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SOME UPPER VISÉAN COLUMNATE TETRACORALS FROM THE  
HOLY CROSS MOUNTAINS (POLAND)

Abstract.—This paper is an elaboration of the representatives of the Upper Viséan tetracoral families Amygdalophyllidae Grabau and Rozkowskiidae n. fam. of the Holy Cross Mts. Development trends within the superfamily Aulophyllicae, as well as the microstructure of septa and columellae are presented in the general part, in which the microstructure of columella has been assumed as a basis for erecting families. The systematic part contains descriptions of 16 species (and two subspecies) belonging to four genera and two families. Most taxonomic units have for the first time been erected in the present paper.

## INTRODUCTION

The present paper contains the results of an elaboration of the families Amygdalophyllidae Grabau and Rozkowskiidae n. fam. from the Upper Viséan of Gałęzice in the Holy Cross Mts. on the basis of similar ontogenies. These families, along with the Aulophyllidae previously described by the present writer (Palaeont. Polonica, No. 24, *in press*), have been combined in the present paper to form the superfamily Aulophyllicae. The two publications make up an elaboration of all species of the superfamily Aulophyllicae from the Sudeten and the Holy Cross Mts., so far collected in these areas. Judging by a great variety of this group of corals, it seems, however, that there is still a possibility of finding in these regions a certain number of species not yet described.

In the Sudeten Mts., the superfamily Aulophyllicae makes up a rather small percentage as compared with the colonial species of the genera *Lithostrotion* and *Diphyphyllum*. Only the representatives of the family Aulophyllidae mostly of the genera *Dibunophyllum* and *Clisiophyllum*, have so far been found in these mountains. At Gałęzice, on the other hand, all the three families are represented and make up a group of the Tetracoralla predominant both numerically, and taxonomically. The most

abundant are the genera *Dibunophyllum* of the Aulophyllidae and *Spirophyllum* n. gen. of the Amygdalophyllidae. These genera, along with *Koninckophyllum* and *Palaeosmia* are the most characteristic group of the fauna of corals. They are marked not only by a vast number of the specimens found (several hundred specimens each of some of the species have been collected), but also by an extensive taxonomic differentiation and, at the same time, a great individual variability.

A discussion of the stratigraphic position of the Carboniferous limestone from Gałęzice, from which come all the specimens here elaborated, has been omitted from the present paper. In this respect, the present writer's opinion remains identical (Upper Viséan, D<sub>2</sub> top) with that expressed previously in the description of the aulophyllids referred to above. The writer wishes only to state that *Lithostrotion junceum*, typical of zone D<sub>2</sub> occurs abundantly only in the lowermost beds on the Todowa Grząba Hill and Besówka Hill, whereas the species described from the west- and east — European beds younger geologically occur in this area on the whole above the beds containing *L. junceum*. Attention should, however, be attracted to the fact that classical stratigraphic elaborations from Great Britain, France and Belgium mostly have not been so far revised and that, the stratigraphic position of the corals from those countries is uncertain. Since the boundaries between the Viséan and Namurian in Poland and the U. S. S. R. do not coincide with each other, the correlation with Eastern Europe is also difficult. It is possible, therefore, that the indications of corals, not corresponding at Gałęzice to those of goniatites, are not at present a precise stratigraphic document. The present writer considers, therefore, as important to state that the assemblage of tetracorals described occurs in this area together, with *Goniatites crenistria* (Phillips).

In completing the relationships between the fauna of tetracorals of Poland and other areas, discussed previously (Palaeont. Polon., No. 24, *in press*), noteworthy seems to be the fact that the Upper Viséan deposits of Gałęzice contain the species closely related to the Namurian and Westphalian ones from Northern Spain (Asturia). The occurrence of these same species in so distant areas and so different geological horizons may be explained by the persistence of similar facies. Detailed lists of coral fauna of particular ecological types, for various localities and geological horizons in Asturia were presented by de Groot (1963). As follows from these lists and lithological remarks, the facies that was predominant in Asturia from the Namurian to the Westphalian was related to the reef facies and very favourable to the development of the tetracorals. On the other hand, it is difficult to find where these species developed during a short period between the Upper Viséan and the Namurian and Westphalian. It should be conjectured that it took place near the shores or on Thetis shoals along which they probably migrated.

As stated in the writer's previous work (*l.c.*), the area of the Lublin Coalfield was the main route of the coral fauna's migration from the east to the territory of Poland. What is called the "Sławatycze elevation" (unpublished data), recently found by borings, does not preclude the possibility of a migration along this route but compels one to pay a closer attention to the southern, sub-Carpathian way. Although, as a result of the Tertiary flysch being too thick, no Carboniferous could be bored in that area, but the Carboniferous exotics found there may indicate that such a sideroute did actually exist. Even most of the fauna, in particular the corals of the Cracow Region and of the Holy Cross Mts., might migrate along this route. A similar opinion was expressed by Dr. H. Żakowa from the Geological Institute Holy Cross Branch in Kielce (oral communication).

The present paper contains the descriptions of the tetracorals coming only from Gałęzice (Holy Cross Mts.). The material from the Besówka Hill has been collected by the writer and is housed at the Poznań Laboratory of the Palaeozoological Institute, Polish Academy of Sciences. Specimens from the remaining hills in the environs of Gałęzice have been collected by Dr H. Żakowa and are now housed at the Geological Institute, Holy Cross Branch in Kielce.

#### ACKNOWLEDGEMENTS

The writer feels obliged to express his profound gratitude to Professor M. Rózkowska for her discussion of several morphological problems on phylogeny and ecology of the tetracorals described below. Likewise his heartfelt thanks are due to Dr. H. Żakowa (Geological Institute, Holy Cross Branch in Kielce) for the material she offered for elaboration and for the discussion on the stratigraphy and palaeogeography of the Carboniferous in Poland.

#### ABBREVIATIONS

The following abbreviations have been used in the present paper:

- Z. Pal. P. Tc-4/ — catalogue number of a collection housed at the Palaeozoological Institute of the Polish Academy of Sciences, Poznań Branch.
- I. G. No. OS-70/ — catalogue number of a collection housed at the Museum of the Geological Institute, Holy Cross Branch, Kielce.
- n/d* — septal index, where "n" designates the number of septa and "d" the diameter of the coral.

GENERAL PART

A. PHYLOGENY

The review of the stratigraphic occurrence of the genera belonging to the superfamily Aulophyllicae, the development trends found and the ontogeny studied thus far, allow one to reconstruct with a certain degree of probability the phylogenetic relations within this superfamily. The following characters are of a fundamental diagnostic importance: structure of columella in the case of families and formation of the axial structure in the case of genera. At the same time, it should be particularly strongly emphasized that generic characters may be very similar or even identical in different families and therefore, the microstructure of columella, acquiring a particular importance, should be very accurately recognized. The axial structure in *Dibunophyllum* and *Spirophyllum divisum* n. sp. or in *Koninckophyllum*; *Amygdalophyllum* and *Rozkowskia* may here serve as an example.

		AULOPHYLLICAE												
		AULOPHYLLIDAE					AMYGDALOPHYLLIDAE   ROZKOWSKIDAE							
		AULOPHYLLINAE		CLISIOPHYLLINAE										
Permian	Upper													
	Lower													
Carboniferous	Stephanian				?									
	Westphalian		D											
	A		C											
	Namurian		B											
	Upper		A											
	Lower		Upper											
	D <sub>2</sub>		Lower	<i>Zakovia</i>	<i>Slunimophyllum</i>	<i>Aulophyllum</i>	<i>Koninckophyllum</i>	<i>Koninckiophyllum</i>	<i>Neokoninckophyllum</i>	<i>Filra</i>	<i>Nervophyllum</i>	<i>Amandophyllum</i>		
	D <sub>1</sub>													
	S													
	C													
Toumaisan	Z													
	K													
	Etrœungt													

Fig. 1. — Chronological table of the occurrence of genera of the superfamily Aulophyllicae Dybowski, 1873.

The occurrence of similar structures in different families may be explained by their close relationship and by the fact that their representatives develop under similar ecological conditions, frequently even close to each other. Hence, a parallel development within these families, since both the genetic predispositions and the effect of environment are concordant.

The most important role among all families of the Aulophyllicae is played by the family Aulophyllidae and, within the latter, by the subfamily Clisiophyllinae. The representatives of this subfamily have the least complex, biseptal columella and, at the same time, they occur in the oldest and probably also youngest stratigraphic horizons, that is from the Etroeungt zone to the Permian. The highest — and lowermost geological horizons here given are not certain since many forms described as, for instance, the *Corwenia*, may belong to the family Durhaminidae, etc.

*Clisiophyllum omaliusi* Haime (1855) has been described from Northern France's zone considered as Etroeungt and *Clisiophyllum kayseri* Frech (1885) and *C. (Dibunophyllum) praecursor* Frech (1885) from a probable equivalent of this zone in Germany.

Although their stratigraphic position is not certain and requires revision, these species should be considered as the oldest representatives of the genera *Clisiophyllum* and *Dibunophyllum*. Comparing these oldest species, one may find that the development of the genus *Clisiophyllum* has been marked very early by a complex axial structure, which in both the longitudinal and transverse section was not subject to major changes. It was only more or less at the turn of the Tournaisian to the Viséan that there appeared what are known as "nucleate clisiophylla", assigned later to the genera *Clisaxophyllum* or *Neoclisiophyllum* not acknowledged by the present writer. Completely different is the form of axial structure in *Dibunophyllum praecursor*, primarily marked by the occurrence of a strongly developed columella and also by a considerable variability in the ontogenetic development (longitudinal section), as well as, judging from Frech's illustration (1885, Pl. 7, Fig. 1e), by a conspicuously simple structure of the part the youngest ontogenetically. The characters referred to above, along with the fact that the representatives of the genus *Dibunophyllum* are met with as late as the highermost Carboniferous seem to the writer to be sufficient for considering the genus *Dibunophyllum* as a starting genus of many other genera of the Clisiophyllinae. On the other hand, the genus *Clisiophyllum* develops independently of and in parallel with *Dibunophyllum*. It was probably separated from the same stock. Another argument for considering *Dibunophyllum* as an initial genus is provided by a general development trend, strongly emphasized in this genus and occurring in most representatives of the superfamily Aulophyllicae. This trend leads from more complex structures to simplification

and reduction. Certain reservations may, on the other hand be aroused by the ontogeny. Although the ontogenetic development of the oldest species of *Clisiophyllum* and *Dibunophyllum* has not been studied, but the occurrence of a koninckophylloid phase in the early neanic stage was found more than once in species of these genera younger geologically which have been examined by the writer. This phase occurs in fact fairly frequently also in other representatives of the superfamily. In the writer's opinion, this may be an argument for deriving Aulophyllicae from primitive forms having only columella. Such a genus is *Koninckophyllum*, but unfortunately none of its representatives were found in beds older than Z<sub>2</sub> and, therefore, with the present state of knowledge of corals of this superfamily, it can be hardly considered as an initial genus. Nevertheless, such a possibility cannot be precluded, much the same as a polyphyletic origin of the Aulophyllicae.

A very poor knowledge of the tetracorals of the Uppermost Devonian and beds transitional to the Carboniferous prevents one from finding older phylogenetic relationships. The present writer begins the reconstruction of the phylogeny of the Aulophyllicae from Etroeungt zone, considering its stratigraphic position as uncertain. He does not share the view of Hill (1938–1941) who believes the genus *Acrophyllum* from the Lower Devonian of Canada to be a possible ancestor of *Clisiophyllum*. Certain similarities in the form of axial structure are probably the result of a mere convergence so frequent in the tetracorals. This genus, both for its stratigraphic position and morphology, should be related rather with *Streptelasma*.

*Koninckophyllum* may be considered as an initial genus for at least the following two genera: 1) *Neokoninckophyllum*, which even happens to be identified with the latter and 2) *Koninckinaotum*, which, with its typical koninckophylloid structure of columella, is distinguished by the formation of new structures important diagnostically, that is, a shortened counter septum and naotic septa.

On the other hand, *Dibunophyllum* is in the writer's opinion an initial genus for: 1) *Arachnolasma* — by the reduction in width and simplification of axial structure. 2) *Amandophyllum* — by the disposition of axial structure in longitudinal section, with the preservation of columella and major septa reaching it; 3) *Corwenia*, which separates by acquiring a capability of forming permanent colonies; 4) *Nervophyllum* — by the introduction of lamellae, corresponding to minor septa, to axial structure and by a change in the position of lamellae in the structure; 5) *Biphyllum*, which separates due to the shortening of counter septum and formation of a stereoplastic wall around axial structure.

Phylogenetic relationship of the genera *Mira* and *Cravenia* seem to the writer to be rather obscure. The genus *Mira* may be fairly closely compared with *Neokoninckophyllum* due to a very similar ontogeny, although

a mutual relationship of these genera is not clear. The lack of the dissepimentarium in *Cravenia* brings in question the very assignment of this genus to the Aulophyllicae within which it is the only genus of this type. It should be probably related rather to *Lophophyllum* which is also devoid of the dissepimentarium (Lecompte, 1955). Since the latter two genera were not represented in the writer's collection, their ontogeny could not be studied and for this reason the genus *Cravenia* has not been presented in the table.

The stratigraphic position of the subfamily Aulophyllinae is confined to the Upper Viséan and Lower Namurian only. The geological horizon in Novaya Zemlya with representatives of this group is not precisely determined ("Barentsovskaya seria"). The number of genera so far assigned to this subfamily is small and the initial form cannot be indicated at present. The genus *Slimoniphyllum* seems to be most similar in morphology and ontogeny to the Clisiophyllinae but it can be hardly considered as an initial form for other genera of this subfamily because of both the occurrence of such a special structure as the shortened counter septum and the appearance of this genus only in zone D<sub>2</sub>. It seems likely, however that is separated from *Dibunophyllum*. On the basis of a current knowledge of this subfamily, the present writer did not decide on presenting mutual relationships of genera within its range.

The family Amygdalophyllidae may be fairly closely related to and derived from the Clisiophyllinae, as shown by the ontogenetic development, very similar in younger development stage, as well as by the occurrence of a bisepal list in the axial part of columella. This list is formed at the beginning of ontogeny and, identically as in Clisiophyllinae, it results from the connection of the cardinal and counter septum. The appearance of the oldest amygdalophyllids may be open to discussion. Kato (1959) maintains that *Amygdalophyllum* sp. a Minato, 1955 from Hikoroichi series, considered by Hasimoto as equivalent of *Etroeungt* (Kato, l.c.), is the oldest representative of *Amygdalophyllum*. The present writer does not know what was a faunal basis of this stratigraphic determination but if it was not based on conodonts and goniatites it may arouse certain doubts. The occurrence of such an excellently developed form as *Amygdalophyllum* sp. a in such an old stratigraphic horizon seems to the writer to be hardly acceptable. Stating this fact, the writer continues to regard *Cyathoclisia tabernaculum* from the Upper Tournaisian as one of the oldest species of the family. A considerable variability of this species, its low stratigraphic position and an extensive geographical distribution predispose it to be an initial form for the genera *Amygdalophyllum* and *Spirophyllum* n. gen. No koninckophylloid stage has been found in the ontogenetic development of *Cyathoclisia*, while it does occur in both *Spirophyllum* and Polish representatives of *Amygdalophyllum*. The ontogeny of neither A.

*etheridgei* nor other Australian species have never been studied in detail. This difference in ontogeny makes somewhat difficult the reconstruction of phylogenetic relationships between various amygdalophylloids. It seems, however, to result from the origin of columella, which in the amygdalophyllids is formed by a fusion of a biseptal medial lamella with axial ends of major septa. In more a primitive species or genus, there may also remain complete major septa connected directly with the biseptal medial lamella (*Cyathoclisia*), whereas in higher genera only parts of lamellae remain closed in columella (*Amygdalophyllum*). This type of reduction of free lamellae is observed even in *Cyathoclisia tabernaculum*, in which an amygdalophylloid form is presented by Dingwall (1926, Pl. 3, Fig. 2).

The occurrence of a complex axial structure with twisted lamellae in the ontogeny of *Cyathoclisia* provides a certain basis for finding a relationship between *Cyathoclisia* and *Clisiophyllum*. Prior to Dingwall's (*l.c.*) work these genera were in fact identified with each other. The divergence of these genera took place when septal lamellae, loose in *Clisiophyllum*, have fused together to form a compact structure of columella. This new structure became a basis for separating not only the genus, but also the family.

Taking into account the ontogeny and development trends occurring within the genera, we may state that the development of amygdalophyllids tended to the simplification of axial structure. This simplification took place very quickly and, at the same time, differently in various genera. Likewise, the appearance of particular genera is almost simultaneous. The reduction of columella in *Amygdalophyllum* takes place very rarely (Hill, 1934), much more frequent being the disruption of septa and appearance of marginal vesicles and naotic structure (Hill, *l.c.*; Pickett, 1966). Whether the forms with the structures mentioned above belong to *Amygdalophyllum* remains, as stated below, an open question.

The disruption of dissepiments and septa and the formation of typical marginal vesicles are observed in *Carruthersella* in which no naotic structures and reduction of columella are, however, recorded. Since the present writer is unable to take a definite standpoint concerning some species of *Carruthersella* (Salée, 1913; Bikova, 1941, 1966), they have not been taken into consideration in the present paper. The writer had no possibility of studying a complete ontogeny in *C. longiseptata* n. sp., as well as in the type species *C. compacta* Garwood and in *C. tingi*. On the basis of a part of ontogeny studied in Polish specimens, a certain similarity may be found between *Carruthersella* and *Cyathoclisia*, but their actual relationship is uncertain.

The genus *Spirophyllum* n. gen., described in the present paper, strongly resembles *Cyathoclisia* and some of its species here described, e.g., *S. clisium* n. sp. seem to have characters transitional between the two ge-



nera. Mutual relationships between particular species within the limit of a genus are presented below. Here, the writer wishes only to emphasize the leading role of *S. sanctaerucense* n. sp., which occurs abundantly in the entire section of Gałęzice. Of interest seems also to be the fact that species with a disintegrating columella occur in beds older geologically.

The family Rozkowskiidae seems to separate from among Aulophyllicae latest of all. The writer derives this family from primitive koninckophylloid forms. Such an origin is indicated by both the ontogeny and the fact that a medial bisepal lamella remains in columella, composed of tabellae, from the beginning till the end of the development. The development within this family tends towards complication of dissepimentarium and disintegration of septa into pseudonaotic structures. Judging by few observations made so far columella is not subject to reduction.

## B. MICROSTRUCTURE

### 1. Septa

In all representatives of the Aulophyllicae, microstructure of septa is trabecular and semitrabecular (Kato, 1963, terminology). Very many examples of slight modifications in this structure were presented by Kato (*l.c.*, Text-fig. 13). These modifications mostly resolve themselves into a quantitative relation between the trabecular and fibro-normal structure, the latter being a secondary swelling of septa. Septa with only trabecular microstructure are rare.

In the material, described in the present and previous (Pal. Polonica, No 24, *in press*) paper, in addition to some types of microstructure, presented by Kato (*l.c.*), the writer has observed certain modifications in septal structure. These are: a) a longitudinal split of septa and b) a disintegration of peripheral parts of septa into single trabeculae or sets of trabeculae.

The longitudinal split of septa mostly takes place in dissepimental parts. These are not irreversible changes. One and the same septum may, with growth, several times split and consolidate once again. Both branches of the split part have a trabecular structure, with median line, not always distinct on them. The median lines of split branches of septa fuse with each other in their parts which remained unsplit. It seems that double centres of calcification, better visible in median parts of septa, occur in the places in which both branches of split septa contact each other. Transverse props of dissepimental type occur between the branches of split septa, probably playing the role of reinforcing elements. The manner of forming the septal structure of this type is shown in Fig. 2a and a schematic system of micro-

elements in a septum in Fig. 2b. It is clear from these illustrations that a longitudinal split of septa may take place as a result of a periodical arrest of growth in a certain part of septum along its median line. Then, a division takes place into two folds of ectoderm which secrete two branches of a split septum. The bottom of a fissure thus formed rises gradually

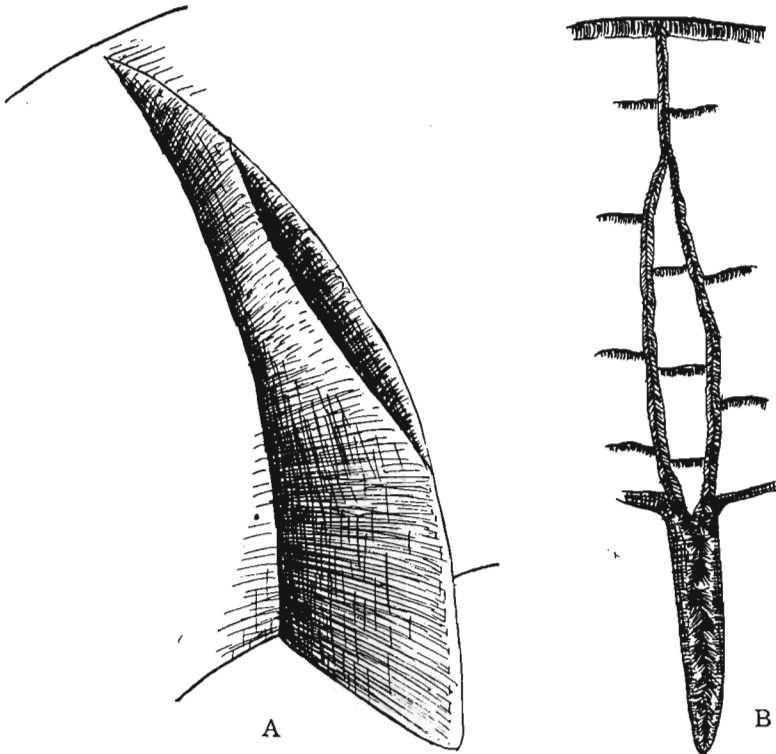


Fig. 2. — Structure of a septum split longitudinally: *A* reconstruction, *B* transverse section with microstructure shown schematically.

resting on the secreted props of dissepimental type. The smoothing down of this secondary septal depression and subsequently the formation of a normal, convex fold of the body lead to stopping the fissure in scleroseptum.

The disintegration of the peripheral parts of septa into single trabeculae or sets of trabeculae has also been known even in the Silurian (e.g.) *Entelophyllum pseudodianthus*, Devonian (*Acantophyllum*) and other tetracorals. Its genesis is connected with the formation of multitrabecular structures in peripheral parts of septa. Particular sets of trabeculae may slightly diverge and then converge once again. Transverse laminae of dissepimental or lateral-cystose type are formed between these sets. Frequently, and even mostly, the structures of the type described above are arranged in a racemose manner with wider side resting on epitheca. It

should be emphasized that racemose structure are not always trabecular. In some of the species of *Koninckophyllum* and *Neokoninckophyllum*, they are composed of very numerous, small dissepiments resting on each other. In these species, septum remains thin and complete, although usually strongly twisted.

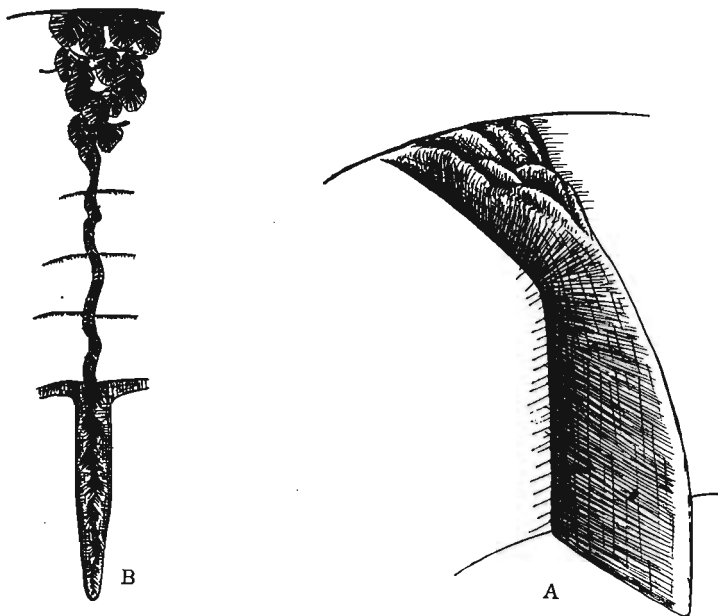


Fig. 3. — Structure of a septum with a pseudonaotic structure occurring the periphery: A reconstruction, B transverse section with microstructure shown schematically; racemose assemblages of trabeculae with dissepiments which connect them with each other arranged on the periphery.

In view of a considerable similarity of the trabecular racemose structure to the naotic structure, the writer suggests to call it pseudonaotic. The main difference here consists in particular septal lamellae being arranged not horizontally, as in *Naos*, but centripetally.

The genesis of the pseudonaotic structure is virtually identical with that of the longitudinal splitting of septa. There are the following main differences. 1) the periepithecal part of septum always disintegrates; 2) ectoderm divides into a few folds which are subject to frequent change in the process of growth of a septum. Both types of structure appear usually as late as the ephebic stage and frequently only at the end of the ontogenetic development.

## 2. Columella

Among the Aulophyllicae, the structure of columella is a main diagnostic character of families. In the family Aulophyllidae, it is formed, as is

well-known, by the connection of the cardinal with the counter septum and, therefore, its microstructure is simple, septal and does not require discussing. Septa and septal lamellae in the representatives of this family may reach and contact columella but they never become its integral part. This is clearly visible in the microstructure of columella and lamellae in the contact place of these elements. Text-fig. 4 a shows the manner of forming such closely adhering elements in separate folds of ectoderm. With the growth of a corallite, these folds fill from below and consequently do not obliterate the boundary between columella and lamellae. This is confirmed both by the growth lines in septa and in columella and by the arrangement of trabeculae in septa.

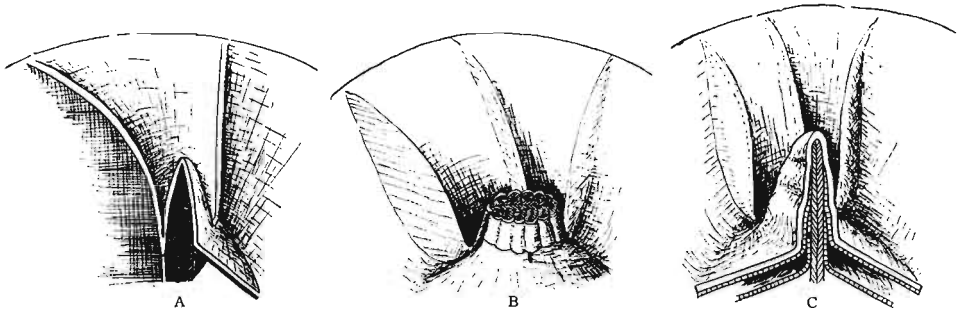


Fig. 4. — Reconstructions of the structure of a columella and axial tabellae and septa joining it: *A* in the family Aulophyllidae — columella with a septal structure, septa (except for the counter and sometimes cardinal one) not penetrating columella, tabella reaching columella in the same manner as septum; *B* in the family Amygdalophyllidae — columella with a multilamellar structure with primary lamella marked in the axial part, septal lamellae are integral part of columella, tabella reaching columella in the same manner as septum; *C* in the family Rozkowskiidae n. fam. — columella with a tabular structure with primary lamella developed in the axial part, tabellae ascending axially very steeply and overlapping each other to form a compact structure, septa do not participate at all in the formation of columella. The system of calcite fibres in particular structural elements are schematically marked in figures.

In the family Amygdalophyllidae, the structure of columella is more involved. Columella is formed in the nepionic stage by the connection of the cardinal and counter protosepta. This biseptal columella, for which the name of a primary lamella is suggested by the writer, is formed still at the beginning of the neanic stage. The ingrowth of lamellae into columella begins with alar protosepta, followed very early by lamellae of other septa or their axial ends. In the genera or species, marked by a speeded-up development of columella, lamellae may not separate themselves, formed as free lists but they may be developed immediately inside columella in a folded ectoderm. The formation of secondary folds of ectoderm, perpendicular to the longitudinal axis of columella is the most characteristic feature of the family Amygdalophyllidae. Macroelements of columella, whose microstructure is identical with that of septa, are formed in these folds.

The name of secondary lamellae is suggested by the writer for these elements.

A compact, complex columella occurs in most genera and species of the family Amygdalophyllidae. Various modifications in columella which lead to its disintegration or simplification at the end of the ontogenetic development, have been found by the writer in a few species of *Spirophyllum* n. gen. In the writer's opinion, the disintegration of columella is a process, in which the contact is lost between secondary lamellae, closely connected with each other, and a primary lamella. This takes place by a gradual mutual withdrawal of the folds of ectoderm which form particular lamellae. The lamellae may keep their radial, spiral or relatively irregular arrangement. In the process of disintegration, a primary lamella loses its central position in corallite. The writer could not succeed in finding whether it becomes reduced or grows similar to the remaining lamellae. In the process of simplification, only secondary lamellae are subject to atrophy or disintegration. A primary lamella remains in the axial part of corallite to the end of development. Such stages of the growth of corallite do not in principle differ from those in the corallites of the family Aulophyllidae.

