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REDESCRIPTION OF THE ORIGINAL COLLECTION OF *ZAPHRENTIS CALYCULUS* MILLER, 1891, RUGOSA

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The type material of the Tournaisian *Zaphrentis calyculus* from the Miller's (1891) collection, redescribed by Easton (1944) has been re-investigated. The better preserved specimens are assigned to 5 species and 5 genera (among them *Rotiphyllum diutinum* sp. n., *Petraia* (?) *milleri* sp. n. and *Patularima* gen. n.). Some forms are described in open nomenclature. The taxa are discussed in terms of morphology, ontogeny, intraspecific variability and relationships. Environmental and/or genetic control of straight, widely-flaring and horn shapes and of stereoplasmic infilling is discussed.

Key words: Rugosa, morphology, ontogeny, taxonomy, environment, Carboniferous, Tournaisian.

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INTRODUCTION

Difficulties in the interpretation of relationships of Lower Visean corals from Spain (Fedorowski and Kullman, in preparation) and the superficial similarity of some Easton's (1944) drawings of North American rotiphylla to some corals studied by us made at least the brief restudy of Easton's specimens necessary. My visit to the Institute of Sedimentary and Petroleum Geology, Calgary, Alberta, Canada in 1986 provided a good opportunity for that task. The originals studied by Easton (1944), housed at the Cincinnati University Museum and kindly provided to me by Professor David L. Meyer for the restudy, appeared to be more complex than I had expected. The paper was thus completed at the A. Mickiewicz University in Poznań, Poland, because a special thinsectioning technique was necessary.

All but one corallite considered by Easton (1944) as belonging to *Rotiphyllum* were restudied. None of those specimens was thinsectioned either originally by Miller (1891) or later on by Easton (1944). None was peeled, but some were ground. Unfortunately, the morphology of tips and/or calices missing because of grinding by the authors mentioned above, have not been documentated by illustrations and must be omitted from the interpretation. The longitudinal grinding of some specimens, continued too far by those authors made them useless for further study. Their re-identifications were thus omitted from this study, or were established with restrictions. Only some better preserved ones were re-illustrate.

Preservation of the internal morphology of vast majority of corallites is very poor due to either the silicification or the dolomitization, or both combined. Also, calices of only a few corallites were available for the study. Thus, the photographic documentation is restricted, and is replaced by drawings. Some portions of the thin sections are uncertain, and were sometimes objects to the subjective interpretation of structures poorly seen in drawings. The revision presented herein should therefore be treated tentatively. The most uncertain portions of drawings were marked by dashed lines and were left white. Dotted axial areas not always mean filling in with the stereoplasm. The uncertain morphology of these areas is separately mentioned together with explanations to figures. Most of the specimens restudied were illustrated at least by transverse sections made just beneath calices. The detailed descriptions of species that follow are only seldom referred to those of Easton (1944), because the generic and species concept of the present paper differs greatly from that of the former author. The separate detailed description has thus been chosen as more proper.

The stratigraphic position of the fauna has not been reinterpreted in this paper. All remarks in this respect were either cited from Miller (1891) or from Easton (1944). Citations in checklist or similar papers were not considered in the synonymy of given taxa.

Acknowledgments. — I would like to express my thanks to Professor David L. Meyer, Department of Geology, University of Cincinnati, Ohio, for his kind loan of the collection for restudy and for the premission to section the specimens. I am also indebted to Mrs. M. Bartkowiak, Mr. E. Chwieduk and Mr. R. Wojciechowski, all from the Department of Geology, A. Mickiewicz University, Poznań, Poland for preparing thin sections and peels for taking photographs, and making some drawings. The paper was in part granted by the Polish Academy of Sciences.

SYSTEMATIC PART

Subclass **Rugosa** Milne-Edwards et Haime, 1850
Order **Stauriida** Verrill, 1865
Suborder **Metriophyllina** Spassky, 1965
Family **Petraiidae de Koninck**, 1872
Genus *Petraia* Münster, 1839

Remarks. — The diagnosis and alleged synonymy of the genus were omitted for the reasons that follow. The commonly accepted concept of the genus *Petraia* Münster, 1839 is based mainly on the paper by Schindewolf (1931). Weyer (1980) expressed some doubts to that concept, but Hill (1981) followed the earlier solutions. In his letter of July 2, 1987 Dr. D. Weyer kindly informed me about his new study on the lectotype of *Petraia decussata* Münster, 1839, i.e. the type species of the genus. Illustrations of that Upper Famennian specimen provided to me for comparison left no doubts as to its difference from the traditionally understood *Petraia* on one side and its similarity to *Neaxon* Kullmann, 1965 on the other. Although not identical on the generic level, the lectotype mentioned is close enough to the latter genus to convince the synonymy of Neaxoninae Hill, 1981 with Petraiidae de Koninck, 1872, which is going to be suggested by Dr. Weyer. Following that unpublished concept I feel obliged to avoid introduction of the generic diagnosis, as well as any further remarks and synonymy.

The corallites here under discussion can either be placed in *Neaxon* or in the emended *Petraia*. The latter solution seems more proper to me because of rather incomplete and inconstant aulos they possess. Representatives of *Petraia* were only once reported from North America (Sutherland 1965), but even that report is more than doubtful, which has already been marked by a querry in the original identification. This Silurian species does not need a detailed discussion in this paper.

The genus *Neaxon* Kullmann, 1965, its probable content and suspected relationships have recently been discussed by Weyer (1984) and needs no further discussion. Also, I agree with that author as far as the lack of the instant relationships between the true *Neaxon* and the European Lower Carboniferous aulate horn corals is concerned.

I know of only a single citation of the illustrated specimen referred to as *Neaxon* Kullmann, 1965 from North America (Sando and Bamber 1985: pl. 7: 8). Even there the name was used with a querry in the explanation to the plate. I would rather consider the corallite illustrated as related or belonging to *Trochophyllum* M.-Edwards et Haime, 1859. A proper identification of this and similar specimens require detailed study, as was correctly pointed out by Sando and Bamber (1985: 25). One phrase in the generic diagnosis introduced by those authors (1985: 24), i.e. "Minor septa contratingent or free", made their citations of the occurence of the genus even more doubtful. There are no contratingent minor septa in *Neaxon* by the original definition of Kullmann (1965) and all specimens bearing such a character should be automatically excluded from that genus. This, and the total absence of the information concerning the microstructure of septa in American *Neaxon*-like corals made the occurence of *Neaxon* in North America ambiguous.

The corallites studied in the present paper are all silicified and/or dolomitized, thus offering almost no chance for the microstructural studies. Only fragments of some septa in a single specimen (pl. 1: 3) show structures that may be interpreted as fine-trabecular. Traces of large monacanthine trabeculae that should be seen in a form of knobs on the upper ridges of septa in calices have not been traced. The differences in the microstructure of septa between the typical *Neaxon* (large monacanths) and the here described species (probably fine-trabecular, but certainly not monacanthine) will probably result in placing the American species in *Petraia*, if results of Schindewolf (1931), who found small trabeculae there, are confirmed by Weyer's (in preparation) investigations. The poor preservation of the inner morphology, the uncertain early ontogeny and microstructure of the material here studied, stopped me from either the formal introduction of a new taxon, or from considering the species discussed to be surely the stratigraphically youngest known species of *Petraia* Münster, 1839 *sensu* Weyer (in litt.).

Petraia (?) *milleri* sp. n.

(pl. 1: 1—3; pl. 2: 3, 4; pl. 6: 5, 9; fig. 1: 1—6)

e.p. 1891. ***Zaphrentis calyculus*** Miller: 10.
e.p. 1892. ***Zaphrentis calyculus*** Miller; Miller: 620.
e.p. 1944. ***Rotiphyllum calyculum*** (Miller); Easton: 32.

Holotype: Specimen No 24307/7.

Type locality: Near Sedalia, Pettis Co., Missouri.

Type horizon: Chouteau Limestone.

Derivation of the name: In honour of S. A. Miller, who collected and first described the corallites studied.

Material. — 8 or 10 specimens, all derived from Miller's (1891) collection and all being orignally considered cotypes of *Zaphrentis calycula* Miller, 1891. Easton (1944) selected ten specimens from among the cotypes originally numbered 3359A and registered them under the common number 24307. All those specimens were included by that author in *Rotiphyllum calyculum* (Miller, 1891) emend. Easton, 1944. Three or four of them are members of the species under consideration here. Seventeen cotypes of *Zaphrentis calyculus* were numbered by Easton 24308 and were left underscribed within the frame of his *Rotiphyllum calyculum*. Two of those are not corals. From among the coral specimens of that number seven were included in the species discussed.

The geographic location and stratigraphic distribution based only on the original indentification of Miller (1891) and remarks by Easton (1944) are unprecise

Most of the corallites studied are fairly complete, but all are strongly silicified or dolomitized or both. Calices, although often present, are either crushed or filled in with matrix. Only three of them (pls. 1: 1; 6: 5, 9) are more or less well preserved, providing all information for the description that follows. Several specimens are very small. I consider them juvenile corallites and include in the species discussed. This procedure may be recognized subjective, because not all of them pessess wide flaring of calices, the character typical of the large specimens.

Diagnosis. — Corallites widely flaring at calice, having n:d ratio near calice margin 24:8.5—24:10.1 and 22:5.1—23:8.7 just beneath calice; quadrants of major septa easily recognizable due to almost permanent underdevelopment of their last pairs; minor septa seen only in upper portion of calice; aulos inconstant; cardinal septum not shortened up to calice floor inclusively.

Description of the holotype. — The corallite is approximately 23 mm long when measured along its convex and only approximately 6 mm long along its concave side. This striking difference resulted to some minor degree from the slight destruction of the calice margin, but is mostly caused by the enormous elongation of the

Dimensions (in mm):

No of coralite	N:d ratio	Remarks
24307/7	23:7.8×7.0	just beneath calice
„	21:7.8×7.0	thin section
„	20:7.1×5.9	just beneath thin section
„	13.4	maximum diameter of calice
24307/1	24/(25?):11.0×9.2	calice margin
„	22:5.3×4.9	just beneath calice
24307/2	27:8.5	„ „ „
„	12.0	maximum diameter of remnants of calice
24307/3	24:9.8×8.0	calice margin
24308/2	21(22?):9.0×8.2	just beneath calice
„	15.0	maximum diameter of calice
24308/3	24:7.0	just beneath calice
„	22:6.8×5.8	middle part of growth
„	19:3.8×3.2	late neanic stage
24308/4	23:10.5×9.9	middle part of calice
„	23:8.7	just beneath calice
„	22:7.5	middle part of growth
„	14.8×13.8	near calice margin
24308/9	18:4.0	just beneath calice
24308/10	15:3.2	„ „ „
24308/11	15:4.8	„ „ „

convex side of the calice. The curvature and elongation mentioned are not in the cardinal-counter plan, but in the left to right alar septa plan.

The external surface of the corallite is poorly preserved, but it may have been smooth or only delicately wrinkled. Also, the attachment adaptations are absent. This and the shape of the corallite strongly suggest the almost horizontal life position of the specimen that most possibly rested unattached on the sea floor, burried partly in the mud.

The ontogenetically earliest part of the corallite is missing and the morphology of the slightly more advanced stage is partly destroyed by silicification. The remaining portions allow to reconstruct the major septa as meeting in the corallite axis and the minor septa lacking. The arrangement of the maojr septa is zaphrentoid. There is no indication of any kind of an aulos being developed on this stage of growth (figs. 1: 2a), although its appearance at the diameter of 2.8×2.2 mm and 13 (14:) septa cannot be excluded. There is no method in this moment to check this for sure with the stage of silicification observed. The simple withdrawal of the major septa from the corallite axis is here considered a way of the appearance of the aulos, but this is again only a subjective reconstruction. The aulos of the stereotheca kind of Grabau (1922) becomes well seen after approximately 2.5 mm of further growth of the corallite (fig. 1: 2b). Almost all major septa are slightly rhopaloid there and are united by narrow ring of stereoplasm to form a continous aulos. The cardinal and the counter septa are slightly longer than the adjacent major septa, with the latter being also slightly thicker. The last pair of the major septa in counter quadrants are underdeveloped, thus marking the alar pseudofossulae. The cardinal fossula is hardly distinguishable, but the cardinal tabular fossula may

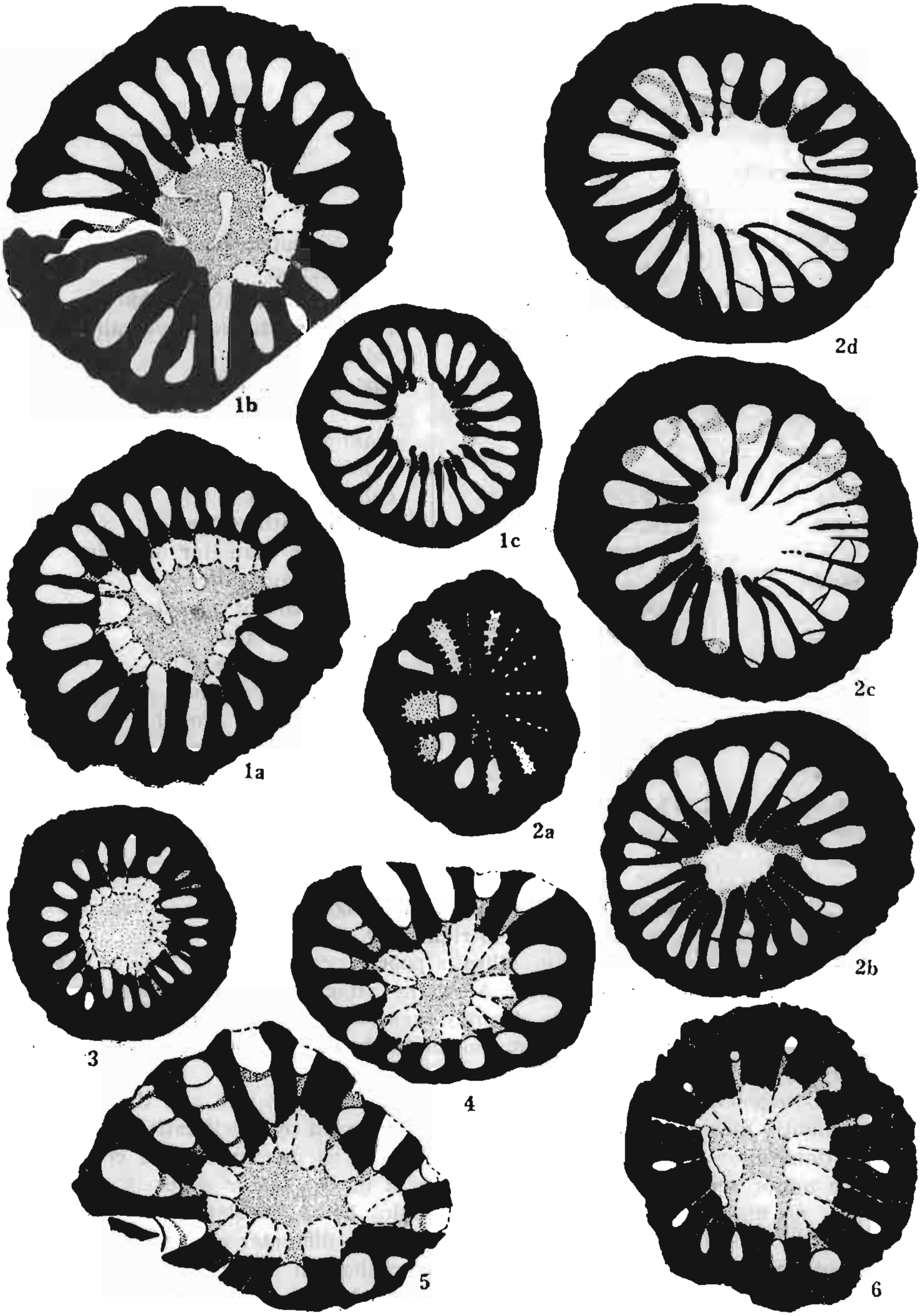

Fig. 1. *Petraia* (?) *milleri* sp. n. Transverse sections: 1 Specimen 24308/4. *a*, *b* ephebic stage, stereoplasmic infilling of axial area may be apparent and may have resulted from dolomite and silica infiltration, ×6.6; *c* above calice floor, except for periaxial ring of inner ends of major septa that form upper limit of aulos, ×3.4. *2* Specimen 24307/7. Holotype. *a* neanic stage (slightly schematized), major septa probably united by stereoplasm, ×13.4; *b* early ephebic stage, ×6.6; *c*, *d* ephebic stage, axial and right periaxial portion made just above calice floor, ×6.6. *3* Specimen 24307/1. Ephebic stage, axial area like in specimen 24308/4, ×6.6. *4* Specimen 24308/10. *5* Specimen 24308/11. *6* Specimen 24307/3. Immature corallites; morphology of axial and periaxial areas slightly schematized and/or uncertain. *4*—*6* ×13.4.

occur. This is indicated by two sections of tabulae on both sides of the cardinal septum. The minor septa are absent both from the corallite lumen and from the microstructure of the external wall.

The calice floor is oblique in accordance to the curvature of the corallite. This and the shape of tabulae deduced as dipping slightly at the periphery and almost flat in axial portions determine the morphology seen in the uppermost sections (pl. 2: 3; fig. 1: 2c, d) that were made partly above (right), but mostly below the calice floor. The permanent increase in septa, the variable thickeness of given major septa during a short period of their upward growth and the differentiated arrangement of their inner ends are most striking characters of this stage of growth. The variable thickness of major septa resulted perhaps from the septa-tabulae relations. The major septa cut just below the tabula (pl. 2: 3; fig. 1: 2c, upper right) are thin, while the same septa are thick and rhopaloid at the level of the attachment of the tabula (fig. 1: 2d, upper right). The arrangement of major septa, although generally closer to the stereotheca-kind of Grabau (1922), may in some portions (fig. 1: 2d, lower left) resemble the phyllotheca of that author. The minor septa are absent.

The individual variation and additional description.—Information concerning the morphology of calices is tentative because of both poor preservation and the fact that two of the three calices available for the study belong to specimens only tentatively included in this species. The corallite 24307/2 is a completely silicified specimen, having some portions missing. Its calice (pl. 6: 9) although incomplete, shows all characteristics of the species, except for the larger number of major septa. All those septa, but last pairs in quadrants, terminate around the periaxial part of the corallite to form the aulos of the stereotheca-kind. The cardinal septum is of the same length as the remaining long major septa, but it is well exposed due to both the underdevelopment of the last pair of major septa in cardinal quadrants, and a slight depression of the periaxial part of the tabula, marking the occurrence of the cardinal tabular fossula. The slightly concave axial part of the tabula is horizontally arranged. This and the shape of the remaining portions of the calice indicate that in contrast to the holotype, the calice was here almost equally deep around. The minor septa, well developed in most parts of the calice, disappeared at the level of the top part of the aulos.

The calice of the corallite 24307/1 (pl. 1: 1) shows the major characteristics similar to the previous specimen. Like the holotype, the corallite discussed is widely flaring at the calice (see dimensions), but the depth of the latter is almost equal around. The floor of the well preserved aulos is slightly oblique, but flat. The thin section made just beneath the calice (fig. 1: 3) may thus be interpreted as not having the axial part filled in with stereoplasm. I dotted it because the strong dolomitization made morphology of that illegible. Like in the other specimens discussed, there are no traces of minor septa and the increase in major septa is permanent.

The corallite 24307/3 is a completely silificied specimen having septal loculi mostly empty from the infilling and the calice margin broken apart. The morphology of the late neanic stage (fig. 1: 6) is not quite certain, which has been marked by the dashed lines and by being not inked in portions of septa. The stereoplasmic infillings of the axial portion of the corallite may have taken place as marked by dots. Some characteristics of the morphology of the calice (pl. 6: 5), i.e. the permanent insertion of septa, the cardinal septum equal in length to other major septa, and the disappearance of minor septa approximately at the level of the axial portion of the calice are closely comparable to those of other specimens discussed above. Also, the inner ends of major septa at the right side of the calice surround the periaxial portion of it in a way suggesting the development of an aulos. However, the major septa located at the left side of the calice are amplexoid in a character, and are elongated on the surface of the tabula. This is not a character of *Petraia* and the species has been thus tentatively included in the genus discussed.

The widest corallite in the collection (24308/4) is a strongly trochoid, almost patellate specimen. The silicification and dolomitization of it made the peel technique useless for the study of its ontogeny, while a very short portion of early growth was available for no more than two thin sections up to the portion illustrated in fig. 1: 1c. I thus decided to restrict my observations to one thin section (pl. 2: 4; fig. 1: 1b) and two surfaces (fig. 1: 1a, c). In the mature portion of growth there is a distinct cardinal fossula and two alar pseudofossulae present. Some major septa traceable to their inner ends, as well as the arrangement of peripheral portions of major septa indicate that there was either a stereocolumn or a stereotheca-kind of the aulos developed. Some disconnections in the axial matrix (pl. 2: 4; fig. 1: 1a, b) may be indicative for the second solution. Minor septa are absent from the corallite lumen and the external wall. This stage of growth is most similar to the corallite 24307/1 and to the small corallites considered immature (24308/9—11) (fig. 1: 4, 5). It differs from the holotype first of all in much better development of the cardinal septal fossula. The morphology of the lower part of the calice (fig. 1: 1c) can be compared to the holotype more closely, because the cardinal fossula is hardly distinguishable there, but the alar pseudofossulae continue to occur.

Remarks. — The microstructure of septa, inadequately recognized in the species discussed, may be a clue for its future generic identification. The type specimen of *Petraia decussata* Münster possesses monacanthine septa, whereas the corallites here under discussion were either not studied in this respect because of diagenetic alterations of the microstructure, or showed the microstructure that could be interpreted as finetrabecular (pl. 1: 3). This interpretation has not been confirmed by findings of trabeculae in longitudinal sections. Even then, however, the differences between the monacanthine and the finetrabecular structure of septa may appear adequate for the generic distinction.

