralloides Sowerby and some Ampleximorph corals from the English Devonian. — *Ann. Mag. Nat. Hist.*, **13**, 6, 161-172, London.

SOBOLEV, D. 1904. Devonskija otloženija profilja Grzegorzowice-Skały-Włochy. — *Izv. Varš. Polit. Inst.*, 1—107, Varšava.

SOSHKINA, E. 1928. Nižnepermskie (artinskie) korally zapadnogo sklona Severnogo Urala. — *Bull. Mosk. Obšč. Ispyt. Prir.*, **36**, 339—393, Moskva-Leningrad.

—, DOBROLYUBOVA, T. & PORFIRIEV, G. 1941. Permskie Rugosa evropejskoj časti SSSR. — *Izd. Akad. Nauk. SSSR*, V, **3**, 1, 1-304, Moskva-Leningrad.

STUMM, E. C. & WATKINS, J. L. 1961. The metriophylloid coral genera Stereoelasma, Amplexiphyllum and Stewartophyllum from the Devonian Hamilton Group of New York. — *J. Paleont.*, **35**, 3, 445—447, New York.

ZEUSCHNER, L. 1869. Geognostische Beschreibung der mittleren devonischen Schichten zwischen Grzegorzowice und Skały-Zagaje bei Nowa Słupia. — *Ztschr. deutsch. geol. Ges.*, **21**, 263—247, Berlin.

JERZY FEDOROWSKI

LINDSTROEMIIDAE I AMPLEXOCARINIIDAE (TETRACORALLA) Z ŚRODKOWEGO DEWONU SKAŁ (GÓRY ŚWIĘTOKRZYSKIE)

Streszczenie

Opisano koralowce czteropromienne, cechujące się specjalną strukturą osiowej części kielicha, należące do rodzin Lindstroemiidae Počta i Amplexocariniidae Różkowska (MS).

Z pierwszej z tych rodzin zbadano 6 gatunków i 1 podgatunek, należące do 5 rodzajów. Z rodziny drugiej opisano 1 gatunek.

Budowę większości opisanych form zbadano na podstawie szlifów seryjnych i w ten sposób wyjaśniono również ich rozwój ontogenetyczny.

Z rodzaju *Metriophyllum* zbadano ponadto przebieg zjawiska odmłodzenia i kolejne stadia blastogenezy.

Wprowadzono 3 następujące nowe jednostki taksonomiczne:

Metriophyllum skalense n.sp.

Diagnoza. — Korality o średnicy do 10,5 mm i do 22 septów I rzędu ułożonych w systemy. Kariny dość rzadkie, poziome, widoczne przeważnie tylko w przekroju podłużnym. Tabule w części przyosiowej prawie pionowe, zwrócone ku osi i ku górze.

Metrionaxon accipiter n.sp.

Diagnoza. — Korality o średnicy kielicha 6,0 — 8,5 mm. Septa I rzędu w liczbie 18—20. Bardzo wydatne kariny, w przekroju poprzecznym hakowate, rzadziej równoległe do septów. Niepełna liczba krótkich septów II rzędu.

Blothrophyllum skalense vesiculata n.subsp.

Diagnoza. — *Blothrophyllum* o średnicy 6,5 — 10,0 mm i 19—22 septach I rzędu, często oddzielonych od epiteki. Septum główne często nieskrócone. Septa II rzędu zanikające. Dissepimentarium wąskie.

ЕРЖИ ФЭДОРОВСКИ

LINDSTROEMIIDAE и AMPLEXOCARINIIDAE (TETRACORALLA) ИЗ СРЕДНЕГО ДЕВОНА МЕСТНОСТИ СКАЛЫ (СВЕНТОКРЖИСКИЕ ГОРЫ, ПОЛЬША)

Резюме

В настоящей работе дано описание четырехлучевых кораллов, характеризующихся особенным строением осевой части чашки, принадлежащим к семействам Lindstroemiidae Počta и Amplexocariniidae Różkowska (MS).