The writer did not find a complete atrophy of the elements of axial structure and of a formation of caninoidal stages. In all the specimens studied, a loose axial structure is formed as a result of the disintegration or simplification of columella. Thus, initial bisepetal development stages in some species of the Amygdalophyllidae are very similar to or identical with those in the Aulophyllidae.

A columella with a quite different structure has been found by the writer in the family Rozkowskiidae, in which the lamella connecting cardinal and counter septum (primary lamella) is also an original structural element. From the beginning till the end of ontogeny, it is the only element with septal structure in columella. A further development of columella is connected only with tabulae, which steeply join primary lamella and fuse with it, forming a tabular columella, similar to that known in *Cyathaxonia*. Growth lines are strongly obliterated in transverse section by thick fibres of calcite, while in longitudinal section they are clearly visible since tabulae, forming columella, are swollen.

The formation of the structure of this type may be probably explained by the process of the deposition of calcite, in which particular growth lines correspond to the periods of formation of a new tabula which follow an upward shift of the bottom of the polyp. In a free part, tabula is deposited in tabularium in the form of a new list and in a part composing columella; this period is marked by a more fine-grained structure of this part of tabula. The tabular structure of columella may be particularly well observed in peels, since individual tabellae, following a cyclical change in the thickness of grains, differently refract the light.

The isolation of a tabular columella from septa is very distinct. Axial ends of septa may even penetrate in columella (Text-fig. 2a), which consequently may be wavy in outline but the arrangement of calcite fibres at the end of septum is always semicircular, the median line not reaching columella. This also concerns the cardinal and counter septa which may slightly elongate.

#### SYSTEMATIC PART

Suborder **Streptelasmatina** Wedekind, 1927

Superfamily **Aulophyllicae** Dybowski, 1873

(nom. transl. Fedorowski, herein (ex **Aulophyllidae** Dybowski, 1873))

Families assigned: Aulophyllidae Dybowski, 1873; Amygdalophyllidae Grabau, 1922; Rozkowskiidae n. fam.

*Diagnosis.* — Corallites solitary, less frequently in the form of phaceloid colonies having axial structure and, at least at the beginning of development, columella formed by the connection of cardinal and counter septa; dissepimentarium well developed; microstructure tabecular.

*Geographical and stratigraphic range.* — Eurasia, N. Africa, N. America, Australia: Etroeung zone or the Lower Carboniferous to the Lower Permian.

*Remarks.* — Since they have many characters in common, the combination of the families Aulophyllidae, Amygdalophyllidae and Rozkowskiidae to form a superfamily seems to the writer to be purposeful and necessary. These characters are: ontogeny and the occurrence of axial structure or, at least, columella. At the same time, fundamental differences are, however, observed in the structure of columella in these families. The taxonomic rank of these differences is connected with a degree of morphological transformations and surely also of genetic changes determining these transformations. It seems that the taxonomic rank not lower than that of family should be given to such structure, completely new in the tetracorals, as a complex or tabular columella.

Family **Amygdalophyllidae** Grabau, 1922

(Type genus *Amygdalophyllum* Dun & Benson, 1920)

Genera assigned: *Amygdalophyllum* Dun & Benson, 1920; *Cyathoclisia* Dingwall, 1926; *Carruthersella* Garwood, 1913; *Spirophyllum* n. gen.

*Diagnosis.* — A representative of the Aulophyllicae with columella composed of a central bisepthal primary lamella and septal lamellae fused with it; ontogeny clisiophylloid.

*Geographical and stratigraphic range.* — Eurasia, N. America, Australia: Upper Tournaisian to Middle Carboniferous.

*Remarks.* — Only those genera have been included by the writer in the Amygdalophyllidae which have a multilamellar columella and a clisiophylloid ontogeny. Of the genera having a complex columella and not included in the present paper in the Amygdalophyllidae, also the genus *Amygdalophylloides* may be possibly assigned to this family despite its having concave tabulae. Its assignment primarily requires the knowledge of its ontogeny. On the other hand, the genera whose ontogeny is different, for instance, *Rylstonia* Hudson & Platt do not, in the present writer's opinion, belong to this family.

The writer is not inclined to believe the structure of cardinal fossula to be a fundamental character of the family Amygdalophyllidae. According to Hill (1956, p. F. 290), it should be "... deepened, lengthened or expanded axially in tabularium". Of the genera, which have a complex columella, only *Cyathoclisia* has such a fossula. This character seems to be related rather to the length of major septa.

Genus: *Carruthersella* Garwood, 1913  
(Type species *C. compacta* Garwood, 1913)

*Species assigned:* *C. compacta* Garwood; *C. fongi* Yü; *C. pachyseptata* n. sp. Non *Carruthersella* Garwood sensu Salée, 1913; non *Carruthersella* Garwood sensu Volkova, 1941; non *Carruthersella* Garwood sensu Bikova, 1966.

*Diagnosis.* — See Hill (1956, p. F289).

*Geographical and stratigraphic range.* — Eurasia, Upper Tournaisian to Upper Viséan.

*Remarks.* — Garwood (1913) introduced the genus *Carruthersella* for solitary tetracorals which are primarily marked by: 1) a massive columella, composed of lamellae connected with each other; 2) a zone of lonsdaleoid vesicles on the periphery. It was almost at the same time that Salée (1913) revised and changed Garwood's (*l.c.*) determinations concerning precisely these fundamental characters. He assumes that continuous septa and the structure of axial part similar to what is known as "nucleate clisiophylla" are characteristic of *Carruthersella*. Salée's completely optional and, in the present writer's opinion, erroneous interpretation caused that species, most likely to belong to *Clisiophyllum* and marked by swollen axial structural element, were later included in the genus *Carruthersella*. A stereoplasmatic deposit on structural elements is, as proved by, among other authors, Schouppé & Stacul (1966), secondary in character and secreted by the basal parts of the polyp in the process of its growth. Thus, the genesis of swollen structural elements in "*Carruthersella*" *garwoodi* Salée and in species

described by Volkova (1941) and Bikova (1966) is quite different than that of the complex columella in *C. compacta* and others. Consequently, both groups of the species should be unequivocally separated since they belong to two different families, that is, Aulophyllidae and Amygdalophyllidae.

Unfortunately, due to the lack of an elaborated ontogeny of the genus *Carruthersella*, the inclusion of this genus in the Amygdalophyllidae, might arouse reservation. However, it seems that the structure of columella, identical with that in the Amygdalophyllidae, sufficiently determines its taxonomic position.

*Carruthersella longiseptata* n. sp.  
(Text-fig. 5; Pl. I, Fig. 1)

*Holotype*: No. Z. Pal. P. Tc-4/2, 578.

*Type locality*: Gałęzice, Holy Cross Mts.

*Type stratum*: Upper Viséan, D<sub>2</sub> (top).

*Derivation of the name*: *longiseptata* — having long major septa.

*Diagnosis*. — A *Carruthersella* 13–17 mm in diameter and with (30–34) × 2 septa; cardinal and counter septa connected with columella almost till the end of development; major septa long; dissepimentarium occupying about a half of the diameter of corallite; marginal vesicles occur only in fragments of corallite.

*Material*. — Two solitary corallites with calices and without proximal ends.

Dimensions (diameters in mm):

Z. Pal. P. Tc—4	Index of septa n/d
2.574	30 : 13 × 12
2.578	34 : 17 × 15

*Description*. — Transverse section (Text-fig. 5<sub>1,2a</sub>; Pl. I., Fig. 1). Epitheca thin, covering septotheca which is about 0.7 mm thick and composed of peripheral parts of major and minor septa connected with each other. Septotheca also occurs when septa are interrupted by vesicles at the very base. Major septa reaching columella, some of them penetrate it; they are the thickest in septotheca and on the boundary of tabularium, where they form a wide, massive ring, supplemented here and there by thick axial parts of minor septa. Minor septa are interrupted earlier and subsequently occur mostly in the form of spines on vesicles. Cardinal and counter septa are connected with columella almost to the end of development. Columella elongate, slightly swollen. The number of lamellae, connected in it, more or less corresponds to the number of major septa. Free septal lamellae are absent. Dissepimentarium occupies about a half of the diameter of corallite. Frequently, in particular near inner wall, only normal dissepiments are



developed. Margin vesicles varying in size, larger and flatter occurring on the periphery. All dissepiments and marginal vesicles are swollen.

Longitudinal section (Text-fig. 5<sub>2b</sub>). Dissepiments and marginal vesicles large, flat, with strongly thickened walls, situated subvertically near a

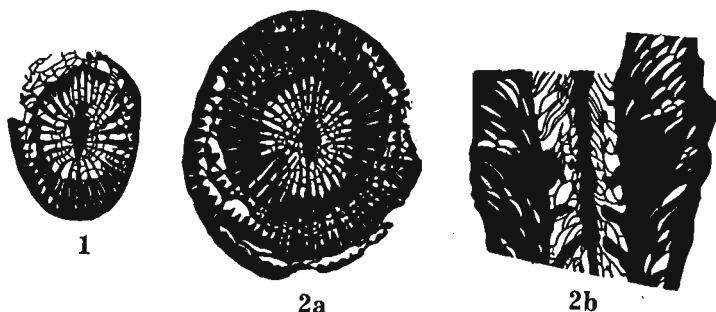


Fig. 5. — *Carruthersella longiseptata* n. sp.: 1 transverse section, late-neanic stage (Z. Pal. P. No. Tc-4/2574); 2a transverse section epehebic stage, 2b longitudinal section (Z. Pal. P. No. Tc-4/2978, holotype);  $\times 1.8$ .

very thick inner wall and steeply or semicircularly in further parts approaching periphery. Tabularium loose. Tabulae and tabellae thin, close to dissepimentarium horizontal and in deeper parts steeply ascending towards columella. Complete tabulae occur frequently. Columella thickened tubercularly, massive, irregular.

*Ontogeny.* — The youngest ontogenetic stage, which the writer succeeded to examine (Text-fig. 5<sub>1</sub>) displayed all characters of a mature form, except for dimensions.

*Remarks.* — *C. longiseptata* n. sp. differs from *C. compacta* and *C. fongi* primarily in its long major septa, connection of columella with cardinal and counter septa and a wide dissepimentarium with fairly numerous normal dissepiments. As seen in one of the sections of the holotype of type species (Garwood, 1913, Pl. 48, Fig. 1c), marginal vesicles may, however, not cover the entire circumference of a corallite and cardinal septum is not always shortened. Similar characters are observed in *C. fongi* and, therefore, they may perhaps be considered as generic ones.

The Polish species seems to be more related to *C. fongi* than to *C. compacta* as it has a very similar longitudinal section, approximately the same dimensions and a belt of thickened structures on the boundary between tabularium and dissepimentarium. The stratigraphic position of *C. fongi* is also similar.

*Occurrence.* — Gałęzice, Holy Cross Mts., Upper Viséan, D<sub>2</sub> (top).

Genus *Amygdalophyllum* Dun & Benson, 1920(Type species: *D. etheridgei* Dun & Benson, 1920)

*Synonyms*: *Axophyllum* M. — Edw. & H. sensu Vaughan, 1905, *Ekvasophyllum* Parks, 1951, *Arachnolasmella* Bikova, 1966.

*Species assigned*: *Koninckophyllum inopinatum* Etheridge, jr. 1900; *Axophyllum* ♂ Vaughan, 1905; *Amygdalophyllum etheridgei* Dun & Benson, 1920; *A. conicum* Hill, 1934; ?*A. near conicum* Hill, 1934; *A. wangi* Chi, 1935; ?*A. quiringi* Weissermal, 1935; *A. setamainensis* Yabe et Minato, 1946; *Amygdalophyllum* sp. Smith, 1948; *Ekvasophyllum inclinatum* Parks, 1951; *Ekvasophyllum turbineum* Parks, 1951; *Amygdalophyllum* sp. a Minato, 1955; *Amygdalophyllum* sp. b Minato, 1955; ?*Amygdalophyllum* sp. indet. Yamagiva, 1961; *Amygdalophyllum augustum* Yü & Lin, 1962; *Arachnolasmella interruptocolumellata* Bikova, 1966; ?*Arachnolasmella gigantea* Bikova, 1966; *Amygdalophyllum columellare* Pickett, 1966; ?*Amygdalophyllum praecox* Pickett, 1966; *Amygdalophyllum* sp. Ivanovsky, 1967; *Amygdalophyllum* aff. *inopinatum* (Etheridge), Fedorowski; *A. axophylloides* n. sp.

Non *Amygdalophyllum* sp. Chi, 1938; non *A. vallum* Hill, 1934; non *Amygdalophyllum etheridgei* Dun & Benson sensu Kostič-Podgorska, 1957 and 1958; non *Amygdalophyllum naosoidea* Minato, 1951; non *Amygdalophyllum* cf. *naosoidea* Minato sensu Yamagiva, 1961.

*Diagnosis*. — See Hill (1956, p. F290).

*Geographical and stratigraphic range*. — Eurasia, Australia, N. America: Lower to Middle Carboniferous.

*Remarks*. — *Amygdalophyllum* is a cosmopolitan genus but relatively few species are assigned to it. There is probably a greater number of such species but they have been assigned to other genera since the structure of their columella not always was taken into account during determination. At the same time, species having structures of the naotic type (e.g., *A. naosoidea* Minato) and which in the present writer's and Professor M. Minato's (Sapporo, Japan, oral communication) opinion should be separated as a new genus, were assigned to this genus. Species with normally developed marginal vesicles, which correspond rather to the diagnosis of *Carruthersella* should be also separated from *Amygdalophyllum*. The structures mentioned above occur in fact in some specimens of *Amygdalophyllum etheridgei* (Dun & Benson, 1920, Text-fig. 10) but the writer believes that this assignment may be incorrect.

Erected by Bikova (1966), the subgenus *Arachnolasmella* of the genus *Arachnolasma* does not display any essential differences as compared with the genus *Amygdalophyllum*, whereas the structure of its columella automatically excludes it from the genus *Arachnolasma* and family Aulophylloidea.

The differences and similarities between *Amygdalophyllum* and *Carruthersella* were discussed by Benson & Smith (1923) and those between *Amygdalophyllum* and *Spirophyllum* n. gen. are described below in the discussion of the last-named genus. Here, the writer wishes only to emphasize the similarity in ontogeny of the Polish representatives of both genera.

Unfortunately, the ontogenetic development of the Australian and Asian species has not been studied accurately and, therefore, a full comparison was very difficult under such conditions. The ontogeny of the Polish representatives of *Amygdalophyllum* and *Spirophyllum* differs primarily in an earlier separation in the former genus of columella from cardinal septum than from counter septum and not in the occurrence of a spiral upturning of septal lamellae. Despite these differences it is not unlikely that the species included in the present paper in the genus *Amygdalophyllum* are only specialized species of *Spirophyllum* which completely lost their stage of axial structure.

*Amygdalophyllum* aff. *inopinatum* (Etheridge, 1900)

(Text-Fig. 6<sub>1a-d</sub>; Pl. I. Figs. 2-4)

*Material.* — Three solitary corallites with calices and partly preserved proximal ends.

Dimensions (diameter in mm):

I.G. OS—70	Index of septa n/d
1.051	43 : 20 × 19
1.201	43 : 22 × 20
2.318	40 : 20 × 20

*Diagnosis.* — An *Amygdalophyllum* about 22 mm in diameter and with (40–43) × 2 septa; major septa reach the vicinity of a slightly swollen columella; dissepimentarium regular, occupying about one third of the corallite's diameter.

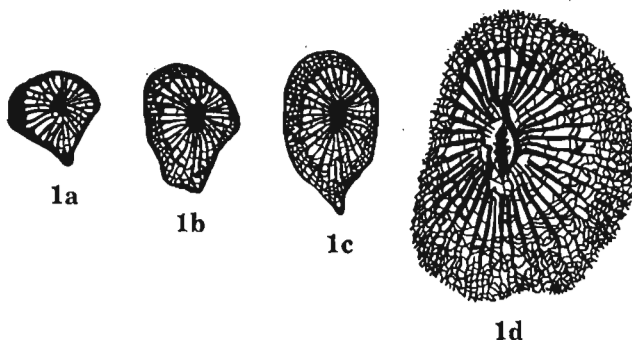


Fig. 6. — *Amygdalophyllum* aff. *inopinatum* (Etheridge, 1900): 1 a–c successive transverse sections of the neanic stage, 1d transverse section of the ephebic stage (I. G. No. OS-70/2318); ×1.8.

*Remarks.* — Polish specimens are similar to *A. inopinatum*, described from the Upper Viséan of Australia in: 1) long major septa reaching almost as far as columella; 2) columella which, as compared with other species

is thin; 3) long minor septa; 4) structure observed in longitudinal section. They differ in: 1) smaller width of dissepimentarium in which no tendency is observed to form either naotic structures, or marginal vesicles; 2) smaller dimensions and a slightly smaller number of septa, the last-named character being, however, very variable in Australian specimens, 3) tendency to shorten minor septa. These differences are not great, but they seemed sufficiently important to exclude the identification of the Polish with the Australian specimens.

*Occurrence.* — Gałęzice, Holy Cross Mts, Upper Viséan, D<sub>2</sub> (top).

*Amygdalophyllum axophylloides* n. sp.

(Text-Fig. 7; Pl. I, Figs. 6, 7)

*Holotype:* No. I. G. OS-70/1177

*Type locality:* Gałęzice, Holy Cross Mts.

*Type stratum:* Upper Viséan, D<sub>2</sub> (top)

*Derivation of the name:* *axophylloides* — like *Axophyllum* ♂ Vaughan.

*Diagnosis.* — An *Amygdalophyllum* with (36–41) × 2 septa and 20–25 mm in diameter; major and minor septa slightly shortened; columella small slightly swollen; dissepimentarium complex, occupying about a half of the corallite's diameter.

*Material.* — Ten solitary corallites without proximal ends, some of them with calices preserved.

Dimensions (diameters in mm):

No. I. G. OS—70	Index of septa n/d
990	37 : 23 × 23
1046	41 : 24 × 22
1048a	37 : 20 × 18
1047	39 : 25 × 25
1050	38 : 22 × 20
1141	39 : 22 × 21
1166	36 : 23 × 20
1177	39 : 22 × 22

*Description.* — Transverse section (Text-fig. 7<sub>1d,e</sub>; Pl. I, Figs. 5–7b). Epitheca about 0.2 mm thick, almost smooth. Clustery structures composed of dissepiments in which septa remain complete and slightly penetrate epitheca, frequently occur at the bases of septa. Major septa complete, in dissepimentarium strongly bent, in tabularium straight, slightly swollen. Minor septa, bent much the same as major septa, mostly reach two thirds of the width of dissepimentarium, less frequently the inner wall. Dissepimentarium mostly very close, consisting of numerous pseudo-herringbone and, over shortened minor septa, of herringbone dissepiments. Dissepimen-

tal racemose structures mostly strongly developed, their underdevelopment has been found in only one of the paratypes (Pl. I, Fig. 5).

Columella small, sometimes with a narrow septal lamella directed towards cardinal fossula. Margins of columella even or serrate. Sometimes, there occur a few septal lamellae slightly projecting from columella. No axial structure is formed.

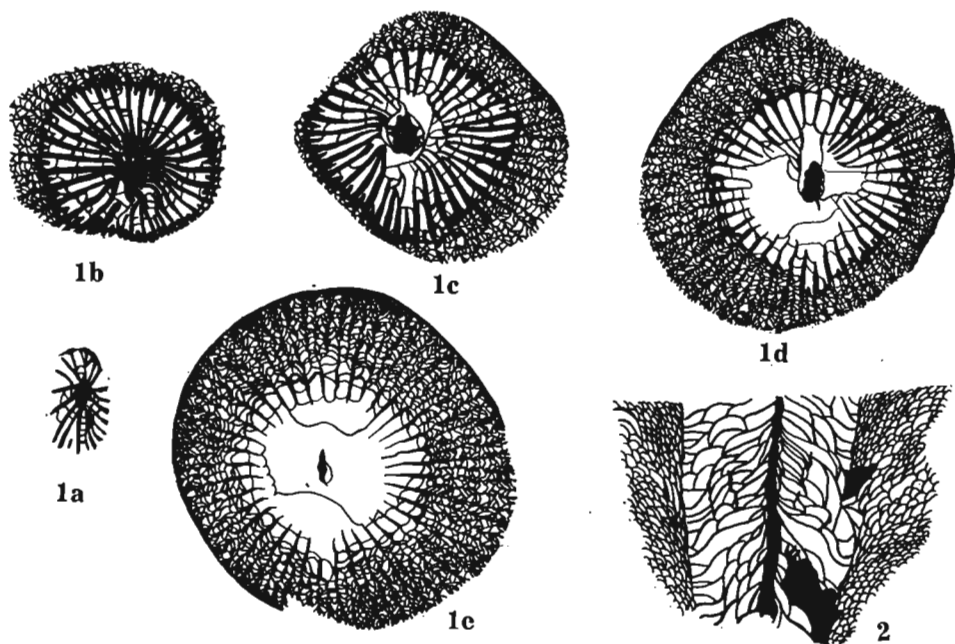


Fig. 7. — *Amygdalophyllum axophylloides* n. sp.: 1 a—c successive transverse sections of the neanic stage, 1d transverse section of the early-ephebic stage, 1e transverse section of the late-ephebic stage (I. G. No. OS-70/1177, holotype), 2 longitudinal section (I. G. No. OS-70/990);  $\times 1.8$ .

Longitudinal section (Text-fig. 7<sub>2</sub>). Columella variable in thickness, undulating, mostly with a well visible median line. Tabularium without a separated, axial structure, more or less identically close on the periphery and axially. Complete tabulae occur sporadically. Close to columella, tabellae are flat and ascending to it in a roof-like manner, nearer periphery they are vesicular and also ascending. Marginal part of tabularium composed of flat, slightly concave or convex tabellae arranged horizontally. Dissepiments small, convex, near tabularium arranged vertically and towards epitheca becoming less and less steep.

*Ontogeny.*—In the youngest stage studied,  $7 \times 4$  mm in diameter (oblique section) and with 22 septa (Text-fig. 7<sub>1a</sub>), cardinal and counter septum are connected with columella. The remaining major septa, arranged in a nearly zaphrentoid system, also reach columella. Minor septa and dissepimentarium are probably lacking in this stage.

A successive section (Text-fig. 7<sub>1b</sub>), 13.5 × 12 mm in diameter and with 35 × 2 septa, already has a disseptimentarium formed of irregular disseptiments. Minor septa long, with swollen ends in tabularium. Major septa mostly reach columella or its vicinity. Counter septum connected with columella, cardinal septum shortened. In a further development (Text-fig. 7<sub>1c</sub>; Pl. I, Fig. 7a), major septa gradually withdraw from columella, leaving a wider and wider axial area.

As compared with the holotype, the following differences are found in the development of the paratypes studied: 1) major septa are subject to shortening as early as the neanic stage; 2) a dibunophylloid axial structure is formed in transverse section of the neanic stage.

*Individual variability.* — As compared with holotype, the following differences seem to be particularly important: 1) periodical connection of columella with cardinal and counter septum in the ephebic stage (Pl. I, Fig. 6) and 2) an almost complete lack of disseptimental racemose structures at the base of septa near epitheca (Pl. I, Fig. 5). Accompanying differences in the width of disseptimentarium and of a free axial area, as well as in the length of minor septa are small and occur even in the process of growth of one and the same corallite.

*Remarks.* — The species described is considerably similar primarily in generic characters to *Axophyllum* Θ Vaughan, 1905 from D<sub>2</sub> zone of Bristol Area. British specimens described by Vaughan under the name of *Axophyllum* Θ are considered by the writer as *Amygdalophyllum*. The main characters which differ Polish specimens from those described by Vaughan are as follows: shorter major septa, wider free axial area, narrower disseptimentarium, and lack of marginal vesicles mentioned in Vaughan's description. A more accurate elaboration of British specimens may allow one to find their conspecificity with Polish ones. The introduction of a new specific name was, however, necessary as no such name had been given by Vaughan. The species under study differs from *A. cf. inopinatum* and other species of *Amygdalophyllum* in the width of the free axial area, shortened minor septa and a very strong reduction in the thickness of columella in the late-ephebic stage.

*Occurrence.* — Gałęzice, Holy Cross Mts., Upper Viséan, D<sub>2</sub> (top).

### Genus *Spirophyllum* n. gen.

(Type species: *S. sanctaecrucense* n. sp.)

Synonyms: *Koninckophyllum* Thomson & Nicholson, 1876, partim; *Clisiophyllum* M'Coy, 1849, partim; *Arachnolasma* Grabau, 1922, partim.

Species assigned: *Clisiopsillum credneri* Stuckenbergh, 1904; *Koninckophyllum clitheroense* Parkinson, 1926 (partim, holotype only) ?*Clisiophyllum siblyi* Gorsky, 1932; ?*Koninckophyllum nantanense* Chi, 1936; *Amygdalophyllum* sp. Chi, 1938; *Arachnolasma clisaxophylloides* Volkova, 1941; *Arachnolasma cf. sinense* Minato, 1955.

Table 1

Morphologically comparative table of characters of the species of *Spirophyllum* n. gen.

Name of species	Diameter of corallite	Width (in mm) of			Number of septa	Structure of septa		Axial structure	Longitudinal section	Remarks
		tabularium	dissepimentarium	free area		major	minor			
<i>S. nexilis</i> (Vassiljuk)	12—16	9—18	2—6	variable	34—46	swollen in tabularium; pseudonaotic structures	long, sometimes deep in tabularium	columella complete, macelike; lamellae usually numerous	axial structure not separated; systems lacking	
<i>S. multilamellatum</i> (de Groot)	21×23	14×15	4	wide	40	complete, free, short	entering tabularium	columella persisting till the end of development; lamellae numerous, radial	not examined	
<i>S. histiophylloides</i> (de Groot)	19—27	10—16	4—7	very narrow	41—48	complete, frequently connected with lamellae	mostly entering tabularium	columella persisting till the end of development; lamellae numerous spiral	axial structure not separated; systems lacking	
<i>S. clisium</i> n. sp.	18—25	8—14	ab. 5	lacking	40—48	complete, almost all of them connected with lamellae	penetrating inner wall	columella thick till the end of development; lamellae = major septa	axial structure separated, vesicular	
<i>S. sanctaerucense sanctaerucense</i> n. subsp.	10—33	7—19	4—6,5	variable	33—65	free, near epitheca pseudonaotic	variable, usually penetrating inner wall	columella persisting till the end of development; number of lamellae very variable	axial structure not separated; systems typically developed	
<i>S. sanctaerucense pauper</i> n. subsp.	15—28	10—20	2—5,5	wide	35—54	free; near epitheca pseudonaotic; sporadically split longitudinally	equalling a half to three quarters of the width of dissepimentarium	columella persisting till the end of development; lamellae few, short	axial structure not separated; systems lacking	
<i>S. divisum</i> n. sp.	16—31	9—20	4—6	fairly narrow	41—63	complete; free; slight pseudonaotic structures	about three quarters of the width of dissepimentarium	columella persisting till the end of development, list-like; lamellae radial	axial structure separated, axial tabellae long	
<i>S. complexum</i> n. sp.	22—25	18—20	2—4	mostly lacking	47—56	split, plus pseudonaotic structures	long, in tabularium swollen, split	columella disintegrates leaving primary lamella; lamellae numerous	axial structure not separated; tabularium trizonal	
<i>S. regulare</i> n. sp.	25—40	13—18	6—10	narrow	44—58	free, lonsdaleoid vesicles	about three quarters of the width of dissepimentarium	columella completely disintegrating; few lamellae	axial structure not separated; systems of tabellae	
<i>S. perditum</i> n.sp.	20—28	11—15	5—7	narrow	40—46	pseudonaotic structures, sometimes split.	two to three quarters of the width of dissepimentarium	columella completely disintegrating; few lamellae	axial structure separated, vesicular	
<i>S. bifurcatum</i> n. sp.	19—24	11—15	3—4	wide	41—54	split, near epitheca pseudonaotic	three quarters or less of the width of dissepimentarium	columella persisting till the end of development; a few lamellae	axial structure not separated; systems lacking	
<i>S. geminum</i> n. sp.	14—22	10—16	2—4	wide	45—51	free, complete, only gerontic changes	usually penetrating tabularium	columella persisting till the end of development; few spiral lamellae	axial structure not separated, systems lacking	develops protocolonies

*Clisiophyllum* (?) *panamintense* Langenheim & Tischler, 1960; *Koninckophyllum multilamellatum* de Groot, 1963; *K. gentisae* de Groot, 1963; *K. histiophylloides* de Groot, 1963; *Amygdalophyllum nexilis* Vassiljuk, 1964; *Spirophyllum clisium* n. sp.; *S. sanctaerucense* n. sp.; *S. densum* n. sp.; *S. divisum* n. sp.; *S. regulare* n. sp.; *S. bifurcatum* n. sp.; *S. complexum* n. sp.; *S. perditum*; n. sp.; *S. geminum* n. sp.

*Derivation of the name: Spirophyllum* — after a spiral arrangement of the septal lamellae.