The cardinal septal fossula and the alar pseudofossulae, fairly well marked in the species discussed, and the possibility of the occurrence of a shallow tabular cardinal fossula, indicated by tabulae located next to the cardinal septum in some transverse sections of the holotype (fig. 1: 2b) are additional characters distinguishing the species discussed from the type species of *Petraia* emended by Weyer (in preparation). All those doubts and the uncertain development in early ontogeny prevent the doubtless placing of this species in *Petraia*. The provisional recognition of some basic characters made at the same time the creation of a new genus premature. There is no species of that kind of the morphology described so far from the Lower Mississippian of North America, however.

Occurence. — As for the holotype.

?*Petraia* sp.

(pl. 2: 1a, b; fig. 2a—e)

Material. — A single, incomplete, slightly dolomitized corallite No. 24308/8, left unidentified by Easton (1944) in a frame of *Rotiphyllum calyculum* (Miller, 1891). The tip of the corallite is missing. The calice is preserved in its major part, but is almost completely filled in with matrix.

Description. — The corallite is 9.5 mm long when measured along the convex, cardinal side and only 2 mm long on the opposite side. The difference is almost entirely caused by the shape of the calice that is approximately 7 mm higher on the cardinal side. The curvature of the corallite is slight. The smoothness of the external surface of the corallite, although exaggerated by a slight corrosion is probably natural, because there is no waviness of the upper edge of the calice observed. The minor and major septa, almost equally developed near the calice rim, have the peripheral portions thickened up to the lateral contiguity. The thickest peripheral portions may in fact be foundations of septa. The upwards flaring specimen is 5.2 mm wide just beneath the calice and 9.2 mm at the widest preserved portion of the calice.

The slightly damaged, ontogenetically earliest portion of the corallite (fig. 2a) shows the major septa nearing the corallite axis and the minor septa present already in the thick external wall. However, the true length of only few major septa can be established.

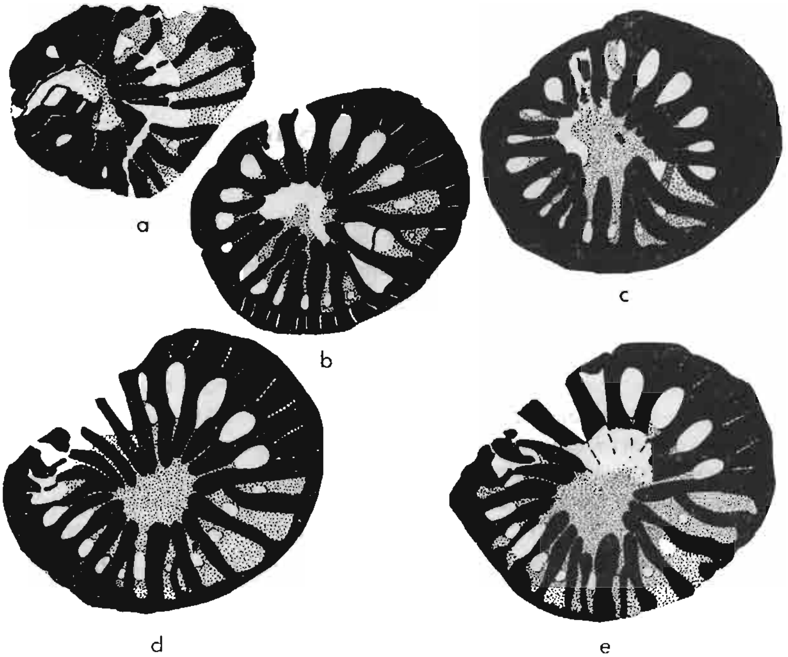

Fig. 2. *Petraia* (?) sp. Specimen 24308/8. Transverse sections: *a* late neanic/early ephebic stage, slightly damaged, inner ends of major septa almost reach corallite axis; *b*—*e* ephebic stage; disappearance of axial stereoplasmic infilling in some sections. All ×10.

The following 2 mm of growth of the corallite (pl. 2: 1a, b; fig. 2b—e) is characterized by a semi-radial arrangement of the major septa, most of which are slightly rhopaloid. They surround the axial area that is occupied by a more or less solid stereocolumn. The latter may almost disappear just below the tabula (pl. 2: 1a; fig. 2b), where only a ring of the stereoplasm joins inner ends of major septa together. Quadrants of major septa are easily distinguishable due to the longlasting underdevelopment of last pairs of septa and, sometimes, by their arrangement as well (fig. 2c). The cardinal fossula is inconspicuous and the cardinal septum may be hardly distinguishable in the case of a better development of the last pair of the major septa in the cardinal quadrants (pl. 2: 1a; fig. 2b). The length of the cardinal septum varies a little, but it is never truly shortened, being only slightly shorter than the alar septa, but equal to the next of the last pair of the major septa in the cardinal quadrants. The minor septa are well developed in the thick septotheca, but only rare of them penetrate the corallite lumen a little. The stereoplasmic infilling is much heavier in the cardinal quadrants, where septal loculi are almost completely filled in. Although varying from section to section in density, it may be generally connected to the position of the coral on the sea floor (see considerations) and is not necessarily of a taxonomic value.

Remarks. — The specimen described resembles most closely *P. (?) milleri* sp. n. in the arrangement of major septa, in the longlasting underdevelopment of the last pairs of major septa in quadrants and in flaring of the calice. The strong minor septa developed in the septotheca, smaller dimensions and slightly different n:d ratio are its distinguishing characters. Differences in the stereoplasmic infillings are not considered, because of a possibly ecological reasons.

Occurrence. — Chouteau Limestone (unrestricted), near Sedalia, Pettis Co., Missouri.

Genus *Meniscophyllum* Simpson, 1900

Type species: *M. minutum* Simpson, 1900.

Monotypic. Synonymy not established, because I consider only references to the North American type species certain. All other references to that genus seem incorrect as far as this can be judged from the literature data.

Emended diagnosis. — Nondissepimentate horn corals, having cardinal septum on convex side; in neanic stage major septa groupped in quadrants, surround axial stereocolumn, with none of protosepta being shortened or visibly elongated; in maturity major septa equal in length, radially arranged around axial area that may be partly free to form aulos; axial stereoplasm became reduced first near counter septum; it persists near cardinal septum up to calice floor, that is much higher in this area; cardinal fossula inconspicuous; minor septa underdeveloped; peripheral parts of tabulae declined upwards, axial horizontal or slightly sagging.

Remarks. — The genus *Meniscophyllum* Simpson, 1900 was redescribed only by Easton (1944) on the basis of the type and the new material. All other papers dealing with that name in the here accepted meaning were based on the original Simpson's (1900) descriptions and illustratons. This includes the revised Treatise by Hill (1981), who ignored the photographs of Easton (1944) taken from the type material. Brief remarks that follow do not pretend to be a revision of that genus. The morphology of specimens studied herein brought some more light to that ambiguous taxon, thus making a short discussion possible.

The family status of the genus, not established originally by Simpson (1900) was almost univocally considered hapsiphyllid since Grabau (1928) (e.g. Sanford 1939, Easton 1944, Soshkina and Kabakovich 1962, Hill 1937, 1981) with some exceptions for Metriophyllidae Hill, 1939 (Hill 1956, Yu *et al.* 1983). The arrangement of major septa in the fairly early stage of the ontogeny (fig. 3: 1b, c) shows that the aulos present there is closely comparable to those of *Syringaxon* Lindstroem, 1882 or *Neaxon* Kullmann, 1965, and even more so to the axial structure of *Trochophyllum* M.-Edwards and Haime, 1850 recently revised by Fedorowski and Sando (1989). The latter may in fact be indicated as leading directly towards *Meniscophyllum* and making these two genera closely related to each other. The shape of calices in *Trochophyllum*, with the stereoplasmic infillings higher near the cardinal than near the counter septum, the position of the latter on the concave side of a corallite, and the strong underdevelopment of minor septa may serve as additional proofs for that relationship. Consequently, *Meniscophyllum* Simpson, 1900 should be placed with the same family as *Trochophyllum*, i.e. Petraiidae de Koninck, 1872, emend. Weyer (in preparation). This is confirmed by the longitudinal section made by Easton (1944, pl. 5: 3), ignored by the subsequent students. The arrangement of tabulae in the transverse sections in the specimen described herein (pl. 3: 1a, b; fig. 3: 1d—f) may indirectly prove Easton's (1944) drawings. Also, the sketch by Simpson (1900, fig. 2), although made from the eccentric longitudinal section does not contradict with that, except for peripheral parts of tabulae, which are more horizontal and more densely packed there. Easton's (1944, pl. 16: 20) photograph confirms Simpson's (1900) illustration.

It is in fact more difficult to distinguish *Meniscophyllum* from *Trochophyllum* than to prove their relatinoship. This similarity may have resulted from their adaptations to similar environment. However, in the situation of lack of information concerning the microstructure of septa in *Meniscophyllum*, this feature, so characteristic for *Trochophyllum*, cannot be fully adopted herein. The poorly preserved specimens described in this paper, although apparently distinct in this respect, cannot be conclusive. Thus, there are no strong criteria for the distinction of those two genera. I do not propose herein to synonymize *Meniscophyllum* with *Trochophyllum* mainly because of lack of information of the microstructure and early ontogeny in *Meniscophyllum*. The possibility of elongation of some major septa in counter quadrants in the latter genus (Easton 1944: pl. 16: 21; fig. 3: 2a—c in this paper) can be indicated as the main distinguishing character between the mature portions of these two genera.

The orientation, of the specimens by Simpson (1900) is ambiguous. Indicating the cardinal fossula as located "on the side of the least curvature" he then wrote: "The extremities of the septa situated on the side of greatest curvature became thickened and coalesce..." These two statements are in contradiction, but the repetition in the description of the species: "The extremities of the septa of the cardinal and lateral aspects became thickened and coalesce..." makes it clear that he correctly considered the cardinal septum as one of the major septa connected to aech other by thick leyers of stereoplasm. As it has already been stated by Easton (1944: 46), Grabau's (1928: 139) deduction concerning the position of the cardinal septum was incorrect, and so was his identification of the Chinese Moscovian coral as *Meniscophyllum*. The same may be true of Dobroljubova (1937) who obviously followed Grabau (1928). Hill (1981: F316), ignoring the emendation of Easton (1944) disoriented again the corallite, which led to the incorectness of her generic diagnosis and possibly in placing of that genus within Hapsiphyllidae Grabau, 1928.

The name "fossula" often applied to the area next to the counter septum (misinterpreted as cardinal septum by authors), is incorrect. The morphology observed results simply from the obliqueness of the calice floor towards the counter septum, and from the overwhelming secretion of the stereoplasm on the convex side of the corallite. The early disappearance of the stereoplasm from the vicinity of the counter septum makes a false impression of the occurrence of the fossula.

I cannot indicate any species or genus described so far outside the North America as being related or synonymous with *Meniscophyllum*. *Heptaphyllum* Clark, 1924, questionably included in that genus by Easton (1944) and some subsequent authors is known only from sketchy figures and from the description in which seven protosepta were accepted by Clark (1924: 419). It is premature even to mention that generic name, as well as *Caenophyllum* Clark, 1926 until the proper redescription and reillustration of the type material is made.

The family status of the genus will be finally established when the microstructure of septa is studied.

Meniscophyllum minutum Simpson, 1900

(pl. 3: 1, 2; fig. 3: 1, 2)

1900. *Meniscophyllum minutum* Simpson: 200, figs. 1—4.
1928. *Meniscophyllum minutum* Simpson; Grabau: fig. 22.
1937. *Meniscophyllum minutum* Simpson; Hill: fig. 14.
1939. *Meniscophyllum minutum* Simpson; Sanford: fig. $10B_{1,2}$.
1944. *Meniscophyllum minutum* Simpson; Easton: 46, pl. 5: 1—4, pl. 16: 20—22.
1956. *Meniscophyllum minutum* Simpson; Hill: fig. 174: 8.
1981. *Meniscophyllum minutum* Simpson; Hill: fig. 207: 2a—d.

Remarks. — The non-illustrated citations of the species are not considered in the above synonymy.

Material. — One silicified corallite No. 24308/1 derived from Miller's (1891) collection of *Zaphrentis calyculus*. Specimen was renumbered by Easton (1944). The ontogenetically earliest part of the corallite is missing and its calice is slightly flattened diagenetically. The corallite No. 24308/7 (data as above) was included in this species with some restriction. Its brief description follows that of the first one.

Diagnosis. — *Meniscophyllum* having n:d: ratio just beneath calice floor up to 18:7.

Description. — In the ontogenetically earliest preserved portion of the corallite (fig. 3: 1a) the counter septum is free and three other septa in counter quadrants, the counter-lateral septa included, are inclined towards one another to form distinct groups. Middle lines of those septa are not united. The morphology of cardinal quadrants is not quite clear because the silicification is more advanced there. The occurrence of two major septa, inclined slightly towards the cardinal septum as shown in the picture, was deduced in part. The complete length of five septa in cardinal quadrants (the cardinal septum included) is unknown. They should not be long, however, which can be deduced from the direction of the alar septa. The alar pseudofossulae are marked due to the arrangement of septa described. Also, there is something like the counter pseudofossula present for the similar reason. The axial stereoplasm seems to be solid. The same is true of the surface just above the thin section described (fig. 3: 1b). Having n:d ratio 14:3.4 (septal formula $\frac{3|3}{2|2}$ and all but last septa in cardinal quadrants radially arranged (fig. 3: 1b), this part of the corallite can easily be compared to the early ontogeny of *Neaxon* Kullmann, 1965. The arrangement of major septa described, is to be seen 2.5 mm above the previous one as well. The n:d ratio increased during that period of growth of the corallite to 18:5.6 (septal formula $\frac{4|4}{3|3}$). The morphology of this part of the corallite (fig. 3: 1c) resembles *Neaxon* even more closely than the previous one because a very narrow aulos became open there, and the stereoplasmic infillings between inner ends of major septa form the solid ring.

In the thin section that follows the stage described (pl. 3: 1a; fig. 3: 1d) the morphology attributed to this species by authors, Simpson (1900) included, is especially clear. The stereoplasmic ring was reduced near the counter septum but remained strong, solid and in the horse-shoe shape around most of the corallite, being the thickest next to the cardinal septum. The same is true of the next section (pl. 3: 1b; fig. 3: 1e), although more septa are free from the stereoplasmic ring there and the latter became much thinner. The section now under the consideration illustrates a very beginning of the laterally-axial rejuvenation, better seen in the next section (fig. 3: 1f), where the inner portions of the counter septum, the counter-lateral septa (one damaged) and one metaseptum are already disconnected from

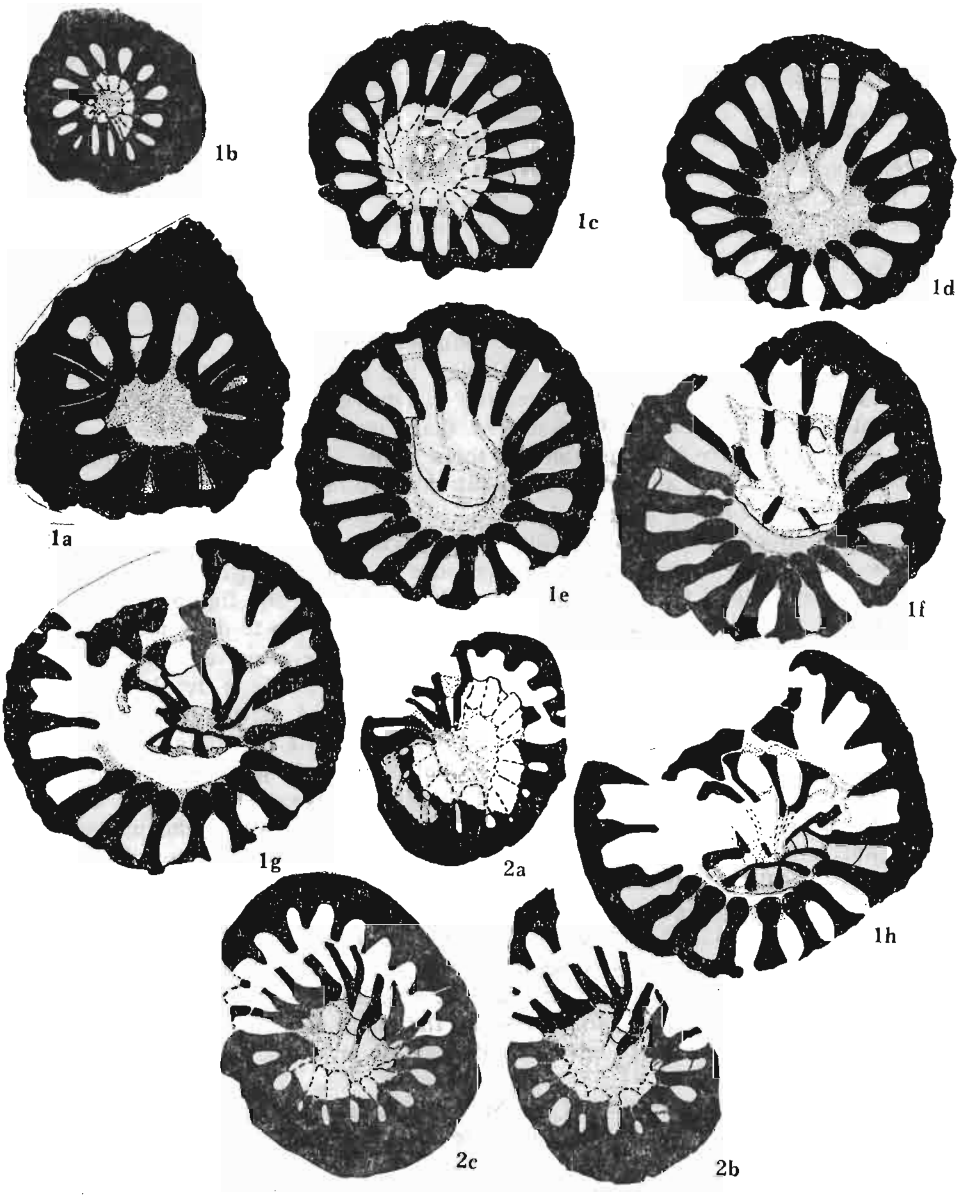

Fig. 3. *Meniscophyllum minutum* Simpson, 1900. Transverse sections: *1* Specimen 24308/1. *a* neanic stage ×13.4; *b*, *c* early ephebic stage, step by step reduction of axial stereoplasm. *d* ephebic stage, strong half-moon of stereoplasm open towards counter septum; *e* beginning of rejuvenation, first new major septum appeared without any obvious connection to old major septa; *f*—*h* successive stages of insertion of new septa in rejuvenated portion (*h* slightly damaged), stereoplasmic infilling near old cardinal septum lasts up to upper portion of calice. All ×6.6. *2* Specimen 24308/7. *a*—*c* early to late (?) ephebic stages, stereoplasmic infilling of axial area lasts up to calice floor. All ×6.6.

their peripheral portions. The part of the corallite out of the wall surrounding the rejuvenated portion is placed above the last tabula in the calice. The development of minor septa, penetrating the corallite lumen in the form of knobs, is worth noticing. The rejuvenation is not uncommon in the species discussed, because the longitudinal section illustrated by Easton (1944, pl. 5: 3) shows this phenomenon as well.

Rejuvenation. — In contrast to several instances of that process investigated recently in Upper Pennsylvanian and Wolfcampian corals from SW Texas (Fedorowski 1987), the specimen studied herein shows no obvious relation of the new septa in cardinal quadrants to the old ones. They seem to be inserted one after another (pl. 3: 1b, c; fig. 3: 1e—h) on the axial part of the tabula that started to play a role of the new external wall. Major septa in counter quadrants included in the process, the counter septum in this number, are continous at the early stage of the process (pl. 3: 1b; fig. 3: 1e), although the polyp body left the peripheral part of the old calice there, and secreted a new external wall, based on the peripheral part of the tabula. True role of that tabula becomes clear in the next section (fig. 3: 1f) where inner portions of three major septa became separated from their peripheral portions, and one counter-lateral septum disapeared. The reason for the latter is most probably diagenetic.

The insertion of septa in the rejuvenated portion of the calice is ambiguous. The new septa seem to have their counterparts in old peripheral septa, but this connection is not clear. Two points that can be read from the figure 3: 1e—h and pl. 3: 1b, c are especially controversial in the light of the up-to-date studies of the rejuvenation in the rugose corals: 1) the increase of the new septa seems to be directed not towards the cardinal septum, but outwards (pl. 3: 1c; fig. 3: 1f—g, right), 2) two new septa were derived from the inner end of the old septum. The direct connection of new major septa in cardinal quadrants (pl. 3: 1c; fig. 3: 1g, h), suggested by a density of calcium carbonate, that is identical with that of the radial portions of new septa, may be superficial and may have resulted from a dense accumulation of the stereoplasm. Due to the diagenetic alterations the unquestionable septal microstructure has not been observed in any portion of septa. The stereoplasmic infilling of the inner portion of the new corallite, denser near cardinal quadrants, and the arrangement of septa in that corallite are hardly comparable to the pre-juvenal portion of the specimen discussed, but are surprisingly similar to the second corallite briefly described below (pl. 3: 2; fig. 3: 2b, c), which was one of the main reason for including it in this species. Although some of the characters described may have been partly influenced by the diagenesis, the process as a whole is very peculiar and difficult to interprete completely on a basis of a single corallite available for the study.