В первом из вышеупомянутых семейств изучено 6 видов и 1 подвид, принадлежащих к 5 родам. Из второго семейства дано описание 1 вида. Строение большинства описанных форм изучено в ориентированных сериальных шлифах, что сделало возможным выяснить их онтогенетическое развитие. В роде *Metrophyllum* изучено также процесс омоложения и последовательные стадии бластогенезиса. Дано описание 3 новых таксономических единиц.

Metriophyllum skalense n. sp.

Диагноз. — Кораллиты, до 10,5 мм в диаметре, имеют не больше 22 септ первого порядка уложенных в системы. Карины довольно редкие, горизон-

тальные, выступающие по большей части исключительно в продольном разрезе. Днища поблизости осевой колонны почти вертикальные, повернутые к осевой колонне и к верху.

Metrionaxon accipiter n. sp.

Диагноз. — Диаметр чашки кораллитов равняется 6,0 — 8,5 мм. Септы первого порядка в числе 18—20. Карины очень явственные, в поперечном разрезе крючковатые, реже параллельные к септам. Неполное число коротких септ второго порядка.

Blothrophyllum skalense vesiculata n. subsp.

Диагноз. — *Blothrophyllum* 6,5 — 10,0 мм в диаметре. Число септ первого порядка, часто отделенных от эпитеки, колеблется от 19 до 22. Главная септа часто несокращена. Септы второго порядка исчезающие. Диссепиментариум узкое.

PLATES

Plate I

Figs. 1—3. *Metriophyllum skalense* n.sp., transverse sections: Fig. 1 — specimen No. 79, Fig. 2 — specimen No. 41, Fig. 3 — specimen No. 231.

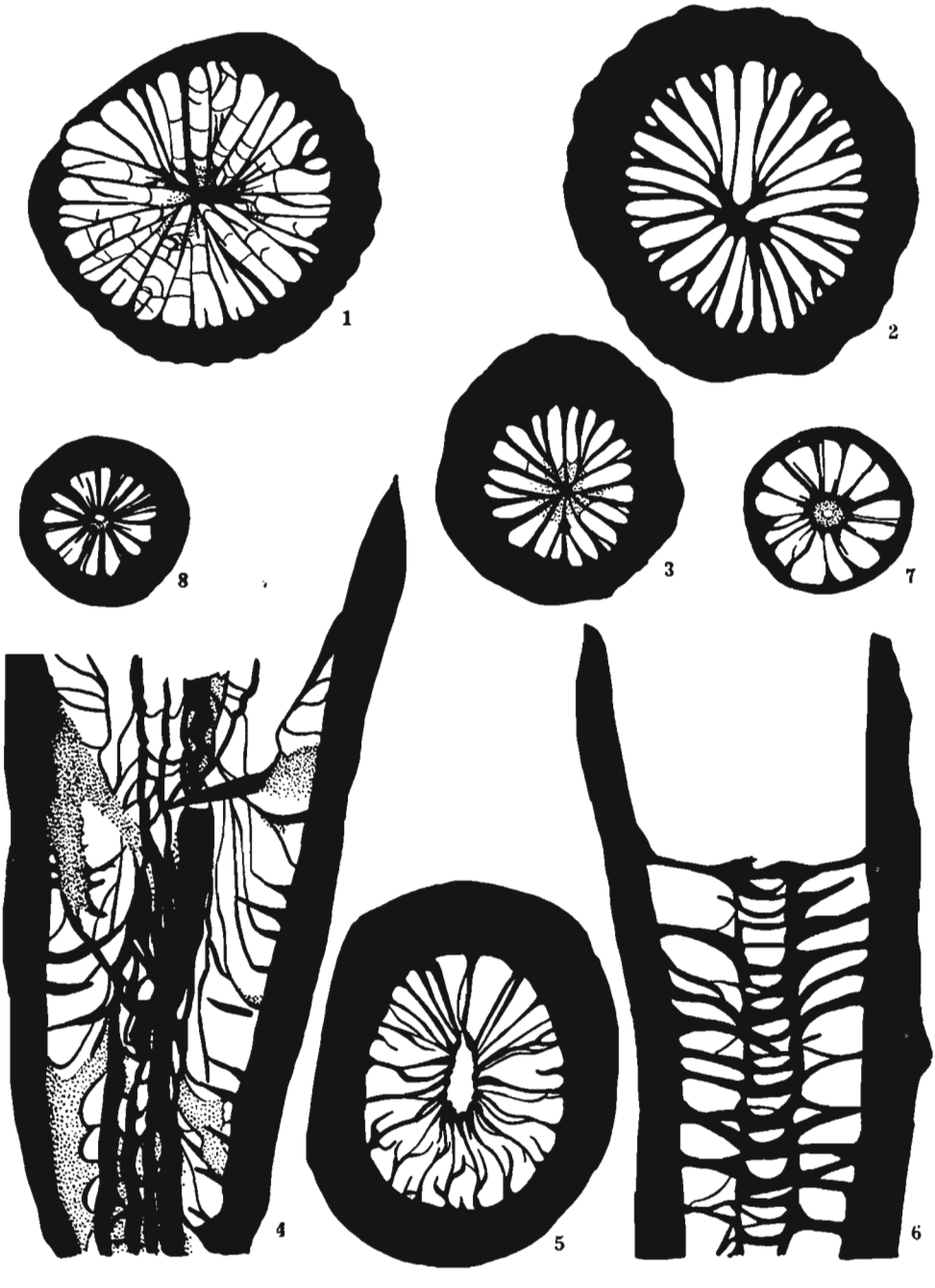
Fig. 4. *Metriophyllum skalense* n.sp., longitudinal section of the specimen No. 7.