*Diagnosis.* — Solitary corals or incipient colonies; septa displaying tendency to disintegration into pseudonaotic structure on the periphery; minor septa well developed, columella related ontogenetically to cardinal septum; it may be subject to disintegration or simplification; does not disappear; in transverse section axial structure occurs at least in some of the development stages; in longitudinal section frequently occurring systems of tabellae and lamellae less so — a separate axial structure.

*Geographical and stratigraphic range.* — Eurasia, N. America: Upper Viséan, to Westphalian D.

*Remarks.* — The genus *Cyathoclisia* Dingwall from the Upper Tournaisian of Eurasia is strongly similar and even closely related to *Spirophyllum* n. gen. As emphasized in the remarks on phylogeny, it is probably an initial genus of *Spirophyllum*. Similar characters are: 1) a spiral arrangement of septal lamellae (mostly in *Spirophyllum*) or axial ends of septa (in *Cyathoclisia*) in axial structure; 2) complex columella; 3) some similar of longitudinal sections; 4) characters common for the family, including a similar ontogeny.

Differences: 1) cardinal fossula in *Spirophyllum* short, not extended axially; 2) longitudinal sections in most species; in *Spirophyllum* systems of tabellae and lamellae or a separate axial structure; 3) ontogeny: in *Cyathoclisia*, septa are from the beginning connected with columella and upturned in *Spirophyllum*, there occurs a koninckophylloid stage; 4) during the entire development, counter septum is more closely connected with columella in *Cyathoclisia* and cardinal septum in *Spirophyllum*; 5) trends in variability. A trend towards the forms of the structural type of *Caninia* was found in *Cyathoclisia* by Vojnowsky-Krieger (1956). The following two trends have been found by the present writer in *Spirophyllum* n. gen.: a) a simplification of axial structure with the preservation of a well developed columella (amygdalophylloid trend) and b) a disintegration of columella into lamellae forming a loose axial structure (clisiophylloid trend). A caninoid structural type does not occur in *Spirophyllum*.

Very similar to *Spirophyllum* is also the genus *Amygdalophyllum* Dun & Benson. A fundamental difference between these two genera is the lack of any forms of axial structure in *Amygdalophyllum* whereas such a structure does occur in *Spirophyllum* at least in fragments of corallites. This is, therefore, a difference analogous to that occurring between *Koninckophyllum* and *Clisiophyllum*. However, as stated above, the amygdalo-



phylloid trend is one of the development trends in *Spirophyllum*. Although axial structure in all cases was found by the writer in the development of the amygdalophylloid specimens of *Spirophyllum* there is, however, the possibility that the stages with axial structure may disappear at all. If such will be the case, there will be no criterion of division and the representation of the two genera will be within the range of *Amygdalophyllum*. It is quite likely that the ontogenetic development of typical Australian species will turn out, after an accurate study, to be different than the development of *Spirophyllum*. Now, it is not yet sufficiently studied to be used as a basis for reliable conclusion.

Typical spirophylla differ, however, conspicuously from *Amygdalophyllum* in: 1) the occurrence of axial structure in transverse section; 2) structure of tabularium in longitudinal section, frequently consisting of the systems of tabellae and lamellae and sometimes with a separated axial structure; 3) disintegration of columella (clisiophylloid trend) in a certain group of species.

*Kazachiphyllum* Bikova, 1966 is a genus having similar younger development stages, but, unfortunately, it was rather insufficiently illustrated by Bikova. The present writer has, however, the opportunity to examine a dozen or so well preserved topotypes of this genus at the Palaeontological Institute in Moskow. On the basis of the observations and Bikova's (1966) description, the following differences have been found between *Spirophyllum* and *Kazachiphyllum*: 1) axial structure, mentioned by Bikova occurs only in very early development stages; in the neanic stage, only a very simply built columella is observed; 2) this columella also rapidly disappears, mostly at the end of the neanic stage and, therefore, the ephebic stage is as a rule caninoid; 3) *Kazachiphyllum* has, in addition, a caninoid cardinal fossula and strongly swollen major septa occurring in cardinal quadrants.

*Spirophyllum nexilis* (Vassiljuk, 1964)

(Text-figs. 8, 9; Pl. II, Figs. 1-5;

Pl. XII, Figs. 1-3)

1964. *Amygdalophyllum nexilis* Vassiljuk; N. P. Vassiljuk, Korally zon..., p. 85, Pl. 6, Figs. 1-6.

*Revised diagnosis.* — A *Spirophyllum* to 30×25 mm in diameter and with 46×2 septa which are subject to splitting or changes of the pseudonatic type; columella frequently connected with cardinal septum; lamellae usually numerous in axial structure; dissepimentarium wide, complex.

*Material.* — About 30 solitary corallites mostly without calices, many of them with partly preserved proximal ends. Measurable characters shown in a diagram in Text-fig. 9.

*Remarks.* — Polish specimens, as well as Soviet ones which were examined by the writer at Donietsk, display a considerable individual variability. The extent of this variability is similar in both populations and its accurate specification seems to the writer to be very important. Small specimens with a narrow dissepimentarium determined by Vassiljuk (1964, Pl. 6, Fig. 6) as *A. aff. nexilis* should not be separated from the species. Admittedly, they are fairly different morphologically than the large ones, but both in Vassiljuk's (for instance, Pl. 6, Fig. 5) and the present writer's (Pl. II, Figs. 2, 3) collections, there are many specimens with, transitional characters. Vassiljuk considered these small specimens as adult but underdeveloped morphologically as a result of unfavourable ecological conditions. Since, in the ontogenetic development of Polish corallites, a fairly exact correlation was found by the present writer between the diameter of corallites and the width of dissepimentarium and structure of axial part, he agrees with Vassiljuk's interpretation only in part. Small and medium-

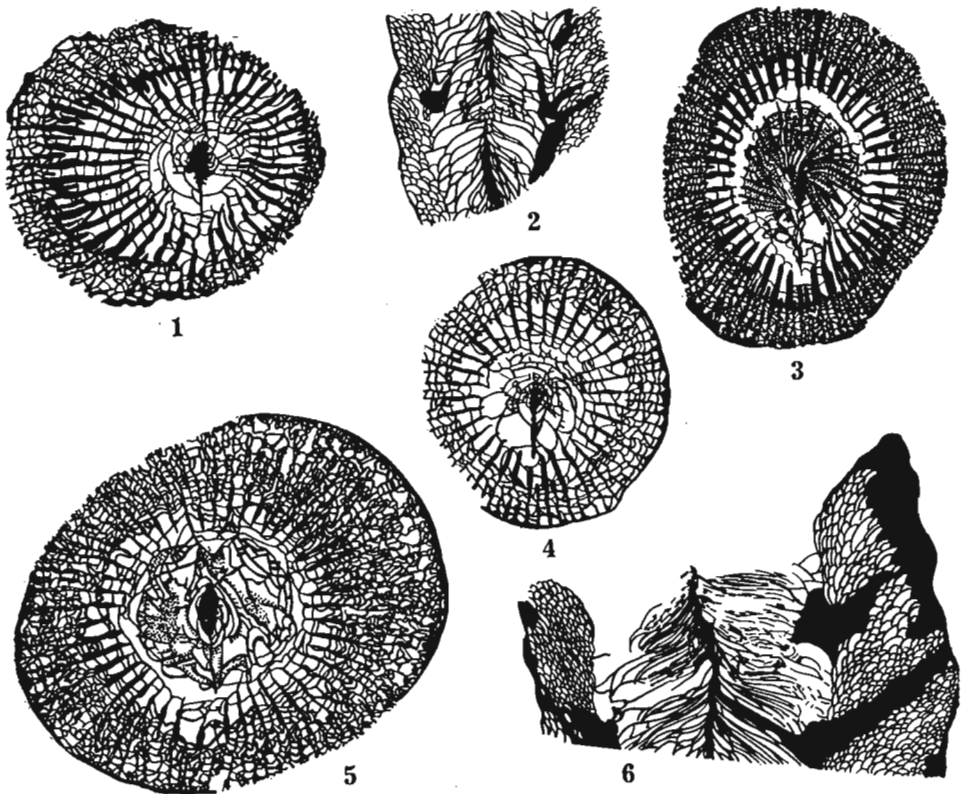


Fig. 8. — *Spirophyllum nexilis* (Vassiljuk, 1964): 1 transverse section, early-ephebic stage (I. G. No. OS-70/939), 2 longitudinal section (I. G. No. OS-70/1191), 3 transverse section, ephebic stage (I. G. No. OS-70/1183), 4 transverse section, early-ephebic stage (I. G. No. OS-70/937), 5 transverse section, ephebic stage (I. G. No. OS-70/1136), 6 longitudinal section (I. G. No. OS-70/941);  $\times 1.8$ .

sized specimens may be well compared with corresponding growth stages of large ones. The writer believes that the small specimens are, therefore, forms not so much arrested in their development as individuals dead in a younger development stage as a result of a violent change in outward conditions, e.g., getting buried in sediment.

A considerable variability is observed in the axial part of corallites fully developed morphologically. The more important is, therefore, a relatively constant structure of columella, which is macelike and always extends towards cardinal septum by a long septal lamella, sometimes even being connected with this septum. The following three main types of structure of axial part may be distinguished: 1) few lamellae, occurring mostly in counter quadrants (Pl. II, Fig. 2); 2) few lamellae with a wide, clisio-phylloid structure (Pl. II, Fig. 1a, b); 3) very numerous lamellae almost completely fused together around columella (Pl. II, Fig. 4).

The possibility should also be emphasized of the occurrence of long minor septa which in some of Polish specimens penetrate tabularium and have swollen axial ends.

*S. nexilis* differs from *S. sanctaerucense sanctaerucense* n. subsp. in measurable characters, structure of axial part, complex, wide dissepimen-

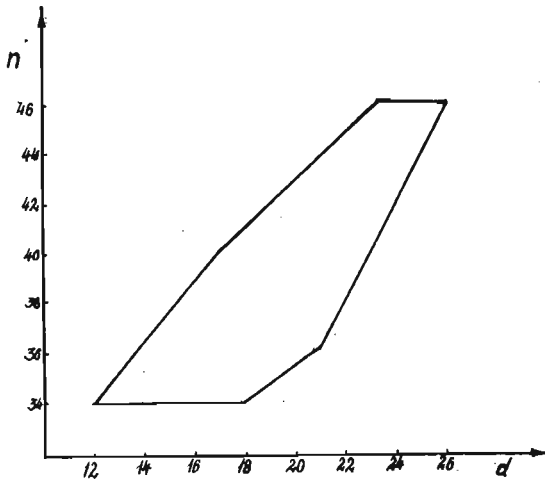


Fig. 9. — Index of septa ( $n/d$ ) for *Spirophyllum nexilis* (Vassiljuk, 1964) in which  $n$  = number of major septa, and  $d$  = diameter of corallite; extreme points are connected by lines.

tarium and longitudinal split of some of septa. More similar seems to be *S. sanctaerucense pauper* n. subsp. which has a similar index of septa ( $n/d$ ) and displays a tendency to form pseudonaotic structures. Both species differ, however, in the structure of axial part and in a regular structure and smaller width of dissepimentarium in *S. sanctaerucense pauper* n. subsp.

*Occurrence.* — U. S. S. R.: (Donietsk Basin),  $C_1^y$  g zone; Poland; Gałęzice, Holy Cross Mts., Upper Viséan,  $D_2$  (top).

*Spirophyllum multilamellatum* (de Groot, 1963)

(Text-fig. 10; Pl. I, Fig. 8)

1963. *Koninckophyllum multilamellatum* de Groot; G. E. de Groot, *Rugose Corals...*, p. 60, Pl. 9, Figs. 4–7; Pl. 10, Fig. 1.

*Diagnosis.* — See de Groot (1963, p. 60).

*Material.* — One solitary corallite without calice and proximal end.



Fig. 10. — *Spirophyllum multilamellatum* (de Groot, 1963), transverse section, epebic stage (I. G. No. OS-70/1875);  $\times 1.8$ .

*Remarks.* — The Polish specimen,  $21 \times 23$  mm in diameter and with  $40 \times 2$  septa, is 2 mm larger than Spanish specimens and has ten septa more. Morphologically, it resembles much more the holotype selected by de Groot (*l.c.*, Pl. 9, Fig. 5) rather, than Spanish paratypes. It has a relatively narrow axial structure with many lamellae, a narrow and simple dissepimentarium with few, lateral-cystose dissepiments and long minor septa penetrating tabularium. It differs from Spanish specimens (in particular from paratypes) in a narrower dissepimentarium and wider free axial area. But these differences are insignificant.

*Occurrence.* — Spain (Asturia): Perapertu Formation, Namurian; Poland: Gałęzice, Holy Cross Mts., Upper Viséan,  $D_2$  (top).

*Spirophyllum histiophylloides* (de Groot, 1963)

(Text-fig. 11, Pl. II, Fig. 6a, b; Pl. III, Figs. 1, 2)

1963. *Koninckophyllum histiophylloides* de Groot; G. E. de Groot, *Rugose Corals...*, p. 64, Pl. 11, Figs. 1–4.

*Diagnosis.* — See de Groot (1963, p. 64).

*Material.* — A dozen or so solitary corallites some of them with calices and partly preserved proximal ends.

Some of the dimensions (diameters in mm):

No. I.G. OS—70	Index of septa n/d
238	48 : 29 × 26
1997	41 : 19 × 18
1100	42 : 22 × 20
1140	43 : 25 × 23

*Remarks.* — The following characters relate Polish to Spanish specimens: 1) neanic stages of ontogeny, in which axial structure is of the dibu-nophylloid type with columella connected with cardinal septum, major septa swollen in tabularium, minor septa long and dissepimentarium with rectangular dissepiments, 2) a close relationship of columella to cardinal septum observed till the end of the ontogenetic development, 3) a very narrow free axial area, 4) many septa reaching columella, 5) long minor septa.

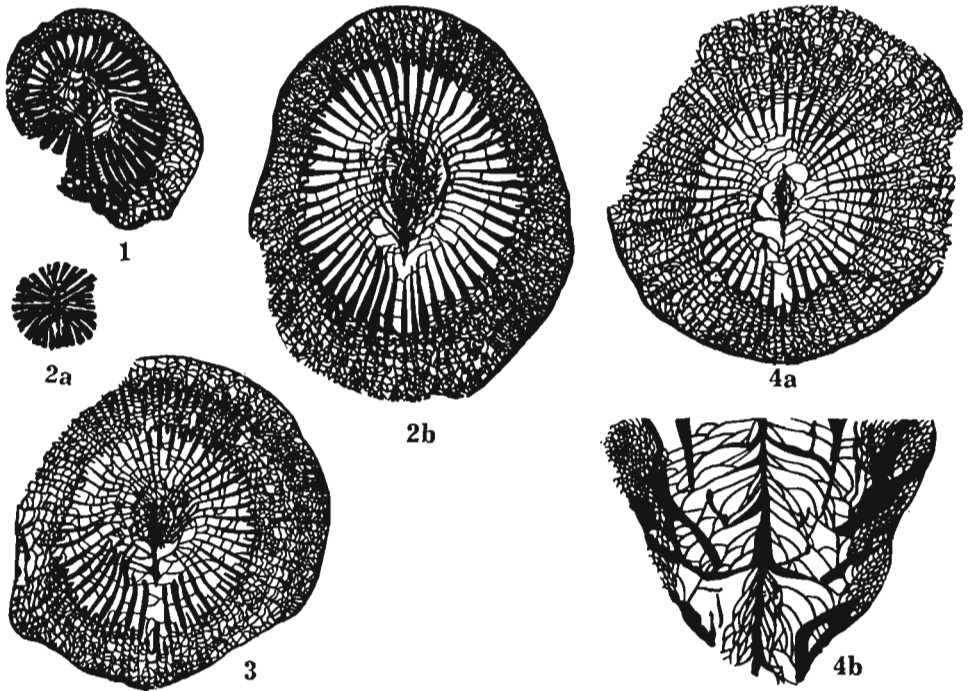


Fig. 11. — *Spirophyllum histiophylloides* (de Groot, 1963): 1 transverse section, late-neanic stage (I. G. No. OS-70/735), 2a transverse section, early-neanic stage, 2b transverse section, ephebic stage (I. G. No. OS-70/238), 3 transverse section, ephebic stage (I. G. No. OS-70/1234), 4a transverse section, ephebic stage, 4b longitudinal section (I. G. No. OS-70/1140);  $\times 1.8$ .

Fundamental differences: 1) a greater number of septa with a smaller diameter of corallites, 2) narrower dissepimentarium; 3) thicker columella; 4) more numerous lamellae or axial ends of septa in axial structure.

Since the differences mentioned above are small, concern measurable characters only and do not predominate over similarities the writer has resolved to include Polish specimens in the species described by de Groot despite considerable chronological differences in occurrence. Polish specimens might be perhaps excluded to form a separate subspecies but this did not seem to the writer to be purposeful.

*Occurrence.* — Spain (Asturia), Sierra Corisa Limestone, Westphalian D; Poland; Gałęzice, Holy Cross Mts., Upper Viséan, D<sub>2</sub> (top).

*Spirophyllum clisium* n. sp.

(Text-fig. 12; Pl. III, Figs. 3-7, Pl. XII, Figs. 4, 5)

*Holotype:* I. G. OS-70/1374. Text-fig. 12<sub>2a,b</sub>; Pl. III, Fig. 7.

*Type locality:* Gałęzice, Holy Cross Mts.

*Type stratum:* Upper Viséan, D<sub>2</sub> (top).

*Derivation of the name:* Lat. *clisium* — a shed, after upturned axial parts of major septa.

*Diagnosis.* — A *Spirophyllum* with a maximum septal index of 48: 25×21; septal lamellae not separated from major septa, twisted around a massive columella; minor septa reaching tabularium; a complex, separated axial structure in longitudinal section.

*Material.* — About ten solitary corallites with damaged proximal ends, some specimens with calices.

Dimensions (diameters in mm):

No. I.G. OS—70	Index of septa n/d
1354	44 : 24×18
1373	48 : 25×21
”	46 : 16×15
1374	47 : 24×20
1446	47 : 17×16
1841	42 : 13×11
1842	38 : 15×15
2881	40 : 21×15

*Description.* — Transverse section (Text-fig. 12<sub>1,2a</sub>; Pl. III, Figs. 3-6). Major septa thin in dissepimentarium, swollen in tabularium, particularly rapidly growing in young development stages. Septal lamellae separate from some major septa at the end of development, only complete septa occurring in younger stages. Cardinal fossula not depressed in dissepimentarium. Major septa limiting it, are bent and similar in size to the remaining ones. Dissepiments mostly rectangular. No changes of the pseudo-naotic type observed.

Longitudinal section (Text-fig. 12<sub>2b</sub>; Pl. III, Fig. 7). Tabularium bizonal. Peripheral part composed of loosely arranged, and variously shaped

peripheral tabellae. Axial part very close, most complex near columella, consisting of axial tabellae and septal lamellae so compactly and closely entangled with each other that they form a sort of a network. This network becomes slightly looser towards the periphery of axial structure and it is only in this place that particular axial tabellae may be distinguished as they ascend in a domelike manner towards columella and directly join peripheral tabellae.

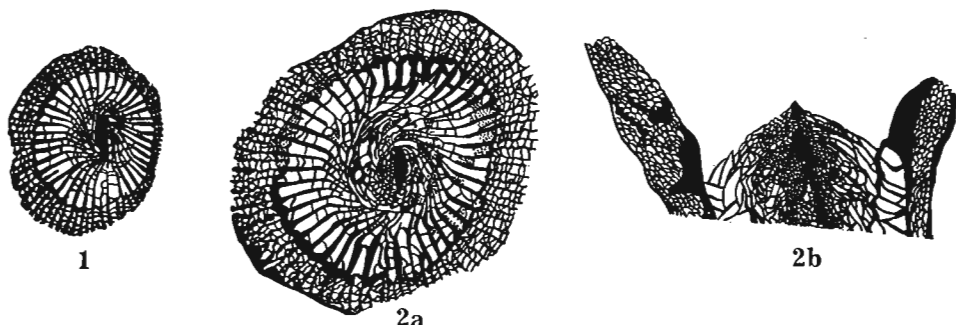


Fig. 12. — *Spirophyllum clisium* n. sp.: 1 transverse section, early-ephebic stage (I. G. No. OS-70/1841), 2a transverse section, ephebic stage, 2b longitudinal section (I. G. No. OS-70/1374, holotype);  $\times 1.8$ .

Columella variable in thickness, tubercular, with septal lamellae clearly distinguishable in its structure. It reaches calice but does not project much above axial structure. No cyclicity is marked in the structure of tabularium. Dissepiments more or less even, very fine, steeply arranged.

*Individual variability.* — The occurrence of a various number of septal lamellae, separated from septa, and a stronger or poorer development of columella are observed in axial structure. Major septa may, in some specimens, be shortened (Pl. III, Figs. 5, 6). Dissepimentarium may occupy slightly more than a quarter of the diameter of corallite, but in all cases less than one third. Poorly developed, dissepimental, racemose structures may occur at the base of septa. The differences mentioned above are not, however, great and *S. clisium* n. sp. belongs to the least variable species of *Spirophyllum*.

*Occurrence.* — Gałęzice, Holy Cross Mts., Upper Viséan, D<sub>2</sub> (top).

*Spirophyllum sanctaegrucense sanctaegrucense* n. subsp.

(Text-figs. 13, 14; Pl. III, Figs. 8–10; Pl. IV, Pl. V, Figs. 1, 2)

*Holotype:* I. G. No. OS-70/639, Text-fig. 13<sub>4a-c</sub>.

*Type locality:* Gałęzice, Holy Cross Mts.

*Type stratum:* Upper Viséan, D<sub>2</sub> (top).

*Derivation of the name:* Lat. *sanctaegrucense* — from the Holy Cross Mts.

*Diagnosis.* — A *Spirophyllum* to 30 mm in diameter and with  $64 \times 2$  septa; a multilamellar columella preserved till the end of development; lamellae separated from septa arranged spirally; minor septa reaching tabularium, less frequently slightly shortened; dissepimental racemose or, less frequently, pseudonaotic structures developing near epitheca; systems of tabellae visible in longitudinal section.

*Material.* — More than 360 specimens, many of them with calices, some with almost complete proximal ends. Measurable characters shown in a diagram in Text-fig. 14.

*Description.* — Transverse section (Text-figs. 13<sub>1a, 2a, 3a, 4b, c, 5a, 6, 7, 8d, 9e, f, 12a, b, 13, 14a, b, 15b, c, 16b</sub>, Pl. III, Figs. 9 and 10; Pl. IV, Figs. 1a, 2a, 4, 5, 6a, 7, 8–11; Pl. V, Figs. 1, 2). Major septa varying in length, in dissepimentarium thin, undulating, in fragments of some corallites strongly twisted, tubercular. Close to epitheca, they may form pseudonaotic structures. In tabularium they are variously swollen. Minor septa well developed, subject to changes similar to those in major septa. Rectangular dissepiments convex to periphery predominate in dissepimentarium. Herringbone dissepiments occur above shortened minor septa. Lateral-cystose dissepiments may appear at the margin of corallite. Racemose structures, if developed at all, do not reach deeper than to one fifth of the width of dissepimentarium.

Longitudinal section (Text-figs. 13<sub>1b, 2b, 3b</sub>; Pl. IV, Figs. 1b, 2b, 3, 6b). — Dissepiments arranged very steeply or even vertically. Complete tabulae occurring rarely, spaced at about 2–5 mm and relatively flat when they make up bases of systems. If such is the case, shorter and shorter axial tabellae, mostly reaching columella, are resting on complete tabulae or on each other. The shortest tabellae occur below a successive complete tabula (Text-fig. 13<sub>1b, 3b</sub>). Numerous sections of short septal lamellae occur here in addition to tabellae. In the places in which complete tabulae occur, lamellae are very few or do not occur at all. Peripheral part of tabularium loose, with only horizontal or slightly elevated peripheral tabellae occurring in this place.

*Ontogeny.* — The youngest ontogenetic stage studied is about 3 mm in diameter and has 14 major septa in an arrangement similar to zaphrentoid (Text-fig. 13<sub>9a</sub>) Cardinal septum connected with counter septum, form a biseptal columella. Some of major septa reach columella but do not yet make up its component parts. Minor septa lacking. Successive sections (Text-figs. 13<sub>9b, c, 13<sub>11a-c</sub></sub>) are marked by a similar arrangement of major septa, their axial ends or lamellae which correspond to them here already penetrating columella which becomes multilamellar. Thus, the zaphrentoid arrangement of major septa, initially biseptal columella and a very rapid growth of major septa, are the main characters of a younger part of the neanic stage.



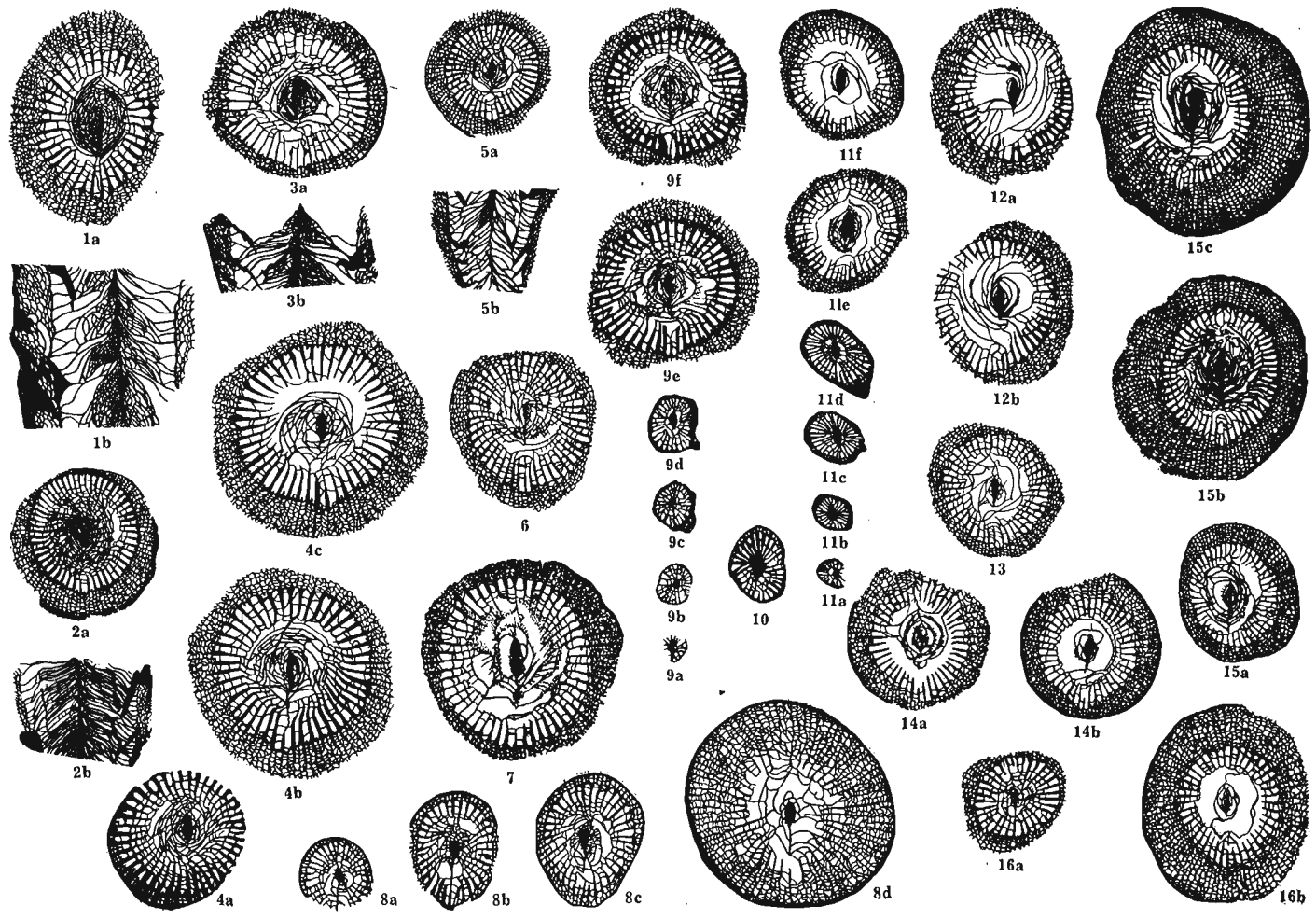


Fig. 13

In the process of further development (Text-fig. 13<sub>9d,11d</sub>), there disappears the zaphrentoid system of septa which withdraw from columella. This stage may be called a koninckophylloid phase. Since this stage, the development of lamellae in axial structure has been independent of septa, but they may be periodically connected with some of septa. In all cases, columella separates first from counter septum. This separation may be observed either directly if septa are subject to a stronger shortening, or in microstructure if they remain near columella. The median line of cardinal septum then continues in columella, while that of counter septum is separated from it. The following main characters of the older part of neanic stage are considered by the writer as generic ones: the formation of a lamellar axial structure, occurrence of the koninckophylloid phase and earlier separation of columella from counter than cardinal septum.