Remarks. — The corallite 24307/7 (pl. 3: 2; fig. 3: 2a—c) exhibits several features attributed to the species and genus discussed, but the development of the counter septum and one of the counter-lateral septa that seem to be elongated, is misleading. The preservation of the corallite is such that I was not able to decide for sure whether these elements possess the septal microstructure, or illustrate only a peculiar arrangement and density of the stereoplasm. The occurence of this character for approximately 1 mm of growth of the corallite (pl. 3: 2; fig. 3: 2b, c) and the presence of sections of tabulae in the area free from the axial stereoplasm speak in favour of the first interpretation. It should be mentioned that the holotype also seems to have one major septum in the counter quadrants elongated so as to almost meet the corallite axis (Easton 1944: pl. 16: 21). The ontogenetically youngest section of the corallite discussed (fig. 3: 2a) is most similar to the first corallite described herein, and to the section of Simpson's (1900) paratype (Easton 1944: pl. 16: 22). The holotype of the species discussed, designated and re-illustrated by Easton

(1944: 46, pl. 16: 21) is preserved in a single section, illustrated by Simpson (1900: fig. 3). Easton (1944: 46) noted: "It is possible that fig. 4 (idem) was made from a different section of the same specimen, but this cannot be substantiated". The situation is unfortunate, because there is no rocky material left for the reinvestigation and the ontogeny of the type will never be studied. Both thin sections of the type material were made above the calice floor next to the counter septum, and the holotype thin section seems to exhibit at least one free septum in counter quadrants (the counter-lateral?) fairly well elongated, which is not the case of the other transverse thin section of Simpson (1900: fig. 4), reillustrated by Easton (1944: pl. 16: 22). Also, the specimen illustrated by Easton (1944: pl. 5: 1) from his new collection, and the corallite described in this paper (pl. 3: 1a—c; fig. 3: 1a—h) do not have any septa of counter quadrants elongated. Having no opportunity to check this more widely, I leave the problem open, although it may eventually influence the generic identity of the group of corals discussed.

The earliest part of the ontogeny of the species is unknown. Two specimens (Easton 1944: pl. 5: 2 and herein: fig. 3: 1a) have been investigated starting from the stage of 12 major septa and 1.5×2.0 and 3.0 mm in the diameter respectively. Easton (1944: 46) mentioned only 11 septa on this stage of growth, but the presence of the twelfth septum can almost for sure be read in the upper (or left after the re-orientation) counter quadrant in this specimen. The zaphrentoid arrangement of septa in that picture becomes clear after its re-orientation by turning slightly more than 90° to the left. The cardinal septum located presently in the upper left corner, will be then at the bottom of the picture like in both corallites illustrated in the present paper. The expression "large fossula in cardinal position" (Easton 1944: 46) erroneously resulted from the incorrect orientation of the corallite. The true cardinal fossula is quite inconspicuous there. The specimen 24308/1 described in this paper (fig. 3: 1a) is slightly larger and exhibits slightly different arrangement of its twelve septa, especially next to the counter septum. Also, there is a solid stereoplasmic column present in this section, while the latter character is weak in Easton's (1944: pl. 5: 2) section.

The section called "Early ephebic" by Easton (1944: 68) differs very little from the earlier section of his specimen and exhibits the neanic morphology. Judging from the position of alar pseudofossulae, the cardinal septum is located upwards in the picture discussed and there is an increase in number of major septa by one in the cardinal quadrants. Again, however, the axial stereocolumn is rather weak and there is apparently no room in the corallite axis for any kind of an aulos or the stereocolumn surrounded by inner ends of major septa, like in the corallite here under study.

The longitudinal section illustrated by Easton (1944: pl. 5: 3) showing the appearance of the aulos quite late in the ontogeny, and the comparison of the corallite investigated by that author and in this paper seem to prove some heterochrony in the appearance of individual characters in the ontogeny of particular corallites. This again should be confirmed by the study on the more aboundant material. By now the neanic ontogeny of *M. minutum* remains slightly ambigous.

The mature morphology is much more similar in all three cases (Simpson 1900; Easton 1944; and herein), except for some doubts concerning the holotype thin section, which were mentioned above.

I cannot indicate any taxon, except for *Trochophyllum verneuilanum* M.-Edwards and Haime, 1850 which can be related to *M. minutum* Simpson, 1900. The mutual relations of the genera were discussed with remarks on the genus *Meniscophyllum* and it is premature to discuss relationships of species as long as the synonymy of genera is not proved.

Occurrence. — Chouteau Limestone (unrestricted), near Sedalia, Pettis Co., Missouri.

Genus *Patularima* gen. n.

Type species: *Zaphrentis calyculus* Miller, 1891.

e.p. 1891. *Zaphrentis* of Miller, 1891, *non* Rafinesque et Clifford, 1820.

e.p. 1944. *Rotiphyllum* of Easton, 1944 *non* Hudson, 1942.

Derivation of the name: Lat. *patulus* — spacious, wide; *rima* — rift, chink, crevice — after widely expanded calice.

Diagnosis. — Solitary, nondissepimentate amplexoid coral having cardinal septum located on concave side of corallite; variable in length beneath calice, but equal to adjacent major septa at calice floor; cardinal fossula absent; calice deep, widely flaring; septa of two orders, with minors seen only in calice; aulos, built of bent major septa and tabulae, seldom complete in individual sections; microstructure of septa monacanthine; external surface of corallite bears delicate growth striae, but no septal furrows.

The genus is monotypic.

Remarks. — Introduction of a new generic name on the basis of a single corallite was caused by the earlier selection of this corallite (Easton 1944) as the type specimen of *Rotiphyllum calyculum* (Miller, 1891). Unfortunately, the generic name was incorrectly applied by Easton (1944). Also, none of Miller's (1891) specimens appeared to be conspecific with the discussed one, and I have not been able to find a genus appropriate for the specimen in question. Thus, the proposed solution seems to be the only one possible.

The coarse trabeculae seen on septal ridges in the calice determine a position of the genus discussed within a new concept of Petraiinae de Koninck, 1872 (see remarks on *Petraia* Münster, 1839). *Neaxon* Kullmann, 1965 having a strong permanent aulos and the cardinal septum hardly recognizable and permanently equal to other major septa, although possibly related to *Patularima* gen. n., may be considered only its ancestral taxon, if the free connection between the Mississipi Basin and the Western European Province in the Upper Famennian and/or Lowermost Tournaisian is proven. The shortened cardinal septum and the biform tabularium are main distinguishing characters of *Neaxonella* Weyer, 1978, whereas pali, the permanent aulos and the constantly long cardinal septum distinguish *Paliaxon* Weyer, 1981. The upper Famennian Central-European genera *Czarnockia* Różkowska, 1969, *Friedbergia* Różkowska and *Famenelasma* Weyer, 1973, some of which or all are synonymous, differ distinctly from *Patularima* gen. n. in having the cardinal fossula developed, and the cardinal and/or counter septum variable in length during the ontogeny, but shortened in the calice.

Petraia Münster, 1839 (in the new concept) is the closest genus to compare. The *Amplexocarinia*-like, inconstant aulos of the subcalicular region of the new genus, with the cardinal septum variable in length, are main characters distinguishing it from the former genus, as well, as from most of the genera discussed above.

Patularima calycula (Miller, 1891)

(pl. 4: 1a—f; fig. 4a—g)

e.p. 1891. *Zaphrentis calyculus* Miller: 10.

e.p. 1892. *Zaphrentis calyculus* Miller; Miller: 620.

e.p. 1944. *Rotiphyllum calyculum* (Miller); Easton: 32, pls. 3: 7; 16: 32, 33.

Diagnosis. — *Patularima* having 25 major septa that surround wide, free axial area; inner ends of most major septa bend to meet adjacent septa; minor septa well developed in upper and middle part of calice, disappear lower down.

Material. — Single corallite chosen lectotype of *Rotiphyllum calyculum* (Miller, 1891) by Easton (1944). The other three specimens illustrated by Easton (1944: pl. 3: 8—10) were included herein in *Rotiphyllum diutinum* sp. n. and *Rotiphyllum* sp. and are discussed with these species.

Description. — The corallite is trochoid, slightly curved in the cardinal-counter plan, with the cardinal septum located on the concave side. The preserved part of the corallite is 15 mm long when measured along the convex side. No kind of attachment is observed, but the ontogenetically youngest portion of the corallite was ground out prior to this restudy. The best preserved fragment of the external wall shows clear growth striae, groupped in more or less distinct bands (pl. 4: 1e). The analysis of waviness of the former does not show any regularity comparable to septal furrows. Also, the marginal part of the calice is not wavy (pl. 4: 1d). I thus consider septal furrows as being absent from the specimen in question.

The trochoid shape of the corallite and its curvature determine the shape and depth of individual parts of the calice (pl. 4: 1c). The 8 mm of its approximate depth at the convex side (measured along the curvature) is reduced to only 5 mm at the concave side (with an approximation of the missing portion included).

The almost complete ridge of some portions of the calice (pl. 4: 1d) is externally smooth and shows only the inwards directed protrusions of major and minor septa.

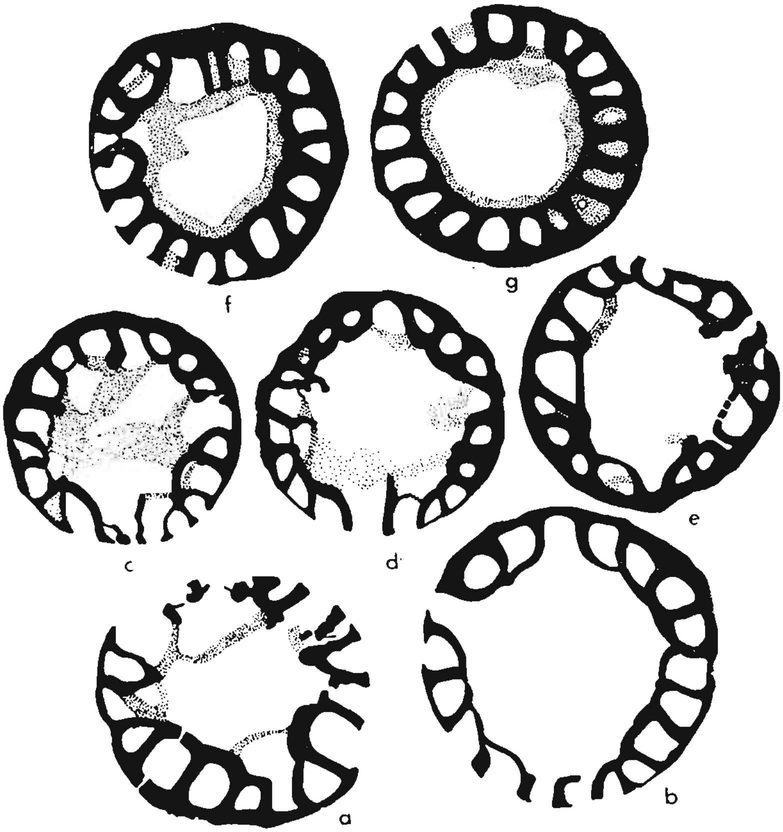

Fig. 4. *Patularima calycula* (Miller, 1891). Specimen 3359. Holotype. *a*—*g* successive transverse sections made from 2.5 mm of growth of corallite; *g* approximately 1.5 mm below calice floor. *a*, *b* ×20, *c*—*g* ×15.

Wide, hemispherical foundations of septa do not occur and were either not developed, which seems most possible, or were restricted to very short period of growth, just at the top of the calice margin. Blades of major septa increase their width slightly downwards. They do not exceed 1 mm in their widest portions, i.e. those surrounding the axial area near the calice floor. Almost all major septa are fused together around the axial part of the corallite by the stereoplasmic body, most probably the tabula. The partial separation of the right alar septum (pl. 4: 1c) is superficial and is caused by the lower position of the tabula in the adjacent septal loculi. The upwards extension of the last tabula, i.e. the axial and periaxial part of the calice floor varies, being the deepest at the right side and shallowest near the left one. Such an arrangement of the calice floor is the most important character from both physiological and taxonomic point of view. Near the right alar septum a true tabular fossula is developed in the calice, but there is not even a pseudofossula near the left one, where the last major septum is simply underdeveloped a little. No kind of the alar fossula is developed beneath the calice. Thus, I consider this character incidentally developed by the last tabula inserted by the polyp, i.e. the actually observed floor of the calice. The cardinal septal fossula is well marked there, without influencing the shape of the periaxial ring of the last tabula. The cardinal septum, equal in length to other major septa, reaches that ring directly. The inner ridges of all major septa are mostly smooth, showing only a slight undulation in some cases that could be interpreted as uppermost portions of trabeculae.

The minor septa are all short, but they are clearly traceable down to the level of the tabular connection of inner ends of major septa. Inner ridges of most of them in the upper portion of the calice are smooth. The deeper located inner ridges of several minor septa exhibit an undulation characteristic of the trabeculate monacanthine septa (pl. 4: 1f). This observation has not been confirmed by the longitudinal sections of middle parts of septa, because the microstructural studies in thin sections were impossible. Thus, the presence of trabeculae in the species discussed, although very probable, remains an open question. Also, I am not able to find a reasonable explanation for the difference in the morphology of the upper ridges of major and minor septa, as well as between different portions of individual minor septa, if that morphology is original, not secondary (diagenetic). It should be pointed out, however, that neither the smooth nor undulated ridges show any obvious signs of destruction (pl. 4: 1c) and that the lateral sides of all septa are smooth. In some loculi (pl. 4: 1f, arrows) there are vertical rows of very tiny depressions present. Following my previous interpretation in Diffingiina (Fedorowski 1986*b*)I consider those structures the attachment scars of the polyp body, located against the mesentheria, and most possibly functioning as strenghtenings of the latter.

The ontogeny and insertion of septa. — The morphology observed below the calice is constant in a general character, being at the same time very variable in small details. Starting from the earliest growth stage observed (Easton 1944: pl. 3: 7) there is a wide free axial area, surrounded by inner ends of major septa, that are bent in the manner commonly attributed by former authors to *Amplexocarinia* Soshkina, 1928. This arrangement failed to be shown in Easton's drawing, but it has been observed on the ground surface of the tip prior to its further grinding that was made in order to expose the better preserved part of the corallite. All seven thin sections made from the thickeness of 2.5 mm of the corallite show variants of that morphology (fig. 4a—f; pl. 4: 1a, b) and so does the surface of the section exposed just beneath the calice (not illustrated). Also, the arrangement of septa near the axial part of the calice floor is similar, which has been pointed out both by Easton (1944: 32) and in the present paper.

In contrast to the morphology of the calice, where the newly inserted major septa are clearly underdeveloped, there is hardly any differentiation in length of major septa in transverse sections. It seems incidental to me, when present (e.g. slightly shortened cardinal septum in fig. 4a or elongated a little in figs. 4c, d; pl. 4: 1a), because there is no sequence in either shortening or elongation. The latter may have simply resulted from the amplexoid character of septa. Lack of a clear underdevelopment of newly inserted major septa depends on their fast growth up to the stage of reaching the limit of the ring of inner ends of other major septa around the lower part of the calice. All sections were made below the calice, i.e. in those parts of the corallite in which the ring of major septa of the upwards growing calice had already been formed.

The increase in number of septa is slow but permanent. It has been observed starting from 18 major septa in the ontogenetically youngest thin section up to 21 major septa in the lowermost and 25 in the upper part of the calice. Four major septa should be added to those numbers if Weyer's (1974) concept of the insertion of septa is accepted.

The longitudinal section has not been prepared because the subcalicular portion of the corallite was too short. Some transverse sections, and especially fig. **4a,** c and pl. 4: 1a show that tabulae are complete, wide, slightly convex axially, but with some concavities possible in places (fig. 4c, d, f; pl. 4: 1a).

Remarks. — The inadequately known *Zaphrentis radicula* Rowley, 1900, redescribed by Easton (1957) as *Rotiphyllum radicula*, shows a potential possibility of having the morphology similar to the here described species. It is premature for any considerations, however, because the only existing specimen of that species has never been sectioned. Besides, its axial, not lateral attachment to the substrate, the character rare in the rugose corals and probably absent from the specimen here under discussion, may eliminate it from the comparison.

Amplexocarinia aff. *A. heimoi* Heritsch of Sando (1960), and especially the corallite illustrated by that author in pl. 16: 18—20 may also be related to *P. calycula*. However, all corallites mentioned have calices broken, thus offering only the possibility of comparison to the deep portion of the calice in *P. calycula* and to its transverse sections. Those two areas are fairly similar in both species. The inadequate knowledge of Sando's (1960) specimens made closer comparison and further considerations baseless. It seems right to say, however, that the species described should find relatives among the Lower Mississippian North American coral fauna, when the latter is more widely studied.

Occurrence. — Chouteau Limestone (unrestricted), near Sedalia, Pettis Co., Missouri.

Suborder **Zaphrentoididaceae** Schuppé et Stacul, 1959

Family ?**Zaphrentoididae** Schindewolf, 1938

Gen. et sp. indet. 1

(pl. 3: 3a, b; fig. 5a—j)

Material. — A single, slightly silicified corallite, derived from Miller's (1891) collection of *Zaphrentis calyculus*, renumbered 24308 by Easton (1944) and left unidentified by the latter author within *Rotiphyllum calyculum* (Miller, 1891).

Description. — The corallite is horn-shaped with the cardinal septum located on the convex side. The calice is diagenetically flattened. The ontogenetically earliest portion is missing. The earliest thin sectioned portion is silicified so that it was left undescribed. The better preserved, early portion of growth (fig. 5a) having 15—16 major septa at the diameter or 3.2 mm shows the zaphrentoid arrangement of major septa, but with the counter septum already tending to be shortened and the counter-lateral septa long and probably bending a little over or towards it. This remains uncertain because of the silicification. Also, the morphology of the cardinal quadrants and the length of the cardinal septum were only deduced from sparse remainings seen within the silica.

The series of thin sections and peels made beneath the calice (fig. 5b—e; pl. 3: 3a) show a dominant role of the cardinal septum that penetrates the axial stereocolumn. The counter septum underwent a fast reduction, first in thickeness (fig. 5c) and in the length soon after (fig. 5d). The arrangement of major septa, especially those of cardinal quadrants, forms a kind of a key-hole, filled in with the stereoplasm in the axial part, but free from it in the axially widened cardinal fossula. Inner ends of most major septa are rhopaloid. Two major septa in one counter quadrant are shortened as much as the counter septum (pl. 3: 3b; fig. 5d—g). The reason for this reduction is unknown. The minor septa are recognizable in the thick septotheca.

In the section made exactly at the top of the axial part of the calice floor (pl. 3: 3b; fig. 5f) the solid stereocolumn is still present, but the cardinal septum is already separated from it due to a slight shortening. The next section, made just above the calice floor in the slightly depressed corallite axis, but still below its floor in the periaxial area, shows the stereoplasm remaining between inner ends of major septa, and the cardinal septum undergoing further reduction in length and thickness, but remaining fairly long (fig. 5g). It became clearly shortened in the section made above the cardinal fossula floor fig. 5h). The cardinal fossula tends to become narrower adaxially, but the last pair of the major septa within it remains underdeveloped well above the calice floor (fig. 5i). Reduction of the periaxial stereoplasm and the disintegration of inner ends of septa in cardinal quadrants are slow and some of those septa remain connected high in the calice (fig. 5j, left).

The minor septa are well developed starting from early growth stage but they only slightly, if at all, penetrate the corallite lumen, being the component of the septotheca equal in value to the peripheral parts of major septa. They started to elongate near or just above the calice floor (fig. 5h), being best developed in the middle part of the calice (fig. 5j).

Remarks. — The taxonomic position of the specimen discussed is rather ambiguous because of both the restricted material available for the study and its characters comparable to such weakly related families as Zaphrentoididae Schindewolf, 1938 (or Hapsiphyllidae Grabau, 1928) on one side and Plerophyllidae Koker, 1924 or Tachylasmatidae Grabau, 1928 (Pentaphyllidae Schindewolf, 1942) on the other. The arrangement of the major septa, the shape of the cardinal fossula, and the occurrence of the axial stereocolumn speak in favour of the first alternative and especially of the relation with *Sychnoelasma* Lang, Smith and Thomas, 1940, while the elongation of the cardinal septum and shortening of the counter septum indicate on the second.

However, the order Plerophyllina Sokolov, 1960 is characterised by the differentiation in length of more than just two protosepta. Also, there is no stereocolumn present in the mature stage of almost any genera, except for those distinguished in the subfamily Baryphyllinae by Weyer (1973). In the latter corals, however, the stereocolumn was secreted due to the patellate growth form and everted calices that caused necessity of connection of all skeletal elements together. The stereocolumn, although often omitted from the taxonomic discussions, should be considered as having the physiological and, therefore, the taxonomic value when its constant occurence is proved as co-existing with other distinctive characters.

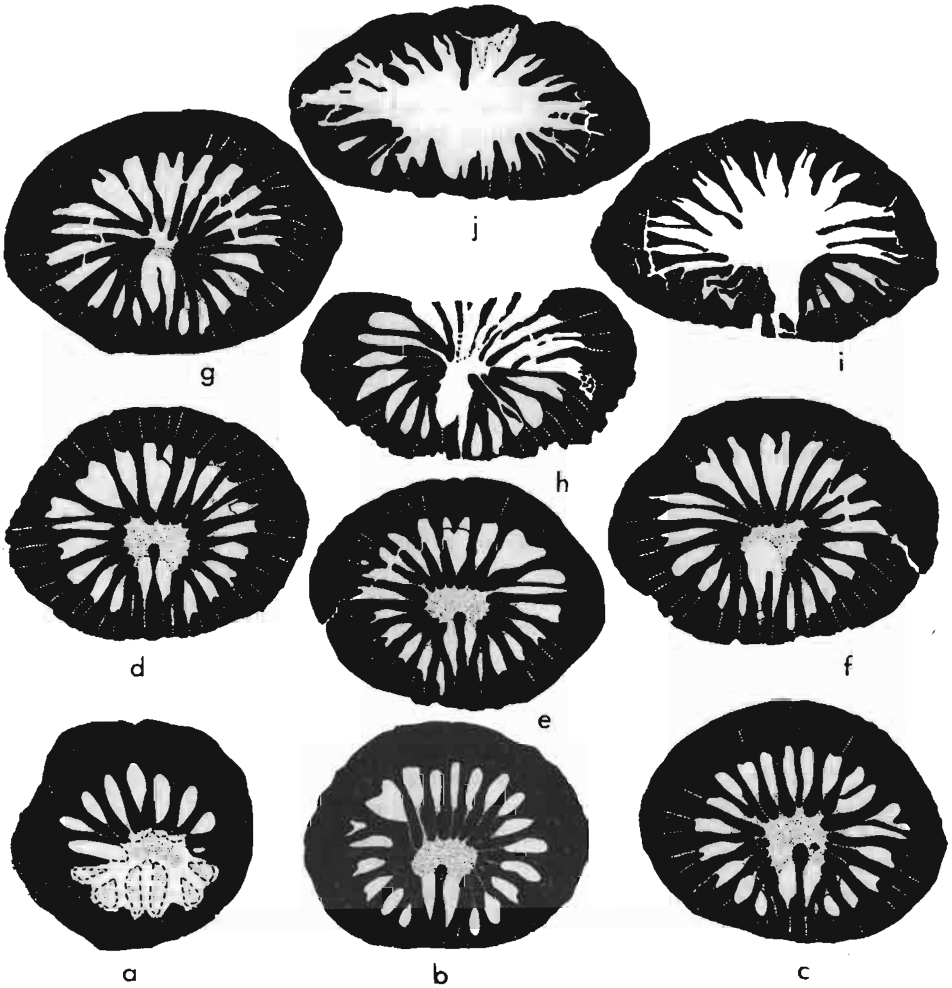

Fig. 5. Family Zaphrentidae Schindewolf, 1938. Gen. et sp. indet 1. Specimen 24308/6. Transverse sections: *a* late neanic/early ephebic stage, counter septum slightly shorter than counter-lateral septa, ×10; *b* counter septum as long as adjacent septa; rapid disappearance of two major septa from corallite lumen; *c* counter septum thinner and slightly shorter than counter-lateral septa (section reversed); *d*, *e* ephebic stage, counter septum shortened (*e* reversed); *f*, *g* cardinal septum became shortened near calice floor; *h*, *i* mostly above calice floor, minor septa start to elongate; *j* above calice floor, minor septa long. All ×6.6.