Fig. 5. *Metrionaxon accipiter* n.sp. transverse section of the specimen No. 314 (holotype).

Fig. 6. *Metrionaxon accipiter* n.sp., longitudinal section of the specimen No. 321.

Figs. 7, 8. *Metrionaxon schlueteri* Gliński, transverse sections: Fig. 7 — specimen No. 75, Fig. 8 — specimen No. 78.

All figures × 10


1
2
3
8
7
4
5
6

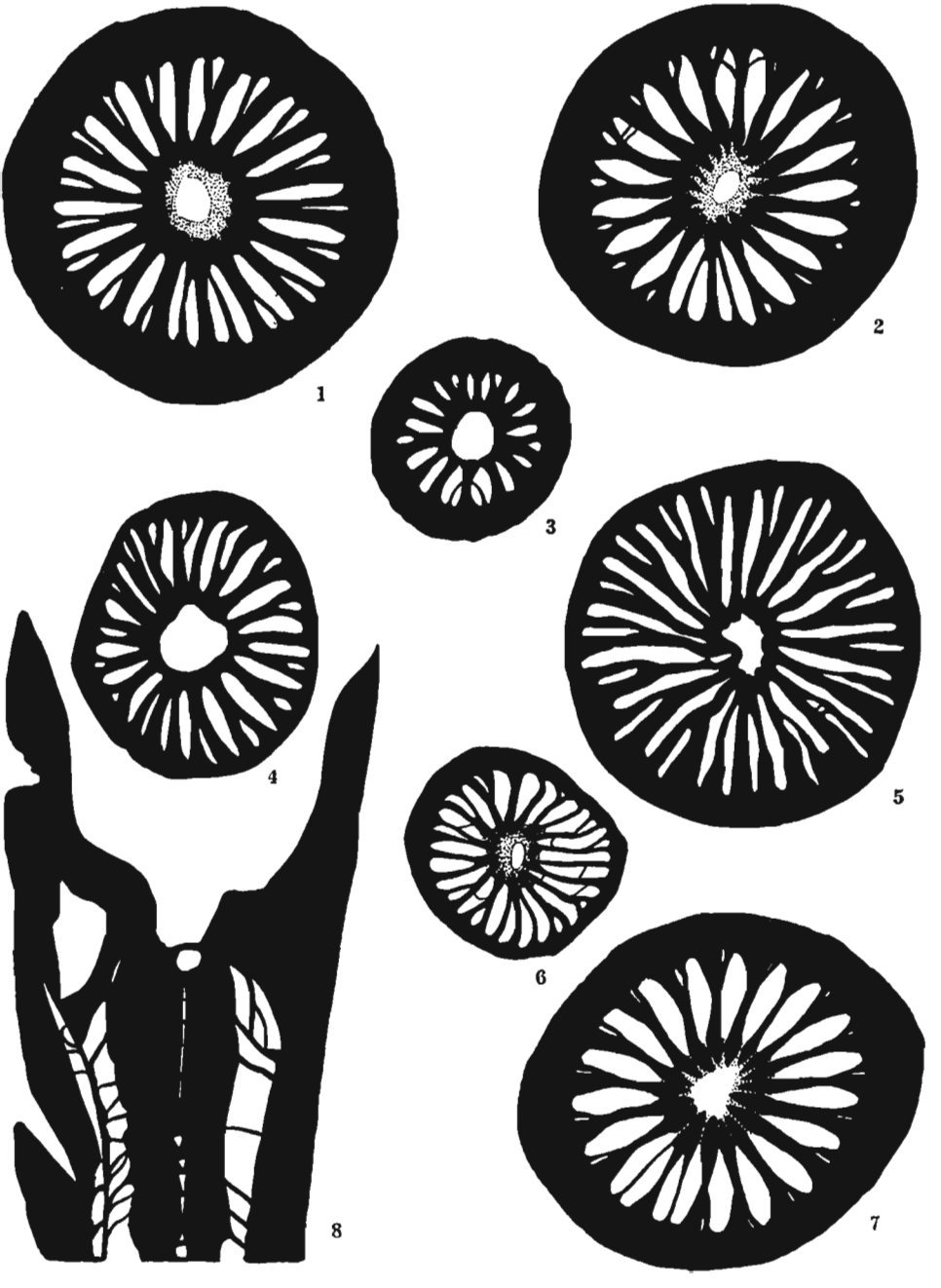

1
2
3
4
5
6
7
8

Plate II

Figs. 1—7. *Syringaxon bohemica bohemica* (Barrande), transverse sections: Fig. 1 — specimen No. 221, Fig. 2 — specimen No. 5, Fig. 3 — specimen No. 271, Fig. 4 — specimen No. 48, Fig. 5 — specimen No. 360, Fig. 6 — specimen No. 349, Fig. 7 — specimen No. 361.