*Individual variability.* — The exceptionally great variability of this subspecies is discussed below in the following two aspects: 1) as a differentiation of the most important structural elements and 2) as a separation of certain morphological groups from the population.

In the variability of structural elements, a foremost place is taken by the variability of axial structure which is the most important diagnostically and, at the same time, the most differentiated of all of structural elements. Permanent characters are: a) the occurrence of columella, which usually penetrates deep in calice, till the end of ontogenic development (Pl. IV, Fig. 6b) and b) the existence — if only in some of the sections of a given corallite — of free septal lamellae which, together with tabellae, form axial structure. This structure may vary in width, be variously complicated and, contain from a few to some scores of free lamellae. Major septa may either reach the vicinity of axial structure and join some of lamellae or withdraw far from it. Columella may sometimes be list-like,

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Fig. 13. — *Spirophyllum sanctaecrusense sanctaecrusense* n. subsp.: 1a transverse section, ephebic stage, 1b longitudinal section (I. G. No. OS-70/1057), 2a transverse section, ephebic stage, 2b longitudinal section (I. G. No. OS-70/1932), 3a transverse section, ephebic stage, 3b longitudinal section (I. G. No. OS-70/1443), 4a transverse section, late-neanic stage, 4 b—c successive transverse sections of the ephebic stage (I. G. No. OS-70/639, holotype), 5a transverse section, ephebic stage, 5b longitudinal section (I. G. No. OS-70/1448), 6 transverse section, early-ephebic stage (I. G. No. OS-70/854), 7 transverse section, ephebic stage (I. G. No. OS-70/1819), 8 a—c successive transverse sections of the neanic stage, 8d transverse section, ephebic stage (I. G. No. OS-70/1182), 9 a—d successive transverse sections of the neanic stage, 9 e—f successive transverse sections of the ephebic stage (I. G. No. OS-70/1933), 10 transverse section of the late-neanic stage (I. G. No. OS-70/1813), 11a—d successive transverse sections of the neanic stage, 11 e—f successive transverse sections of the ephebic stage (I. G. No. OS-70/1912), 12 a—b transverse sections of the ephebic stage (I. G. No. OS-70/1921), 13 transverse section of the ephebic stage (I. G. No. OS-70/1801), 14 a—b transverse sections of the ephebic stage (I. G. No. OS-70/1556), 15a transverse section of the late-neanic stage, 15b—c successive transverse sections of the ephebic stage (I. G. No. OS-70/829), 16a transverse section, late-neanic stage, 16d transverse section, ephebic stage (I. G. No. OS-70/1430);  $\times 1.8$ .

but usually it is lenticulate with septal list extended towards cardinal fossula.

The individual variability of the remaining structural elements is either smaller, or of a smaller diagnostic significance. Minor septa mostly reach inner wall or its region, but in some individuals they may even penetrate tabularium. Sometimes, they become shortened but not more than to two thirds of the width of dissepimentarium. The width of dissepimentarium varies from about one sixth in the smallest to more than one third of the diameter in medium-sized and large corallites. Almost all corallites produce racemose dissepimental structures at the base of septa and some of them develop in this place pseudonaotic structures. These structures occupy varying widths of dissepimentarium.

In longitudinal section, the arrangement of tabellae and tabulae in systems is mostly distinct, but sometimes it happens to be poorly marked or does not develop at all. If such is the case, predominant tabulae are complete and arranged in a roof-like or tent-like manner (Text-fig. 13<sub>2b,5b</sub>; Pl. IV, Fig. 3). The number of sections of septal lamellae is considerably variable and consequently the axial part of tabularium is visible either quite well, or poorly, or else — invisible at all. Longitudinal sections of the corallites developed typically, allows one to consider morphological groups seemingly distant from each other (separated below) as conspecific. Making a transverse section through the place of occurrence of densely arranged lamellae and tabellae, one may obtain a very complex axial structure, while almost exclusively a columella is visible in a section through a loose space between the systems.

As mentioned above, the following morphological groups may be distinguished in the species: a) the most numerous group, including the holotype, is considered as typically developed. Index of septa about 46×18; systems of tabulae and tabellae occurring in longitudinal section; a well, but not excessively, developed axial structure occurs in transverse section; minor septa reaching inner wall; dissepimental racemose and pseudonaotic structures developed slightly; b) a very well developed axial structure consisting of many tabellae and tabulae; major septa reaching near axial structure, some of them connected with lamellae (Pl. IV, Fig. 1a, b); c) a morphology similar to that in group a, except for a wider dissepimentarium and index of septa amounting to about 60:28 (Text-fig. 13<sub>15a,c</sub>; Pl. III, Figs. 9, 10); d) an index of septa the same as in group a, but axial structure developed very poorly frequently only a thick columella remains in the ephelic stage; corallites of this group are similar in the morphology of ephelic stages to the genus *Amygdalophyllum*, but in younger development stages they have, in all cases, axial structure occurring in transverse section (Text-fig. 17<sub>7,8d,11f,12a</sub> Pl. IV, Fig. 9; Pl. V, Figs. 1, 2).

The differences between the groups of corallites described above are

considerable, but they become easily obliterated in an entire population, since there are numerous individuals with transitional characters.

*Remarks.* — Apart from the species described earlier, the species des-

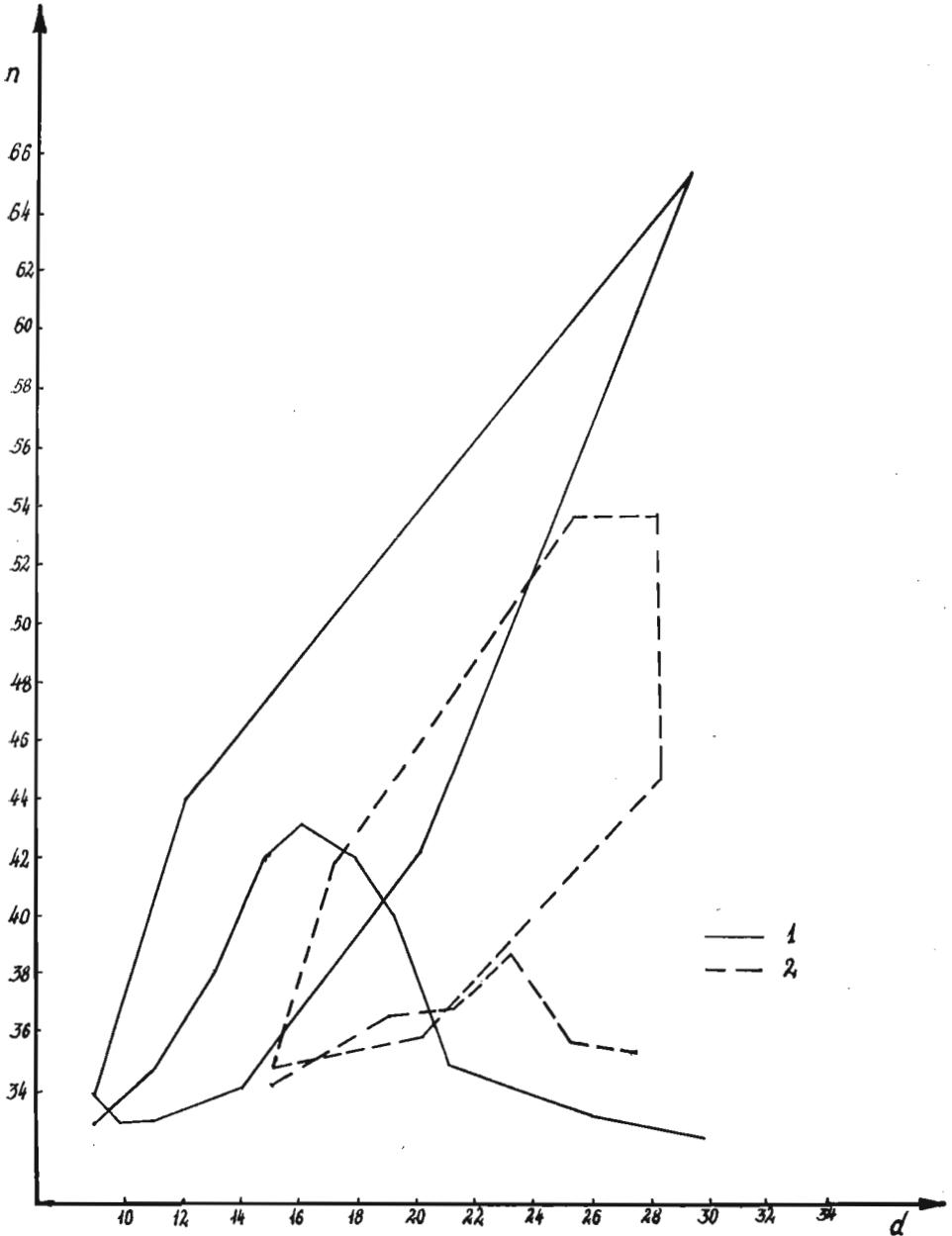


Fig. 14. — Index of septa ( $n/d$ ) for subspecies of *Spirophyllum sanctaerucense* n. sp. in which  $n$  = number of major septa,  $d$  = diameter of corallite, extreme points are connected by lines, curves show number of specimens in appropriate classes. 1 *Spirophyllum sanctaerucense sanctaerucense* n. subsp., 2 *S. sanctaerucense pauper* n. subsp.

cribed above has been considered by the writer as typical of the genus *Spirophyllum* n. gen. This is a species, elaborated on the basis of a very rich collection and consequently it was easy to trace accurately and determine the limits of its individual variability. In addition, it displays well developed diagnostic characters of the genus. The differences between *S. sanctaerucense* n. sp. and other species, as well as those between particular subspecies of this species are given below.

*Occurrence.* — Gałęzice, Holy Cross Mts., Upper Viséan, D<sub>2</sub> (top).

*Spirophyllum sanctaerucense pauper* n. subsp.

(Text-figs. 14, 15; Pl. V, Figs. 3-7, Pl. VI)

*Holotype:* No. I. G. OS-70/1809, Text-fig. 15; Pl. VI, Fig. 1a, b.

*Type locality:* Gałęzice, Holy Cross Mts.

*Type stratum:* Upper Viséan, D<sub>2</sub> (top).

*Derivation of the name:* Lat. *pauper* — after an impoverished structure.

*Diagnosis.* — A *Spirophyllum sanctaerucense* with a reduced, narrow axial structure, shortened minor septa and a lower value of n/d as compared with the nominal subspecies.

*Material.* — More than 60 corallites, some of them with calices preserved, most without proximal ends. Dimensions given in a diagram in Text-fig. 14.

*Description.* — Transverse section (Text-fig. 15; Pl. V, Figs. 3b, 4b, 5b, 6, 7; Pl. VI, Figs. 1b, 2, 3b, 4b, 5, 6). Major septa thickened in tabularium and usually more so in cardinal quadrants, shallowly penetrating tabularium, in most corallites not reaching axial structure. In some of the corallites, a few major septa with an incipient bifurcation. Small pseudonaotic structures occurring in most individuals. Axial structure very variable, loose. Dissepimentarium varying in width, with a predominance of heringbone and rectangular dissepiments in inner part and pseudoherringbone in peripheral part.

Longitudinal section (Pl. V, Fig. 3a; Pl. VI, Figs. 1a, 3a). Dissepiments variable in size, convex, arranged at an angle of about 60° sometimes even almost vertically. Axial tabellae long, ascending gently, except close to columella where they are steeper. Peripheral tabellae few, horizontal, flat or vesicular. Complete tabulae relatively numerous. In younger parts of corallites, axial tabellae happen to ascend steeply (Pl. V, Fig. 3a).

*Ontogeny.* — Typical of the genus, with a clearly marked koninckophylloid phase and zaphrentoid arrangement of septa in a younger part of the neanic stage. The late-neanic considerably similar to the ephebic stage of some morphological groups of the nominal subspecies.

*Individual variability.* — The range of the individual variability of this subspecies is slightly less extensive than in the nominal subspecies.

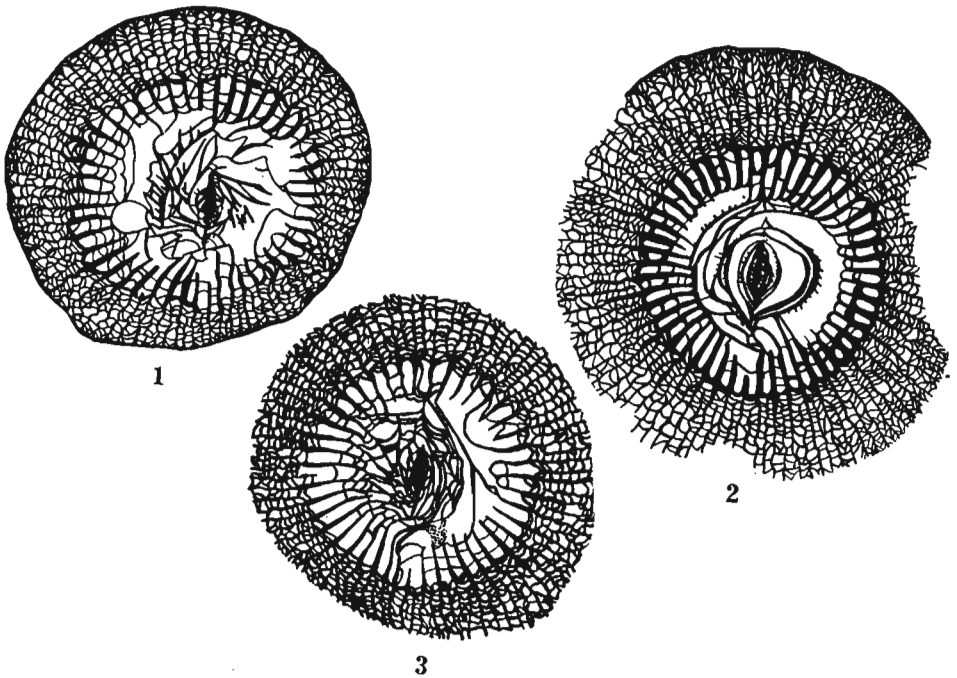


Fig. 15.—*Spirophyllum sanctaerucense pauper* n. subsp.: 1 transverse section, epebic stage (I. G. No. OS-70/1552), 2 transverse section, epebic stage (I. G. No. OS-70/1812), 3 transverse section, epebic stage (I. G. No. OS-70/1809, holotype);  $\times 1.8$ .

Only two groups of individuals, differing in the composition of axial structure may here be distinguished, whereas the remaining structural elements vary in both groups within more or less identical limits. In the first group of corallites, axial structure becomes considerably reduced as early as the end of the neanic stage, leaving only a small, thin columella and a few free septal lamellae and axial tabellae (Pl. V, Figs. 3, 5–7). In the second group of corallites, a fairly complex axial structure persists until the end of the ontogenetic development (Pl. VI, Figs. 1, 4). In contradistinction to the nominal subspecies, no amygdalophylloid trend has been found in the subspecies under study.

The structure and width of dissepimentarium, as well as length of major and minor septa vary independently of the groups separated above. Most frequent are corallites with a narrow dissepimentarium, short major septa, leaving a wide free axial area, and shortened minor septa. Corallites, having in the epebic stage a particularly wide or narrow dissepimentarium, thick columella and complex axial structure are less frequent. Such specimens differ from the nominal subspecies only in the  $n/d$  ratio.

*Remarks.* — The subspecies under study is very closely related to the holotype of *Koninckophyllum clitheroense* Parkinson, 1926 which probably has a multilamellar columella. The remaining similar characters are: a si-

milar n/d ratio, width of dissepimentarium and composition of axial structure. The structure of the marginal part of dissepimentarium, in which marginal vesicles are formed in the British specimen but pseudonaotic structures in the Polish ones, is a fundamental difference. These are so different development trends that they preclude the possibility of considering British and Polish specimens as conspecific.

*S. nexilis* (Vassiljuk, 1964), which differs mostly in the development of a wider and more complex dissepimentarium, massive columella and axial structure, is also a species related morphologically. The ontogeny of both species, which tends to the complication of axial structure with a corallite's growth in *S. nexilis* and to its simplification in *S. sanctaerucense pauper* n. subsp., is also a character which differs them from each other.

The new subspecies differs from the nominal one in diagnostic characters, the most important and the stablest of them being the n/d ratio, which is particularly clearly visible in diagrams (Text-fig. 14).

*Occurrence.* — Gałęzice, Holy Cross Mts, Upper Viséan, D<sub>2</sub> (top).

*Spirophyllum densum* n. sp.

(Pl. VII, Figs. 1-5)

*Holotype:* No. I. G. OS-70/2417; Pl. VII, Fig. 1.

*Type locality:* Gałęzice, Holy Cross Mts.

*Type stratum:* Upper Viséan, D<sub>2</sub> (top).

*Derivation of the name:* Lat. *densum* — after a dense, compact structure.

*Diagnosis.* — A *Spirophyllum* with a thick columella and few, thick lamellae in a narrow axial structure; major septa long, minor — shortened.

*Material.* — Ten solitary corallites with damaged proximal ends; some of them with calices.

Dimensions (diameters in mm):

No. I.G. OS—70	Index of septa
1121	40 : 17 × 15
1979	44 : 19 × 16
2048	48 : 27 × 20
2417	46 : 18 × 16
2417	51 : 23 × 21
2419	42 : 20 × 17
2654	41 : 15 × 13
<hr/>	
No. Z. Pal. P. Tc—4	
2916	44 : 17 × 14

*Description.* — Transverse section (Pl. VII, Figs. 1-5). Major septa with axial ends bent spirally, sometimes adhering to each other or connected with stereoplasm. In the ephebic stage, they are not connected with lamel-

lae and at the end of the ontogenetic development may be subject to pseudo-naotic changes on the periphery. Minor septa slightly shortened, in some corallites remaining long even at the end of the neanic stage. In the ephebic stage, axial structure consists of a roller-like columella, a few thick, spirally arranged lamellae and thin axial tabellae. Inner part of dissepimentarium regular, composed mostly of herringbone and regular dissepiments. Angular and pseudo-herringbone dissepiments predominate in the peripheral part. Near epitheca, they form racemose structures of the pseudo-naotic type.

*Ontogeny.* — Ontogeny, which has only partly been studied, does not deviate in its main traits from a schema typical of the genus. In a few corallites, surprising is only a very thin columella in the late neanic stage. This columella very rapidly grows thicker. The fact that, in all cases, only a few very thick septal lamellae make up columella, is an important feature of this species.

*Individual variability.* — Despite a relatively small number of specimens, a considerable individual variability may be found in this species. The most different from the remaining ones is a specimen shown in Pl. VII, Fig. 5, which has a wide, free axial area and long minor septa. On account of its columella having a structure typical of this species, it has been included by the writer in *S. densum* n. sp. The remaining specimens slightly differ from each other in a degree of complexity of their dissepimentaria, length of minor septa and measurable characters.

*Remarks.* — Some of the sections of this species' corallites younger ontogenetically suggest a considerable similarity to *Amygdalophyllum*. This similarity decreases with corallite's growth and adults have already structures quite typical of *Spirophyllum*.

The differences between *S. densum* n. sp. and the remaining species of *Spirophyllum* n. gen. are fairly considerable and concern such characters, most important diagnostically, as ontogeny and composition of axial structure. It is in this species only that the amygdalophylloid stage persists in its development and columella consists of only a few thick lamellae connected with primary lamella.

*Occurrence.* — Gałęzice, Holy Mts., Upper Viséan, D<sub>2</sub> (top).

*Spirophyllum divisum* n. sp.

(Text-fig. 16, 17; Pl. VII, Figs. 6, 7; Pl. VIII, Figs. 1-4)

*Holotype:* No. I. G. OS-70/2045, Text-fig. 16<sub>a,b</sub>; Pl. VIII, Fig. 2.

*Type locality:* Gałęzice, Holy Cross Mts.

*Type stratum:* Upper Viséan, D<sub>2</sub> (top).

*Derivation of the name:* Lat. *divisum* — after two zones in tabularium.

*Diagnosis.* — A *Spirophyllum* with a maximum number of septa being 63×2 and 30 mm in diameter; columella list-like, free lamellae few, arran-



ged almost radially; axial structure in longitudinal section separated, dibunophylloid.

*Material.* — More than 20 solitary corallites, most of them with calices preserved, a few with partly preserved proximal ends.

Dimensions (diameter in mm):

No. I.G. OS—70	Index of septa n/d
507	45 : 25 × 20
1198	50 : 27 × 23
1817	45 : 23 × 23
1970	48 : 26 × 24
1984	45 : 24 × 20
2045	63 : 30 × 26
2204	50 : 25 × 24
2331	55 : 27 × 23

*Description.* — Transverse section (Text. fig. 16<sub>1c,2a,3a</sub>, 4a-b; Pl. VII, Figs. 6a, 7a; Pl. VIII, Figs. 1a-b, 2a, 3, 4a-b). Major septa mostly thickened in tabularium in a roller-like manner, not twisted around columella; in dissepimentarium thin, undulating, with tubercular swellings; pseudonaotic structure occurring sometimes on the periphery. Minor septa slightly shortened. Cardinal fossula very slightly depressed in dissepimentarium. Axial structure dibunophylloid, with list-like columella, few loose lamellae and regularly arranged tabellae. Modifications are described below in remarks on ontogenetic variability. In dissepimentarium, herringbone dissepiments predominate near inner wall, irregular ones in its central part, and pseudo-herringbone dissepiments and pseudonaotic structures near epitheca.

Longitudinal section (Text. fig. 16<sub>2h,5</sub>; Pl. VII, Figs. 6b, 7b; Pl. VIII, Fig. 2b). Dissepiments small, convex, arranged steeply, near inner wall — vertically. Tabularium bizonal, in some specimens may several times turn unizonal (Pl. VII, Fig. 6b). Peripheral part of tabularium composed of vesicular, convex tabellae, arranged horizontally or slightly ascending towards axial structure. Some of peripheral tabellae are continued in axial structure. Tabellae of axial structure flat, tent-shaped, on the periphery of axial structure resting on each other. In younger parts of corallites, axial structure is less distinct.

*Ontogeny.* — The following characters are most important in the ontogeny of this species: 1) a very long-lasting stage of biseptal columella and a strongly marked koninckophylloid phase; 2) changes in the rate of increase in the number of septa in relation to corallite's diameter; in younger stages predominant is the rate of increase in the number of septa (to about 45 major septa), in older, the diameter is rapidly increased (to about 20 mm); a further growth is synchronous; 3) a close correlation between columella and cardinal septum; counter septum reaches it only in the

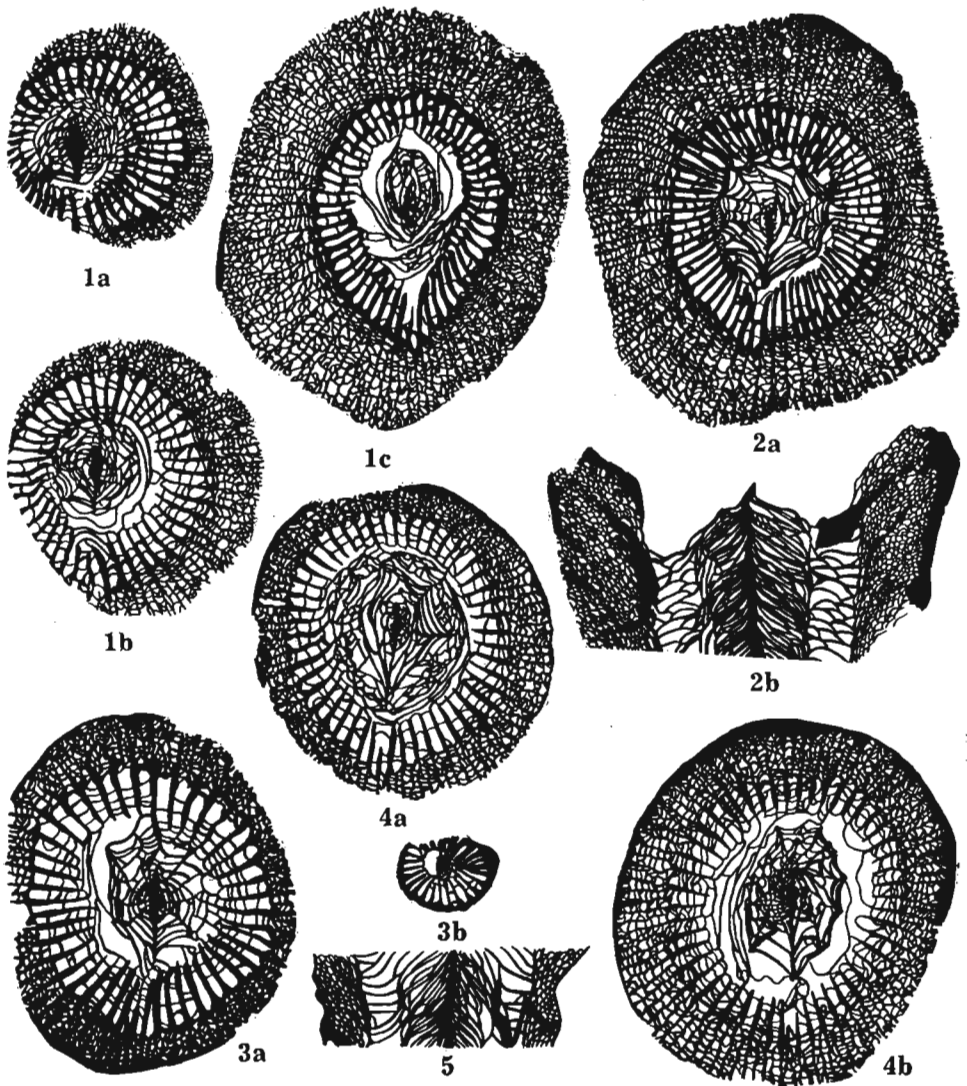


Fig. 16. — *Spirophyllum divisum* n. sp.: 1a transverse section, late-neanic stage, 1b transverse section, early-ephebic stage, 1c transverse section, late-ephebic stage (I. G. No. OS-70/2414), 2a transverse section, ephebic stage, 2b longitudinal section (I. G. No. OS-70/2045, holotype), 3a transverse section of the ephebic stage, 3b transverse section of the early-neanic stage (I. G. No. OS-70/507), 4 a—b successive transverse sections of the ephebic stage (I. G. No. OS-70/1198), 5 longitudinal section (I. G. No. OS-70/1970);  $\times 1.8$ .

youngest part of corallite. Dissepimentarium and minor septa appear early, even with a diameter of about 7 mm and their development starts from cardinal towards counter septum.

*Individual variability.* — Axial structure very variable, rather rarely having such a classically dibunophylloid type as that in the holotype (Pl. VIII, Fig. 2a, b). Its various modifications are observed in both its

width and structure. Particularly variable in structure is a specimen shown in Pl. VII, Fig. 6a, b; it is exceptionally very narrow, with a decreased number of lamellae, short columella and, in addition, it disappears periodically as illustrated by longitudinal section. Plate VIII, Fig. 4a, b shows a specimen with axial structure varying in width, with many, frequently short and irregular lamellae. There also occur axial structures with colu-

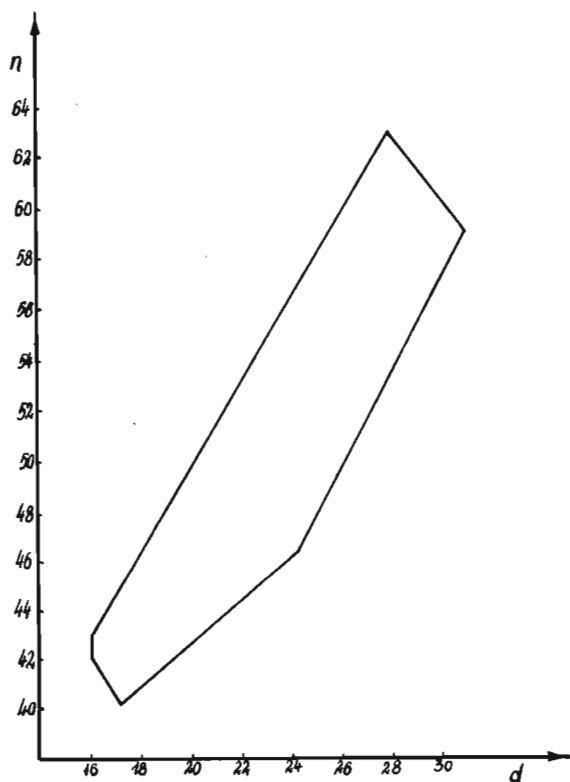


Fig. 17. — Index of septa ( $n/d$ ) for *Spirophyllum divisum* n. sp. in which  $n$  = number of major septa, and  $d$  = diameter of corallite; extreme points are connected by lines.

mella intersecting the entire inside of a corallite from cardinal to counter septum (Pl. VIII, Fig. 3), or else structures similar to *S. sanctaecrucense* n. sp. (Pl. VIII, Fig. 1a, b). The separation of axial structure in longitudinal section is here a common and fundamental character.