It is well known that all structural elements in the Rugosa may be thickned by the stereoplasm. These thickenings are often differently distributed during a given growth stage. The distribution is even more variable when not particular elements, but different growth stages of individual solitary specimens are compared. There is a structural element, the stereocolumn, however, that must be considered purely stereoplasmic.

Considering the occurrence of the axial stereocolumn only the auxillary taxonomic character, I would like to point out that it occurs extremally seldom in the non-patellate Plerophyllina. I can indicate only some representatives of

Tachylasma rhizoides Soshkina, 1925 from the Upper Permian of East Greenland as showing this kind of the structure in the mature portion of growth (Fedorowski 1982: pl. 3: 4). Even in this case, the stereocolumn may in part be false and may have resulted from the diagenetic alterations of inner ends of major septa and the stereoplasmic infillings of their inner loculi. I did not consider this character to be even of a specific value there. *Pleophyllum* Lecompte, 1952 may be the only genus of Plerophyllina in which the stereocolumn occurs as a natural completion of the extremally strong four protosepta. In all other cases known to me either from my personal experience or from the literature data the true stereocolumn is absent from corallite axes in Plerophyllina. Family Lophophyllidae Grabau, 1928 is omitted from the consideration, because its access to that suborder seems doubtful to me. In several cases of Plerophyllina there were sections of top portions of tabulae illustrated in corallite axes that made impression of a stereocolumn. The lack of continuation of these structures during longer portions of a corallite growth speaks against considering them as stereocolumn.

The absence of clear differentiation in length of protosepta in the specimen discussed is the next character distinguishing it from Plerophyllina. We may point out such genera as *Paracaninia* Chi, 1937, *Pleramplexus* Schindewolf, 1940, *Pentamplexus* Schindewolf, 1940, *Pseudobradyphyllum* Dobroljubova, 1940, *Basleophyllum* Schouppé et Stacul, 1959 or *Endothecium* Koker, 1924 (synonymy, postulated for some of those genera is omitted), but there almost always is a clear differentiation in length of protosepta, characteristic of the whole suborder, observed at least in some portions of their ontogeny. *Endothecium* is not quite certain in this respect.

The taxonomic solutions concerning *Paracaninia* Chi, 1937, *Pseudobradyphylllum* Dobroljubova, 1940, *Pentamplexus* Schindewolf and *Pleramplexus* Schindewolf, 1940 were recently discussed in detail by Weyer and Ilina (1979), Weyer (1981), and Ilina (1984). I have no comments concerning facts and only a few concerning the interpretation. First of all we do not know early ontogeny of *Paracaninia* and the Chinese material has not been restudied by the authors mentioned above. They only reinterpreted the original drawings of Chi (1937). The microstructure of septa, strongly expressed in diagnoses and remarks by Ilina (1984) is thus baseless, because it has never been studied in the type material. The latter is true not only of *Paracaninia*, but also for *Pentaphyllum* de Koninck, 1872, *Barbarella* Flügel, 1972, *Antikinkaidia*, *Commutia* and *Dalnia*, all of Fedorowski, 1973. All those genera were synonymized by Ilina (1984) with *Pentaphyllum*. The state of presentation of the specimen reinvestigated in the present paper is inadequate for the microstructural studies, and this problem is omitted from the discussion. It differs from *Paracaninia* Chi, 1937 (however interpreted) in possessing the axial stereocolumn, the cardinal septum dominating as far as to the calice floor in the peripheral part of the latter, and in having the lateral protosepta practically indistinguishable from other major septa by length and thickness starting from fairly early growth stage (the earliest portion is missing). Also, the tabularium is normal, not biform like in *Paracaninia* and its possible younger synonyms *Pseudobradyphyllum* Dobroljubova, 1940 and *Pleramplexus* Schindewolf, 1940.

The difference between here discussed coral and *Pentamplexus* Schindewolf, 1940 are much bigger and these two taxa can hardly be compared. The well accentuated and long-lasting pentaphylloid stage, the wide free tabularium, lack of stereocolumn, and the different middle part of the ontogeny, are characters fully adequate for the distinction. The question of the earliest ontogeny and the taxonomic value of the insertion of protosepta and especially of the counter septum, strongly expressed by Schindewolf (1949) and Fedorowski (1973) was omitted herein from the broader discussion. I would only like to mention that this idea was criticized by Weyer and Ilina (1979) and Ilina (1980, 1984), but was accepted on a family level (i.e. accordingly with Schindewolf's 1940 concept) by Hill (1981).

The similarity of the specimen here under discussion to *Sychnoelasma* Lang, Smith et Thomas, 1940 in such morphological characters as the arrangement of major septa, shape of the cardinal fossula, development of minor septa and position of the cardinal septum on the convex side of the corallite is striking. The strong development of the cardinal septum up to the peripheral part of the calice floor and the fairly early shortening of the counter septum are the only, but very important qualitative characters, adequate for the generic distinction. It seems probable, however, that *Sychnoelasma* is the taxon most closely related to the discussed one. I consider this relationship much more probable thant that with Plerophyllidae Koker, 1924 although the differentiation in length of protosepta is traditionally considered adequate for placing a given taxon within Plerophyllina. The Lower Namurian E_2 species from Great Britain, described by Hudson (1943) as *Zaphrentites schunnerensis* and *Z. breviseptatus*, are the rare exceptions from that approach. Both those species, which are possibly synonymous, show the morphology characteristic of *Ufimia* Stuckenberg, 1895. They may either show the phylogenetic line leading towards the latter genus or are homeomorphic to it. Both those solutions seem almost equally true for the time being. This would be enough to consider a possibility of the occurrence of diversified protosepta within the suborder Zaphrentoididaceae Schouppé et Stacul, 1959. In consequence, I temporarily place the specimen discussed within Zaphrentoididae Schindewolf, 1938, although the concept of this family by Hill (1981) is only in part acceptable to me. I have already transferred *Bassleophyllum* Schouppé et Stacul, 1959 to Plerophyllina (Fedorowski 1986*a*) and have synonymized *Fasciculiamplexus* Easton, 1962 with *Bradyphyllum* Grabau, 1928, placing the latter genus within Antiphyllidae Ilina, 1970 (Fedrowski 1987).

The shortening of some major septa in counter quadrants of the specimen discussed was pathological. They were reduced in length rapidly and underwent some further and temporary modifications (pl. 3: 3b; fig. 5d—j). In contrast to this, the reduction in length of the counter septum was gradual (pl. 3: 3a; fig. 5b—d) and constant process, which proves its natural occurrence and the genetic (thus taxonomical) background.

Occurrence. — Chouteau Limestone (unrestricted), near Sedalia, Pettis Co., Missouri.

Family **Antiphyllidae** Ilina, 1970

Genus *Rotiphyllum* Hudson, 1942

Type species: *Densiphyllum rushianum* Vaughan, 1908.

e.p. 1891. *Zaphrentis* Miller *non* Rafinesque and Clifford, 1820.
e.p. 1892. *Zaphrentis* Miller *non* Rafinesque and Clifford, 1820.
1906. *Densiphyllum* Vaughan: 318 *non* Dybowski, 1873.
1942. *Rotiphyllum* Hudson: 257.
e.p. 1944. *Rotiphyllum* Hudson; Easton: 32.
?1956. *Rotophyllum* (*sic!*) Hudson; Davis: 33.
non 1957. *Rotiphyllum* Hudson; Easton: 623.
non 1958. *Rotiphyllum* Hudson; Easton: 20.
non 1960. *Rotiphyllum* Hudson; Langenheim and Tischler: 112.
non 1960. *Rotiphyllum* Hudson; Sando: 171.
non 1985. *Rotiphyllum* Hudson; Sando and Bamber: 27.

Notice: Because only the complementary descriptions and illustrations of some North American specimens, but not the formal revision is the purpose of this paper, the complete synonymy has not been established. The above citations are restricted to the North American papers, except for the type species and the original designation of the genus.

Diagnosis. — Solitary, nondissepimentate, horn corals; early ontogeny zaphrentoid; in maturity cardinal septum, located on either side of corallite, is equal to other major septa, reaching their length along cardinal fossula floor; at calice wall cardinal septum shortened; counter septum slightly longer from or equal to other major septa; dilated inner ends of major septa reach stereocolumn; minor septa underdeveloped; axial portions of calice floor flat, slightly concave or convex, but without axial boss; peripheral portion steeply declined towards peripheral wall; tabularium normal; microstructure of septa probably fine trabecular.

Remarks. — The genus discussed has recently been diagnosed by Hill (1981) and Sando and Bamber (1985). Some elements in both those diagnoses are unsatisfactory to me, the new one is thus proposed. Several aspects of the morphology and suspected relationships of the genus were recently discussed together with remarks on *Monophyllum* Fomichev, 1953 (Fedorowski 1987) and will not be repeated. Now, I propose first of all not to consider the cardinal septum as being permanently located on any side of the corallite. This position is variable when the literature data are compared. Also, all specimens ever investigated by me, the material here under study included, do not show a constant position of the cardinal septum. The conical shape of tabulae (Sando and Bamber 1985) is the second question. The shape of this structural element must be compared to the shape of the calice floor, because the latter is the function of the former. This is the obvious, but sometimes forgotten relation. Thus, in the case of flat or concave axial part of a calice, the shape of the tabulae could not be conical. They must be flat or concave in the axial portion, and then overgrown by the stereoplasm in some specimens. This overgrowth may be so advanced that no room is left between the subsequent tabulae or, strictly speaking it is no more a tabula, but a solid stereoplasm in the corallite axis. The origin of the latter, however, is identical with that of normal separated tabulae. This problem is more widely discussed by Fedorowski and Sando (1989) in the revision of the genus *Trochophyllum* M.-Edwards and Haime, 1850.

Even in the case of the convex axial part of a calice, the tabulae can only be called dome-shaped. The above remarks concern corals that have inner ends of major septa united axially by the stereoplasm, but not joining directly one another. This is a separate problem and one can doubt wheter or not the latter corals should be placed within *Rotiphyllum* Hudson in spite of having the cardinal septum permanently long.

That the minor septa are long and contratingent, as pointed out by Sando and Bamber (1985: 27) in the diagnosis of *Rotiphyllum*, is probably ony a mistake, because neither the corallite illustrated by those authors (pl. 8: 6), or any other specimen, the holotype of the type species of that genus including, show this character.

The question of American rotiphylla is complex and cannot be solved without a careful revision of individual specimens described so far. The idea, probably introduced by Easton (1944) that this genus consists of both columellate and noncolumellate corals, was followed by him in his next papers (Easton 1957, 1958, 1962) as well as by Langenheim and Tischler (1960) and Sando (1960). The question of presence or absence of the columella is not mentioned by some other authors (e.g. Davis 1956, Sando and Bamber 1985), but a complete ontogenetic study of specimens of those authors has never been made. Because the revision of the North American

"*Rotiphyllum*" is not the purpose of this paper, and the material studied herein is poor, I may only provisionally included some coral studied in this paper in *Rotiphyllum* Hudson, 1942 thus, provisionally confirming the occurrence of that genus in the Lower Mississippian of the North America.

Rotiphyllum diutinum sp. n.

(pls. 2: 2; 6: 8; 8: 3; fig. 6: 1—4)

e.p. 1891. *Zaphrentis calyculus* Miller: 10.
e.p. 1892. *Zaphrentis calyculus* Miller; Miller: 620.
e.p. 1944. *Rotiphyllum calyculum* Miller; Easton: 32.

Holotype: Specimen 3359A/1.

Type locality: Near Sedalia, Pettis Co., Missouri = Locality 1 of Easton (1944).

Type horizon: Chouteau Limestone (unrestricted).

Derivation of the name: Lat. *diutinus*, — long-lasting — after permanently long cardinal septum.

Material. — Among five specimens included in this species two were longitudinally ground prior to this study. One of them (fig. 6: 2a, c) shows the septal arrangement comparable to that in other specimens of this species. The other, not illustrated one, is preserved in such a small fragment that its identification is very uncertain. All specimens discussed were included by Easton (1944: 33) in *Rotiphyllum calyculum.* Two of them (3359/1, 3) as the paratypes and three (24308/12, 13, 15) as unidentified cotypes. The stratigraphic and geographical data for all of them are the same as for the holotype.

There is a contradiction between statements published on pp. 33 and 64 by Easton (1944) and concerning the illustrated paratypes. The correct number is 3359a, because it is written on the surface of corallites. Among those three corallites, the one illustrated by Easton (1944) in pl. 3: 8 is here included in *R. diutinum* sp. n. and reillustrated in fig. 6: 2a—c. The other illustration of Easton (1944, pl. 3: 10) belongs to the holotype of *R. diutinum* sp. n. Easton's figure can be compared to the ontogenetically earliest section, illustrated herein in fig. 6: 1a. This was the only section of the holotype made prior to my study. Some differences in the arrangement of major septa resulted from the fact that my drawings had been made on the basis of the photograph of the thin section, while Easton made his illustration directly from the ground surface and orientated the drawings differently. The third corallite of Easton (1944), numbered 3359a is identified herein as being illustrated by that author in pl. 3: 9. It is included herein in *Rotiphyllum* sp.

Diagnosis. — *Rotiphyllum* having n:d: ratio near calice floor 18:4.5; calice deep, flaring to 10 mm at margin; major septa slightly rhopaloid, become free or almost free when stereocolumn of flat axial portion of calice is reduced; minor septa absent from corallite lumen and external wall, but present in upper portion of calice.

Description of the holotype. — The corallite is incomplete, with the ontogenetically earliest portion and the major part of the calice missing. It is widely conical, only slightly curved, with the cardinal septum located laterally. The external surface is corroded, but the almost smooth calice ridge indicates that septal furrows were very shallow if present. The calice (pl. 6: 8) is in part filled in with matrix. The major septa are short at the calice wall and elongated along its floor, but not enough to meet in its axis, where a small depression occurs. The minor septa are hardly distinguishable near the calice margin. They may in fact be not a true septa but only foundations of septa.

Fig. 6. 1—4 *Rotiphyllum diutinum* sp. n. *1* Specimen 3359A/1. Holotype. Transverse sections: *a* late neanic/early ephebic stage ×13.4; *b* ephebic stage ×6.6; *c*, *d*, *e* ephebic stage, above calice floor at periphery, successive reduction of stereocolumn, ×6.6. *2* Specimen 3359A/3. *a*, *b* upper (*a*) and lower (*b*) surfaces of the same transverse section made just beneath calice, ×6.6; *c* slightly eccentric longitudinal section, rejuvenation in upper portion (= Easton, 1944, pl. 3: 8), ×5. *3* Specimen 24308/15. Transverse sections: *a* near calice floor; *b* just above calice floor, except for peripheral area. Both ×6.6. *4* Specimen 24308/12. Transverse sections: *a* late neanic/early ephebic stage, *b* partly above calice floor, *c* almost entirely above calice floor, except for dotted area. All ×6.6. *5 Rotiphyllum* sp. Specimen 3359A/2. Transverse sections: *a* neanic stage, *b*, *c* early ephebic stage, *d* ephebic stage (= Easton, 1944, pl. 3: 9). All ×6.6.

The morphology beneath the calice (fig. 6: 1d, e) differs only slightly from that of the ontogenetically youngest part (pl. 2: 2a; fig. 6: 1a). The wider corallite, the more advanced development of last pairs of major septa in quadrants, the narrower cardinal fossula and hardly distinguishable alar pseudofossulae, form the major differences. The number of septa and their zaphrentoid arrangement is similar in all thin sections and peels made (pl. 2: 2a, b; fig. 6: 1a—e). The cardinal septum reaches the stereocolumn, but it is not elongated. There is some elongation of the counter septum, observed mainly in the ontogenetically earliest section, where its median line reaches the median line of one of the counter-lateral septa (pl. 2: 2a; fig. 6: 1a). The arrangement of those lines (primary septa) varies from section to section, being especially ambiguous in the middle one pl. 2: 2b; fig. 6: 1b). The same section shows a small disintegration of the stereocolumn near the corallite axis. Minor septa are absent both from the corallite lumen and from the external wall.

Individual variation. — The paratypes, except for 3359A/3 are smaller than the holotype. The corallite 3359A/3 (fig. 6: 2a—c), included in this species with restriction, is not discussed in detail.

The remaining two paratypes are similar to each other in n:d ratio and in having the major septa rhopaloid. The stereocolumn in one ot them (fig. 6: 3a, b), strong just beneath the calice, forms a kind of a large key-hole fossula at the calice floor. This is just an axial depression of the calice, similar to that in the holotype, but more widely open towards the cardinal septum. The latter is thin but longer than the adjacent pair of major septa and equal to other major septa in the section discussed (fig. 6: 3b). The second paratype (pl. 8: 3; fig. 6: 4a—c) differs from the holotype and from the paratype discussed above in having a very weak axial column, starting from the fairly early ontogeny (fig. 6: 4a). The zaphrentoid arrangement of the major septa is much less clearly seen in both of the paratypes than in the holotype, but the minor septa are absent from both their lumens and external walls.

Remarks. — Except for such characters as deep calice, widely conical, almost trochoid shape, and the external surface probably lacking septal furrows, the species described has nothing in common with the holotype of "*Zaphrentis*" *calycula* Miller, 1891, that was transferred herein to the new genus *Patularima*.

All North American genera that have the prominent axial boss or a columella developed in the calice are excluded from the consideration. They belong to different genera, mostly *Lophophyllum* M.-Edwards et Haime, 1850. *Rotophyllum* (*sic!*) *rushianum densum* Carruthers of Davis (1956) is similar to the species discussed in n:d ratio. Its morphology is not clear. The corallite illustrated was probably misoriented. The septum that does not reach the stereocolumn (lowermost in the picture of Davis 1956) is probably not the cardinal septum, as suspected by that author, but the first metaseptum of the right counter quadrant. If this is correct, the cardinal septum is long, the arrangement of septa is similar to the here described one, and their connection is only stereoplasmic. Thus, Davis' (1956) specimen may belong to the species discussed.

Rotiphyllum radicula (Rowley, 1900), redescribed by Easton (1957) resembles the species discussed in having the major septa withdrawn from the corallite axis. The former species, represented by the holotype only, has not been sectioned and its early ontogeny cannot be compared. Also, the axial mode of the attachment, very rare among the rugose corals, is nontypical for *Rotiphyllum*. This is in spite of permanently long cardinal septum. Different n:d ratio, better development of minor septa, and the counter, clockwise twisting of major septa would be specific distinctions of this species, if its generic status as *Rotiphyllum* is proved.

Rotiphyllum hians Easton? of Sando, 1960, re-illustrated by Sando and Bamber (1985) as *Rotiphyllum* sp. is said to possess the axial boss in the calice (Sando 1960: 171) and is thus excluded from the discussion.

R. diutinum sp. n., and especially its holotype, shows some similarity to *R. omaliusi* (M.-Edwards et Haime, 1851) demonstrated mainly by the pinnate arrangement of septa. Much smaller dimensions, different n:d ratio and different patterns of individual variation within the populations of American and European species form differences adequate for the specific distinctino. The similarity discussed may at the same time prove the true relationship of both these species, thus making the endemism of the American Midcontinental Basin less obvious. The similarity and relation of the here discussed species to the type species of the genus is much weaker and needs no special discussion.

Occurrence. — As for the holotype.

Rothiphyllum sp.

(pl. 8: 1; fig. 6: 5a—d)

Material. — Single, incomplete corallite No. 3359A/2, included by Easton (1944: 33) in *Rotiphyllum calyculum* (Miller, 1891) and illustrated by him in pl. 3: fig. 9. The corallite is silicified and slightly weathered out near the cardinal septum. The tip and the calice are missing.

Description. — From the major septa marked by Easton (1944: pl. 3: 9) only the cardinal septum is correctly indicated. The counter septum is in fact the third septum towards left from the septum marked by Easton (compare fig. 6: 5d in this paper), and the position of the alar septa is to be read from the septal formula $\frac{4|4}{7|6}$. None of Easton's (1944: 33) descriptions of paratypes fits with the specimen under discussion.

In the ontogenetically most advanced portion of growth preserved (fig. 6: 5d), the corallite has the n:d ratio 25:7.5×7.0 and shows a strong acceleration in the number of septa in cardinal quadrants. The arrangement of septa is zaphrentoid with some irregular grouping, thinning or shortening of individual septa in all quadrants. All septa, but the last pair in cardinal quadrants meet the axial stereocolumn which is weak, joining only the innermost portions of most of major septa. The latter stop rather short of the corallite axis. The cardinal septum is one of the longest major septa. It intersects the whole cardinal fossula. The latter is wide with almost parallel walls. The counter septum, counter-lateral and alar septa are the longest and/or the thickest in quadrants, but they do not dominate like those in *Plerophyllina*. From alar pseudofossulae only the left one is better marked. The occurrence of the minor septa has not been stated, but this may be due to the poor state of preservation of the corallite.