Fig. 8. *Syringaxon bohemica bohemica* (Barrande), longitudinal section of the specimen No. 38.

All figures × 10

Plate III

Fig. 1. *Metrionaxon schlueteri* Glinski, transverse section of the specimen No. 223.

Fig. 2. *Metrionaxon accipiter* n.sp., transverse section of the specimen No. 322.

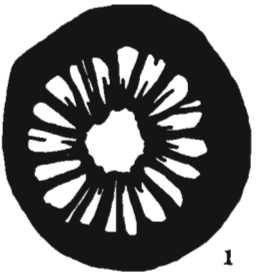
Figs. 3—5. *Stewartophyllum polonicum* (Sobolev), specimen No. 81: Figs. 3 and 4 — transverse sections of different stages of the ontogeny, Fig. 5 — longitudinal section.

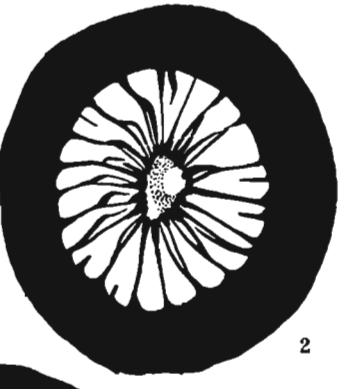
Fig. 6. *Stewartophyllum polonicum* (Sobolev), transverse section of the specimen No. 46.