Of the remaining structural elements, the width and structure of dissepimentarium, which occupies between one fifth and one third of a corallite's diameter, are subject to major changes. The length of minor septa varies within limits of two thirds to a full width of dissepimentarium.

*Remarks.* — This is a species with dibunophylloid characters in morphology and development (a strongly marked koninckophylloid phase). Its generic assignment is sufficiently determined by the multilamellar colu-

mella in axial structure. It differs from all species of *Spirophyllum* n. gen. in a separated, dibunophylloid axial structure in longitudinal section.

*Occurrence.* — Gałęzice, Holy Cross Mts, Upper Viséan, D<sub>2</sub> (top).

*Spirophyllum complexum* n. sp.

(Text-fig. 18; Pl. XII, Figs. 8, 9)

*Holotype:* No. I. G. OS-70/2353; Text-fig. 18<sub>1a-e</sub>, Pl. XII, Fig. 8.

*Type locality:* Gałęzice, Holy Cross Mts.

*Type stratum:* Upper Viséan, D<sub>2</sub> (top).

*Derivation of the name:* Lat. *complexum* — after a complex development and structure.

*Diagnosis.* — A *Spirophyllum* to 27 mm in diameter and with (47–56) × 2 septa; a loose axial structure with a thin bisepthal columella occurs in the late ephebic stage; many, longitudinally split major and minor septa; minor septa penetrating tabularium.

*Material.* — About ten solitary corallites without the youngest ontogenetic stages; some of them with calices preserved.

Dimensions (diameters in mm):

No. I.G. OS—70	Index of septa n/d
505	49 : 22 × 21
2049	45 : 25 × 23
2309	56 : 27 × 24
2339	47 : 26 × 24
2353	47 : 25 × 22
2407	43 : 17 × 15

*Description.* — Transverse section (Text. fig. 18<sub>1e,2a,3</sub>; Pl. XII, Figs. 8, 9). Major septa in tabularium straight or with bent axial ends. Most of them are longitudinally split already on the boundary of dissepimentarium. Diverging septal branches are usually strongly curved, tubercular. They are connected with each other by transverse lamellae of the dissepimental type. Separated septal branches may reach epitheca or one of them once again connects with the other, or else they disintegrate near epitheca to form racemose pseudonaotic structures. In addition to such strongly changed septa, there are complete, with only tubercular swellings; near epitheca, the last-named are also subject to pseudonaotic changes. Minor septa thickened in tabularium; frequently, longitudinally split into 2–3 septal branches, even in this thickened part they are subject to identical changes as major septa. In few corallites, they reach inner wall only.

Axial structure with complex development, described below, variable. In the ephebic stage of holotype, it is composed of a bisepthal columella, reaching nearly as far as cardinal septum and of numerous free septal lamellae, divided into short segments, and irregular axial tabellae.

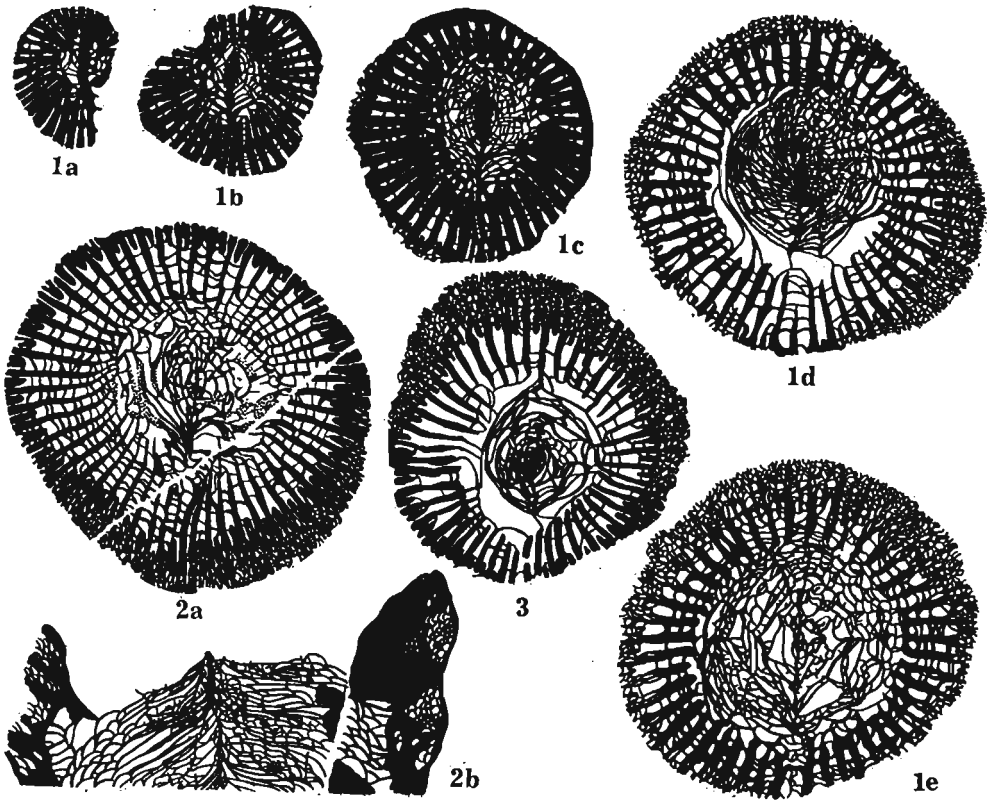


Fig. 18. — *Spirophyllum complexum* n. sp.: 1 a—c successive transverse sections of the neanic stage, 1d transverse section of the early-ephebic stage, 1e transverse section, ephebic stage (I. G. No. OS-70/2353, holotype), 2a transverse section, ephebic stage, 2b longitudinal section (I. G. No. OS-70/2309), 3 transverse section, ephebic stage (I. G. No. OS-70/505);  $\times 1.8$ .

Dissepimentarium consists mostly of lateral-cystose and angular dissepiments with a very pointed apex directed towards epitheca. Flatter dissepiments occur only sporadically.

Longitudinal section (Text-fig. 18<sub>2b</sub>). Dissepimentarium narrow, with fine, subvertical dissepiments. Three zones not separated from each other may be distinguished in tabularium. Near dissepimentarium, the peripheral zone is composed of horizontal, flat or slightly convex peripheral tabellae. Towards the inside of corallite it turns in a zone of convex, dissepimental like median tabellae, disposed obliquely at an angle of about  $30^\circ$  to the inside of corallite. The third zone consists of long, flat axial tabellae slightly ascending towards tabularium. Few sections of septal lamellae do not obliterate characteristic features of the structure of tabularium. Columella varying in thickness, wavy.

*Ontogeny.* — The youngest section studied (Text-fig. 18<sub>1a</sub>) has not yet dissepimentarium, but has minor septa. Columella very thick, connected

with cardinal and counter septum and is as early as in this stage multilamellar. In another section, cut nearly 0.5 mm above (Text-fig. 18<sub>1b</sub>), columella detaches itself from counter septum, but still remains connected with cardinal septum and this connections persists till the ephebic stage. It is difficult to state whether or not dissepimentarium already occurs in this stage since entire spaces between major septa are filled by minor septa and the surface of studied corallite is destroyed.

Dissepimentarium has been found about 2 mm above (Text-fig. 18<sub>1c</sub>). The formation of a dense axial structure, consisting of a thick columella and many free septal lamellae, twisted around columella, are also visible in this section. The number of these lamellae increases until the early-ephebic stage (Text-fig. 18<sub>1d</sub>), from which starts a decrease in the thickness of columella and its disintegration into free lamellae. This stage has been described above in a transverse section.

*Individual variability.* — Diagnostically, the most important are: 1) Variability in axial structure. Differences may here be found which result from a different rate of ontogenetic development, e.g. a degree of decrease in the thickness of columella, as well as — independent of ontogeny — width of axial structure, number of septal lamellae and extension or shortening of columella. 2) Variability in length of minor septa. The holotype and most paratypes have long minor septa with axial ends strongly swollen in tabularium. Some of the paratypes have, however, certain minor septa so shortened that they equal the width of dissepimentarium or even less. 3) The development of naotic structures and number of septa split longitudinally increase with the age of an individual. These characters, as well as the degree of thickening of major septa and their more or less roller-like shape in tabularium, are in the ephebic stage different for almost each corallite.

*Remarks.* — Since they have a biseptal columella, ephebic stages of the representatives of this species can be hardly compared with corresponding stages of other species of *Spirophyllum* n. gen. On the other hand, younger ontogenetic stages are quite typical of the genus.

The development of a very complex dissepimentarium and well developed pseudonaotic structures slightly relate this species to *S. nexilis* and *S. perditum* n. sp.

*Occurrence.* — Gałęzice, Holy Cross Mts, Upper Viséan, D<sub>2</sub> (top).

*Spirophyllum regulare* n. sp.  
(Text-fig. 19; Pl. IX; Pl. X, Figs. 5, 6)

*Holotype:* No. I. G. OS-70/1006; Text-fig. 19<sub>2</sub>, Pl. IX, Fig. 3a, b.

*Type locality:* Gałęzice, Holy Cross Mts.

*Type stratum:* Upper Viséan, D<sub>2</sub> (top).

*Derivation of the name:* Lat. *regulare* — after a regular structure.

*Diagnosis.* — A *Spirophyllum* to 40 mm in diameter and with (46–58)×2 septa; dissepimentarium regular, occupying more than a half of the corallite's diameter; minor septa shortened; columella disintegrating at the end of the ephebic stage; lonsdaleoid vesicles present.

*Material.* — About ten solitary corallites, some of them partly damaged, without complete proximal ends, a few with preserved calices.

Dimensions (diameters in mm):

No. I.G. OS—70	Diameter of		Number of septa
	corallite	tabularium	
976	34×26	19×17	50
977	29×25	17×17	46
1006	38	17	52
1098	25×21	16×14	44
1170	22×18	13×12	41
1184	32×24	17×14	58
1186	26×24	14×13	53
1238	83×31	15×15	46
Z. Pal. P. Tc—4			
2314	28×27	14×13	50

*Description.* — Transverse section (Text-fig. 19<sub>1e,f</sub>; Pl. IV; Pl. X, Figs. 5a, 6a). Major septa in dissepimentarium thin, in tabularium swollen, mostly roller-like. Minor septa in the neanic stage may penetrate tabularium, in the ephebic stage so shortened that they equal a half of the width of dissepimentarium. Axial structure variable, sometimes with many free lamellae, in other sections of this same corallite only columella being visible (Pl. IX, Fig. 4a-b). At the end of development, columella disintegrates into free lamellae, among which usually no primary lamella may be distinguished. Rectangular dissepiments is an almost only type of them occurring in dissepimentarium and herringbone dissepiments occur over shortened minor septa. In some of the corallites (also in the holotype) lateral-cystose dissepiments are relatively numerous in the inner part of dissepimentarium. Lonsdaleoid vesicles, which initially break only minor septa, are relatively frequent. No pseudonaotic structures observed.

Longitudinal section (Text-fig. 19<sub>1g</sub>; Pl. X, Fig. 6b). Dissepiments arranged semicircularly, near the margin of corallite subhorizontally, near inner wall vertically. Tabularium more or less uniform in width, contracted only in the place of rejuvenescence. Tabellae vesicular, finer on periphery, arranged in systems, near columella ascending more steeply. Axial structure not separated, sections of lamellae few. Columella variable in thickness, may disintegrate in sections younger ontogenetically (Pl. X, Fig. 6b) and consolidate once again in the proces of further development.

*Ontogeny.* — A development typical of the genus. The koninckophylloid phase turns in a stage with a multilamellar columella which at first is

thick and, at the end of development; disintegrates. The length of minor septa decreases as compared with the width of dissepimentarium. Lateral-cystose dissepiments appear at the end of development.

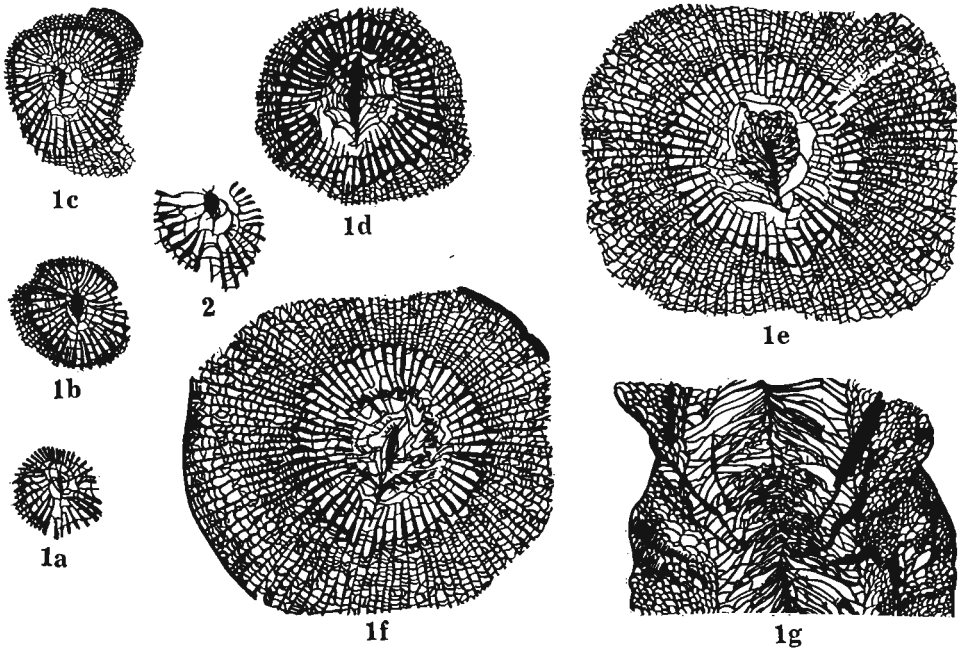


Fig. 19. — *Spirophyllum regulare* n. sp.: 1 a—d successive transverse sections of the neanic stage, 1 e—f successive transverse sections of the ephebic stage, 1g longitudinal section (I. G. No. OS-70/1186), 2 transverse section of the neanic stage (koninckophylloid phase (I. G. No. OS-70/1006, holotype);  $\times 1.8$ ).

*Individual variability.* — As in all species of this genus, axial structure is very variable. This variability is observed, however, also during the development of particular corallites. The disintegration of columella which forms free septal lamellae is the most important character of axial structure. It may take place only at the end of the ontogenetic development or several times during ontogeny. The number of free septal lamellae and the manner of their arrangement are different in each corallite.

A certain variability is also displayed by dissepimentarium. Lateral-cystose dissepiments, the most numerous in the holotype, are developed not in all corallites. Likewise, not all corallites have lonsdaleoid vesicles in their marginal part.

*Remarks.* — The disintegration of columella during the ontogenetic development limits the range of related species to *S. perditum* n. sp. and *S. complexum* n. sp. only. *S. regulare* n. sp. differs from both the species named above in a very large size of corallites, wide, regular dissepimentarium and non-split septa, which do not display pseudonaotic changes. In



addition, it differs from *S. complexum* n. sp. in a lack of a bisepal columella in the late-ephebic stage.

*Occurrence.* — Gałęzice, Holy Cross Mts., Upper Viséan, D<sub>2</sub> (top).

*Spirophyllum perditum* n. sp.

(Text-fig. 20; Pl. X, Figs. 1-4)

*Holotype:* No. I. G. oS-70/2205; Text-fig. 20<sub>1a-c</sub>, Pl. X, Fig. 1.

*Type locality:* Gałęzice, Holy Cross Mts.

*Type stratum:* Upper Viséan, D<sub>2</sub> (top).

*Derivation of the name:* Lat. *perditus* — destroyed; after a disintegrating columella.

*Diagnosis.* — A *Spirophyllum* with (40-46)×2 septa and to 35 mm in diameter near the margin of calice; columella disintegrating into lamellae; some of major septa split longitudinally; pseudonaotic structures occurring on the periphery; a vesicular axial structure visible in longitudinal section.

*Material.* — More than ten solitary corallites, some of them with calices and partly preserved proximal ends.

Dimensions (diameters in mm):

No. I.G. OS—70	Index of septa n/d
232	40 : 23 × 21
808	40 : 17 × 17
978	43 : 20 × 16
2172	42 : 20 × 19
2205	42 : 28 × 25
2293	44 : 24
2306	43 : 23 × 21
2341	46 : 25 × 25
2427	40 : 17 × 17

*Description.* — Transverse section (Text-fig. 20<sub>1a,b,2a,3,4b,c</sub>; Pl. X, Figs. 1-4). Major septa slightly more swollen in cardinal quadrants. Thin ends of some major septa may reach columella. Cardinal fossula almost not depressed at all in dissepimentarium, open. Minor septa thinner than major but, the same as the latter, are subject to naotic changes on the periphery.

Axial structure variable during ontogeny. At the beginning of the ephebic stage, it still has columella and many free lamellae fusing with it. On the side of counter septum, these lamellae may be connected with major septa. In a more advanced ephebic stage, columella disintegrates to form free lamellae of which a loose structure is composed in the axial part of corallite. In the holotype and some of the paratypes, lamellae are arranged in this structure centripetally, in some others more or less twisted. Disssepimentarium complex only on the periphery. Predominant are herring-

bone, pseudo-herringbone and irregular dissepiments, lateral-cystose ones occurring rarely.

Longitudinal section (Text-fig. 20<sub>1c</sub>). Tabularium bizonal. In axial structure tabellae fine, vesicular, flat, intersected by lamellae, on the margin of structure arranged steeply. In the peripheral part of tabularium tabellae

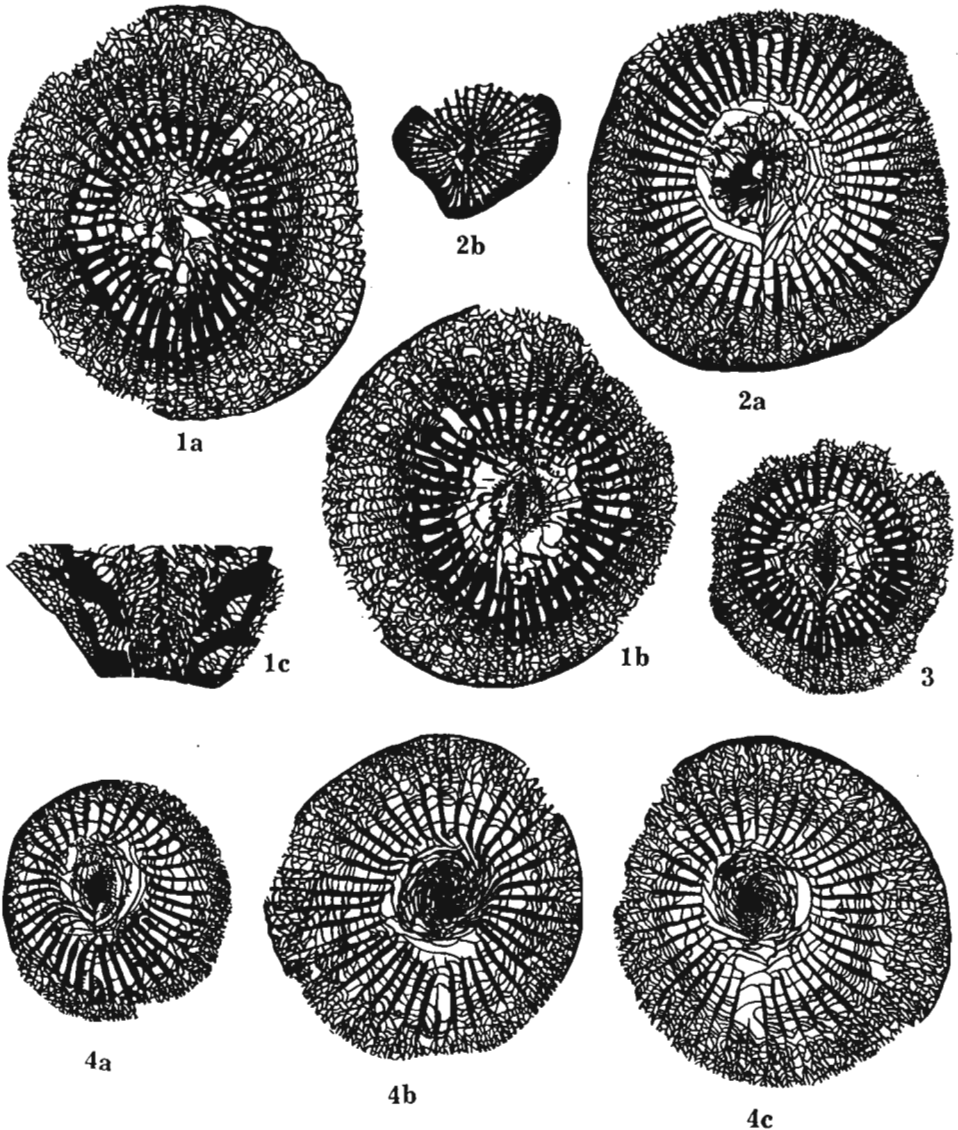


Fig. 20. — *Spirophyllum perditum* n. sp.: 1 a—b transverse sections of the ephebic stage, 1c longitudinal section (I. G. No. OS-70/2205, holotype), 2a transverse section, ephebic stage, 2b transverse section, neanic stage (I. G. No. OS-70/2341), 3 transverse section of the early-ephebic stage (I. G. No. OS-70/2427), 4a transverse section, neanic stage, 4 b—c successive transverse section of the ephebic stage (I. G. No. OS-70/232);  $\times 1.8$ .

convex, fine, resembling dissepiments, situated at an angle of about  $30^\circ$  to axial structure. Columella tubercular, variable in thickness.

*Ontogeny.* — The koninckophylloid phase and, subsequently, the formation of a complex axial structure are conspicuously marked in the neanic stage (Text-fig. 20<sub>2a</sub>). Axial structure may be of the dibunophylloid type, with few, centripetally directed lamellae (Text-fig. 20<sub>3</sub>), or similar to an axial structure of the type species, with twisted lamellae (Text-fig. 20<sub>4a,b</sub>). The disintegration of columella takes place at a various rate in particular corallites. In some of them it occurs at the end of the neanic stage, in some others only below the calice.

*Individual variability.* — In the ephebic stage, axial structure may consist of a variable number of free, more or less centripetal lamellae. They are long or divided into small segments. A varying degree of twisting lamellae is observed, from those situated almost radially in the holotype to those twisted tightly and spirally in a specimen shown in Text-fig. 20<sub>4a-c</sub>.

Dissepimentarium is mostly not very complex and the degree of its density depends on the number of pseudo-herringbone and lateral-cystose dissepiments. Particularly different from the holotype is a specimen, shown in Pl. X, Fig. 3a-b, having a very narrow, regular dissepimentarium and columella which disintegrates as early as the neanic stage. It may belong to a separate subspecies.

*Remarks.* — The species described belongs to those with axial structure separated in longitudinal section. In this section the most similar is the structure of *S. clisium* n. sp. in which axial structure is also fine-vesicular, but transverse sections of both species are quite different. Another characteristic feature of *S. perditum* n. sp., i.e. disintegration of columella, also occurs in *S. regulare* n. sp. The two species differ one from the other in the structure of septa and dissepimentarium, different n/d ratio and longitudinal sections.

*Occurrence.* — Gałęzice, Holy Cross Mts., Upper Viséan, D<sub>2</sub> (top).

*Spirophyllum bifurcatum* n. sp.

(Text-fig. 21; Pl. XII, Figs. 6, 7)

*Holotype:* No. I. G. OS-70/835; Text-fig. 21<sub>2a,b</sub>.

*Type locality:* Gałęzice, Holy Cross Mts.

*Type stratum:* Upper Viséan, D<sub>2</sub> (top).

*Derivation of the name:* Lat. *bifurcatum* — after a longitudinal split of septa.

*Diagnosis.* — A *Spirophyllum* with non-complex axial structure, frequently having only columella; many major septa split longitudinally, pseudonaotic ones also frequent.

*Material.* — About ten solitary corallites without proximal ends, frequently with calices.

Dimensions (diameters in mm):

No. I.G. OS—70	Index of septa n/d
835	45 : 23 × 20
860	41 : 25 × 23
985	44 : 23 × 21
1421	49 : 24 × 22
1678	52 : 20 × 18
1746	54 : 22 × 19

*Description.* — Transverse section (Text-fig. 21<sub>1,2a</sub>; Pl. XII, Figs. 6, 7). Epitheca thin, almost completely smooth. Number of septa variable, independently of the diameter of corallite. Not all of major septa are split longitudinally, some of them in each corallite have a normal structure. The splitting usually takes place on the boundary between tabularium and dissepimentarium, occurring more generally in older development stages, in juvenile stages not recorded. Minor septa are subject to pseudonaotic changes, split ones not found. Axial structure very variable, non-complex. Free septal lamellae few, short, disappearing, Columella mostly very thin, list-like, sometimes twisted.

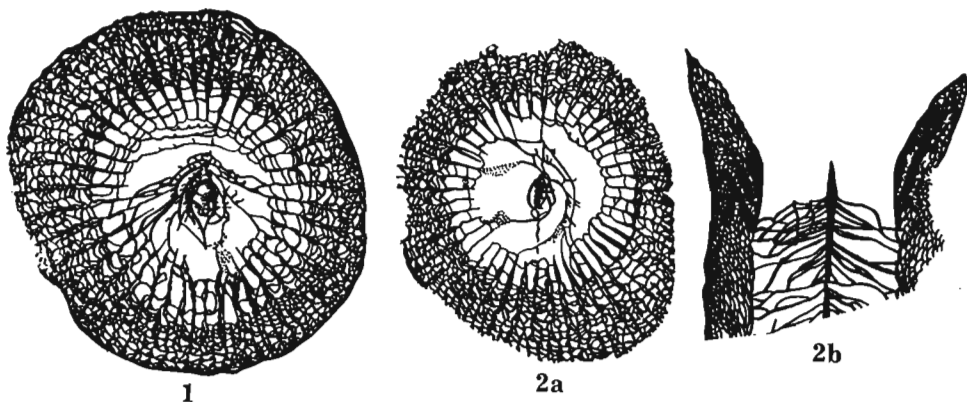


Fig. 21. — *Spirophyllum bifurcatum* n. sp.: 1 transverse section, ephebic stage (I. G. No. OS-70/860), 2a transverse section, ephebic stage, 2b longitudinal section (I. G. No. OS-70/835, holotype);  $\times 1.8$ .

Longitudinal section (Text-fig. 21<sub>2b</sub>). Columella straight, variable in thickness. Tabularium loose, without separated axial structure. Systems of tabellae may be marked. Dissepiments very steep, near inner wall vertical, near epitheca smaller.

*Individual variability.* — A considerable differentiation is displayed by the n/d index of septa (cf. Table) which, as compared with the variability of morphological characters, in particular that of axial structure, may

arouse certain doubts concerning the conspecificity of the specimens grouped in this species. It seems that the characters most important diagnostically in this species are however 1) the bifurcation of septa and 2) the development of a thin columella persisting till the end of ontogeny. These characters are common to all corallites.

*Remarks.* — The specimen described is similar in the bifurcation of septa to *S. complexum* n. sp. This is, however, the only common character of these species, except for generic characters, and the separateness of these species need not be emphasized. More similar is *S. sanctaerucense pauper* n. subsp., in which the beginning of bifurcation has been found in a few corallites. Corallites of *S. bifurcatum* n. sp., having a small number of septa and a slightly more complex axial structure, are particularly closely related to the last-named subspecies. In this case, the main difference consists in a conspicuously marked longitudinal split of septa in *S. bifurcatum* n. sp.

*Occurrence.* — Gałęzice, Holy Cross Mts., Upper Viséan, D<sub>2</sub> (top).

*Spirophyllum geminum* n. sp.

(Text-fig. 22; Pl. VIII, Figs. 5, 6)

*Holotype:* No. I. G. OS-70/1827; Text-fig. 22<sub>1a-g</sub>.

*Type locality:* Gałęzice, Holy Cross Mts.

*Type stratum:* Upper Viséan, D<sub>2</sub> (top).

*Derivation of the name:* Lat. *geminum* — after forming buds.

*Diagnosis.* — A *Spirophyllum* with incipient colonies; septa are subject to pseudonaotic changes on the periphery; minor septa penetrating tabularium; columella does not disintegrate.

*Material.* — More than ten corallites having the nature of incipient colonies, without proximal ends.