The morphology of ontogenetically younger stages (pl. 8: 1; fig. 6: 5b, c) does not differ from the above described one, except for smaller dimensions. The ontogenetically youngest portion (fig. 6: 5a) is zaphrentoid with the number of septa in quadrants equal to each other. The metasepta in the right cardinal quadrant were omitted from the picture due to the diagenetic and mechanical damage of the corallite.

Remarks. — The corallite described resembles most closely the holotype of *R. diutinum* sp. n. in having the major septa only slightly rhopaloid and the cardinal fossula boardered by the almost parallel walls. Its main distinguishing characters from the latter species are: a strong acceleration in the increase in major septa of cardinal quadrants that started from early growth stage; larger dimensions; and slightly different ontogeny.

Occurrence. — Chouteau Limestone (unrestricted), near Sedalia, Pettis Co., Missouri.

Gen. et sp. indet. 2

(pls. 6: 3, 6, 7; 7: 3; fig. 7: 1, 2)

Material. — Four silicified corallites. Two of them preserved only in the uppermost portions, the incomplete calices included (pl. 6: 3, 7; fig. 7: 2); one almost complete (pl. 6: 6), but silicified so that only a partly damaged calice is available for the study; and one having the incomplete calice filled in with matrix, but possessing a fairly complete early ontogeny instead (pl. 7: 3a—c; fig. 7: 1a—g). Although all corallites were sectioned for the purpose of this study, or were ground earlier, probably by Easton (specimens Nos. 24307/4,8), the inner morphology of two of them (24307/5,8) is altered by silicification to such a degree that I decided not to describe those corallites. Also, the other two specimens are silicified, but there are portions of growth or portions of individual sections available for the more or less detailed study.

All four specimens were re-identified by Easton (1944) as *Rotiphyllum calyculum* (Miller, 1891). The present groupping of the specimens in the gen. et sp. indet. 2 is provisional and reflects lack of adequate data rather than the final conclusion based on the complete investigation. The poor preservation of the material allows only imprecise determination for the time being.

Description. — Among the three calices investigated one shows major septa twisted (pl. 6: 6), one has this character poorly developed (pl. 6: 7), and in one calice the major septa are straight (pl. 6: 3). In all three corallites the cardinal and the counter septa are as long as other major septa; the cardinal fossulae, placed at the convex side or laterally, are inconspicuous or absent; the minor septa are seen only in the upper portion of calices; and the axial part of the calice floor is flat or concave, with (pl. 6: 3) or without (pl. 6: 6) inner ends of major septa penetrating that area. This penetration is differently accentuated, being common only in one corallite (pl. 6: 3).

The mature morphologies of two best preserved corallites differ from each other in some details, but the complete comparison of them is rather impossible due to the silicification. Both those corallites have the cardinal septa penetrating the corallite lumen as far as other major septa, except perhaps for some septa in the specimen 24308/3, that are temporarily elongated (pl. 7: 3a; fig. 7: 1c, e). The cardinal fossula is inconspicuous but it can be distinguished due to the underdevelopment of last pairs of major septa (pl. 7: 3c; figs. 7: 1g, 2). The alar pseudofossulae are hardly recognizable in individual sections, or are absent. The corallite 24307/4 (fig. 7: 2) shows the major septa in cardinal quadrants shorter than those in counter quadrants, which is opposite to the morphology seen in its calice (pl. 6: 7). Also, those septa were either originally strongly thickened and then silicified or were only altered by the silicification. All major septa, but the newly inserted ones, come close to the corallite axis. The major septa in the corallite 24308/3 twist slightly (pl. 7: 3c; fig. 7: 1 fig), being shorter in counter quadrants, and almost equal in thickeness elsewhere. Their true length, as well as the width of the axial stereocolumn, are uncertain. In the early ontogeny, investigated in the same corallite, the arrangement and early insertion of the major septa (fig. 7: 1a) is of the zaphrentoid kind. During the further growth (pl. 7: 3b; fig. 7: 1b—e), probably altered by diagenesis,

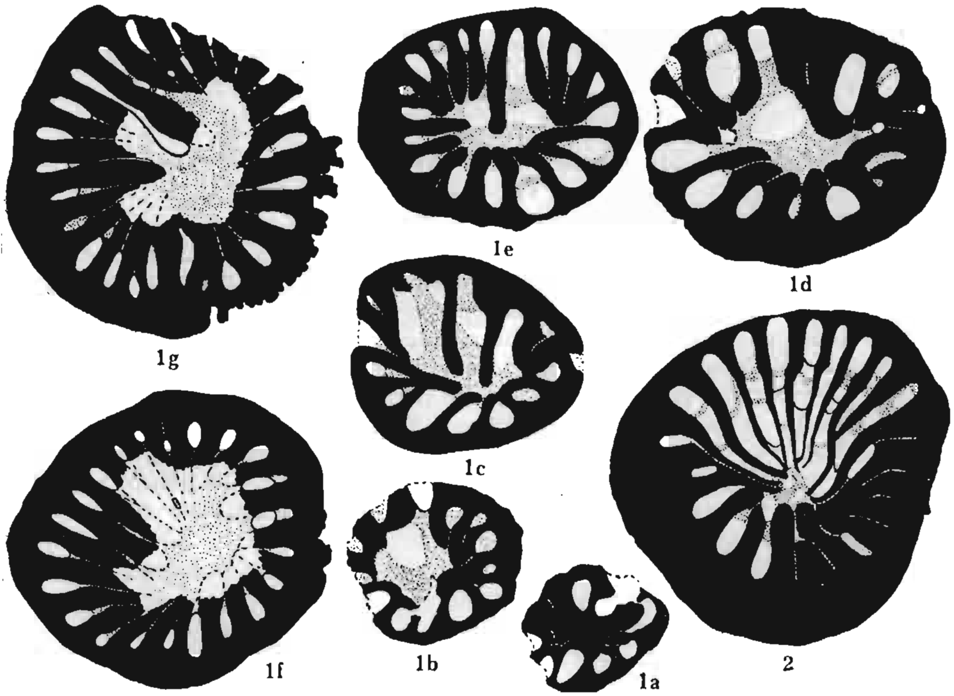

Fig. 7. Gen. et sp. indet 2. Transverse sections: *1* Specimen 24308/3. *a* early neanic stage; partly damaged major septa seem to be zaphrentoidally arranged, ×13.4; *b* neanic stage, counter septum fairly long, other septa form a kind of aulos, ×13.4; *c—e* neanic stage, major septa in cardinal quadrants form a kind of half-aulos, in counter quadrants some major septa temporarily damaged by diagenesis or/and pathologically (?) altered, *c*, *d* ×13.4, *e* ×10; *f*, *g* ephebic stage, axial and periaxial portion of corallite deeply silicified, but probably filled in with stereoplasm, ×6.6. *2* Specimen 24307/4. Ephebic stage, cardinal quadrants deeply silicified, major septa of right quadrant mostly deduced from slight shades in silica, ×6.6.

the major septa in cardinal quadrants are short and inclined towards the cardinal septum, that is equal to them in length. In counter quadrants, more strongly effected by the diagenesis, some major septa may be fairly short, while some other are long (pl. 7: 3a, b; fig. 7: 1b—d). The counter septum, diagenetically damaged in one section (pl. 7: 3b; fig. 7: 1d) is the longest septum of all in the late neanic stage (fig. 7: 1e), reaching alone the corallite axis. There are no minor septa present in the corallite lumen. The early ontogeny described is similar to the mature portion of the corallite 24307/4, except for the long counter septum.

Remarks. — The specimen described exhibit some features of *Rotiphyllum* Hudosn, 1942, but does not fit to the diagnosis of that genus completely. The cardinal septum, not shortened up to the calice floor, and the major septa reaching the axial stereocolumn, are the main characters in common with *Rotiphyllum.* The arrangement of major septa, and especially the early ontogeny, differs from those attributed to that genus, with latter character being unknown from the holotype of *R. rushianum*, and being only deduced from the studies on some Lower Carboniferous European specimens, starting from the study by Carruthers (1908). Also, none of the Mississipi Basin genera, revised by Grove (1935) and Easton (1944) fits to the morphology of early and mature portions of those specimens. The poor preservation and their inadequate representation prevent the introduction of a formal taxonomic name. I decided to describe and to illustrate those specimens in order to make the image of the variety of Chouteau corals more complete.

Occurrence. — Chouteau Limestone (unrestricted), near Sedalia, Pettis Co., Missouri.

Gen. et sp. indet 3

(pl. 6: 4; fig. 10: 4)

Material. — A single, horn-shaped corallite, No 24307/6 having the tip deeply silicified and partly damaged; not studied. The calice is in a large part preserved and well exposed for the study. The corallite was included by Easton (1944) in *Rotiphyllum calyculum* (Miller, 1891) as the studied paratype.

Description. — The corallite is strongly curved in the alar septa plan, and is flaring in the calicular region. The preserved external surface is smooth, but it is slightly corroded, and the shallow septal furrow may have occurred.

The calice rim is slightly damaged at the concave side of the corallite, but judging from the thickness of the broken part it was originally lower than the opposite one. The laterally located cardinal septum occupies approximately 2/3 of a narrow, inconspicuous cardinal fossula, and reaches the lateral surface of the adjacent major septum (pl. 6: 4). The counter septum is slightly longer than the counter-lateral septa and reaches the corallite axis. It does not dominate in height or thickness, however. The arrangement of major septa is irregular, being most strongly disturbed in the left counter quadrant, the middle metaseptum of which is the shortest of all. The left alar pseudofossula is not developed, while the right one is well seen due to the underdevelopment of the last major septum. The disturbances described were most probably caused by the alar plan of the curvature of the corallite. Most of the major septa are joined together by the stereoplasm in groups and reach or almost reach the corallite axis. The minor septa are developed only near the calice margin, disappearing down the calice. Their foundations are almost equally thick as those of the major septa (pl. 6: 4).

In the section made just beneath the calice (reversed when compared to the picture of the calice) (fig. 10: 4), the mutual relation of major septa near the corallite axis is uncertain due to the silicification. The cardinal septum is most probably not shortened, but this has not been established for sure. One alar septum is well marked. Minor septa are lacking. The morphology is otherwise similar to that in the calice.

Remarks. — The corallite described shows several characteristics of *Rotiphyllum* Hudson, 1942, except for the shortening of the cardinal septum at the calice floor. The slight elongation of the counter septum, combined with the shortening of the cardinal septum in the calice, may indicate *Monophyllum* Fomichev, 1953 as a potentially similar genus. I consider this similarity random and homeomorphic, because there is no linkage between the Lower Mississippian coral here under discussion and that Upper Carboniferous genus.

Some similarity of the transverse section (fig. 10: 4) to the transverse sections of specimens identified in this paper as Gen. et sp. indet 1 (pl. 3: 3a, b; fig. 5a—j) and to *Petraia? milleri* sp. n. (pls. 1: 1—3; 2: 24; 6: 5—9; fig. 1: 1—6) is at least in part caused by the diagenetic alterations of the axial and periaxial parts of corallites, making morphology of those areas uncertain. Morphology of calices of the three groups of specimens discussed differs distinctly, proving their different taxonomic positions.

Occurrence. — Chouteau Limestone (unrestricted), near Sedalia, Pettis Co., Missouri.

Family uncertain

Genus and species indet. 4

(pl. 8: 2a—c; fig. 8a—i)

Material. — A single, almost complete, partly silicified specimen No. 24308/5 left by Easton (1944) among the undescribed specimens, included in *Rotiphyllum calyculum* (Miller, 1891). The almost complete calice is partly filled in with matrix.

Description. — The corallite is 14 mm long when measured along the convex, cardinal side. Its surface is mostly damaged, but some parts indicate that shallow septal furrows were present. The slightly flaring calice is approximately 6 mm deep in its axial portion, but slightly deeper in the vicinity of the counter septum and shallower near the cardinal septum. This difference, not balanced by the curvature of the specimen, indicates the original position of the polyp body. Fairly short major septa at the calice wall, and a probable occurrence of minor septa near its margin, are everything which can be observed because of the partial infilling with matrix.

The ontogenetically earliest morphology (fig. 8a, b) observed in the deeply silicified thin sections, should be treated as an approximate and subjective reconstructions. There seems to be no doubt, however, that the arrangement and insertion of major septa are typical of majority of the Rugosa, commonly called zaphrentoid.

In the late neanic/early ephebic stage (fig. 8c) all major septa are thickened and almost meet each other near the corallite axis. The large part of the axial and periaxial portion of the corallite is filled in with the stereoplasm. The cardinal septum is slightly shorter than the major septa of the cardinal quadrants that bent over it. The counter septum is only slightly longer than counter-lateral septa. Its diagenetic damage looks like a carination in the picture (fig. 8c).

The mature morphology of the corallite observed beneath the calice (pl. 8: 2a, b; fig. 8d—f) shows the cardinal septum not shortened and the counter septum disctinctly elongated. It reaches the corallite axis and makes an impression of being a part of the axial structure when met by sections of tabulae (fig. 8e). The alar septa are the longest in cardinal quadrants, but their elongation, larger than resulted from the zaphrentoid arrangement, is seen only in one section (pl. 8: 2a; fig. 8d). The counter-lateral septa have their inner ends bent towards and attached to the first pair of metasepta. They are either equal to or shorter than other major septa in counter quadrants. This, and the morphology of their inner ends resulted in forming a kind of the counter pseudofossula, which is more conspicuous than the cardinal fossula in earlier sections (pl. 8: 2a; fig. 8d, e). The latter is hardly recognizable there and is better marked only due to the insertion of new septa (pl. 8: 2b; fig. 8f). The thickness of major septa is almost regularly reduced starting from the septa next to the cardinal septum and ending at the counter septum, with the exception for the cardinal septum, that may be slightly thinner and the alar septa, sometimes slightly thicker than the adjacent major septa. The occurrence of the minor septa in the external wall is not established, but this may have resulted from the silicification. They are absent from the corallite lumen. The axial stereoplasmic infilling is reduced during the course of growth of the corallite.

Sections made partly above partly below the calice floor (pl. 8: 2c; fig. 8g—i) reflect to some extent differences in depth of the calice, mentioned above. Some basal elements seem to occur at the corallite periphery as high as 1.5 mm below

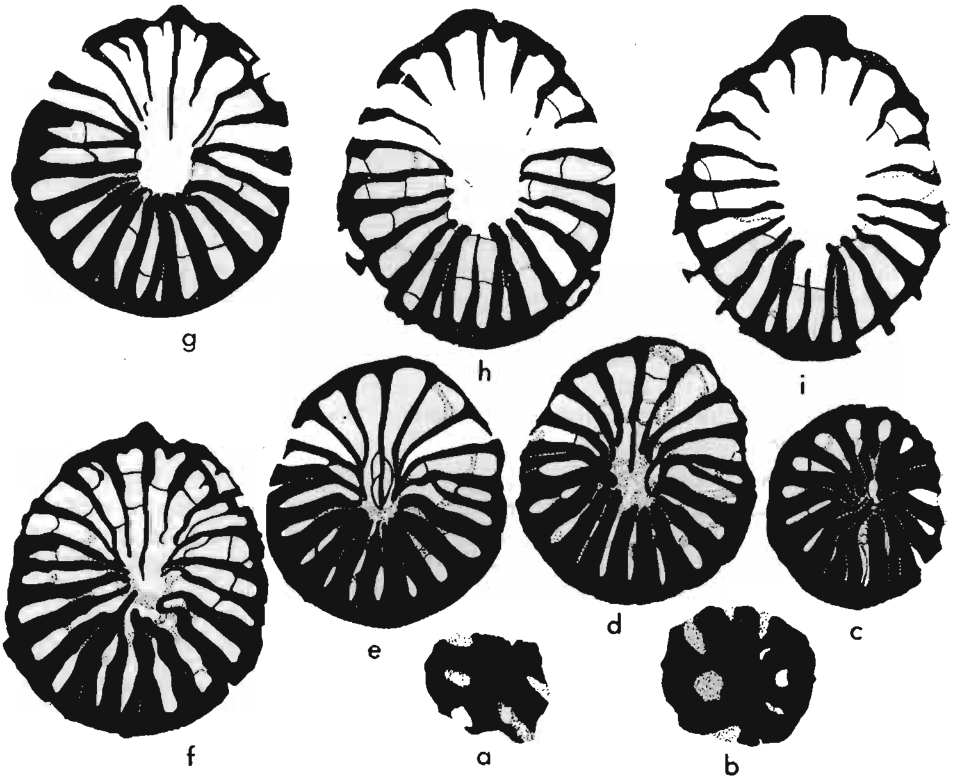

Fig. 8. Gen. et sp. indet 4. Specimen 24308/5. Transverse sections: *a*, *b* early neanic stage partly deduced and reconstructed, ×20; *c* late neanic/early ephebic stage, ×6.6; *d—f* ephebic stage, beginning of peripheral rejuvenation or isolated dissepiments (fig. *f*, upper right), ×6.6; *g—i* ephebic stage, partly above (near counter septum), partly below calice floor, cardinal septum above last tabula shortened (fig. *i*). All ×6.6.

the calice margin in the vicinity of the cardinal septum, while this is not so in the counter quadrants. Probability of having the sections in question made not exactly along striae should also be considered, because growth of the corallite wall was slightly faster in the cardinal region. Thus, the structural elements in counter quadrants are ontogenetically older a little than those in the cardinal quadrants.

The cardinal septum is long up to the last tabula in the cardinal fossula (pl. 8: 2c; fig. 8h), but is shortened above it (fig. 8i). The elongation of the counter septum, well accentuated just above the calice floor (fig. 8g), is quickly reduced down to the length of adjacent major septa (pl. 8: 2c; fig. 8h, i). The ephemerid structures appear in the portion of the corallite discussed and occupy the position of minor septa in some loculi of counter quadrants (pl. 8: 2b, c; fig. 8f—i). The insertion of those structural elements may be connected with the appearance of ambiguous structures that can be interpreted as either dissepiments or a very incipient peripheral rejuvenation. They do not show a definite character of either of those structures being better developed in cardinal quadrants, which is generally not the case of dissepiments. In contrast to the rejuvenation, that is always connected to a definite portion of a corallite, the structures discussed appear on the opposite sides of the here discussed coralite (pl. 8: 2b; fig. 8f, g upper right; pl. 8: 2c;

fig. 8h, i, lower part). Two incipient phases of the rejuvenation — first in the counter and the second in the cardinal quadrants — may explain the second solution.

Remarks. — The specimen described has no equivalent in the presently known coral fauna. *Neozaphrentis* Grove, 1935, *Clinophyllum* Grove, 1935 and *Meniscophyllum* Simpson, 1900, all derived from the Mississipi Basin and probably from the similar stratigraphic level are the only genera to be compared. The strong elongation of the counter septum in the calice of *Neozaphrentis* seems to eliminate that genus from the further discussion. However, the counter-lateral septa underdeveloped in length, some groupping of major septa around the axial area, and a slight domination in length of alar septa in most of the illustrated specimens of *Neozaphrentis* made the corallite described herein comparable with that genus. Length of the cardinal septum in *N. tenella* (Miller 1891) is critical in such a situation. If it is proved to be long up to the calice floor inclusively, the elongation of the counter septum in the calice will remain the only distinctive character between *Neozaphrentis* and the specimen described herein. The microstructure, unknown in both cases, is not considered.

Similarity to *Clinophyllum* Grove, 1935 is restricted mostly to the elongation of the counter septum. However, there is also the cardinal septum elongated in that genus and the alar septa are said to be shortened in *Clinophyllum* (Grove 1935; Easton 1944). Although the specimen discussed is very unlikely a member of *Clinophyllum*, it should be mentioned that the latter genus needs more careful restudy before being fully understood.

The arrangement of major septa and their differentiation in thickness as well as the not shortened cardinal septum, are characters of the specimen discussed comparable to *Meniscophyllum* Simpson, 1900. The strong elongation of the counter septum, retained up to the lower part of the calice, lack of any kind of an aulos, the arrangement and underdevelopment in length of the counter-lateral septa, and the different morphology in the premature portion of growth, are the most substantial distinguishing characters of the specimen discussed when compared to *Meniscophyllum*.

Occurrence. — Chouteau Limestone (unrestricted), near Sedalia, Pettis Co., Missouri.

Suborder ?**Plerophyllina** Sokolov, 1960

Family **Lophophyllidae** Grabau, 1928

Genus *Lophophyllum* Milne-Edwards et Haime, 1850

Type species: *L. konincki* M.-Edwards and Haime, 1850.

Diagnosis. — See Hill, 1981: F333.

Remarks. — The state of preservation of the material here under consideration is inadequate for detailed revision. It is obvious, however, that the columellate specimens can in no way be included in *Rotiphyllum* Hudson, 1942. The wide concept of the latter genus by Hill (1981) and by some earlier authors was critically discussed by Fedorowski (1987) and will not be repeated. It may only be right to maintain that *Monophyllum* Fomichev, 1953, included in *Rotiphyllum* accordingly to the earlier concept, has the cardinal septum shortened beneath the calice floor which is solely adequate for distinguishing it both from *Rotiphyllum* and from the genus discussed.