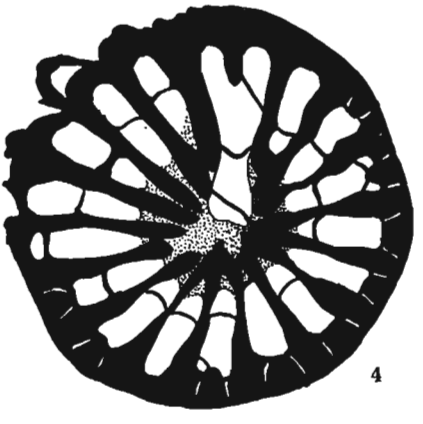
Figs. 7, 8. *Stewartophyllum polonicum* (Sobolev), specimen No. 255: Fig. 7 — transverse section, Fig. 8 — longitudinal section in the plane parallel to the cardinal septum.

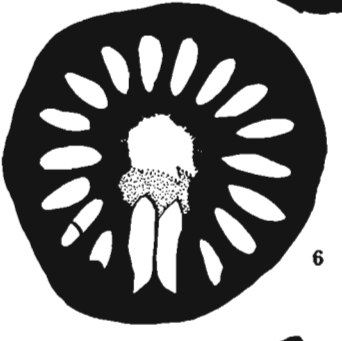
All figures × 10


3

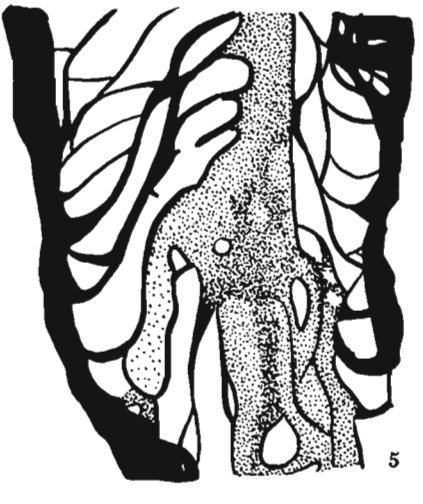

1

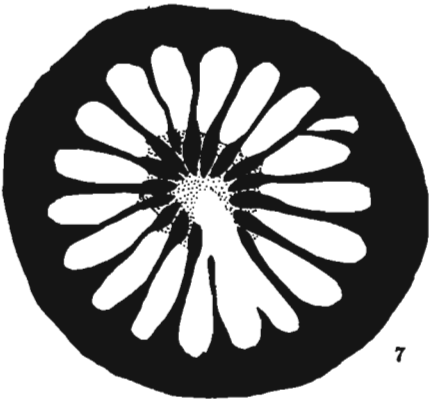

2

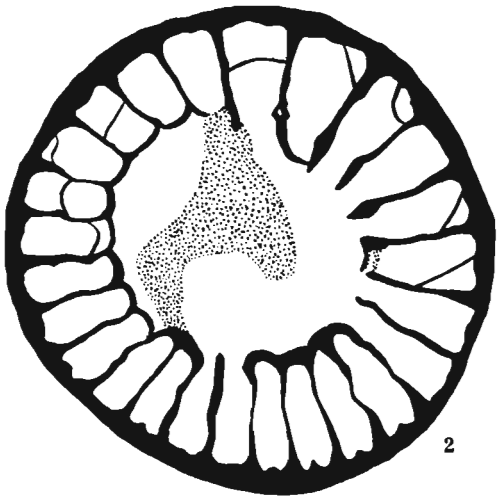

4

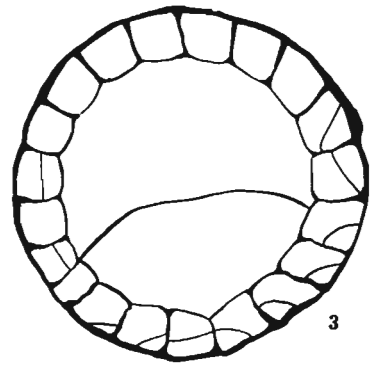

6

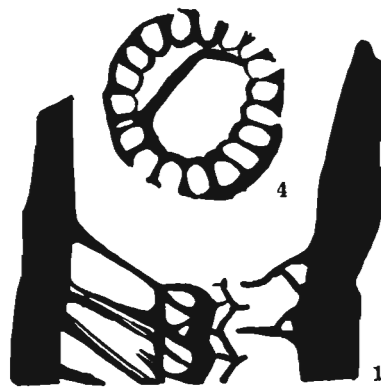

8

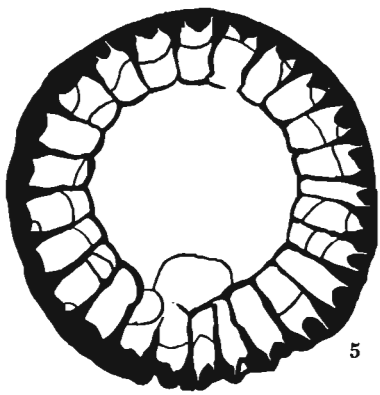

5

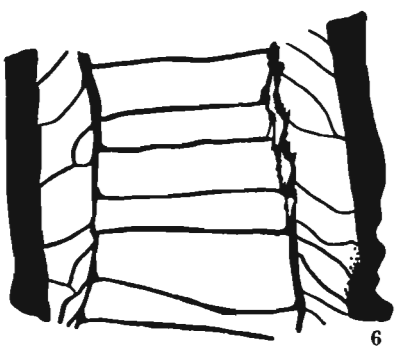

7


2


3


4
1


5


6

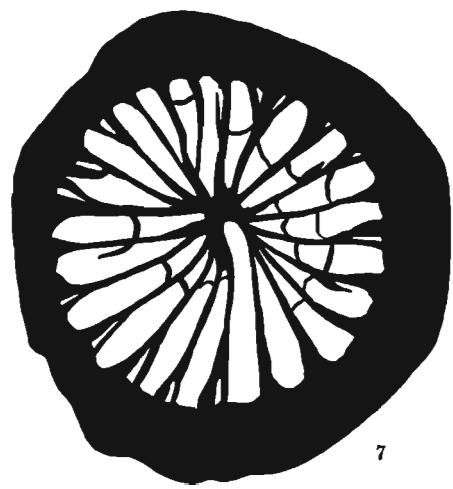

7

Plate IV

Fig. 1. *Metrionaxon accipiter* n.sp., specimen No. 314, longitudinal section; holotype.