Dimensions (diameters in mm):

No. I.G. OS—70	Index of septa n/d
1523	51 : 24
1797	42 : 13
1827	41 : 18
2046	45 : 24
Z. Pal. P. Tc—4	
2572	48 : 20
2643	43 : 15

*Description.* — Transverse section (Text-fig. 22<sub>1d,e</sub>). Calice very deep, which is connected with the development of perimural buds inside of it. A maximum measured diameter of calice amounts to 35×33 mm. Major septa short, their tabular parts straight and slightly swollen, particularly

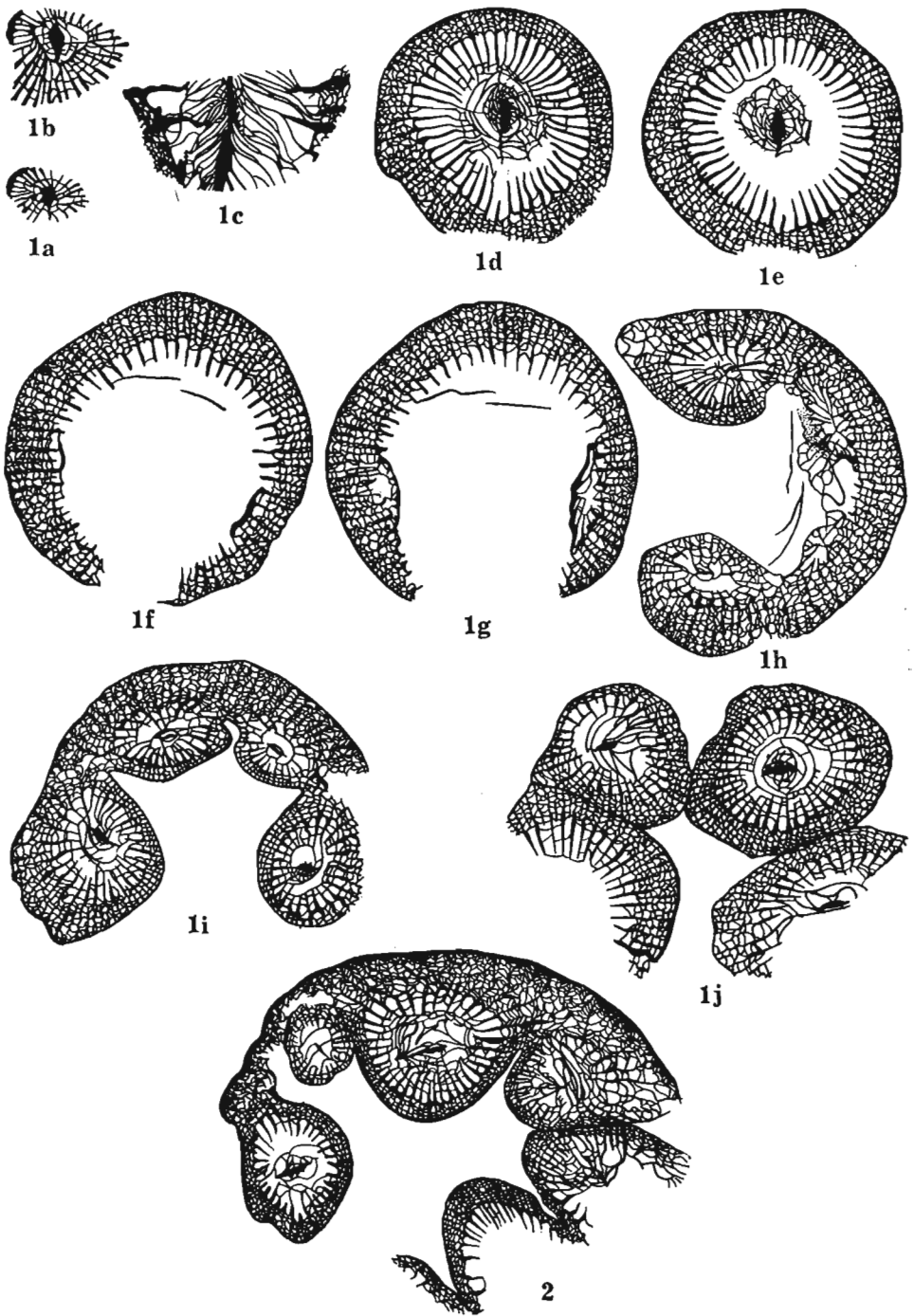


Fig. 22. — *Spirophyllum geminum* n. sp.: 1 a—b successive transverse sections of the neanic stage, 1c longitudinal section, 1 d—e successive transverse sections of the ephebic stage, 1 f—g successive transverse sections of the hystero-neanic stage (I. G. No. OS-70/1827, holotype), 2 transverse section across the protocolony (I. G. No. OS-70/2046);  $\times 1.8$ .

near inner wall. Dissepimental segments varying in thickness, tuberculate. It is only in the places in which buds are formed in calice, that they are subject to pseudonaotic changes and longitudinal split. Dissepimentarium narrow, dissepiments anguloconcentric, only at the end of development more complex. Axial structure with a well developed columella and few septal lamellae twisted around it.

Longitudinal section (Text-fig. 22<sub>1c</sub>). Columella variable in thickness. Axial tabellae tent like, bent in the axial part upwards and directed towards columella, more numerous than on the periphery. Near dissepimentarium, tabulae are bent to the plane. Tabellae few, horizontal.

*Ontogeny.* — The development has been studied only from the neanic stage (Text-fig. 22<sub>1a,b</sub>). Columella, at first very strongly swollen, connected with cardinal and counter septum. This connection is broken simultaneously with both septa; the koninckophylloid phase becomes marked then. The ontogenetic development almost identical with that in type species.

*Blastogeny.* — Hystero-nepionic stage (Text-fig. 22<sub>1a,b</sub>). Budding starts in the peripheral part of tabularium between axial ends of major septa and dissepimentarium. In all cases, there forms an entire series of buds which develop from the inner wall to the inside of calice. The formation of a bud is initiated by the secretion of a tabula which connects axial ends of major septa. This tabula starts from the beginning to play the role of an epitheca, transforming, itself from a basal into a vertical element. It gets rapidly reinforced by a deposit of stereoplasma and gradually detaches and withdraws from axial ends of major septa towards the inside of calice of a parent corallite. On the tabula mentioned above, which might be already called neoepitheca, the neosepta of a bud start to form almost directly after its separation from the old septa of a parent corallite. It should be particularly emphasized that these are completely new septa and not detached axial segments of septa of a parent corallite. The atavo-septa of a parent corallite have now been situated in the peripheral part of the bud formed. They are subject to conspicuous changes. Their periepithecal parts disintegrate to form irregular lamellae, as well as bend, become thinner and shorter. Straight, complete and swollen inner parts of these septa elongate at the same time. Thus, the interesting phenomenon here occurs in which old septa of a parent corallite are taken over and adapted by the bud and, at the same time, they become reconstructed and rejuvenated (Text-fig. 22<sub>1h,2</sub>).

Columella is formed rather late but still in the nepionic stage and it is connected with counter septum. Cardinal fossula develops, in all cases, from the inside of a parent corallite. Cardinal septum shortened.

Hystero-neanic stage. The moment at which the bud completely detaches from the parent corallite has in the writer's former works (1965, 1967 a, b) been assumed as a beginning of the neanic stage. In the case of

the species here described, this criterion is fairly deceptive, since frequently a young individual displays all symptoms of ageing and decay still before a complete detachment. Relatively well developed are young corallites of the holotype (Text-fig. 22<sub>1j</sub>). They have a regular dissepimentarium, long major and minor septa and an axial structure simplified as compared with the parent corallite. These corallites become subject to decay even before reaching the dimensions and structure of the ephelic stage of parent corallite and, therefore, they do not produce offsprings.

*Remarks on blastogeny.* — The budding described above does not lead to the formation of permanent colonies. Such a "protocolony" develops within limits outlined by the circumference of calice of a parent corallite, only slightly projecting above its margin. However, the circumference of this calice is almost or even more than twice as large than that before the beginning of the budding and, therefore, the species goes through a certain period of development as a colony. The parent corallite does not decay upon producing a series of buds, the evidence of which are changes that gradually take place in structural elements and an increase in dimensions. The budding described is not, therefore, a parricidal budding. However, a gradual take-over of life functions of the parent corallite by more strongly developed descendent corallites takes place. This is particularly clearly marked in the development of the holotype, in which part of calice has been subject to regression. The lack of this part is not caused mechanically, since the decay and degeneration of septa, dissepimentarium and tabulae may be clearly seen in this part. The epitheca of a parent corallite gradually passes to the extreme descendant corallites and extends inside calice to the youngest buds (Text-fig. 22<sub>1h,i</sub>). Due to this phenomenon, a completely integrated, many-member organism is formed, in which particular component parts, also including fragments of parent corallite, still remaining on the periphery, may be easily distinguished. A complete resorption of the tissue of a parent corallite by the descendent ones and their complete isolation may take place at the end of development or else, the protocolony decays even before reaching this stage.

A very similar blastogeny observed in *Lithostrotion* sp. from the Upper Viséan of Australia was described by Jull (1965). The main differences are: 1) a more radial position of columella in the buds of *S. geminum* in relation to the axis of a parent corallite and 2) a bifurcation and pseudonaotic changes in septa of *S. geminum* and their stronger involvement in the formation of a bud than in *Lithostrotion* sp. These differences are so insignificant that we should either consider the Australian *Lithostrotion* sp. as congeneric with *S. geminum*, or exclude this manner of budding from diagnostic characters. It may be characteristic of various species and higher taxons with an incipient colonial structure. This problem may be solved



only by the study on the microstructure of columella in the Australian specimens.

*Remarks.*—The capability of budding is a fundamental difference between *S. geminum* n. sp. and the remaining species of *Spirophyllum* n. gen. Morphologically it is most strongly related to *S. sanctaerucense sanctaerucense* n. subsp. The only difference is a longitudinal split of septa in *S. geminum* n. sp., which, however, should be considered in this case as a gerontic character.

*Occurrence.*—Gałęzice, Holy Cross Mts., Upper Viséan, D<sub>2</sub> (top).

**Family Rozkowskiidae n. fam.**  
(Type genus *Rozkowskia* n. gen.)

*Genera assigned:* by monotypy.

*Diagnosis.*—Solitary corallites with a well developed dissepimentarium; columella composed of a thin primary lamella and axial tabellae connected with it; microstructure trabecular; the youngest ontogenetic stages clisiophylloid.

*Geographical and stratigraphic range.*—Poland and E Australia—Upper Viséan.

*Remarks.*—The structure of columella is a main diagnostic character of this family, distinguishing it not only from the related families of the superfamily Aulophyllicae, but also from most of tetracorals. As far as the present writer knows, a columella of the related type has so far been described only in *Cyathaxonia* and *Rylstonia*. However, even in these genera columellae are not identical with that of Rozkowskiidae n. fam. In *Cyathaxonia*, columella is formed in the early-neanic stage as a result of a connection of cardinal and counter septum (Schouppé & Stacul, 1962; Rózkowska, 1969). This biseptal primary lamella in *Cyathaxonia* is, however, very early reduced and columella is tabular only. In *Rozkowskia* n. gen. primary lamella remains inside columella until the end of development. This is what Kato (1963, p. 615) writes on columella in *Cyathaxonia*: "It certainly is comparable to a very large single trabecula". Since both in *Cyathaxonia* and *Rozkowskia*, n. gen. columella is of the basal origin, formed by tabulae and by no means can be compared with trabecula, the present writer does not agree with Kato's statement.

In *Rylstonia*, columella is much more complex than in *Rozkowskia* n. gen., but even in it, the most peripheral part is of the basal origin. According to Hudson and Platt (1927, p. 42), "...here the tabulae are steeply inclined to the columella, and arch upwards against it forming a series of collars". The same manner of forming columella has been found by the writer in *Rozkowskia* n. gen. In *Rylstonia*, columella is founded, however,

as a monoseptal swelling of counter septum, on which the multilamellar part grows (as in *Amygdalophyllidae*) and only the last-named is covered with tabular part. In *Rozkowskia* n. gen. the foundation of columella is bisepal and the multilamellar part does not occur at all. A completely different ontogeny excludes *Rylstonia* from the superfamily Aulophyllicae.

In specimens, which can be assigned to the superfamily Aulophyllicae, tabular columella has for the first time been found by Hill (1934) in *Amygdalophyllum vallum* Hill. In those times, however, no major importance was ascribed to this structure which was only mentioned in a brief commentary.

Genus *Rozkowskia* n. gen.  
(Type species: *R. compacta* n. sp.)

*Species assigned:* *Amygdalophyllum vallum* Hill, 1934; *Rozkowskia compacta* n. sp.; *Rozkowskia parva* n. sp.

*Derivation of the name:* In honour of Professor M. Rózkowska, a well known Polish palaeontologist.

*Diagnosis.* — As for the family.

*Geographical and stratigraphic range.* — As for the family.

*Remarks.* — As for the family.

*Rozkowskia compacta* n. sp.  
(Text-fig. 23; Pl. XI, Figs. 1-3; Pl. XII, Figs. 10, 11)

*Holotype:* No. I. G. OS-70/106; Text-fig. 23<sub>2a,b</sub>; Pl. XII, Fig. 10.

*Type locality:* Gałęzice, Holy Cross Mts.

*Type stratum:* Upper Viséan, D<sub>2</sub> (top).

*Derivation of the name:* Lat. *compacta* — after a dense structure.

*Diagnosis.* — A *Rozkowskia* with 41×2 septa and 24 mm in diameter; septa disintegrating to form pseudonaotic structures; minor septa shortened; dissepimentarium complex, occupying more than a half of the corallite's diameter.

*Material.* — Five solitary corallites without calices, some of them with partly preserved proximal ends.

Dimensions (diameters in mm):

No. I.G. OS—70	Index of septa n/d
106	41 : 24 × 22
1050	39 : 23 × 21
1137	37 : 24 × 23
1608	43 : 16 × 15

*Description.* — Transverse section (Text-fig. 23<sub>1e,f,2a</sub>; Pl. XI, Figs. 1a-b, 3; Pl. XII, Figs. 10, 11). Major septa in dissepimentarium roller-like,

swollen, long, reaching very near columella, some of them contact it. Dissepimental segments of major septa very frequently disintegrate forming pseudonaotic structures. Minor septa reach one to two thirds of the width of dissepimentarium and are subject to similar changes as major septa. Cardinal septum shortened. Counter septum variable in length, frequently extending as far as columella. Cardinal fossula open, almost not depressed in dissepimentarium. Dissepimentarium very complex. Pseudo-herringbone dissepiments are predominant, in some corallites lateral-cystose ones being very numerous. Herringbone and, less frequently, rectangular dissepiments predominate near inner wall.

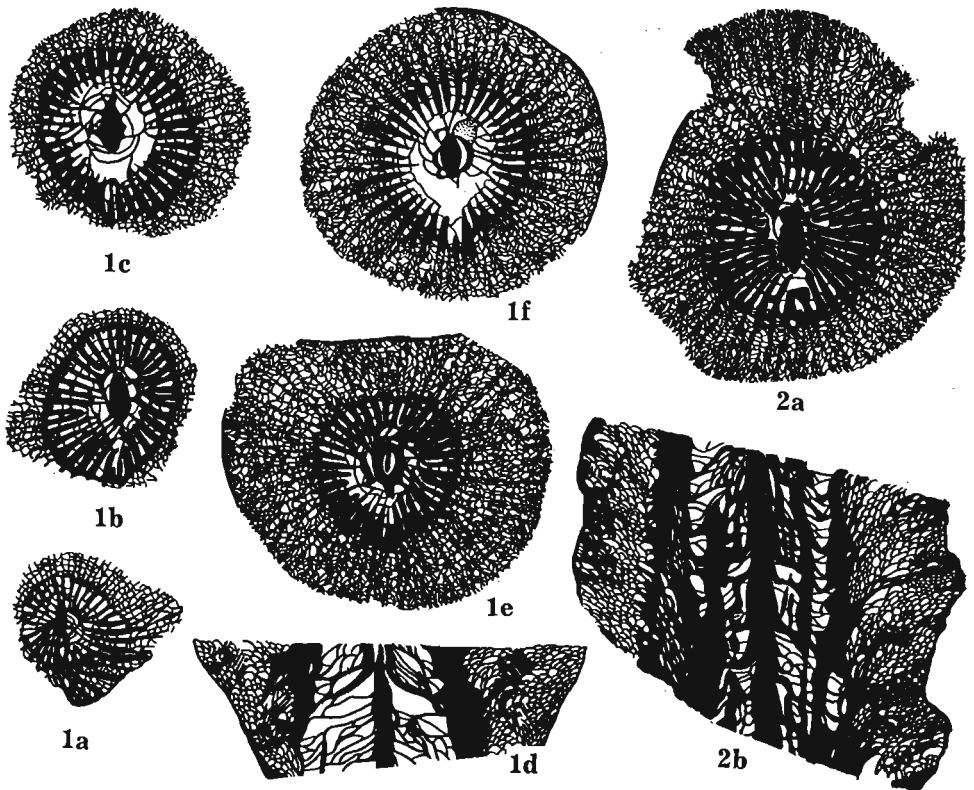


Fig. 23. — *Rozkowskia compacta* n. sp.: 1 a—c successive transverse sections of the neanic stage, 1 e—f successive transverse sections of the ephebic stage, 1d longitudinal section (I. G. No. OS-70/1137), 2a transverse section of the ephebic stage, 2b longitudinal section (I. G. No. OS-70/106, holotype);  $\times 1.8$ .

Longitudinal section (Text-fig. 23<sub>1d,2b</sub>). Dissepiments finer, near epitheca, arranged semicircularly, their inner rows being almost vertical, peripheral horizontal. Tabularium without a separated axial structure. Tabellae reach columella at an angle of about  $60^\circ$ . On the boundary of columella they violently bend upwards and continue already as an integral part of columella. They closely fuse with underlying tabellae and a pri-

mary lamella. Segments of tabellae inside columella are mostly longer than their free parts in tabularium.

*Ontogeny.* — A complete ontogeny could not be studied. The youngest stages available are, however, sufficient to find fundamental similarities and differences as compared with other families of the superfamily Aulophyllicae. The foundation and primary structure of columella are bisepal, the same as in related families (Text-fig. 23<sub>1a</sub>). In addition to cardinal and counter septum, axial ends of a few other major septa reach columella, but the formation of a multilamellar columella has not been found. The separation of columella usually takes place very early. First, cardinal septum becomes shortened, counter septum following immediately. Although the latter reaches columella (Text-fig. 23<sub>1b,c</sub>), the median lines of columella and septum do not join each other. It is already in this stage that a tabular columella, typical of the family, begins to form. At first septa are complete and dissepiments rectangular. The disintegration of septa and complication of dissepimentarium take place at the end of the neanic stage.

*Individual variability.* — Most of the paratypes differ from the holotype in slightly shortened major septa, which do not reach columella. The most important of the remaining differences is a degree of disintegration of septa, which is the highest in a specimen shown in Pl. XI, Fig. 1a-b. Specimen No. I. G. OS-70/1608 (Pl. XI, Fig. 2) differs from the rest of them in the n/d ratio and a narrow dissepimentarium. This is a juvenile form and its assignment to the species described cannot be determined with a complete certainty.

*Remarks.* — *R. vallum* (Hill) is the only species, described formerly, which may be assigned to the genus *Rozkowskia* n. gen. It is similar to the type species described in long major septa and a massive, lenticulate columella, differing from it in a narrow dissepimentarium, complete septa, which do not disintegrate into pseudonaotic structures and very long minor septa deeply penetrating tabularium.

*Occurrence.* — Gałęzice, Holy Cross Mts., Upper Viséan, D<sub>2</sub> (top).

*Rozkowskia parva* n. sp.

(Text-fig. 24; Pl. XI, Figs. 4-7)

*Holotype:* No. Z. Pal. P. Tc-4/2743; Text-fig. 24<sub>2a,b</sub>; Pl. XI, Fig. 4.

*Type locality:* Gałęzice, Holy Cross Mts.

*Type stratum:* Upper Viséan, D<sub>2</sub> (top).

*Derivation of the name:* Lat. *parva* — after small dimensions.

*Diagnosis.* — A *Rozkowskia* with 49×2 septa and 20 mm in diameter; columella very thick, oval; minor septa reaching tabularium; dissepiments mostly rectangular.

*Material.* — About ten solitary corallites, some of them having calices and partly preserved proximal ends.

Dimensions (diameters in mm):

Z. Pal. P. Tc-4	Index of septa n/d
2075	39 : 18 × 16
2204	37 : 13 × 10
2579	48 : 15 × 15
2731	41 : 16 × 13
2743	49 : 20 × 18
<hr/>	
No. I.G. OS-70	
1403	45 : 15 × 15
2015	41 : 15 × 15

*Description.* — Transverse section (Text-fig. 24<sub>2a</sub>; Pl. XI, Figs. 4-7). Major septa short, in tabularium swollen, leaving a relatively wide free axial area. In dissepimentarium they may sometimes be subject to longitudinal split or disintegration into pseudonaotic structures, in particular

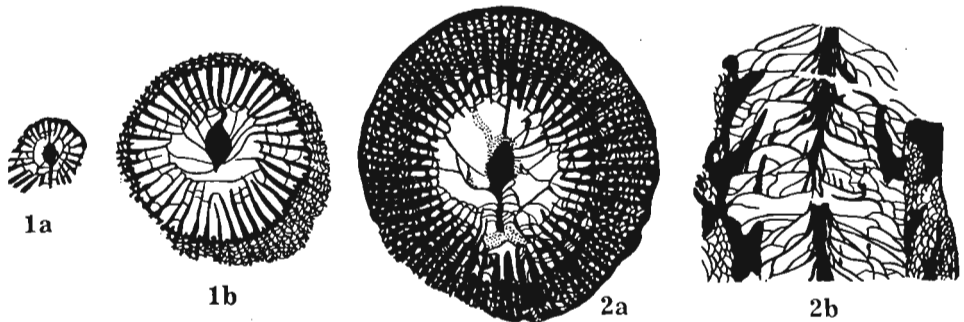


Fig. 24. — *Rozkowskia parva* n. sp.: 1a transverse section of the neanic stage, 1b transverse section, epebic stage (I. G. No. OS-70/2015), 2a transverse section, epebic stage, 2b longitudinal section (Z. Pal. P. No. Tc-4/2743, holotype); ×1.8.

at the end of the ontogenetic development. Minor septa reaching inner wall or slightly penetrating tabularium, in the latter case, then their axial ends become thicker. Cardinal septum and, frequently also, 1-3 adjoining major septa are shortened. Counter septum variable in length, in many sections elongated. Cardinal fossula open, not depressed in dissepimentarium. Columella very thick until the end of development, oval, almond-shaped or lenticulate. Short fragments of septal lamellae are preserved near it in some sections of stages younger ontogenetically. Lamellae do not penetrate columella and are not its component parts. They have been found in few sections, including those of the holotype. Dissepimentarium, occupying a quarter to one sixth of the corallite's diameter, consists of rectangular dissepiments. Their outlines may be deformed by a deposit of stereoplasma and variable thickness of septa. Inner wall mostly strongly thickened.

Longitudinal section (Text-fig. 24<sub>2b</sub>). Dissepiments fine, more or less

uniform in size, convex, arranged in the entire dissepimentarium subvertically. Inner row with walls thickened by stereoplasma. Tabularium composed of finer and more vesicular tabellae in the peripheral and of long tabellae in the axial part, both slightly ascending towards columella. Some periaxial tabellae and most of short tabellae near dissepimentarium are horizontal.

Columella of a thickness depending on the degree of thickening and number of tabellae of which it is composed. On reaching columella, tabellae strongly bend upwards, ascending subvertically. Some parts of the section reveal a mutual overlap of a few very thick tabellae, some others show that primary lamella is joined on each side by only one tabella.

*Ontogeny.* — The youngest ontogenetic stage studied (Text-fig. 24<sub>1a</sub>) indicates a typical development of columella; cardinal and counter septa are still connected with it. The shortening of major septa and a strong thickening of columella, typical of the species, may be found even in this stage.

*Individual variability.* — All the specimens under study may be divided into the following two groups: 1) the holotype and most paratypes almost not different from each other; 2) paratypes shown in Pl. XI, Figs. 6, 7, having a particularly narrow dissepimentarium, very long minor and long tabular segments of major septa. In addition, no pseudonaotic structures have been found in them. These specimens display in the ephebic stage a certain similarity to *Rylstonia*, but their development is quite different.

*Remarks.* — The species described differs from the type species in a considerably greater number of septa with a smaller diameter, narrow, non-complex dissepimentarium, long minor septa and wide free axial area.

*Occurrence.* — Gałęzice, Holy Cross Mts., Upper Viséan, D<sub>2</sub> (top).

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June, 1970*

#### REFERENCES

- BIKOVA, M. S. 1966. Nižnekamennougolnye korally Vostočnogo Kazakstana, 1-214, Alma-Ata.
- CARRUTHERS, R. G. 1913. Lophophyllum and Cyathaxonia: Revision notes on two genera of Carboniferous corals. — *Geol. Mag., N. s.*, 5, 10, 49-56, London.
- CHI, Y. S. 1935. Additional fossil corals from the Weiningian Limestones of Hunan, Yunnan and Kwangsi Provinces, in SW China. — *Palaeont., Sinica, B*, 12, 6, 1-39, Peiping.
- 1938. Permian corals from South-Eastern Yunnan. — *Bull. Geol. Soc. China*, 18, 2, 155-190, Changsha.

- DINGWALL, J. M. 1926. On *Cyathoclesia*, a new genus of Carboniferous coral. — *Quart. J. Geol. Soc.*, **82**, 12–21, London.
- DOBROLJUBOVA, T. A. 1937. Odinočnye korally mjačkovskogo i podolskogo gorizontov srednego karbona Podmoskovnogo bassejna. — *Trudy Paleont. Inst.*, **6**, 3, 1–92, Moskva.
- & KABAKOVITSH, N. V. 1948. Nekotorye predstaviteli Rugosa srednego i verchnego karbona Podmoskovnogo bassejna. — *Ibidem*, **14**, 2, 1–37.
- , — & SAJUTINA, T. A. 1966. Korally nižnego karbona Kuzneckoj kotloviny. — *Ibidem*, **111**, 1–224.
- DUN, W. S. & BENSON, W. N. 1920. The geology and petrology of the Great Serpentine Belt of New South Wales. IX: The geology, paleontology and petrography of the Currabubula District with notes on adjacent regions. 1. Descriptive portion. — *Proc. Linn. Soc. NS Wales*, **45**, 337–374.
- DYBOWSKI, W. N. 1873–1874. Monographie der Zoantharia Sclerodermata Rugosa aus der Silurformation Estlands, Nord-Livlands und der Insel Gotland. — *Arch. Nat. Liv.-, Est.-u. Kurl.*, **1**, 5, 3, 1873, 257–414; 1874, 415–531, Dorpat.
- ETHERIDGE, R. Jr. 1900. Corals from the coral limestone of Lion Creek, Stanwell, near Rockhampton. — *Bull. Geol. Surv. Queensl.*, **12**, 5–24, Brisbane.
- FEDOROWSKI, J. 1965. Lower Permian Tetracoralla of Hornsund, Vestspitsbergen. — *Studia Geol., Pol.*, **17**, 1–173, Warszawa.
- 1967a. The Lower Permian Tetracoralla and Tabulata from Treskelodden, Vestspitsbergen. — *Norsk Polarinst. Skrift.*, **142**, 11–44, Oslo.
- 1967b. A revision of the genus *Ceratophyllum* Gürich, 1896 (Tetracoralla) (Revizja rodzaju *Ceratophyllum* Gürich, 1896 (Tetracoralla). — *Acta Palaeont. Pol.*, **12**, 2, 213–222, Warszawa.
- 1970. Family Aulophyllidae (Tetracoralla) from the Upper Viséan of Sudetes and Holy Cross Mountains (Rodzina Aulophyllidae (Tetracoralla) z górnego wizenu Sudetów i Gór Świętokrzyskich). — *Palaeont. Pol.*, **24**, 1–139, Warszawa.
- FRECH, F. 1885. Die Korallenfauna des Oberdevons in Deutschland. — *Ztschr. Deutsch. Geol. Ges.*, **37**, 21–130, Berlin.
- GARWOOD, E. J. 1913. The Lower Carboniferous succession in the North-West of England. — *Quart. J. Geol. Soc.*, **68**, 449–582, London.
- GEORGE, T. N. 1927. The Carboniferous limestone (Avonian) succession in the Settle District and along the line of Craven Faults. — *Ibidem*, **80**, 184–273.
- GORSKY, I. I. 1932. Korally iz nižnekamennougolnych otloženij Kirgizskoj stepi. — *Trudy Gl. Geol.-Razv. Upravl. SSSR*, **51**, 1–94, Moskva.
- GRABAU, A. W. 1922. Palaeozoic corals of China. 1: Tetraseptata. — *Palaeont. Sinica*, **B**, **2**, 1, 1–76, Peiping.
- 1936. Early Permian fossils of China. 2: Fauna of the Maping limestone of Kwangsi and Kweichow. — *Ibidem*, **8**, 4, 1–441.
- GROOT, G. E. de. 1963. Rugose corals from Northern Palencia (Spain). — *Leidse Geol. Meded.*, **29**, 1–123, Leiden.
- HERITSCH, F. 1935. Rugose Korallen aus dem Karbon der Čechoslovakischen Karpathen. — *Vestn. Geol. Ust. Čsl.*, **10**, 138–154, Praha.
- 1936. Korallen der Moskauer-, Gshel- und Schwagerinen-Stufe der Karnischen Alpen. — *Palaeontographica*, **83A**, 4, 99–162, Stuttgart.
- 1941. „Clisiophyllum” aus dem Oberkarbon. — *Zbl. Min. Geol. Paläont.*, **B**, **5**, 129–138, Stuttgart.
- HILL, D. 1934. The Lower Carboniferous corals of Australia. — *Proc. Roy. Soc. Queensl.*, **45**, 12, 63–115, Brisbane.