The development of the columella forms the basis for not considering "*Rotiphyllum*" *hians* Easton, 1944 a member of *Rotiphyllum* Hudson, 1942, although the histology of that structural element is uncertain. The dolomitized and silicified axial portions of all corallites available for the study seem to show a break between the cardinal and the counter septa in the corallite axis (figs. 9: 1—4; 10: 1). This may be confirmed by a kind of poorly preserved growth lines observed in the longitudinal section (fig. 10: 3) which may be interpreted as having resulted from the tabular and stereoplasmic build up of the columella. Most of columellae observed in calices (pls. 5: 1, 2, 3a; 6: 1, 2b) are either slightly damaged or seem to confirm the above interpretation. One specimen (pl. 5: 2) shows a kind of a comb on the top of the columella produced by the cardinal septum. This means that at least the cardinal septum penetrates the columella deeply participating its creation. The counter septum reaches the columella in all corallites studied. I thus tentatively consider the columella of the species discussed as originated from the cardinal and counter septa which do not form an axial septum and are disconnected axially. Inner ends of these septa are surrounded by a mass of the stereoplasm secreted on surfaces of the upwards declined, axial parts of tabulae. Inner ends of most major septa are not included in the columella directly, but some may have been covered with sheets of the stereoplasm common to them and to the peripheral part of the columella.

Two characters of "*Rotiphyllum*" *hians* Easton, 1944 are of a special value for its identification as a member or *Lophophyllum* M.-Edwards et Haime, 1950: the occurrence of the columella, independently of its origin discussed above, and the long cardinal septum, permanently joining the columella both beneath and above the calice floor. Deep calices and lack or very poor development of septal furrows may be considered less important, but should be mentioned.

The type species of *Lophophyllum* has not been restudied in detail, although Lecompte (1955) re-illustrated six syntypes. First of them has been chosen lectotype by Hill (1981). Judging from the state of preservation of the specimen, this was rather an unfortunate choice, excluding a proper restudy in the future. The lectotype, like the other syntypes, has the cardinal septum located on the convex side of the corallite. In contrast to Hill's (1981: F333) statement, the columella in the lectotype is not distally separated from cardinal septum by wide "notch", but this septum is directly connected to the columella by its inner end along the cardinal fossula floor. The cardinal septum is much lower than the other major septa, however, which was also the reason for my unfortunate schematic illustration (Fedorowski 1974, fig. 4A).

The shape of the cardinal fossula forms the main difference between the American specimens and the type species of the genus, and the symmetry of the major septa is the next one while the microstructure of septa is unknown in both European and American specimens. However, the syntypes of *L. konincki* expose some variation in the first two main characters, which is best illustrated by the corallite shown by Lecompte (1955) in pl. A, fig. 7. Traces of the arrangement of the major septa around the cardinal fossula are seen in some American specimens (pls. 5: 1, 3a, left; 6: 2b right) although the shape of those fossulae is not truly key-hole, as it is in most of syntypes by *L. konincki*. The bilateral arrangement of septa, attributed to *Lophophyllum*, is best seen in the holotype of *L. hians* (pl. 5: 1; fig. 9: 1c—e), but this is a very variable character in American specimens (see "individual variation" of *L. hians*). Considering the taxonomic value of the characters discussed I stay on the position that there is no real reason for distinguishing the here discussed specimens from *Lophophyllum* Milne-Edwards et Haime, 1850 at least for the time being. For the composition purposes further considerations are given below with remarks on *L. hians* (Easton, 1944).

Lophophyllum hians (Easton, 1944)
(pls. 5: 1—4; 6: 1, 2; 7: 1, 2; 8: 4; figs. 9: 1—4; 10: 1—3)

1944. *Rotiphyllum hians* Easton: 33, pls. 3: 4—6; 16: 6—8 (*cum synon.*)

Material. — All specimens included by Easton (1944) in the species discussed, but the specimen 3502, housed in the Illinois State Geological Survey, were restudied and confirmed as belonging to this species. Among these eight corallites, seven have calices more or less well preserved. One calice (specimen No. 24306/4) has been ground out prior to this study. The corallite No. 24304 was longitudinally sectioned (probably by Easton) with no transverse section being made and the corallite No. 24305 is preserved only in its uppermost portion. Sectioning of all other corallites, as well as all peels and thin sections were made recently for the purpose of this restudy. Calices of five corallites are fairly well preserved. The corallite No. 24401 is slightly crushed and has not been sectioned. Its partly preserved calice (pl. 5: 4a) allowed to place it within the species discussed. Interiors of all corallites are partly silicified and some morphological details in individual specimens are uncertain. I marked them by interrupted lines and/or by leaving them not inked in the pictures.

Dimensions (in mm):

No of specimen	N:d ratio	Remarks
24303	12:2.6×2.4	Neanic stage
„	20:6.1×5.5	Early ephebic stage
„	21:7.4×6.1	Just beneath calice
„	24:10.1×8.8	Calice margin
24305	22:9.2×8.0	Just beneath calice
„	22:10.1×10.0	Calice margin
24305/1	21:6.7×6.2	Early ephebic
„	24:8.3×7.5	Just beneath calice
„	26:10.2×10.0	Calice margin
24306/2	20:5.8×5.0	Early ephebic
„	22:7.0×6.2	Just beneath calice
„	24:9.8×9.7	Calice margin
24306/3	19:5.0×4.4	Late neanic/early ephebic stage
„	22:6.0×5.5	Ephebic stage
„	22:6.8×5.8	Just beneath calice
„	22:8.2×8.1	Calice margin
24306/4	?25:8.0×7.2	Beneath calice

Diagnosis. — *Lophophyllum* having n:d ratio just beneath calice up to 24:8,3×7,5, near calice margin up to 26:10,2; columella variable in size and shape, small; major septa may reach columella laterally; adaxial widening of cardinal fossula indistinct or absent; minor septa present in upper portion of calices and at periphery of external wall.

Description of the holotype. — The corallite is widely horn-shaped with the cardinal septum located on the concave side. Its external surface is slightly corroded, but septal furrows must have been very shallow if present at all, because there are no traces of them left.

The wide calice (pl. 5: 1), slightly oblique in accordance to the curvature, is elongated in the cardinal-counter plan. Its margin is slightly broken apart and its deeper peripheral portions are filled with matrix thus making recognition of its true depth impossible. Two cycles of septa are developed in the calice, both having peripheral parts strongly widened, but the minor septa are present only in the uppermost portion of the calice. Fortunately enough some of them are preserved in the vicinity of the counter septum making the recognition of the ambiguously located counter-lateral septa possible.

The major septa are arranged zaphrentoidally in fairly clear quadrants (septal formula $\frac{5|6}{5|4}$) with the cardinal septal fossula well developed, but with alar pseudofossulae practically lacking. The cardinal septum, lower than the other major septa, is long and joins the columella, as also the counter septum does. The direct contact of these two septa inside the columella has not been recognized. The counter-lateral septa are much shorter than the adjacent major septa. The left of them attaches the lateral surface of the counter septum and the right one the lateral surface of the adjacent major septum thus making the impression of those two septa being peripherally split (pl. 5: 1). Remnants of minor septa, located between some of the major septa mentioned, enabled the above interpretation and the recognition of shortened septa as counter-lateral septa, but not the long minor septa.

The length of major septa in quadrants is slightly irregular, except for the right cardinal quadrant, all septa of which are successively longer towards the alar septum and all but the last septum inserted, reach the lateral surface of the preceded septum to form a solid wall of the cardinal fossula. None of these septa, the alar included, reaches the columella. In the remaining three quadrants several major septa reach the columella laterally without showing any regularity or sequence (pl. 5: 1). Also, from the last inserted septa of counter quadrants only the left one is clearly underdeveloped. The columella is oval in shape and protrudes well above the calice floor. The cardinal fossula is almost equally wide along having only the peripheral-most part widened a little. The tabula that reaches the cardinal septum in the middle of the septal fossula indicates that the true cardinal tabular fossula occurs.

The subcalicular part of the corallite, and especially its axial portion is altered by the dolomitization and silicification. Thus the morphology of fairly large part of it was only deduced and is left white in drawings (fig. 9: 1a—e). The ontogenetically youngest portion of the corallite (fig. 9: 1a, b) shows the zaphrentoid arrangement of septa with alar pseudofossulae well developed, but with the cardinal fossula inconspicuous. Septa in counter quadrants are shorter than in cardinal quadrants. Minor septa are not developed in the corallite lumen. Their presence or absence in the external wall is impossible to check due to the diagenetic alterations.

The morphology of the middle and upper portion of the corallite (pl. 7: 1b; fig. 9: 1c—e) is similar in all sections and resembles that in the calice. The following characters should be stressed: 1) The variable shape of the cardinal septal fossula, that may in some portions (fig. 9: 1e) widen axially, resembling clearly the cardinal fossula in the type species of the genus, 2) Some septa, and especially the cardinal septum are rhopaloid, 3) The major septa, the cardinal and counter included, probably do not meet directly in the corallite axis, 4) The counter-lateral septa seem to be permanently shorter than the adjacent major septa, 5) The minor septa are absent from the corallite lumen up to the section made just beneath the calice floor. Like in the earlier stage, their occurrence in the external wall is impossible to establish for sure, 6) The arrangement of sections of tabulae confirms the occurrence of the cardinal tabular fossula.

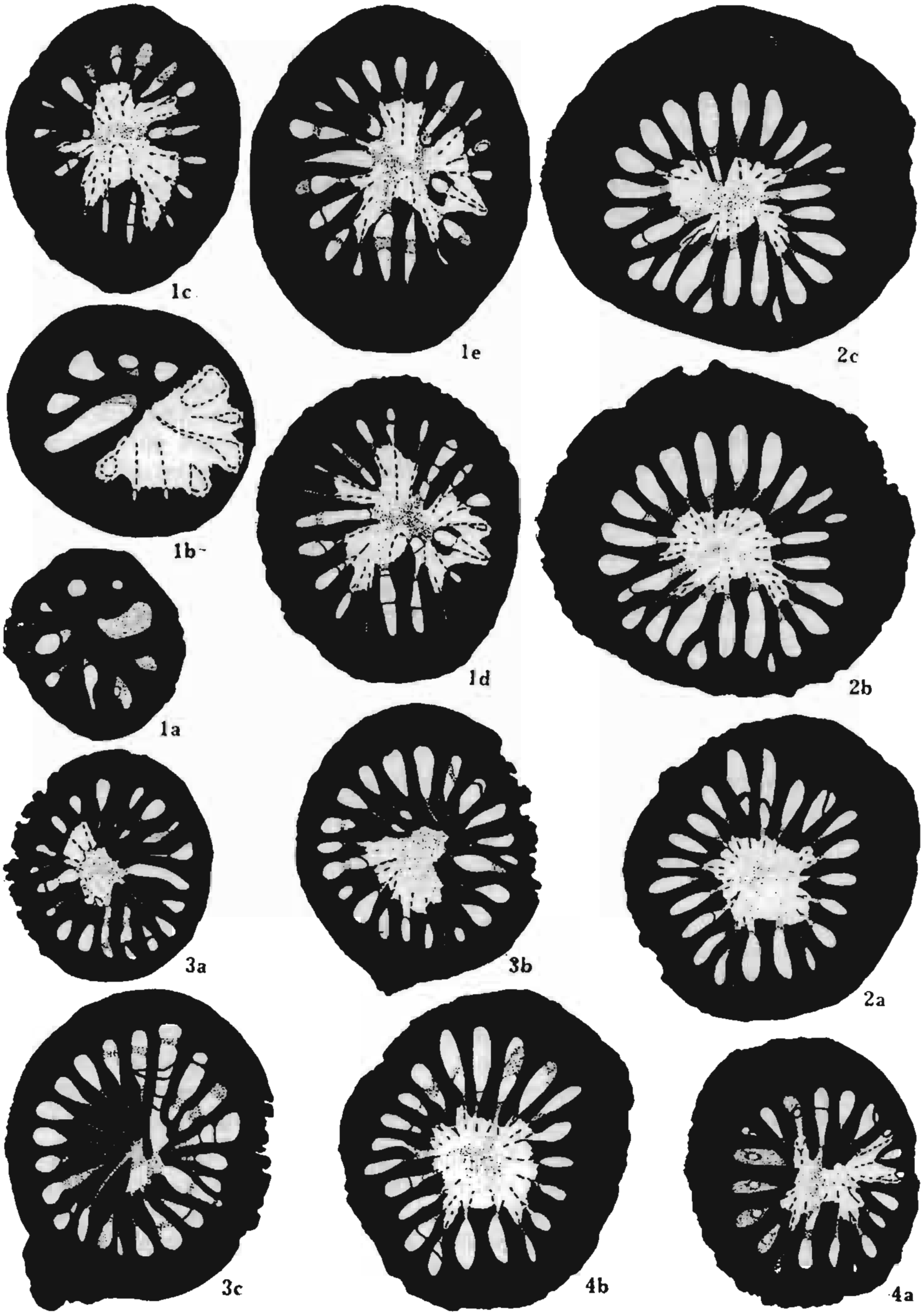

Fig. 9. *Lophophyllum hians* (Easton, 1944). Transverse sections. *1* Specimen 24303. Holotype. *a*, *b* neanic stage, arrangement of major septa deduced in part, ×13.4; *c*—*e* early to late ephebic stage, ×6.6. *2* Specimen 24306/1. *a*—*c* early to late ephebic stages, elongation of contour septum and weak stereoplasmic infilling uppermost, ×6.6. *3* Specimen 24306/3. Transverse sections: *a*, *b*, *c* early to late ephebic stages, ×6.6. *4* Specimen 24306/2. *a*, *b* early and late ephebic stages, ×6.6.

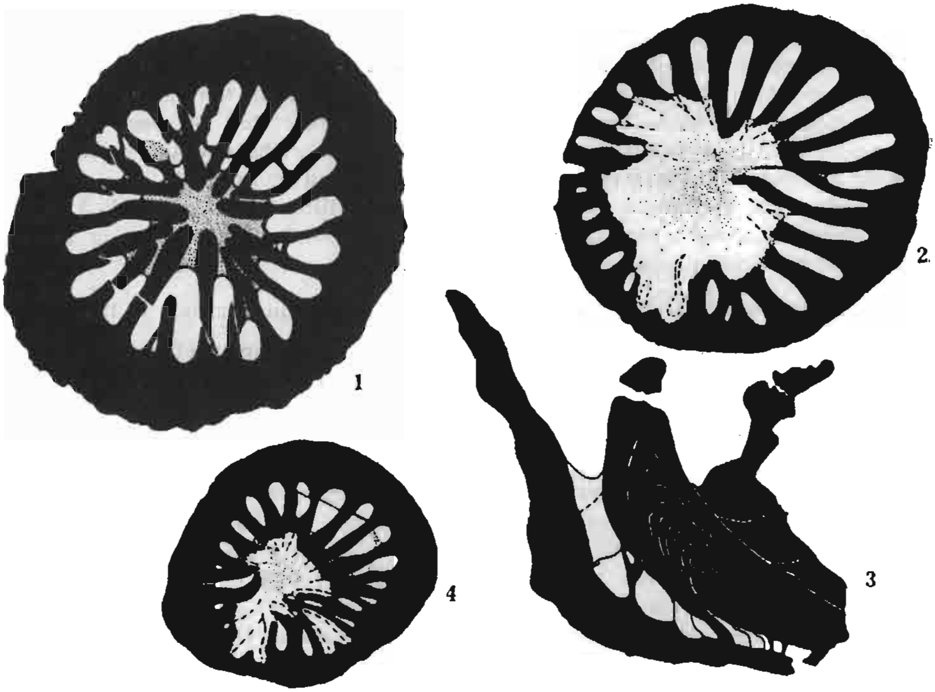

Fig. 10. *Lophophyllum hians* (Easton, 1944). *1* Specimen 24305. Transverse section, ephebic stage (= Easton 1944: pl. 3: 5), ×6.6. *2* Specimen 24306/4. Transverse section, ephebic stage, ×6.6. *3* Specimen 24304. Longitudinal section (= Easton 1944: pl. 3: 4), ×5. *4* Gen. et sp. indet. 3. Specimen 24307/6. Transverse section, ephebic stage, ×6.6.

Individual variations and additional descriptions. — The curvature of corallites varies. Three of them have (one only probably) the cardinal septum located on the concave, three (one probably) on the convex, and one on the lateral side. This is therefore not a character that can be considered taxonomically important. External surfaces of all corallites are smooth, but this is due to their being abraded. In some specimens there are median lines of major and minor septa seen on the actual surface. Only one corallite (pl. 5: 4b) shows some remnants of wide, shallow septal furrows and growth striae. This is treated herein as an indication of the presence of both those elements in the species discussed.

Calices differ in morphology from each other (pl. 5: 1, 2, 3a; 6: 1, 2b), the corallite 24306/3 (pl. 6: 2b) being the most distinctive. It is a trochoid corallite (pl. 6: 2a) that most probably possessed an attachement flattening, and perhaps also a small talon at the proximal end. This is indicated by some remnants as well as by the arrangement of major septa. Its calice is rather shallow (approximately 3.5 mm in the deepest part) and almost equal in depth. The columella protrudes only slightly above the axial part of the calice floor, being lower than inner ends of almost all major septa in counter quadrants. Both the cardinal and the counter septum reach the columella, but this attachement is inconspicuous, and that of the cardinal septum is located slightly laterally. Both alar septa are slightly elongated, but only the left one reaches the columella. The underdevelopment in length of the counter-lateral septa is hardly detectable. The cardinal fossula and the alar pseudofossulae are inconspicuous. The minor septa, well developed in the upper part of the calice, are easily distinguishable in the thick external wall below the calice; they do not penetrate the corallite lumen, however. The stereoplasmic infillings are weak in the thin section made just beneath the calice (fig. 9: 3c), which may have resulted from the fact that this section was made beneath the tabula, where the secretion of stereoplasm is commonly weaker. Both the cardinal and the counter septum are long in this section; their direct contact has not been observed. Two ontogenetically younger sections (fig. 9: 3a, b) have the counter septum less distinctly elongated, but instead possess the stereocolumn more solid.

In contrast to the above described one, the corallite No. 24306/1 (pl. 5: 3a, b) has the cardinal septum located on the concave side, and the calice lower in this portion. The cardinal quadrants are reduced in volume and in the number of major septa (septal formula $\frac{7 \mid 6}{4 \mid 5}$). The columella, although low, is higher than in the former corallite, protruding well above inner ends of major septa, most of them reaching its surface. The cardinal fossula is asymmetrical, with the cardinal septum equal in height to the adjacent major septa at the periphery of the calice and next to the columella, but lower in its middle portion. The counter septum reaches the columella slightly laterally. In contrast to the holotype and to the previously described corallite, the counter-lateral septa are almost as long as the counter septum. They clearly begin the counter quadrants in the arrangement. The right cardinal quadrant is very irregular in the length and increase of its major septa. The same is true of the section made beneath the calice (pl. 8: 4; fig. 9: 2b, c, reversed). In spite of the silicification, the axial portion of the corallite can be considering as solidly stereoplasmic with inner ends of major septa penetrating the stereocolumn, but most probably not meeting the corallite axis.

The corallite 24306/2 (pls. 6: 1; 7: 2; fig. 9: 4a, b) exhibits the morphology beneath the calice similar to that in the above discussed specimen, although its columella in the calice sticks higher above the calice floor and is located directly in the cardinal-counter plan (pl. 6: 1).

The morphology beneath the calice of the corallite 24305 (fig. 10: 1) differs in one important character from the description and illustration of Easton (1944: 33, pl. 3: 5): the cardinal septum is not short, but long. The short septum, indicated by that author as the cardinal septum, is in fact the last inserted septum of the left cardinal quadrant. Diameter of the corallite mentioned by Easton (1944) was also wrong (compare the table above). The silicification, restricted to the narrow axial area allows to state that major septa are rhopaloid and differentiated in length. Their innermost portions shown in the fig. 10: 1 are slightly reconstructed, however. The morphology of this corallite (pl. 5: 2; fig. 10: 1) is in several aspects closer to the holotype than that of other specimens. This concerns the character and arrangement of major septa, and the clear underdevelopment of the counter-lateral septa. However, the cardinal fossula in the corallite discussed is not widened adaxially, the major septa reach or almost reach the columella, and the inner part of the cardinal septum is treaceable as rising up to the top of the rather wide and not too high columella.

In the longitudinal section, made in accordance to the curvature, which is most probably the cardinal-counter plan, the very high columella occupies almost 1/3 of the corallite diameter, being obviously sectioned not perpendicularly, but parallel to its flattening and elongation. The inconspicuous lines, that are seen inside the columella, were interpreted herein as tabular or stereoplasmic growth lines, because at least some peripheral ones (fig. 10: 1, left) follow the arrangement of tabulae. The tabularium is normal, not biform. The shape and arrangement of the tabulae change in the course of growth of the corallite. Those in the proximal part are more oblique and more densely packed than those in the middle and distal portion of the corallite. Some of them are thickened with the stereoplasm.

Remarks. — There are only a few species introduced in the North American literature as *Lophophyllum* M.-Edwards et Haime, 1850 (see table below). Their original identifications are listed in the left hand column, and their probable generic status in the right hand one.

L. avonensis Bell, 1929	*Koninckophyllum* Nich. et Thoms., 1876
L. calceola White et Whitefield, 1862	?*Ekvasophyllum* Parks, 1951
L. cascadense Warren, 1927	dissepimentate coral
L. expansum White, 1876	?
L. radicosum Girty, 1912	*Lophophyllidium* Grabau, 1928
L. sauridens White, 1875	*Lophophyllidium* Grabau, 1928
?*Lophophyllum* sp. in: Sando and Bamber 1985	pobably a new genus
Lophophyllum sp. in.: Waters and Sando 1987	probably *Lophophyllum*

Some of the species listed were already emended (Sando 1965; Fedorowski 1987). The generic identifications of some other ones are easily available from the original illustrations (*L. avonensis*, *L. calceola*). *L. cascadense* and *L. expansum* were left without attempts of the generic identification because of both inadequate illustrations and lack of an access to the original material. It seems possible, however, that the second species is the dissepimentate coral, as well.

The corallite identified by Sando (1960, pl. 17: 2) as *Rylstonia* cf. *R. ters* (Girty, 1899) may belong to *Lophophyllum hians* Easton, 1944. It does not belong to *Rylstonia* Hudson et Platt, 1927. It also differs from other specimens illustrated by Sando (1960) showing the following characters close to or in common with *L. hians*: 1) long cardinal septum that reaches the columella along the deep cardinal fossula, 2) major septa either approaching the columella laterally or coming close to it, 3) weak but recognizable alar pseudofossulae, 4) underdeveloped minor septa. Also, the stratigraphic position of that specimen is comparable to Chouteau Limestone. Dimensions and n:d ratio of Sando's (1960) specimen differ slightly from those discussed in this paper.