Figs. 2—4. *Amplexocarinia tortuosa* (Phillips), transverse sections: Fig. 2 — specimen No. 442, Fig. 3 — specimen No. 422, Fig. 4 — specimen No. 433.

Figs. 5, 6. *Amplexocarinia tortuosa* (Phillips), specimen No. 438: Fig. 5 — transverse section, Fig. 6 — longitudinal section.

Fig. 7. *Metriophyllum skalense* n.sp., specimen No. 218, transverse section; holotype.

All figures × 10

Plate V

Figs. 1, 2. *Blothrophyllum skalense* Gürich, transverse sections: Fig. 1 — of the specimen No. 128, Fig. 2 — of the specimen No. 103.

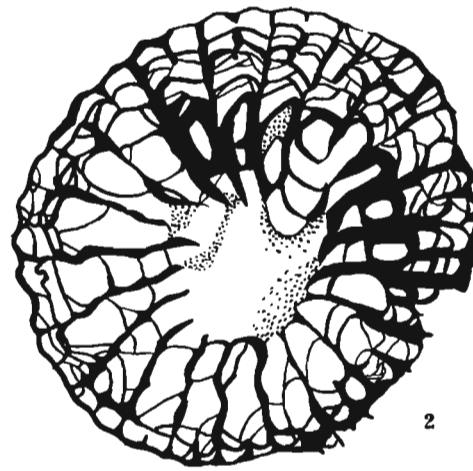
Fig. 3. *Blothrophyllum skalense* Gürich, transverse section of the late-neanic stage of the specimen No. 167.

