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PHYLOGENY OF THE NAUTILOIDEA

(FILOGENEZA ŁODZIKÓW)

BY

JERZY DZIK

(WITH 72 TEXT-FIGURES AND 47 PLATES)

WARSZAWA—KRAKÓW 1984

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UPPER PALAEOZOIC RUGOSE CORALS FROM SOUTHWESTERN TEXAS AND ADJACENT AREAS: GAPTANK FORMATION AND WOLFCAMPIAN CORALS. PART I

(PERMO-KARBOŃSKIE KORALOWCE RUGOSA POŁUDNIOWO-ZACHODNIEGO TEKSASU I REGIONÓW OŚCIENNYCH. CZĘŚĆ I)

BY

JERZY FEDOROWSKI

(WITH 87 TEXT-FIGURES AND 43 PLATES)

WARSZAWA—KRAKÓW 1987

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JERZY FEDOROWSKI

UPPER PALAEOZOIC RUGOSE CORALS FROM SOUTHWESTERN TEXAS AND ADJACENT AREAS: GAPTANK FORMATION AND WOLFCAMPIAN CORALS. PART I

FEDOROWSKI J.: Upper Palaeozoic rugose corals from southwestern Texas and adjacent areas: Gaptank Formation and Wolfcampian corals. Part I. Palaeont. Polonica, 48, 3—271, 1987.

The present volume contains descriptions of the major part of the nondissepimentate taxa of the order Stauriida Verrill, 1865 from the Upper Carboniferous and Lowermost Permian Gaptank Formation and from Wolfcampian (Lower Permian). The further subdivision of the Stauriida is not certain. From the 4 families distinguished only one is assigned to the suborder Stereolasmatina Hill, 1981. The systematic position of the families Lindstroemiidae Počta, 1902, Lophophyllidiidae Moore and Jeffords, 1945 and Lophotichiidae Weyer, 1972 is uncertain. Thirteen genera of which: *Assi mulia* and *Falsiamplexus* are new and 9 subgenera, of which *Abeophyllum*, *Alligia*, *Ericina* and *Vacoea* are new, were identified. Among the total number of 61 species described, 33 are new and 10 were left in the open nomenclature. The systematic descriptions were accompanied by introductory considerations on the evolution and paleography of the Permian Rugosa. The table of occurrence of all species described, as well as morphologically-comparative tables of more diversified taxa were also included.

Key words: Rugosa, Permo-Carboniferous, SW Texas, morphology, systematics

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PERMO-KARBOŃSKIE KORALOWCE RUGOSA POŁUDNIOWO-ZACHODNIEGO TEKSASU I REGIONÓW OŚCIENNYCH. CZĘŚĆ I

Streszczenie — Tom niniejszy otwiera monograficzne opracowanie koralowców Rugosa z południowo-zachodniego Teksasu i regionów ościennych. Ogólne rozważania na temat systematyki i ewolucji permskich Rugosa oraz rekonstrukcje paleogeograficzne i paleoekologiczne, a także zonacja stratygraficzna oparta na opracowanej faunie koralowej, będą opublikowane w ostatnim tomie monografii. Niektóre elementy tych zagadnień znalazły się już jednak w uwagach do poszczególnych taksonów opracowanych w niniejszym tomie. Podstawowych informacji na temat stratygrafii dostarcza tabela występowania gatunków. Dla ułatwienia porównań w obrębie bardziej zróżnicowanych taksonów zamieszczono również tabele morfologiczno-porównawcze.

Opisano większą część korali Rugosa bez dissepimentów z formacji Gaptank (górny karbon — najniższy perm) i z dolnego permu (Wolfcampian). Zostały one włączone do rzędu Stauriida Verrill, 1865. Spośród 4 wydzielonych rodzin tylko rodzina Hapsiphyllidae Grabau, 1928 z podrodzinami Hapsiphyllinae Grabau, 1928 i Antiphyllinae Illina, 1970 zostały włączone do podrzędu Stereolasmatina Hill, 1981. Pozycja systematyczna rodzin Lindstroemiidae Počta, 1902, Lophophyllidiidae Moore i Jeffords, 1945 i Lophotichiidae Weyer, 1972 jest niepewna i pozostała chwilowo otwarta. Wyodrębniono 13 rodzajów w tym 2 nowe: *Assmulia* i *Falsiamplexus* z 9 podrodzajami w tym 4 nowe: *Abeophyllum, Alligia, Ercina, Vacoea.* Spośród 61 opisanych w pracy gatunków 33 są nowe, a 10 pozostawiono w nomenklaturze otwartej. Wydzielono również 5 nowych podgatunków.

CONTENTS

INTRODUCTION

The present paper begins a monographic description of rugose coral faunas from the Upper Pennsylvanian Gaptank Formation and from marine Permian strata of SW. Texas and some adjacent areas. The study was begun in 1972 during my year-long stay in Washington, D. C. as a Smithsonian Institution Fellow. Preliminary inspection of the collection made clear that complete study of it would require a long time, hence the collection was sent to Poznań, Poland in 1974 and still remains the main subject of my studies. Papers on some special problems preceded this volume (FEDOROWSKI 1974, 1978, 1979, 1980).