Rotiphyllum hians Easton? of Sando (1960, pl. 17: 11), re-illustrated by Sando and Bamber (1985; pl. 8: 6), is also a probable representative of the species and genus as understood in this paper. In the description by Sando (1960: 17) "The axial column forms a low axial boss in the calyx", but "a cardinal septum is long and rhopaloid in the subcalicular stages, but short in the calyx." This shortening of the cardinal septum contradicts the concept of both *Rotiphyllum* and *Lophophyllum*, if it is present along the cardinal fossula floor as well. The Williston Basin specimens differ slightly from the Mississipi Basin specimens in n:d ratio, but may be eventually included in this species, if their cardinal septum reaches the columella along the cardinal fossula floor.

Recently, Sando and Bamber (1985: 23) referred *Rylstonia* of Sando (1960) with a query to *Lophophyllum* M.-Edwards et Haime, 1850 and included in that genus *Rylstonia ? columnirotata* Langenheim et Tischler, 1960, ?*Clisiophyllum panamintense* Langenheim et Tischler, 1960, *Ekvasophyllum proteus* Sutherland, 1958 and *Clisiophyllum teres* Girty, 1899. The authors mentioned pointed out an inadequate knowledge of the type species of *Lophophyllum*, but instead of following Hill (1981) who saw the type material and confirmed the lack of dissepiments in the type, they followed some Soviet Union students, who included in *Lophophyllum* the poorly dissepimentate specimens.

I do not acknowledge including of the dissepimentate and nondissepimentate forms in the same genus, because the achievement of the ability to produce dissepiments means the qualitative change in the polyp morphology. This is independent of the state this character has achieved. Moreover, the poor *versus* rich or weak *versus* strong are quantitative characters and cannot be considered as generic. A few dissepiments that appear in the calice of *Nicholsoniella* Soshkina, 1952 were adequate for all students to recognize validity of that genus. Thus, I do not consider the species transferred by Sando and Bamber (1985) to *Lophophyllum* as really representing the latter genus, and they were omitted in this paper from the comparison of the here described species of *Lophophyllum*.

The *Lophophyllum* sp. illustrated by Waters and Sando (1987: fig. 10g) has not been described and the length of the cardinal septum can hardly be estimated from the illustration. I therefore have no final opinion as to the identification of this species. Both species of *Rotiphyllum* introduced by Easton (1958) are columellate corals, but *R. vesiculosum* Easton, 1958 is said to posses dissepiments. If this is correct, the species will be automatically excluded from the discussion. It seems to me, however, that there is rather a series of rejuvenations developed there than a true dissepimentarium. Series of rejuvenations, even more advanced than the one discussed, were recently observed in the Lower Permian rugose corals from SW Texas (Fedorowski 1987). If this interpretation is correct, *R. vesiculosum* may well be synonymized with *R. occidentale* Easton, 1958. The latter species exhibits almost all characteristics of *Lophophyllum* except for having shortened the cardinal septum in the calice of the holotype. The axially swollen cardinal fossula, observed in the holotype, and pointed out by Easton (1958: 20) as occurring in some paratypes, forms the next morphological step towards *L. konincki*, the type species of *Lophophyllum*. Would it be then correct to exclude this species from *Lophophyllum*, if the cardinal septum is proved to be not elongated along the cardinal fossula floor in the calice? Or should rather the generic diagnosis of *Lophophyllum* be modified a little? If the last possibility is accepted, however, there will be almost no difference between *Lophophyllum* M.-Edwards et Haime, 1850 and *Lophophyllidium* Grabau, 1928, which is rather difficult for me to accept. Differences between "*R.*" *occidentale* and "*R.*" *hians*, discussed by Easton (1958: 21) are slight and those two species may be synonymous.

Rotiphyllum cf. *R. occidentale* Easton of Langenheim and Tischler (1960) from the Upper Tin Mountains Formation in California is again a columellate tetracoral. It has the cardinal septum separated from the columella. It is not shorter than other major septa in the cardinal quadrants, however, and the morphology shown by Langenheim and Tischler (1960: fig. 6) may have well resulted from either diagenesis or the lateral rejuvenation. The long minor septa exclude the California specimen from both "*R.*" *hians* and "*R.*" *occidentale*. It seems possible, however, that the re-investigation of the more abundant material will show the congenerity of this species with *Lophophyllum*.

Occurrence. — Localities 7 and 9 of Easton (1944), near Sedalia, Missouri, lower and upper part of Chouteau Limestone (unrestricted).

CONSIDERATIONS ON HABITAT CONTROL

All corallites studied are old museum specimens thus forming rather a weak basis for the comprehensive palaeoecological considerations, because the instant ecological information is lacking. However, the Chouteau Limestone they were derived from is a basinal deposit, therefore some initial prerequisitions do exist. Although representing different taxa, many of the corallites restudied can easily be misinterpreted when only the external shape and morphology are considered. The most frequent characters in common are: (1) distal parts of specimens flaring widely and often rapidly; (2) external surfaces smooth or with only delicate growth striae and/or very shallow septal furrows; (3) strong attachment scars, talons, rootlets, etc. are lacking. Those common characters are accompanied by deep or very deep calices, the upper ridges of which are either equally high around or are much higher at convex side of corallites. *P. calycula* (Miller, 1891) is a good example of the first groups, characterized by major septa equally thick around the calice. *M. minutum* Simpson, 1900 characterizes the second group that possesses major septa in mature portion much thicker at the cardinal side, but strongly and equally thickened around in the early portion of growth.

The external characters mentioned above suggest two kinds of respons of corallites to the environment in which the strong attachment to the rigid substrate is not required. The cephalopod and similar deep water and/or quiet coral bearing facies, e.g. in the Famennian/Lower Tournaisian of Thüringia and Poland (Różkowska 1969, Weyer 1981) or Marbre Griotto facies in Spain (Fedorowski and Kullmann, in preparation) are of that kind. The sedimentation rate is generally small there and there is no danger of the sessile organisms being burried if not growing fast upwards.

The *P. calycula* type of adaptation with short, rather heavy tip and a very deep, flaring, light calice can be considered as being adapted to the environment with a slow sedimentation of the calcium carbonate mud and none or extremelly light movement of water. The widely flaring, straight corallites were perhaps suspended in the dense and comparatively heavy layer of mud. The shape of specimens, their inner morphology, and the disposition of weight prove this reconstruction on a simply hydrostatic basis (fig. 11a). The narrow, but heavy tip prevents overturning of corallites by remnants of waviness or slight currents that may temporarily appear. It stabilized a corallite and allowed it to return to the vertical position, when tilted. The stabilization was made easier by wide calices, the draught of which in the mud was very slight, because of both, their shape and the difference in the specific weight of the mud and the calice that was filled in with water and light, almost gelatineous polyp's body. This was also a simply hydrostatic reason for easy drifting of corallites in the sea floor mud (fig. 11a).

The second group of corallites are horn shape specimens. Their calices are much higher at the convex side. Also, the inner structural elements are thicker and heavier at that side. Such a shape was considered by Seilacher (1984) typical of the unattached horn-shaped marine organisms that lived partly burried in the sea floor mud. *Meniscophyllum minutum* Simpson, 1900 has already been pointed out as a good example. To colonize the sea floor with extremely slow sedimentation rate of carbonate mud or with currents strong enough to wash out a part of those sediments without disturbing corals was condition of surviving for this, like for the previous group of those tiny corals. The fast sedimentation would have caused a total burrial of calices of those corals, the large depth of which rather excluded a possibility of the sediment rejection (Hubbard and Pocock 1972). Their small size and lack of attachment would have enabled stronger current to wash them out together with the sediment. Starving parts of basins and a depth well below the wave base seem most proper to be predicted as habitats of those corals. This deduction must be confirmed by observations in the field. It is easy to accept, however, that the heavy convex side of corallites may have helped them in both retaining their position in the very shallow sheet of the carbonate mud and in returning to the life position when slightly disturbed from it. The shape of calices, apparently so much higher on the convex side of the specimen would be reconstructed as almost horizontal, when the horizontal instead of vertical life position of specimens is accepted (pl. 1: 2b; fig. 11b). It thus forms a kind of the organic geopetal structure when found in the life position.

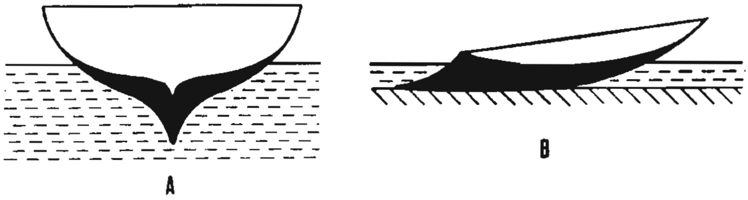

Fig. 11. Reconstruction of growth position of two longitudinally sectioned corallites and their relation to the sea floor mud; thickened structural elements in black. A widely flaring corallite suspended in the mud, B corallite resting on the lithified rock and slightly covered by the slowly accumlated mud.

Seilacher's (1984) idea, based on a single literature datum, cannot be expanded to all horn corals. Much more complex studies are required for the environmental reconstructions of horn corals. They should include at least the shape of calices, the arrangement of major septa, the position of the cardinal fossula, the lack *versus* presence of thickenings of structural elements and their disposition during individual growth stages, the attachment adaptations, the position of the larval attachment, the septal ribbing and the shape and density of the tabularium. His idea may form a good base for starting morphogenetic reconstructions within the Rugosa in the closer connection to their habitats than it is currently made.

Two problems remain open, however: (1) How to reconstruct the stage of metamorphosis and the earliest part of a polyp growth in the sea area that is apparently lacking any hard objects available for a larva to settle? Direct observations are not possible in the material studied. Thus, I can only deduce that there must have been hard grains in the mud large enough for larvae to settle. Otherwise, the area would not have been inhabited. Naked tips of corallites have not been observed. Thus, the mode of increase predicted by Birenheide and Soto (1977) should be excluded for the corals here under discussion. It seems logical to presume that both conical and curved but regularly widened corallites adopted their more mature life position by: (a) sinking in the mud of the small hard object a larva was settled on parallel to the growth of the conical corallite; increase of thickness of the mud sheet would have caused the same result, (b) overturning of the corallite when the grain became too small for keeping a corallite vertically (horn shaped corallites having deep calices). In both cases mentioned the final shape of corallites is established very early in their ontogeny and their size is the only external character that changes. In the case of corallites having the early growth portion narrow and the calice flaring rapidly, the comparatively small but rather rapid increase of the sedimentation of mud thickness may have forced them to increase their draught rapidly. This may have well been a very local event not marked by the not too far growing specimens. (2) The genetic control of adaptations discussed is the next important problem. The purely ecological and somatic approach to the problem will reduce the taxonomic value of the phenomena discussed to none. In the case of *Meniscophyllum minutum*, for instance, such an approach may lead to the suppression of that genus and to its synonymy with *Trochophyllum* M.-Edwards et Haime, 1850 that also shows an absence of the attachment facilities and the accumulation of the stereoplasm stronger on the convex side. I would rather not proceed so far, because that purely ecological approach would lead directly back into the Lamarck's (1809) theory and to the conclusion that all solitary corals dropped suddenly into a given environment would develop identical structures. The adaptations observed probably responded to both, the genetic determination and the somatic plasticity and the ability to adapt to given conditions. These mutual, genetic — environmental relations are not simple, however. For instance one of the specimens of *Petraia* (?) *milleri* sp. n. is externally (pl. 1: 1) most similar to *Patularima calycula* (Miller, 1891), while its inner morphology (fig. 1: 3) fairly closely resembles that of the holotype of the species it was included in.

It is well known that all structural elements in the Rugosa may be thickened by the stereoplasm. These thickenings are often differently distributed during a given growth stage of a corallite. The distribution is even more variable when not particular elements, but different growth stages of individual solitary specimens are compared. There is a structural element, the stereocolumn, however, that must be considered purely stereoplasmic. The stereocolumn may either be evaluated in terms of the skeletal element supporting the calice floor and, quite frequently, influencing its shape, or as a storage area for the excess of the calcium carbonate matrix secreted by the organism in the process of its metabolism. This second interpretation can be deduced from the new approach to the calcium carbonate secretion, introduced by Kaźmierczak *et al.* (1985). This new approach may be of importance for the rugose coral studies, because the stereoplasmic thickenings were every so often developed by those organisms. It opens at least two problems, however: (1) do all marine sessile organisms (or marine organisms as a whole) invented only one way of rejection of an access of calcium carbonate, i.e. by increasing thickness of their skeletons, or were they also aligible to reject that access by a simple expulsion together with other waste products? If the answer on the second part of the question is positive, then immediately the second question arises: should we distinguish all secondary sheets of septa and other structural elements as resulted from that process, or only those should be considered that have those structures especially thick and/or arranged in an extraordinary manner. Moreover, what about differences in thickness of septa observed in different stages of the ontogeny? Although there are many rugosans that have structural elements thicker or very thick in the early ontogeny, there are taxa or specimens, however (e.g. some Lophotichiidae Weyer, 1972, see Fedorowski 1987) in which no thickening at the early growth stage occurs. (2) Should our approach to the, let say, "additional biomineralization" be taxonomic or purely ecological. If the first one is accepted, we may start to exaggerate that character, but even in the second case one has to consider a necessity of the genetic determination of presence or absence of certain abilities, if not special organs, within organisms. Even in the context of the afore-mentioned remarks the occurence of such a genetically controlled mechanism may easily be found doubtful. For instance: when and how this mechanism started its activity, if there are opposite reactions at individual stages of growth, or there are specimens of the same species, derived from identical conditions, that react differently? I have already observed that among the Upper Permian rugosans from East Greenland. Several of them were derived from the same small piece of rock and obviously were not transportet prior to becoming burried (Fedorowski 1982), but the amount of the stereoplasm they produced was highly differentiated. It must be said, however, that the Greenland corals mentioned did not form the stereocolumn. Thus, the occurrence of the latter can hardly be evaluated as simply as the storage area of waste products.

REFERENCES

BIRENHEIDE, R. and SOTO, F. M. 1977. Rugose corals with wall-free apex from the Lower Devonian of the Cantabrian Mountains, Spain. — *Senckenberg. Lethaea*, 58, 1/3, 1—23.

CARRUTHERS, R. G. 1908. A revision of some Carboniferous corals. — *Geol. Mag.*, 5, 1, 20—31, 63—74, 158—171.

CLARK, A. E. 1924. On *Heptaphyllum*, a new genus of Carboniferous corals. — *Ibidem*, **61**, 416—423.

DAVIS, D. E. 1956. A taxonomic study of the Mississippian corals of central Utah. — *Brigham Young Univ. Research Studies* (*Geology*), **3**, **5**, 1—42.

[DOBROLJUBOVA, T. A.] ДОБРОЛЮБОВА, T. A. 1937. Одиночные кораллы Мячковского и Подольского горизонтов среднего карбона Подмосковного бассеина. — *Тр. Палеон. Инст.*, **6**, **3**, 1—92.

DYBOWSKI, W. N. 1873—1874. Monographie der Zoantharia Sclerodermata Rugosa aus der Silurformation Estlands, Nord-Livlands und der Insel Gotland, nebst einer Synopsis aller palaeozoischen Gattungen dieser Abteilung und einer Synonymik der dazugehörigen bereits bekannten Arten. — *Archiv Naturk. Liv.-, Est.- und Kurlands*, **1**, 5, 3, 257—532.

EASTON, W. H. 1944. Corals from the Chouteau and related Formations of the Mississippi Valley region. — *Rep. Geol. Survey Illinois*, **97**, 1—93.

— 1957. On the tetracoral *Rotiphyllum radicula* (Rowley) from the Mississippian of Missouri. — *J. Paleont.*, **31**, 623—624.

— 1958. Mississippian corals from Northwestern Sonora, Mexico. — *In*: W. H. Easton, J. E. Sanders, J. B. Knight, and A. K. Miller, Mississippian fauna in Northwestern Sonora, Mexico. — *Smithsonian Misc. Coll.*, **119**, 3, 1—40.

— 1962. Carboniferous formations and faunas of Central Montana. — *U.S. Geol. Survey Prof. Papers*, **348**, 1—126.

FEDOROWSKI, J. 1973. Rugose corals Polycoelacae and Tachlasmatina subord. n. from Dalnia in the Holy Cross Mts. — *Acta Geol. Polonica*, **23**, 1, 89—133.

— 1974. The Upper Palaeozoic tetracoral genera *Lophophyllidium* and *Timorphyllum*. — *Palaeontology*, **17**, 3, 441—473.

— 1982. Some rugose corals from the Upper Permian of East Greenland. — *Rapp. Grønlands geol. Unders.*, **108**, 71—91.

— 1986. Permian rugose corals from Timor (Remarks on Schouppé and Stacul's collections and publications from 1955 and 1959). — *Palaeontographica A*, **191**, 4—6, 173—226.

— 1987. Upper Palaeozoic rugose corals from Southwestern Texas and adjacent areas: Gaptank Formation and Wolfcampian corals. Part I. — *Palaeont Polonica*, **48**, 1—271.

GRABAU, A. W. 1928. Palaeozoic corals of China. Part I. Tetraseptata II. Second contribution to our knowledge of the streptelasmoid corals of China and adjacent territories. — *Palaeont. Sinica*, B, **2**, 2, 1—175.

GROVE, B. H. 1935. Studies in Paleozoic corals. III. A revision of some Mississippian zaphrentids. — *Amer. Midland Natur.*, **16**, 337—378.

HILL, D. 1937. The Permian corals of Western Australia. — *J. Roy. Soc. Western Australia*, **23**, 43—62.

— 1956. Rugosa. — *In*: R. C. Moore (ed.), Treatise on Invertebrate Paleontology. Part F, Coelenterata. — Geol. Soc. Amer. and Univ. Kansas Press, Lawrence, F233—F324.

— 1981. Part F, Coelenterata, Supplement 1, Rugosa and Tabulata. — *In*: C. Teichert (ed.), Treatise on Invertebrate Paleontology. — *Ibidem*, 1—762.

HUBBARD, J. A. E. B. and POCOCK, Y. P. 1972. Sediment rejection by Recent scleractinian corals: a key to paleo-environmental reconstruction. — *Geol. Rundschau*, **61**, 2, 598—626.

[ILINA, T. G.] ИЛЬИНА, T. Г. 1980. Морфогенез септального аппарата полицелид. — *In*: Б. С. Соколов (ed.), Кораллы и рифы фанерозоя СССР. 148—156. Наука, Москва.

— 1984. Историческое развитие караллов. — *Тр. Палеонт. Инст.*, **198**, 1—183.

HUDSON, R. G. S. 1942. *Fasciculophyllum* Thomson and other genera of the *Zaphrentis omaliusi* group of Carboniferous corals. — *Geol. Mag.*, **79**, 257—263.

KAŹMIERCZAK, J., ITTEKKOT, V., and DEGENS, E. T. 1985. Biocalcification through time: environmental challange and cellular response. — *Palaeont. Ztschr.*, **59**, 15—33.

KOKER, E. M. J. 1924. Anthozoa uit het Perm van het Eiland Timor. — *Jaarb. Mijnwezen Ned. Oost-Indie*, 1—50.

KULLMANN, J. 1965. Rugose Korallen der Cephalopodenfazies und ihre Verbreitung im Devon des südöstlichen Kantabrischen Gebirges Nordspanien. — Abh. Akad. Wiss. Lit. Math.-naturw. Kl., 35—168.

LANGENHEIM, R. L. and TISCHLER, H. 1960. Mississippian and Devonian paleontology and stratigraphy Quartz Spring Area, Inyo County, California. — *Univ. California Geol. Sci. Publ.*, **2**, 38, 89—152.

LECOMPTE, M. 1955. Note introductrice à la révision du genre *Lophophyllum* M.E. et H. — *Publ. Assoc. Etud. Paléont.*, **21**, 8, 401—414.

MILLER, S. A. 1891. Palaeontology. — Indiana Dep. Geol. Nat. Hist. 17th Annual Rep., 1—103.

— 1892. Palaeontology. — Indiana Dep. Geol. Nat. Res. 17th Annual Rep., 611—705.

RAFINESQUE, C. S., and CLIFFORD, J. D. 1820. Prodrome d'une monographie des turbinolies fossiles du Kentucky (dans l'Amerique septentrionale). — *Ann. Gén. Sci. Phys.*, **5**, 231—235.

RÓŻKOWSKA, M. 1969. Famennian tetracoralloid and heterocoralloid fauna from the Holy Cross Mountains Poland. — *Acta Palaeont. Polonica*, **14**, 1, 1—187.

SANDO, W. J. 1960. Corals from Well Cores ofa Madison Group, Williston Basin. — *Bull. U.S. Geol. Survey*, **1071-F**, 157—190.

— 1965. Revision of some Paleozoic coral species from the Western United States. — *U.S. Geol. Survey* Prof. Pap. **503-E**, 1—36.

—, and BAMBER, E. W. 1985. Coral zonation of the Mississippian System in the Western Interior Province of North America. — *Ibidem*, **1334**, 1—61.

SANFORD, W. G. 1939. A review of the families of tetracorals. — *Amer. J. Sci.*, **237**, 295—323, 401—423.

SCHINDEWOLF, O. H. 1931. On the genotype and septal development of the coral genus *Petraia* Münster. — *Quart. J. Geol. Soc. London*, **87**, 630—649.

— 1940. "Konvergenz" bei Korallen und bei Ammoneen. — *Fortschr. Geol. Paläont.*, **41**, 12, VII + 289—392.

— 1942. Zur Kenntnis der Polycoelien und Plerophyllen. — *Abh. Reichsamt Bodenforsch.*, **204**, 1—324.

SIMPSON, G. B. 1900. Preliminary descriptions of new genera of Paleozoic rugose corals. — *Bull N.Y. State Mus.*, **8**, Paleont. Pap., 199—222.