Figs. 4, 5. *Blothrophyllum skalense* Gürich, longitudinal sections: Fig. 4 — of the specimen No. 141, Fig. 5 — of the specimen No. 454.

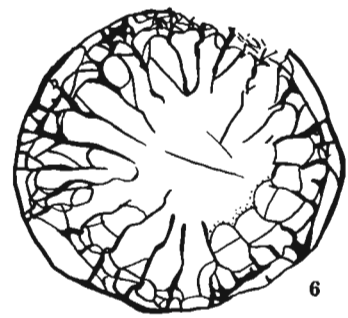
Fig. 6. *Blothrophyllum skalense vesiculata* n.subsp., transverse section of the specimen No. 187.

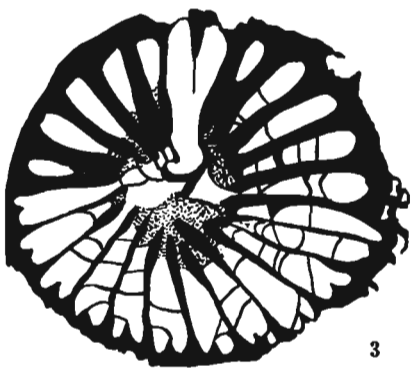
All figures × 6

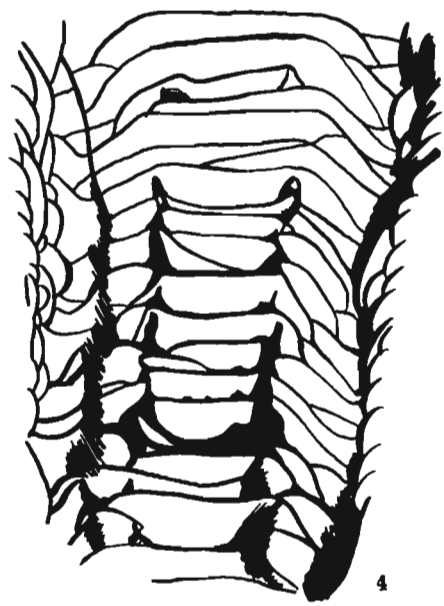

1


2

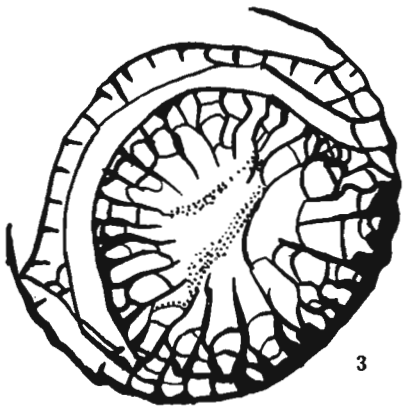

5

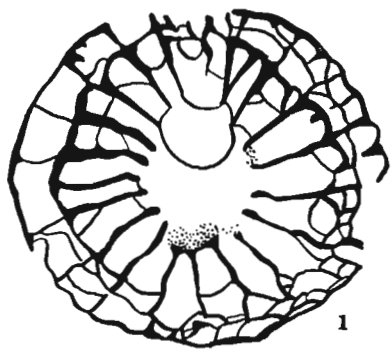

6


3


4


2


3


1


4


6


5


7

Plate VI

Fig. 1. *Blothrophyllum skalense vesiculata* n.subsp., transverse section of the specimen No. 102; holotype.

Figs. 2. 3. *Blothrophyllum skalense vesiculata* n.subsp., specimen No. 445: Fig. 3 — transverse section; Fig. 2 — longitudinal section.

Figs. 4—6. *Blothrophyllum skalense vesiculata* n.subsp., transverse sections: Fig. 4 — of the specimen No. 139; Fig. 5 — of the specimen No. 193, Fig. 6 — of the specimen No. 211.

Fig. 7. *Blothrophyllum skalense vesiculata* n.subsp., longitudinal section of the specimen No. 165.

All figures × 5