- 1938–1941. A monograph on the Carboniferous rugose corals of Scotland. — *Palaeont. Soc.*, **91**, 1–78; **92**, 79–114; **93**, 115–204; **94**, 205–213, London.
- 1956. Rugosa. In: R. C. Moore (ed.), *Treatise on Invertebrate Paleontology*, F233–F327, Kansas.
- HUDSON, R. G. S. & PLATT, M. I. 1927. On the Lower Carboniferous corals. The development of *Rylstonia benecompecta*, gen. et sp. nov. — *Ann. Mag. Nat. Hist.*, **9**, 19, 39–48, London.
- IVANOVSKY, A. B. 1967. Etjudy o rannekamennougolnykh rugozach. 1–92, Moskva.
- JULL, R. K. 1965. Corallum increase in Lithostrotion. — *Palaeontology*, **8**, 2, 204–225, London.
- 1969. The Lower Carboniferous corals of Eastern Australia: A review. 120–139, Canberra.
- KATO, M. 1959. On some Carboniferous corals from the Kitakami Mountains. — *Trans. Proc. Palaeont. Soc. Japan, N. S.*, **33**, 33–43, Tokyo.
- 1963. Fine skeletal structures in Rugosa. — *J. Fac. Sci. Hokkaido Univ.*, **4**, 11, 571–630, Sapporo.
- KOSTIČ-PODGORSKA, V. 1957. Koralska fauna krinoidskih krecnjaka u okolini Prače. — *Zb. Rad. Geol. Inst. „Jovan Zujović“*, **9**, 49–91, Beograd.
- 1958. Fauna i biostratigrafski odnosi paleozojskih tvorevina u okolini Prače. 1–220, Sarajevo.
- LANGENHEIM, R. L. Jr. & TISCHLER, H. 1960. Mississippian and Devonian paleontology and stratigraphy Quartz Spring Area, Inyo County, California. — *Univ. Calif. Publ. Geol. Sci.*, **38**, 2, 89–152, Berkeley—Los Angeles.
- LECOMPTE, M. 1955. Note introductrice à la révision du genre *Lophophyllum* M. E. et J. H. — *Ass. Et. Paléont. Strat. Houil. Publ. Belg.*, **21**, 401–414, Bruxelles.
- M'COY, F. 1849. On some new genera and species of Palaeozoic corals and Foraminifera. — *Ann. Mag. Nat. Hist.*, **2**, 3, 1–20, London.
- MINATO, M. 1951. Some Carboniferous corals from Southwestern Japan. — *Trans. Palaeont. Soc. Japan*, **1**, 1, Tokyo.
- 1955. Japanese Carboniferous and Permian corals. — *J. Fac. Sci. Hokkaido Univ.*, **4**, 9, 2, 1–202, Sapporo.
- PARKINSON, D. 1926. The faunal succession in the Carboniferous limestone and Bowland shales at Clitheroe and Pendle Hill (Lancashire). — *Quart. J. Geol. Soc.*, **82**, 188–249, London.
- PARKS, J. M. Jr. 1951. Corals from the Brazer Formation (Mississippian) of Northern Utah. — *J. Paleont.*, **25**, 2, 171–186, Menasha.
- PICKETT, J. 1966. Lower Carboniferous coral faunas from the New England District of New South Wales. — *Mem. Geol. Surv. NS Wales, Palaeont.*, **15**, 1–38, Sydney.
- RÓZKOWSKA, M. 1969. Famennian tetracoralloid and heterocoralloid fauna from the Holy Cross Mountains, Poland (Fameńskie Tetracoralla i Heterocorallia z Gór Świętokrzyskich). — *Acta Palaeont. Pol.*, **14**, 1, 1–187, Warszawa.
- SALÉE, A. 1913. Le groupe des Clisiophyllidés. — *Mém. Inst. Géol. Louvain*, **1**, 2, 177–293, Louvain.
- SCHOUPPE, A. v. & STACUL, P. 1962. Das Stereoplasma der Pterocorallia, seine Genese und Struktur. — *N. Jb. Geol. Paläont.*, **114**, 24–57, Stuttgart.
- 1966. Morphogenese und Bau des Skelettes der Pterocorallia. — *Palaeontographica*, **11**, 1–186, Stuttgart.
- SMITH, S. 1948. Carboniferous corals from Malaya. In: H. M. Muir-Wood, *Malayan Lower Carboniferous fossils*. Brit. Mus. (Nat. Hist.), 93–107, London.
- STUCKENBERG, A. 1904. Korally i mšanki nižnego otdela srednerusskogo kamenougolnogo izvestnjaka. — *Trudy Geol. Kom.*, **14**, 1–109, St. Peterbourg.



- VASSILJUK, N. P. 1964. Korally zon  $C_{1g}^v$ — $C_{1a}^n$  a Doneckogo bassejna. — *Trudy Inst. Geol. Nauk, Ser. strat. paleont.*, **48**, 60–103, Kiev.
- VAUGHAN, A. 1905. The palaeontological sequence in the Carboniferous limestone of the Bristol Area. — *Quart. J. Geol. Soc.*, **61**, 181–307, London.
- VOJNOVSKY-KRIEGER, K. G. 1956. O vzniknovenii v ontogeneze korallov Cyathoclisia coniseptum (Keys.) struktury tipa Caninia. — *Ježeg. Vses. Paleont. Obšč.*, **15**, 69–75, Moskva.
- VOLKOVA, M. S. 1941. Nižnekamennougolnye korally Centralnogo Kazakstana. — *Mat. Geol. Polezn. Iskop. Kazakst.*, **11**, 1–120, Moskva—Leningrad.
- WEISSERMEL, W. 1935. Zwei Korallen aus dem Karbon Nordspaniens. — *Ztschr. Deutsch. Geol. Ges.*, **4**, 87, 274–278, Berlin.
- YAMAGIWA, N. 1961. The Permo-Carboniferous corals from the Atetsu Plateau and the coral faunas of the same age in the Southwest Japan. — *Mem. Osaka Univ. Lib. Arts Educ.*, **B**, **10**, 77–114, Osaka.
- YÜ, C. C. 1933. Lower Carboniferous corals of China. — *Palaeont. Sinica*, **B**, **12**, **3**, 1–133, Peiping.
- , LIN, I. D. & FAN, Y. N. 1962. Permo-Carboniferous Rugosa of the Chihai Province, Shinchan, China. — *Sci. Art. Commemor.* **10 Ann. Chungchun Geol. Coll.**, 13–35, Peking.

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JERZY FEDOROWSKI

## GÓRNOWIŻEŃSKIE TETRAKORALE Z KOLUMELLĄ Z GÓR ŚWIĘTOKRZYSKICH

### Streszczenie

Przedstawiono wyniki opracowania rodzin Amygdalophyllidae i Rozkowskiidae n. fam. z górnego wizeny Gałęzic (Góry Świętokrzyskie).

Praca obejmuje w większości nowe taksony, co wypływa z faktu, że korale opisywanych tu rodzin były na obszarze Europy bardzo słabo poznane. W części ogólnej przedstawiono filogenezę i mikrostrukturę.

W uwagach o filogenezie uznano ontogenezę za główną cechę łączącą poszczególne rodziny, a budowę kolumelli za podstawową cechę diagnostyczną rodzin. Za najbardziej pierwotną rodzinę spośród Aulophyllicae uznana została rodzina Aulophyllidae. Przedstawiono w jej obrębie przypuszczalne kierunki rozwoju oraz formy wyjściowe dla pozostałych rodzin.

W opracowaniu mikrostruktury przedstawiono rekonstrukcje trabekularnych septów rozszczepionych podłużnie i septów rozpadających się na struktury, dla których zaproponowano nazwę „struktury pseudonaosoidalne”. Zrekonstruowano budowę kolumelli u poszczególnych rodzin i zaproponowano nazwę „lamella pierwotna” dla lamelli powstałej z połączenia septum głównego i przeciwległego.

W części systematycznej opisano 16 gatunków (+2 podgatunki) należące do 4 rodzajów i 2 rodzin.

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ЕЖИ ФЭДОРОВСКИ

ВЕРХНЕВИЗЕЙСКИЕ СТОЛБИКОВЫЕ TETRACORALLA  
ИЗ СВЕНТОКШИСКИХ ГОР (ПОЛЬША)

Резюме

В работе изложены результаты изучения семейств Amygdalophyllidae и Rozkowskiidae n. fam. верхневизейского яруса местности Галэнзице (Свентокшиские Горы).

Работа содержит в основном новые таксоны, так как кораллы описываемых здесь семейств на территории Европы слабо изучены. В общей части представлены проблемы филогенеза и микроструктуры.

В заметках, касающихся филогенеза, онтогенез считается главным признаком, связывающим отдельные семейства, а строение осевой колонны — основным диагностическим признаком семейств. Наиболее примитивным семейством среди Aulophyllicae признается Aulophyllidae, внутри которого представлены предполагаемые направления развития, а также анцестральные формы для остальных семейств.

В главе, посвященной микроструктуре, представлена реконструкция трабекулярных септ, продольно расщепленных, и септ, разделяющихся на структуры, для которых предложено название „псевдонаосоидалные структуры”. Дается реконструкция строения осевой колонны у отдельных семейств и предложено название „первичная пластинка” для пластинок, возникших из соединения главной и противоположной септ.

В систематической части работы описаны 16 видов (+ 2 подвида), принадлежащих к 4 родам и 2 семействам.

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## PLATES

Plate I

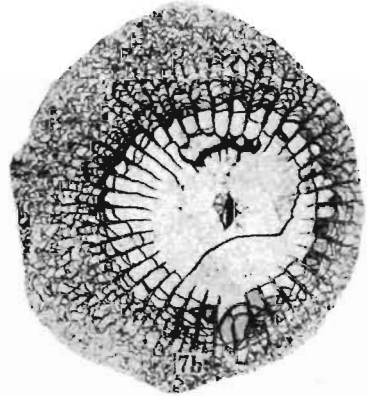
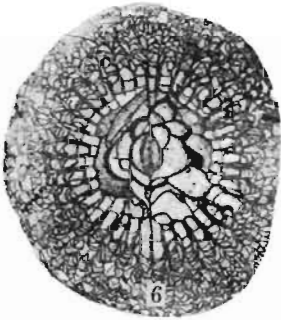
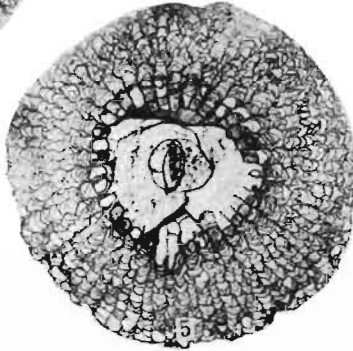
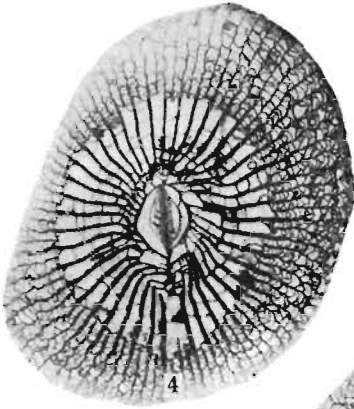
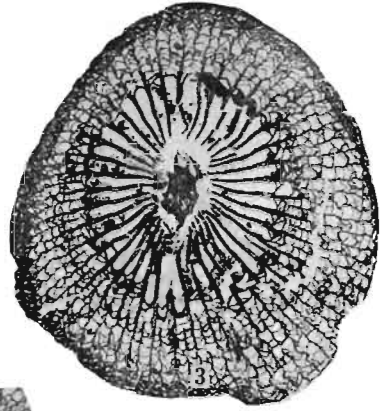
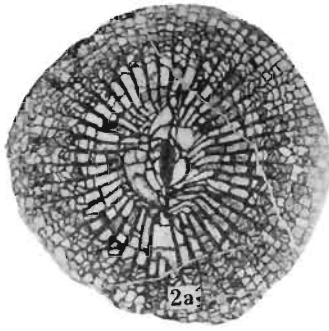
*Carruthersella longiseptata* n. sp.

- Fig. 1. Transverse section (Z. Pal. P. No. Tc-4/2978, holotype).  
*Amygdalophyllum* aff. *inopinatum* (Etheridge, fill, 1900)  
Fig. 2. *a* Transverse section, *b* longitudinal section (I. G. No. OS-70/1051).  
Fig. 3. Transverse section, ephebic stage (I. G. No. OS-70/2318).  
Fig. 4. Transverse section, ephebic stage (I. G. No. OS-70/1201).

*Amygdalophyllum axophylloides* n. sp.

- Fig. 5. Transverse section, ephebic stage (I. G. No. OS-70/990).  
Fig. 6. Transverse section, ephebic stage (I. G. No. OS-70/1048a).  
Fig. 7. *a* Transverse section of the late-neanic stage, *b* transverse section, ephebic stage (I. G. No. OS-70/1177, holotype).  
Fig. 8. Transverse section, ephebic stage (I. G. No. OS-70/1875).

All figures  $\times 2$



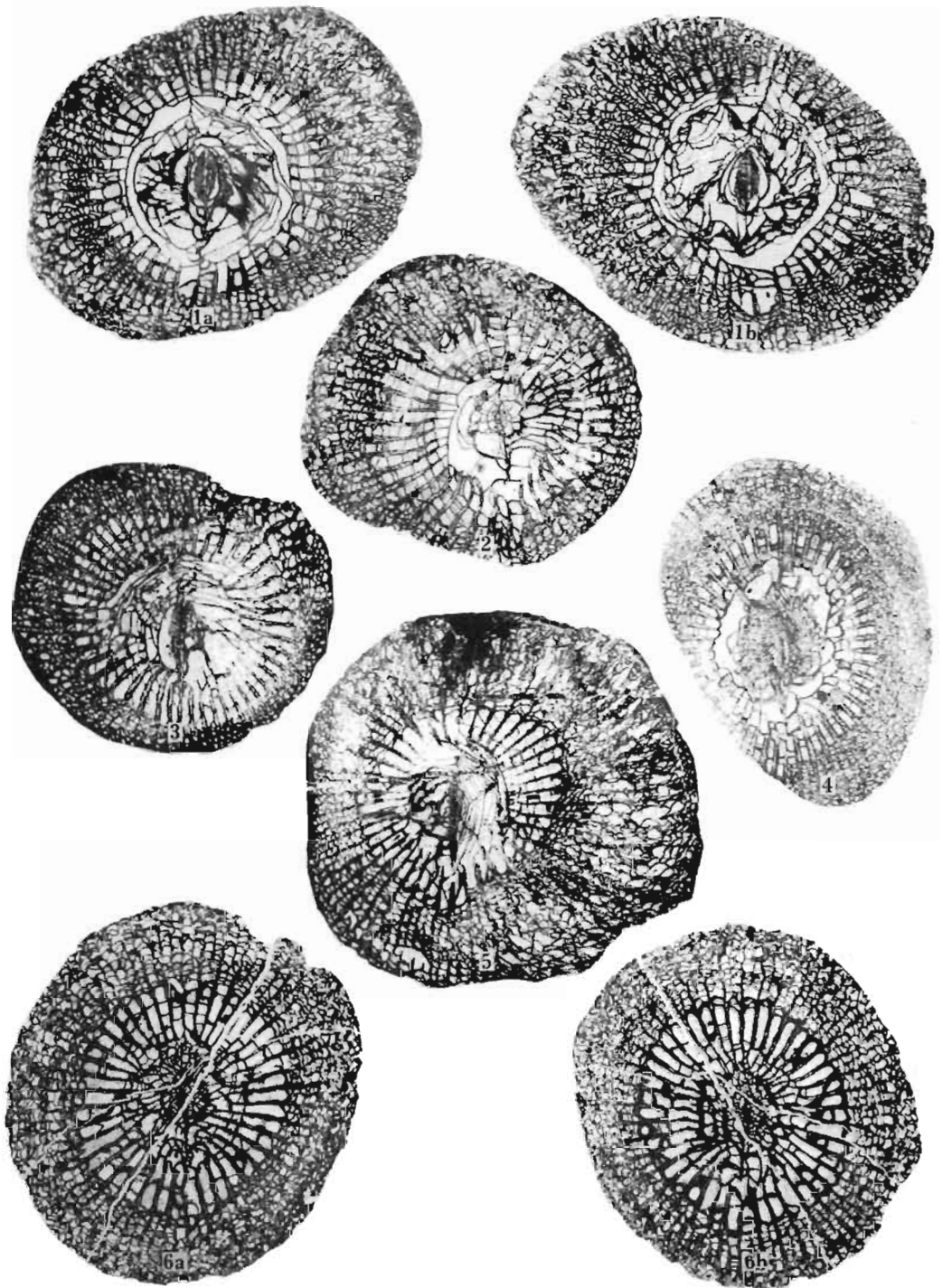


Plate II

*Spirophyllum nexilis* (Vassiljuk, 1964)

- Fig. 1a—b. Transverse sections, ephebic stage (I. G. No. OS-70/1136).  
Fig. 2. Transverse section, ephebic stage (I. G. No. OS-70/1106).  
Fig. 3. Transverse section, ephebic stage (Z. Pal. P. No. Tc-4/2129).  
Fig. 4. Transverse section, ephebic stage (I. G. No. OS-70/1183).  
Fig. 5. Transverse section, ephebic stage (Z. Pal. P. No. Tc-4/2972).

*Spirophyllum histiophylloides* (de Groot, 1963)

- Fig. 6a—b. Transverse sections, ephebic stage,

All figures  $\times 2$



Plate III

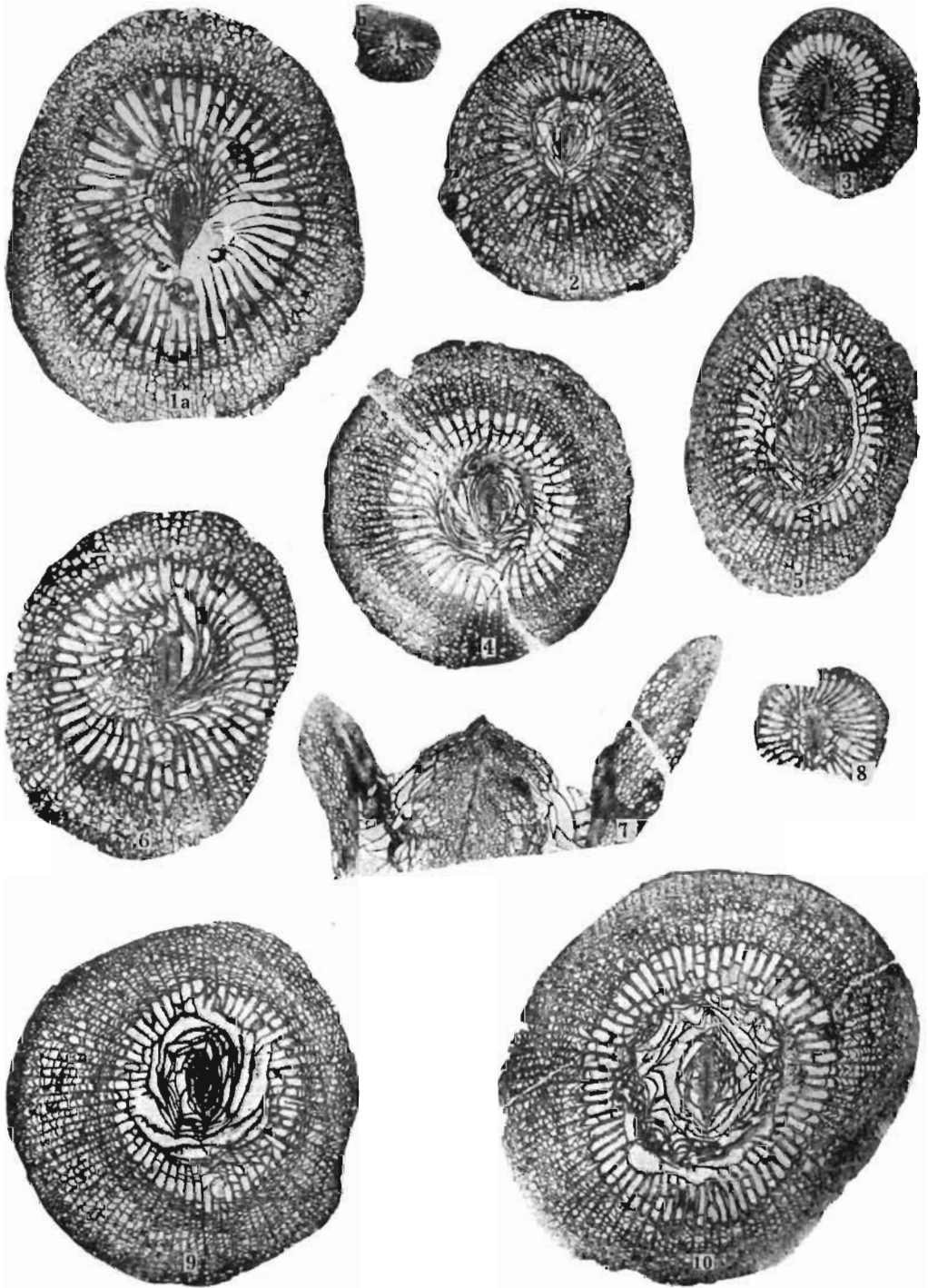
*Spirophyllum histiophylloides* (de Groot, 1963)

- Fig. 1a. Transverse section, ephebic stage, b transverse section, neanic stage (I. G. No. OS-70/238).  
Fig. 2. Transverse section of the early ephebic stage (I. G. No. OS-70/1097).  
*Spirophyllum clisium* n. sp.  
Fig. 3. Transverse section of the early ephebic stage (I. G. No. OS-70/1841).  
Fig. 4. Transverse section, ephebic stage (I. G. No. OS-70/3345).  
Fig. 5. Transverse section, ephebic stage (I. G. No. OS-70/2837).  
Fig. 6. Transverse section, ephebic stage (I. G. No. OS-70/1373).  
Fig. 7. Longitudinal section (I. G. No. OS-70/1374, holotype).

*Spirophyllum sanctaerucense sanctaerucense* n. subsp.

- Fig. 8. Transverse section of the late neanic stage (Z. Pal. P. No. Tc-4/2572).  
Fig. 9. Transverse section, ephebic stage (I. G. No. OS-70/829).  
Fig. 10. Transverse section, ephebic stage (I. G. No. OS-70/1655).

All figures  $\times 2$



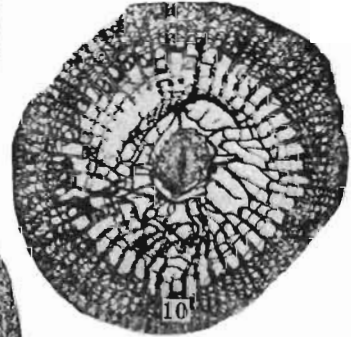
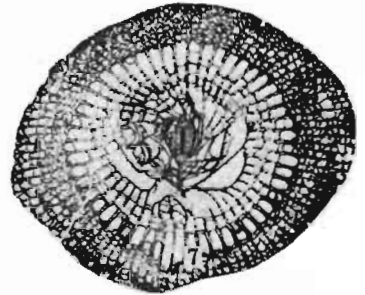
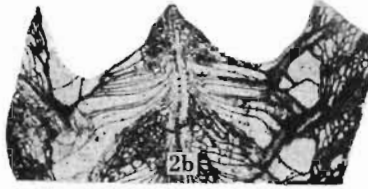
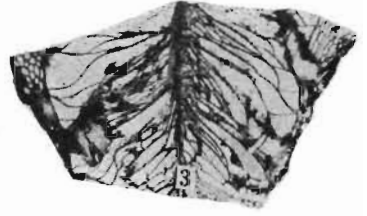
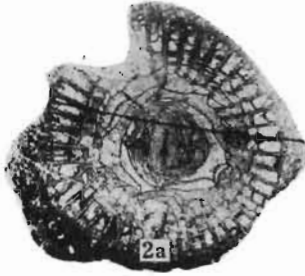


Plate IV

*Spirophyllum sanctaecrucense sanctaecrucense* n. subsp.

- Fig. 1a. Transverse section, ephebic stage, b longitudinal section (I. G. No. OS-70/1057).  
Fig. 2a. Transverse section, ephebic stage, b longitudinal section (I. G. No. OS-70/1443).  
Fig. 3. Longitudinal section (I. G. No. OS-70/1414).  
Fig. 4. Transverse section, ephebic stage (I. G. No. OS-70/1843).  
Fig. 5. Transverse section, ephebic stage (I. G. No. OS-70/1580).  
Fig. 6a. Transverse section, ephebic stage, b longitudinal section (I. G. No. OS-70/1820).  
Fig. 7. Transverse section, ephebic stage (I. G. No. OS-70/1825).  
Fig. 8. Transverse section, ephebic stage (I. G. No. OS-70/1824).  
Fig. 9. Transverse section, ephebic stage (I. G. No. OS-70/1808).  
Fig. 10. Transverse section, ephebic stage (I. G. No. OS-70/1853).  
Fig. 11. Transverse section, late-neanic stage (I. G. No. OS-70/1829).

All figures  $\times 2$

Plate V

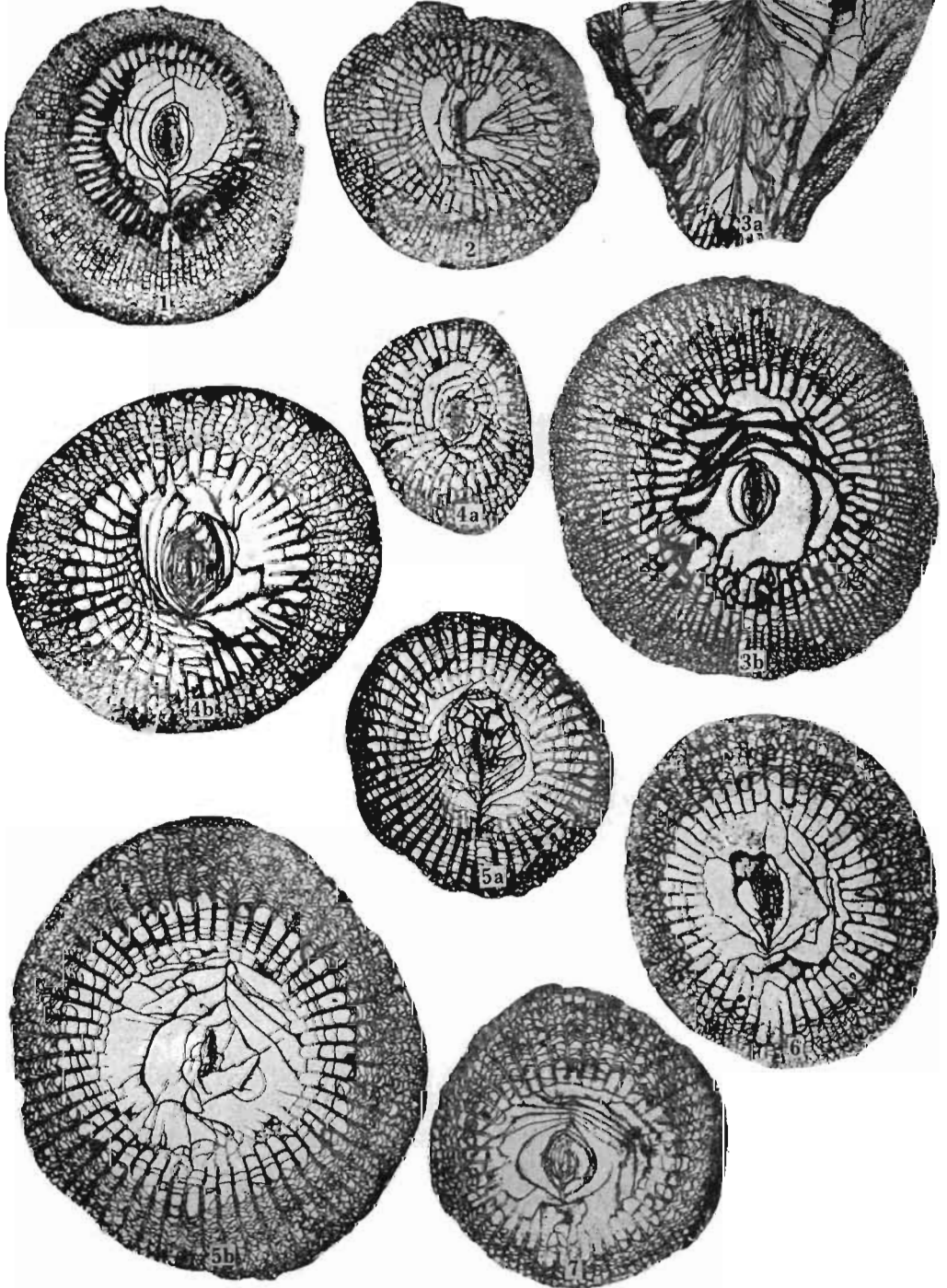
*Spirophyllum sanctaegrucense sanctaegrucense* n. subsp.