[SOSHKINA, E. D., DOBROLJUBOVA, T. A., and KABAKOVICH, N. V.] СОШКИНА, Е. Д., ДОБРОЛЮБОВА, Т. А. и КАБАКОВИЧ, Н. В. 1962. Tetracoralla, Четырехлучевые кораллы. *In*: Ю. А. Орлов (ed.), Основы Палеонтологии. **283**—345. Москва.

SUTHERLAND, P. K. 1965. Rugose corals of the Henryhouse Formation (Silurian) in Oklahoma. — *Bull Geol. Survey Oklahoma*, **109**, 1—92.

VAUGHAN, A. 1906. An account of the faunal succession and correlation. — *In*: C. A. Matley and A. Vaughan, The Carboniferous rocks at Rush County (Dublin). — *Quart. J. Geol. Soc. London*, **62**, 275—323.

WATERS, D. L., and SANDO, W. J. 1987. Coral zonules: new tools for petroleum exploration in the Mission Canyon Limestone and Charles Formation, Williston Basin, North Dakota. — *In*: J.A. Peterson (ed.), Williston Basin: exploration model for a cratonic petroleum province. — *Amer. Assoc. Petrol. Geol. Mem.*, 193—208.

WEYER, D. 1973. Einige Rugose Korallen aus der Erbslochgrauwacke (Unterdevon) des Unterharzes. — *Z. geol. Wiss.*, **1**, 45—65.

— 1974. Das Rugosa-Genus *Antiphyllum* Schindewolf, 1952 (Unternamur, Oberschlesisches Steinkohlenbecken). — *Časopis mineral. geol.*, **19**, 4, 345—365.

— 1980. Das silurisch-devonische Rugosa-Genus *Petraia* Münster, 1839. — *Freiberger Forschungsheft* C **357**, 25—42.

— 1981. Revision von *Pseudobradyphyllum* Dobrolyubova, 1940 (Anthozoa, Rugosa; Oberkarbon). — *Abh. Ber. Naturkd. Vorgesch.* **12**, 3, 3—21.

— 1984. *Neaxon cheilos* n. sp. aus dem Unterfamenne von Schleiz im Thüringer Schiefergebirge (Anthozoa, Rugosa; Oberdevon). — *Ibidem*, **12**, 5, 3—16.

—, and ILINA, T. G. 1979. Die Permischen Rugosa Genera *Pleramplexus* und *Pentamplexus*. — *Z. geol. Wiss.*, **7**, 11, 1315—1341.

YÜ, C. C., LIN, Y. D., SHI, Y., HUANG, Z. X., and YU, X. G. 1983. Carboniferous and Permian corals. — Jilin, 1—357.

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NOWY OPIS ORYGINALNEJ KOLEKCJI *ZAPHRENTIS CALYCULUS* MILLER, 1891, RUGOSA

Streszczenie

Rewizja *Zaphrentis calyculus* Miller, 1891 z Kinderhookian (dolny turnej) basenu Mississipi dokonana przez Eastona (1944) pozostawiła tak liczne wątpliwości, iż zastosowanie niektórych zaproponowanych przez niego taksonów okazało się niemożliwe. Ponowna rewizja oryginałów Millera (1891) zaliczanych przez Eastona (1944) do rodzaju *Rotiphyllum* Hudson, 1942 wykazała, iż w obrębie tego „rodzaju" można wyróżnić przedstawicieli *Lophophyllum* Milne-Edwards et Haime, 1850, *Meniscophyllum* Simpson, 1900, *Petraia* Münster, 1839, *Rotiphyllum* Hudson, 1942 i nowego rodzaju *Patularima*. Cztery dalsze rodzaje wyróżnione w zrewidowanym materiale, pozostawiono w nomenklaturze otwartej z powodu niedostatecznej reprezentatywności bądź złego stanu zachowania okazów.

Opisano morfologię i ontogenezę wszystkich gatunków w takim stopniu, jaki był możliwy przy złym stanie zachowania okazów (figs. 1—10, pls. 1—8). W niektórych przypadkach opisano również mikrostrukturę septów. Przedyskutowano pokrewieństwa i podobieństwa opisanej fauny. W części ogólnej zwrócono uwagę na zależność kształtu koralitów od przypuszczalnych warunków życia (fig. 11). Wyrażono niektóre wątpliwości nasuwające się w związku z nową interpretacją przyczyn wytwarzania złogów wapiennych przez organizmy morskie.

EXPLANATIONS OF PLATES 1—8

Plate 1

1—3. *Petraia ? milleri* sp. n.: *1* Specimen 24307/1. Calice. Cardinal septum upwards, ×4. *2* Specimen 24307/7. Holotype. External view; *a* cardinal, *b* lateral showing suspected life position of corallite. Both ×4. *3* Specimen 24308/11. Transverse section. Two major septa united near corallite axis. Isolated dark points in primary septum suggest its trabecular microstructure, ×100.

Plate 2

1. *Petraia* ? sp.: Specimen 24308/2. Successive transverse sections of mature portion of growth; long cardinal septum located in septal fossula.
2. *Rotiphyllum diutinum* sp. n.: Specimen 3359A. Holotype. *a* transevrse section of major septum; isolated dark points in primary septum suggest its trabecular microstructure, ×100. *b*, *c* successive transverse sections of early and late ephebic stage, ×10.
3. *Petraia ? milleri* sp. n.: Specimen 24307/7. Holotype Transverse section partly beneath (left) partly above last tabula, ×10.
4. *Petraia ? milleri* sp. n.: Specimen 24308/4. Transverse section made above last tabula in peripheral part, but probably beneath it in axial portino, ×10.

Plate 3

1, 2. *Meniscophyllum minutum* Simpson, 1900. Transverse sections: *1* Specimen 24308/1. *a* ephebic stage, *b*, *c* successive stages of rejuvenation. *2* Specimen 24308/7. Ephebic stage. All ×10.

3. Gen. et sp. indet. 1: Specimen 24308/6. Transverse sections. *a* early ephebic stage showing both cardinal and counter septum long, *b* late ephebic stage; section made above last tabula in peripheral portion; both cardinal and counter septum short. All ×10.

Plate 4

Patularima calycula (Miller, 1891): Specimen 3359. Holotype. *a*, *b* transverse sections of early and late portions of subcalicular growth, ×10, *c* calice ×4, *d* calice margin showing no traces of septal furrows, ×10, *e* corallite surface near calice margin; growth striae arranged in bands, but no septal furrows, ×10, *f* fragment of calice enlarged to show comb-like upper ridges of minor septa suggesting monacanthine microstructure and vertical rows of inprints (arrows) that may be remainings of attachment scars, ×12.

Plate 5

1—4. *Lophophyllum hians* (Easton, 1944): *1* Specimen 24303. Holotype. Calice, ×4. *2* Specimen 24305. Calice, ×4. *3* Specimen 24306/1, *a* calice, *b* lateral view.

Both ×4. *4* Specimen 24401. *a* convex side and calice with large, broken columella, ×4, *b* fragment of lowermost portion of corallite showing remainings of septal furrows, ×10.

Plate 6

1, 2. *Lophophyllum hians* (Easton, 1944): *1* Specimen 24306/2. Calice, ×4. *2* Specimen 24306/3. *a* external view, *b* calice. Both ×4.

3, 6, 7. Gen. et sp. indet. 2. Calices: *3* Specimen 24307/8, *6* Specimen 24307/5, *7* Specimen 24307/4. All ×4.

4. Gen. et sp. indet. 3: Specimen 24307/6. Calice ×4.

5, 9. *Petraia ? milleri* sp. n. Calices: *5* Specimen 24307/, ×4. *9* Specimen 24307/2, ×3.

8. *Rotiphyllum diutinum* sp. n. Specimen 3359A/1. Holotype. Partly broken calice, ×4.

Plate 7

1, 2. *Lophophyllum hians* (Easton, 1944). Transverse sections: *1* Specimen 24303. Holotype. *a* late neanic stage ×20, *b* ephebic stage, ×10. *2* Specimen 24306/2. Ephebic stage, ×10.

3. Gen. et sp. indet. 2. Specimen 24308/3. *a*, *b* early and late neanic stage, ×20, *c* ephebic stage, ×10.

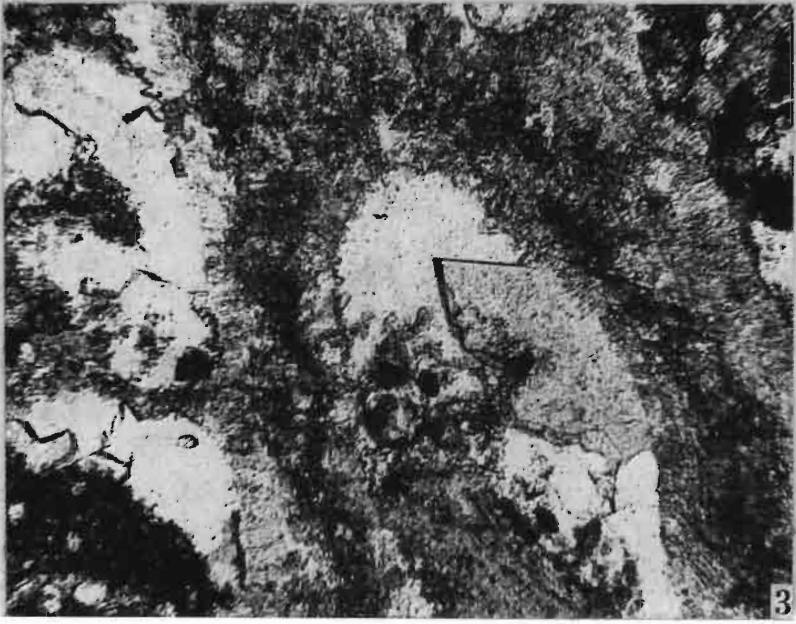
Plate 8

1. *Rotiphyllum* sp. 2: Specimen 3359A/2. Transverse section. Late neanic/early ephebic stage ×10.
2. Gen. et sp. indet. 4: Specimen 24308/5. Transverse sections. *a* ephebic stage, *b* just above calice floor near elongated counter septum; beginning of shallow lateral rejuvenation or increase of isolated dissepiments (upper right), *c* as above, but counter septum and major septa adjacent to it reduced in legth. All ×10.
3. *Rotiphyllum diutinum* sp. n.: Specimen 24308/2. Transverse secion made above calice floor, ×10.
4. *Lophophyllum hians* (Easton, 1944): Specimen 24306/1. Transverse section, ephebic stage, cardinal septum lower right, ×12.


1


2a


2b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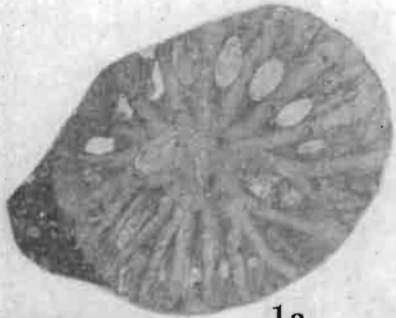
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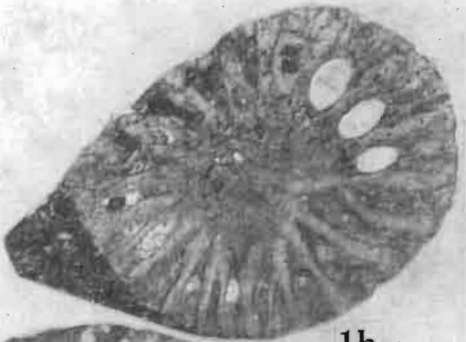
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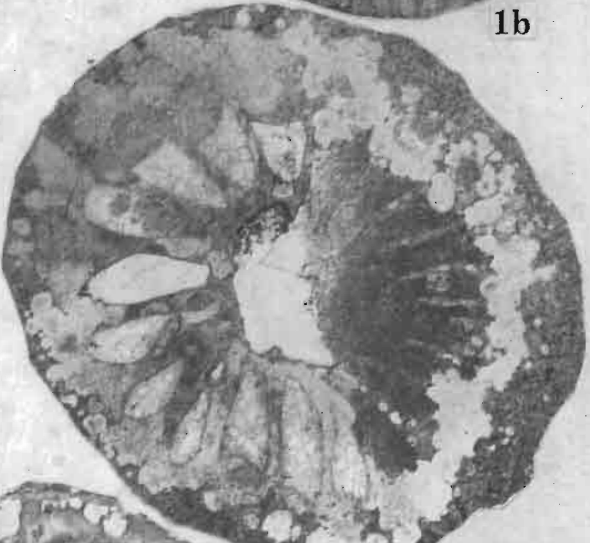
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2a


4


2b

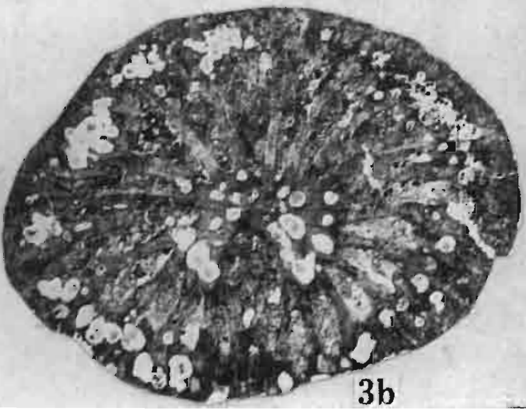

1a


1b


1c


2


3a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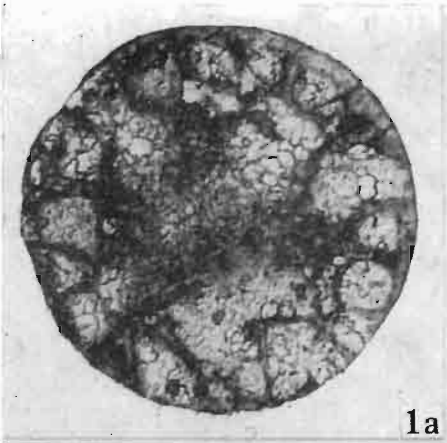
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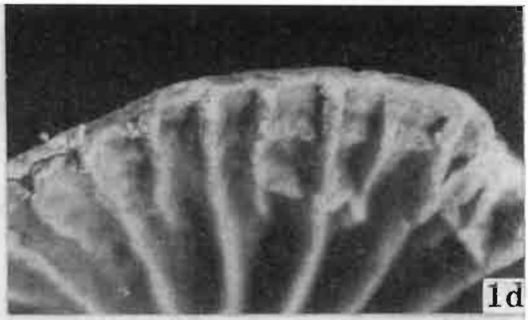
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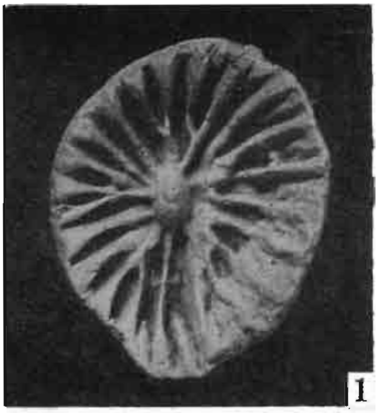
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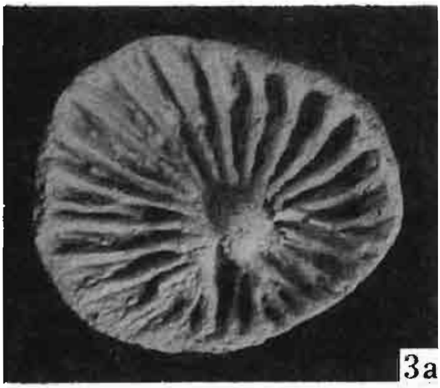
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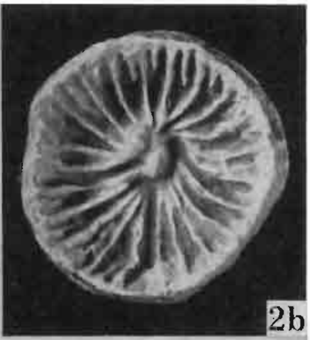
3b


4a


4b


1


2a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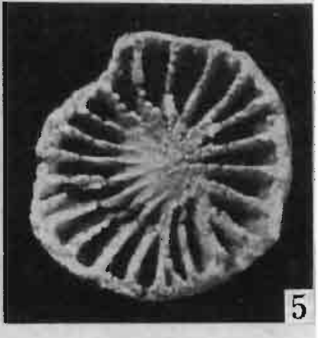
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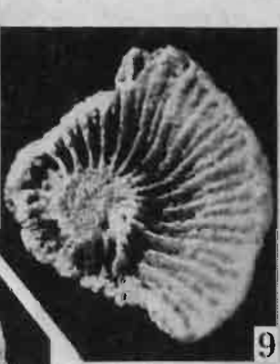
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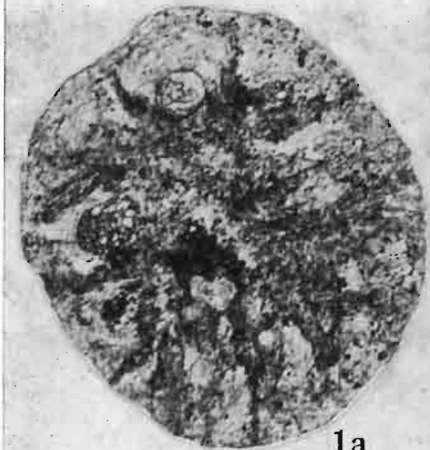

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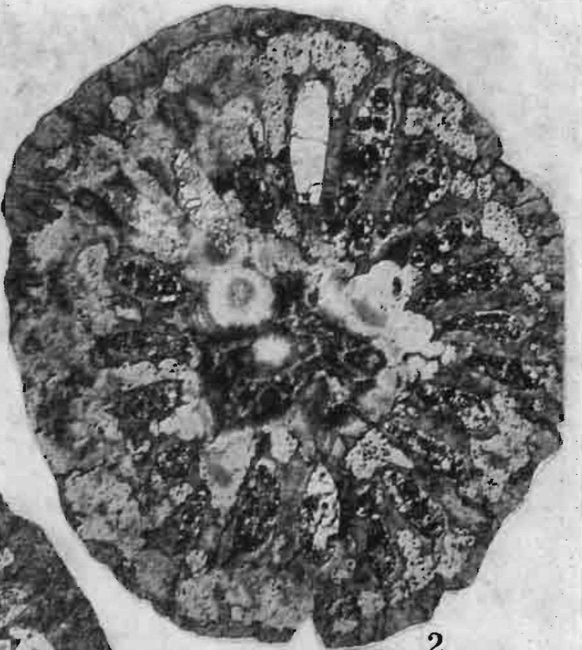

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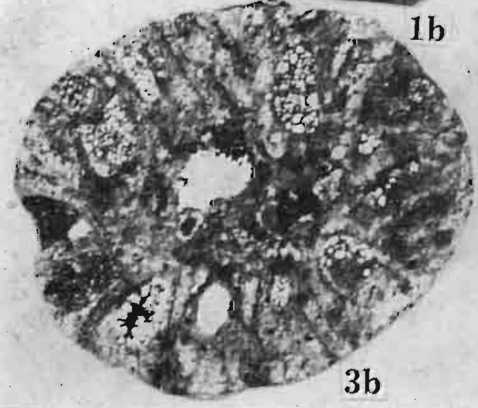

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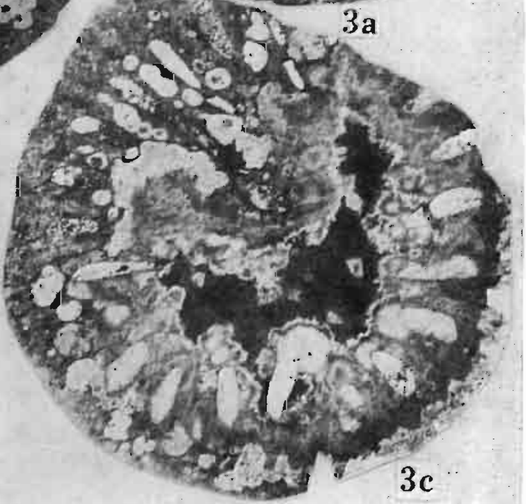

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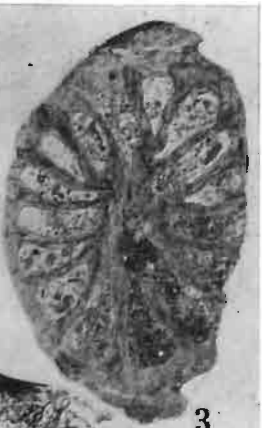
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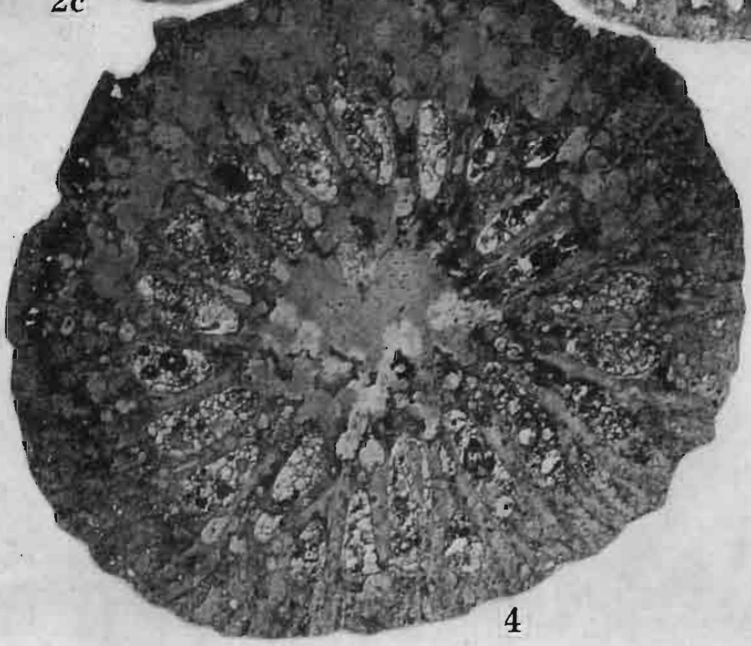
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