- Fig. 1. Transverse section, ephebic stage (I. G. No. OS-70/830).  
Fig. 2. Transverse section, ephebic stage (Z. Pal. P. No. Tc-4/2444).

*Spirophyllum sanctaegrucense pauper* n. subsp.

- Fig. 3a. Longitudinal section, b transverse section, ephebic stage (I. G. No. OS-70/1576).  
Fig. 4a. Transverse section, late-neanic stage, b transverse section, ephebic stage (I. G. No. OS-70/734).  
Fig. 5a. Transverse section, late-neanic stage, b transverse section, ephebic stage (I. G. No. OS-70/2297).  
Fig. 6. Transverse section, ephebic stage (I. G. No. OS-70/1416).  
Fig. 7. Transverse section, ephebic stage (I. G. No. OS-70/1434).

All figures  $\times 2$



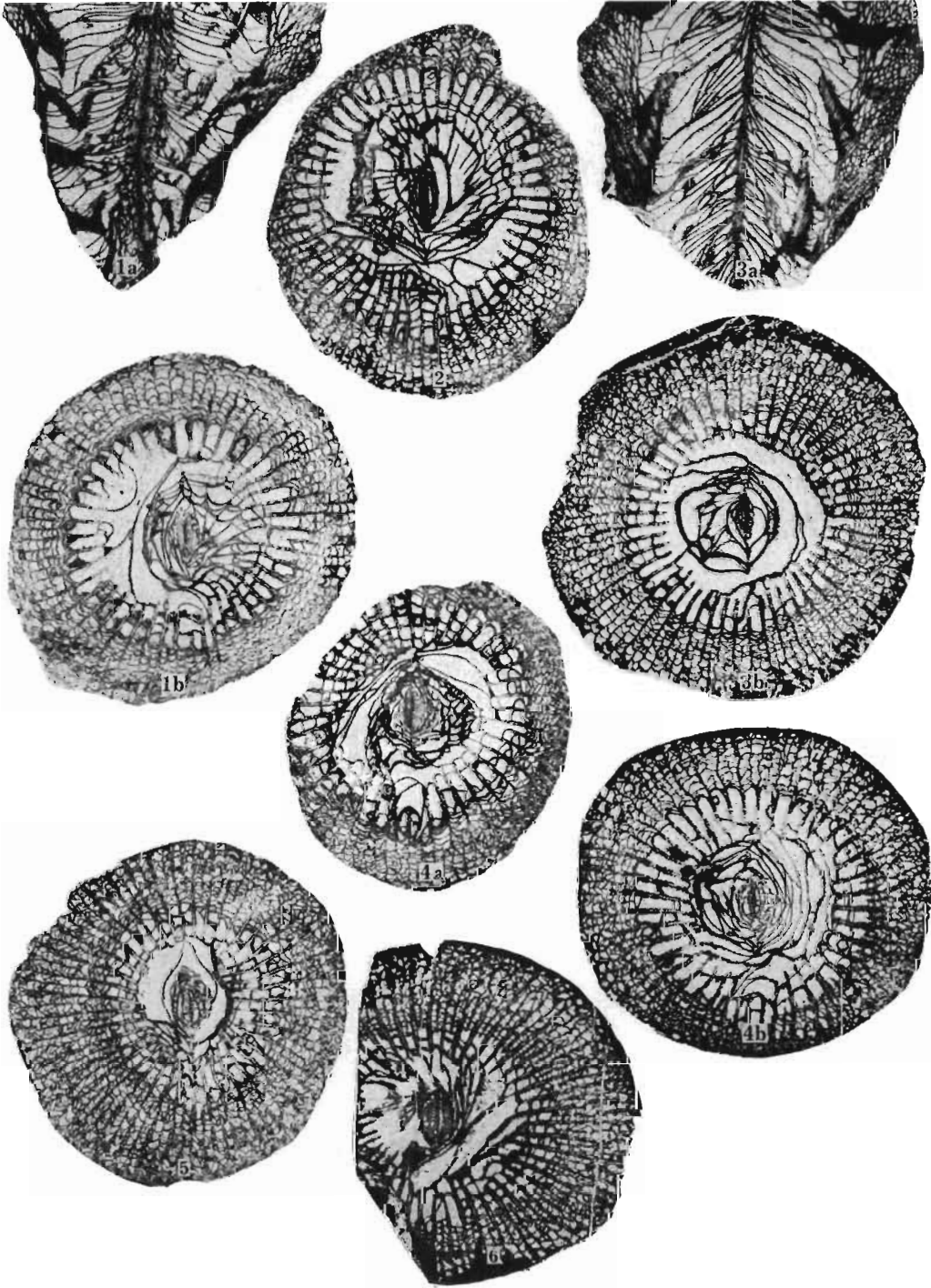


Plate VI

*Spirophyllum sanctaerucense pauper* n. subsp.

- Fig. 1a. Longitudinal section, b transverse section, ephebic stage (I. G. No. OS-70/1809, holotype).  
Fig. 2. Transverse section, ephebic stage (I. G. No. OS-70/1422).  
Fig. 3a. Longitudinal section, b transverse section, ephebic stage (I. G. No. OS-70/1812).  
Fig. 4a. Transverse section, early-ephebic stage, b transverse section, ephebic stage (I. G. No. OS-70/997).  
Fig. 5. Transverse section, ephebic stage (I. G. No. OS-70/1180).  
Fig. 6. Transverse section, ephebic stage (Z. Pal. P. No. Tc-4/2819).

All figures  $\times 2$



Plate VII

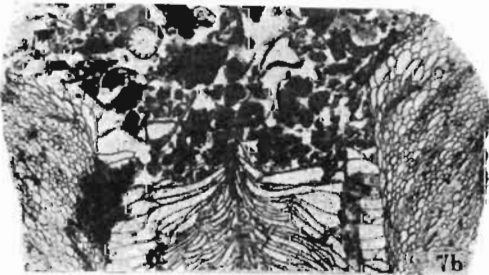
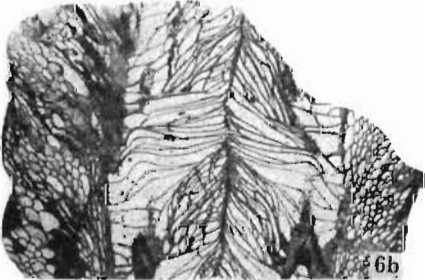
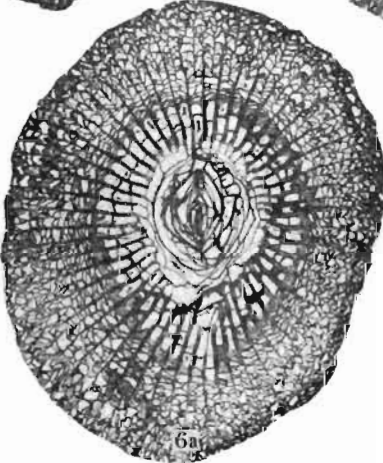
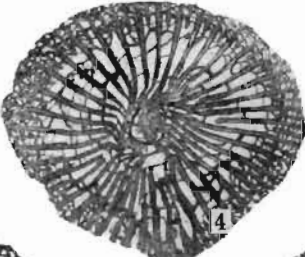
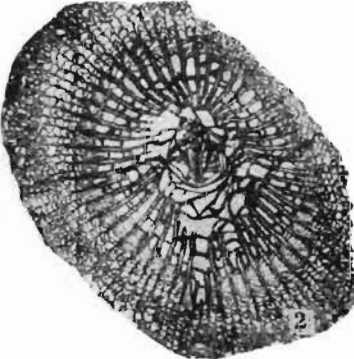
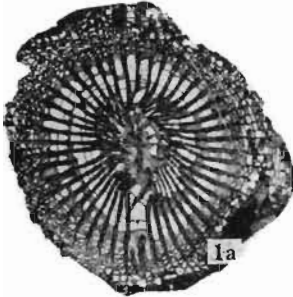
*Spirophyllum densum* n. sp.

- Fig. 1a. Transverse section, early-ephebic stage, b transverse section, ephebic stage (I. G. No. OS-70/2417, holotype).  
Fig. 2. Transverse section, ephebic stage (I. G. No. OS-70/2048).  
Fig. 3. Transverse section, early-ephebic stage (I. G. No. OS-70/1979).  
Fig. 4. Transverse section, early-ephebic stage (I. G. No. OS-70/2419).  
Fig. 5. Transverse section, early-ephebic stage (Z. Pal. P. No. Tc-4/2916).

*Spirophyllum divisum* n. sp.

- Fig. 6a. Transverse section, ephebic stage, b longitudinal section (I. G. No. OS-70/2414).  
Fig. 7a. Transverse section, ephebic stage, b longitudinal section (I. G. No. OS-70/114).

All figures  $\times 2$



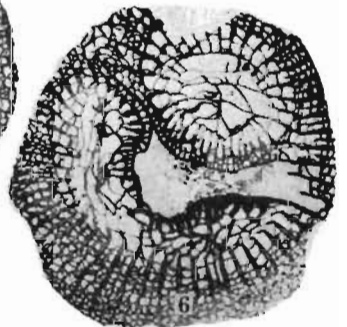
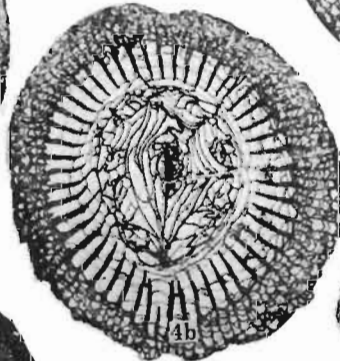
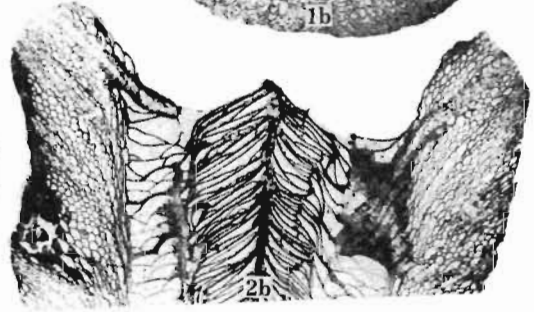
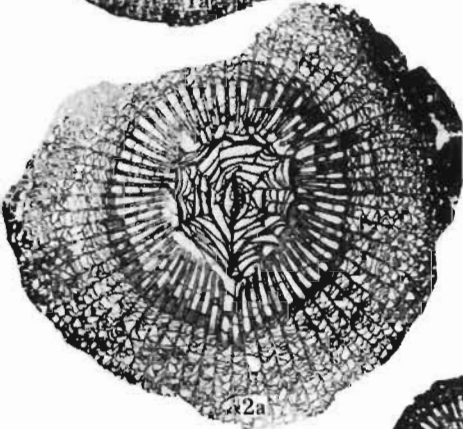
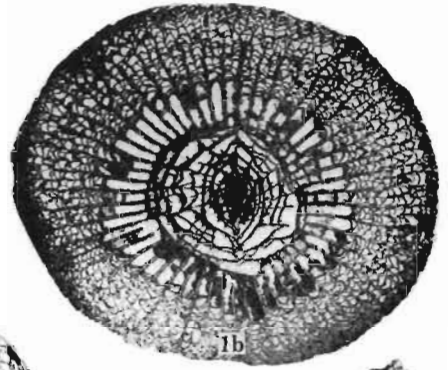
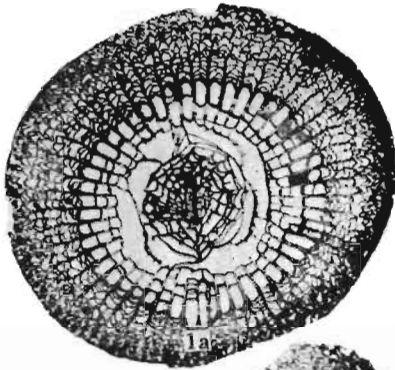


Plate VIII

*Spirophyllum divisum* n. sp.

- Fig. 1a—b. Transverse sections, ephebic stage (I. G. No. OS-70/1970).  
Fig. 2a. Transverse section, ephebic stage, b longitudinal section, c transverse section, neanic stage (I. G. No. OS-70/2045, holotype).  
Fig. 3. Transverse section, ephebic stage (I. G. No. OS-70/2030).  
Fig. 4a—c. Transverse sections, ephebic stage (I. G. No. OS-70/1198).

*Spirophyllum geminum* n. sp.

- Fig. 5. Transverse section across budding part (I. G. No. OS-70/2046).  
Fig. 6. Transverse section across budding part (Z. Pal. P. No. Tc-4/2572).

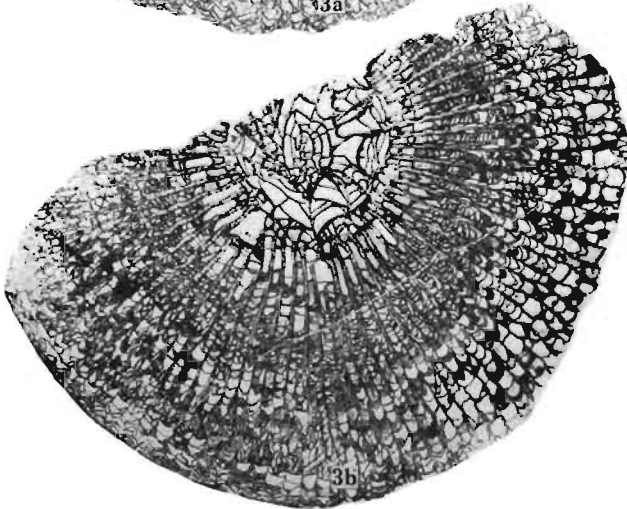
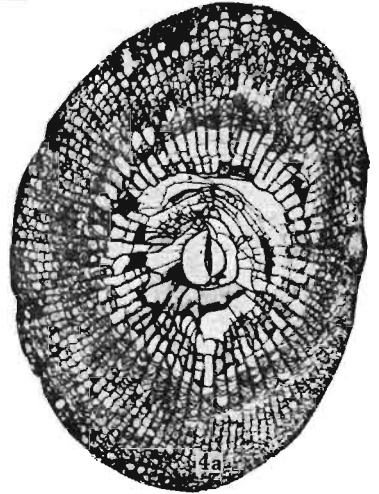
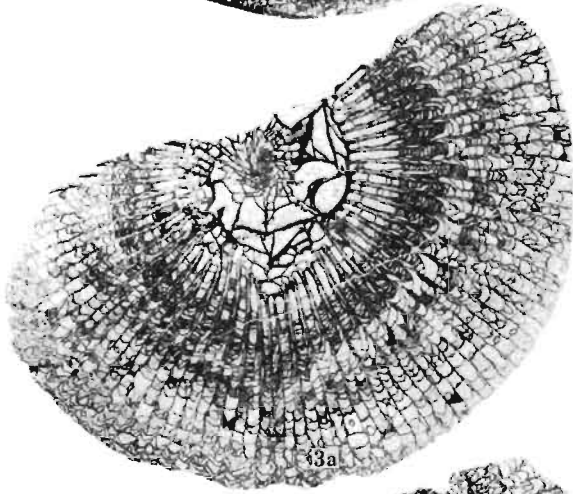
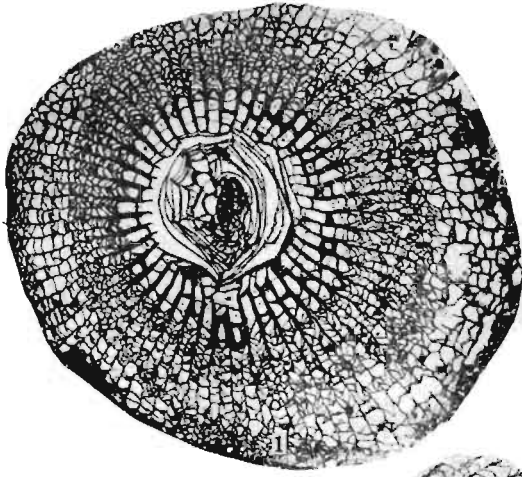
All figures  $\times 2$

Plate IX

*Spirophyllum regulare* n. sp.

- Fig. 1. Transverse section, ephebic stage (I. G. No. OS-70/1238).  
Fig. 2. Transverse section, ephebic stage (I. G. No. OS-70/976).  
Fig. 3a—b. Transverse sections, ephebic stage (I. G. No. OS-70/1006, holotype).  
Fig. 4a—b. Transverse sections, ephebic stage (I. G. No. OS-70/1184).

All figures  $\times 2$



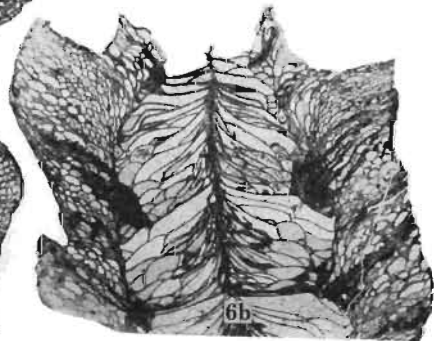
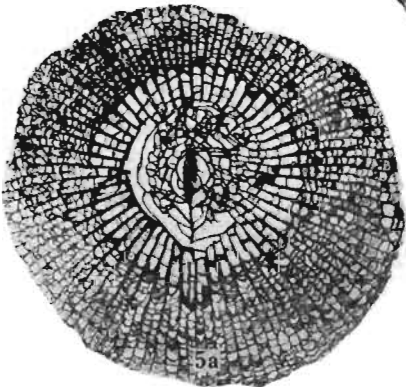
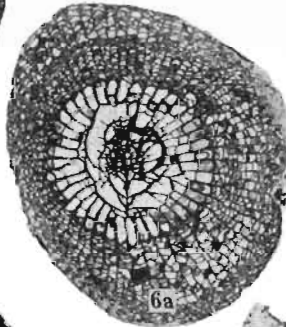
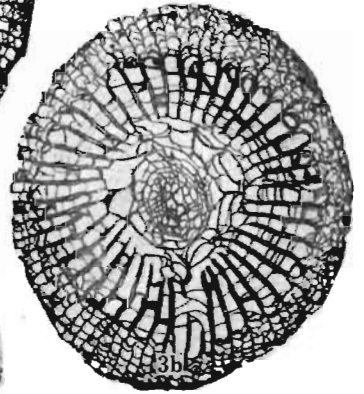
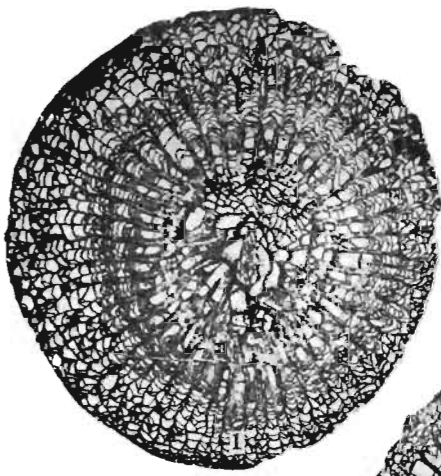


Plate X

*Spirophyllum perditum* n. sp.

- Fig. 1. Transverse section, ephebic stage (I. G. No. OS-70/2205, holotype).  
Fig. 2. Transverse section, ephebic stage (I. G. No. OS-70/2341).  
Fig. 3a—b. Transverse sections, ephebic stage (I. G. No. OS-70/2306).  
Fig. 4. Transverse section, ephebic stage (I. G. No. OS-70/232).

*Spirophyllum regulare* n. sp.

- Fig. 5a. Transverse section, ephebic stage, b transverse section, neanic stage (I. G. No. OS-70/1186).  
Fig. 6a. Transverse section, early-ephebic stage, b longitudinal section (I. G. No. OS-70/1170).

All figures  $\times 2$



Plate XI

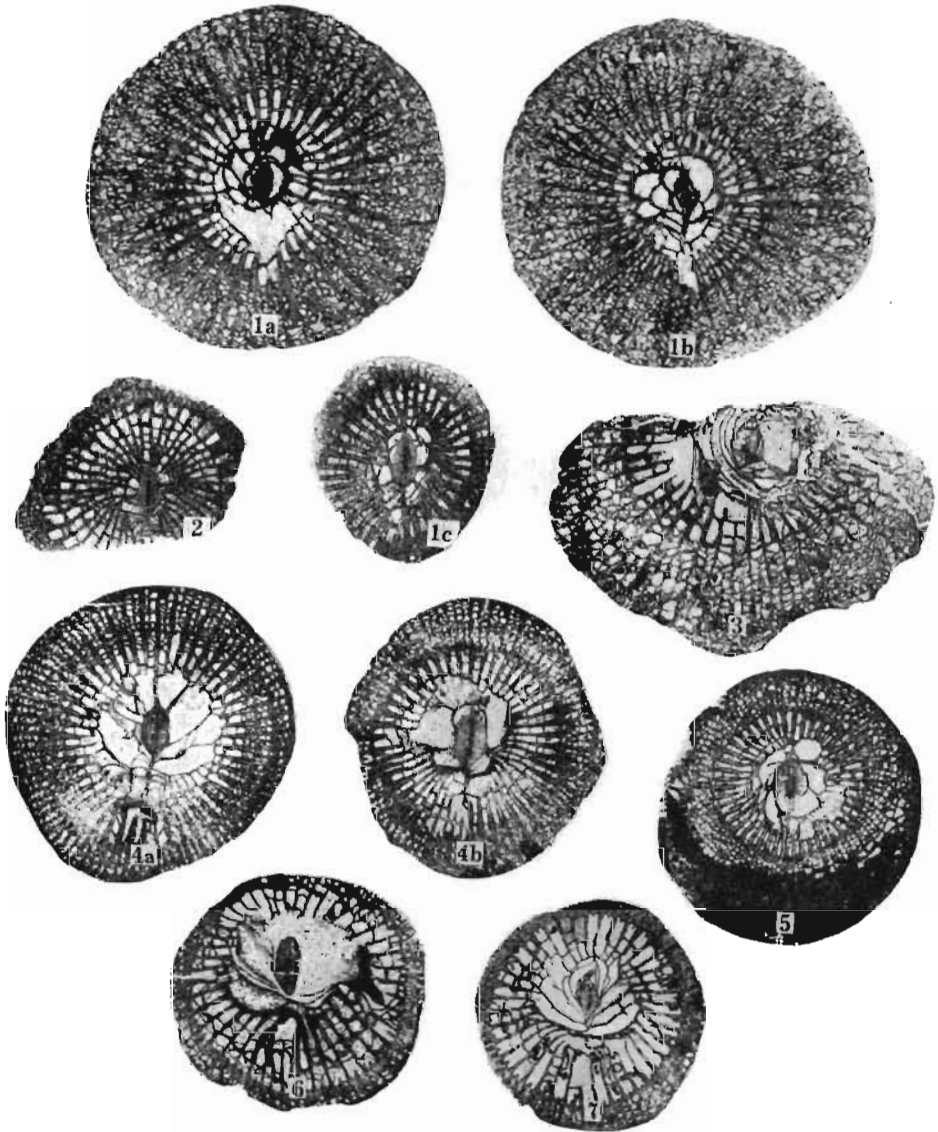
*Rozkowskia compacta* n. sp.

- Fig. 1a—b. Transverse sections, ephebic stage, c transverse section, neanic stage (I. G. No. OS-70/1137).  
Fig. 2. Transverse section, neanic stage (I. G. No. OS-70/1608).  
Fig. 3. Transverse section, ephebic stage (Z. Pal. P. No. Tc-4/2649).

*Rozkowskia parva* n. sp.

- Fig. 4a—b. Transverse sections, ephebic stage (Z. Pal. P. No. Tc-4/2743, holotype).  
Fig. 5. Transverse section, ephebic stage (Z. Pal. P. No. Tc-4/2579).  
Fig. 6. Transverse section, ephebic stage (I. G. Nož OS-70/1403).  
Fig. 7. Transverse section, ephebic stage (I. G. No. OS-70/2015).

All figures  $\times 2$



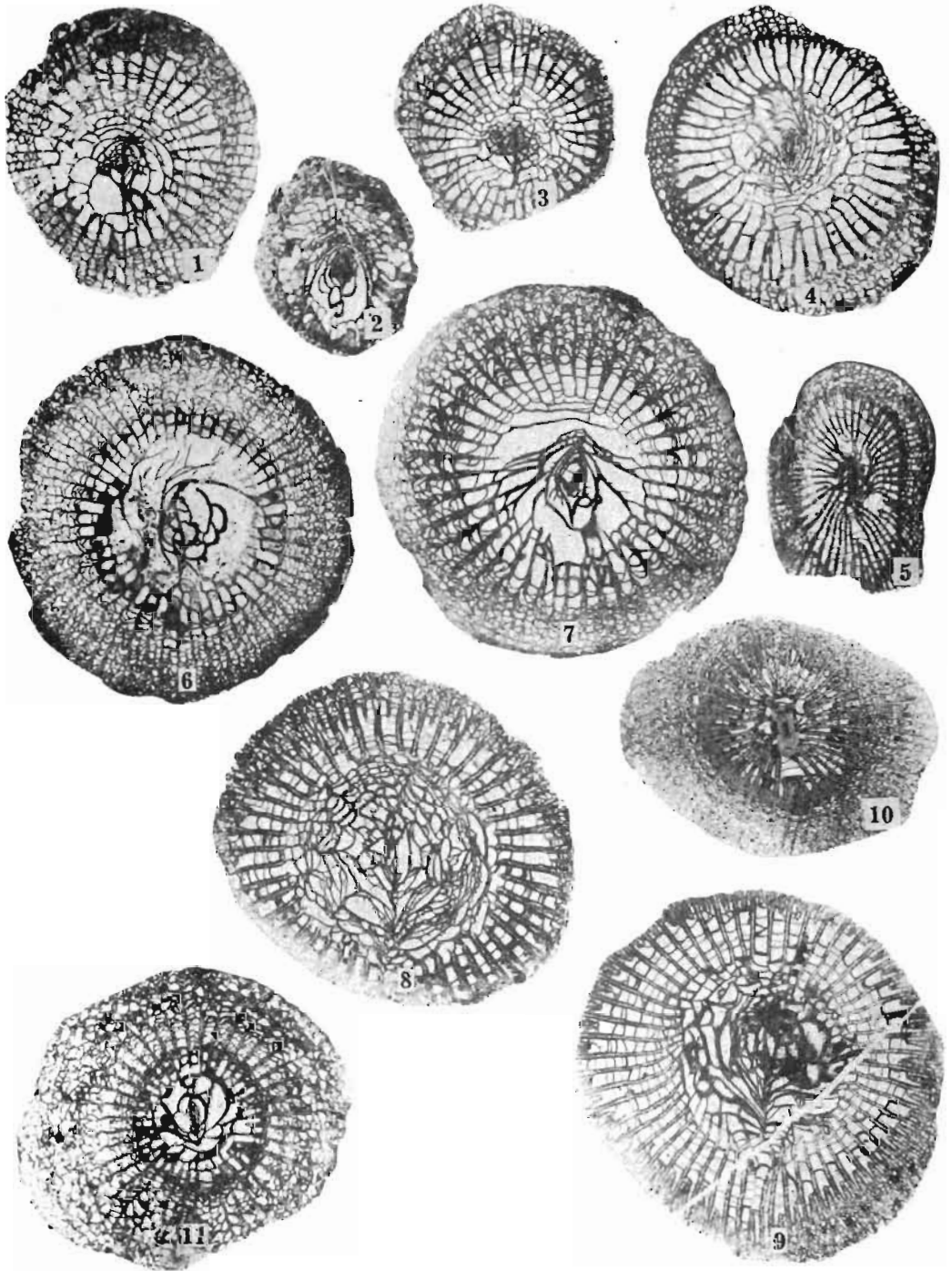


Plate XII

*Spirophyllum nexilis* (Vassiljuk, 1964)

- Fig. 1. Transverse section, early-ephebic stage (I. G. No. OS-70/972).  
Fig. 2. Transverse section, early-ephebic stage (I. G. No. OS-70/951).  
Fig. 3. Transverse section, early-ephebic stage (I. G. No. OS-70/937).

*Spirophyllum clisium* n. sp.

- Fig. 4. Transverse section, ephebic stage (Z. Pal. P. No. Tc-4/2960).  
Fig. 5. Transverse section, early-ephebic stage (Z. Pal. P. No. Tc-4/2985).

*Spirophyllum bifurcatum* n. sp.

- Fig. 6. Transverse section, ephebic stage (I. G. No. OS-70/1425).  
Fig. 7. Transverse section, ephebic stage (I. G. No. OS-70/860).

*Spirophyllum complexum* n. sp.

- Fig. 8. Transverse section, ephebic stage (I. G. No. OS-70/2353, holotype).  
Fig. 9. Transverse section, ephebic stage (I. G. No. OS-70/2309).

*Rozkowskia compacta* n. sp.

- Fig. 10. Transverse section, ephebic stage (I. G. No. OS-70/106, holotype).  
Fig. 11. Transverse section, ephebic stage (I. G. No. OS-70/1050).

All figures  $\times 2$