The coral fauna studied is almost entirely new, but it exhibits several similarities or relations to other faunas of the world. Some of these faunas were inadequately described and/or poorly illustrated, making these taxa useless without re-examination. Some details of other faunas required verification of the original material. Accordingly, I visited several museums and geology departments of universities and borrowed collections when the visit was impossible. The visited museums were as follows: National Museum of Natural History, Washington, D. C.; British Museum (Natural History), London; Sedgwick Museum, Cambridge; Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussel; Paleontologisk Museum, Oslo; VSEGEI Museum, Leningrad; Museum of Paleontology of the Academy of Sciences of the USSR. Departments of Geology Museums of the Universities in Bristol, Edinburgh, Liège, Münster, Leningrad, Donets and Kiev.

The following coral collections or parts of collections were re-examined prior to writing this volume: American collections: WORTHEN (1875), GIRTY (1908, 1912, 1915), MORGAN (1924), HERITSCH (1936*a*), MOORE and JEFFORDS (1941, 1945), JEFFORDS (1942, 1943, 1947), EASTON (1943, 1945, 1958, 1962), ROSS and ROSS (1962, 1963), HOARE (1964), SANDO (1961, 1963, 1965*a*, *b*, 1969*a*, *b*, 1983 and other), ROWETT and SUTHERLAND (1964), ROWETT (1969), ROWETT and TIMMER (1973), STEVENS (1967), ARMSTRONG (1972). Soviet Union collections: EICHWALD (1861), STUCKENBERG (1895, 1904, 1905), LISSITZYN (1925), SOSHKINA (1925, 1928, 1932, 1936), SOSHKINA, DOBROLJUBOVA and PORFIRIEV (1941), TOLMACHOFF (1924, 1931), FOMICHEV (1931, 1953*a*, *b*), GORSKY (1932, 1935, 1951), VOJNOVSKY-KRIEGER (1934), DOBROLJUBOVA (1936, 1937, 1940, 1952, 1958, 1970 and other), DOBROLJUBOVA and KABAKOVICH (1948, 1966), KABAKOVICH (1937, 1952), VASSILJUK (1960, 1964), ILINA (1965, 1970), KOSYREVA (1973, 1974, 1976, 1978*a*, *b*). Other collections: SALTER (1855), de KONINCK (1872), TOULA (1875), HERITSCH (1936*c*), PADGET (1954), SCHOUPPÉ and STACUL (1955, 1959), HARKER and THORSTEINSSON (1960), TIDTEN (1972), FLÜGEL (1973), POTY (1981).

The scheme of the whole monograph was dictated by circumstances rather than resulting from conscious planning. The collection studied is not only enormous, but also consists of numerous variable taxa represented by specifically identifiable specimens, description of which required application of laborious techniques (see below). Because of these factors, the time span between the first taxa systematically described and recently described ones is eight years, and there is still a great deal of the collection awaiting final study. This will require another several years of work and some more years to wait for a publication of such a paper in a few volumes. Some parts of the monograph may be outdated, as some taxa name lost their priority owing to the long period of study. Because of these circumstances, I diverged from the classic format of this kind of a paper, i. e. from publication in systematic order, and decided to divide the whole monograph in accordance with stratigraphic levels. This will surely cause many repetitions as far as higher taxa are concerned, but rather few on a species level.

The present volume contains descriptions of majority of the non-dissepimentate solitary corals from the Upper Pennsylvanian Gaptank Formation and from the Wolfcampian strata. Descriptions of the solitary non-dissepimentate corals of which was no room in this volume, as well as the solitary dissepimentate corals and the colonial corals of the same age, will be published in the second volume.

It is impossible to judge at present how many further volumes will be published. The monograph will be concluded with general considerations containing the following and other problems: discussion of the foundation and development of the septal apparatus, based on comparison of the morphology of external surfaces of corallites, morphology of calices and serial sectioning technique; the microstructure of septa; the morphology of calices with special attention to the calice floor as the area responsible for final modelling of the coral skeletons; the morphology of calices as a function of extrinsic factors and genetic determination; ecological considerations, supported by common commensals, epibionts, and boring organisms; some problems of palaeogeography; an attempt to establish coral biozones and intercontinental correlations based on corals. All these and more specific topics are parallel to the investigations reflected in the systematic descriptions of taxa. The systematic volumes of the monograph will thus contain only necessary data on stratigraphic positions of the fauna described with special reference to COOPER and GRANT (1972—1977).

Historical. — Previous works on the Permo-Carboniferous corals from Texas are very restricted in number. Some of them contain description of only one or very few species of corals or only illustrations (e. g. PLUMMER and MOORE 1921). The first paper was that of Shumard (1859). Unfortunately, his collection was lost in fire and there is rather little chance to determine his taxa with certainty. The following papers are these of CUMMINS (1891), GIRTY (1908, 1912), HERITSCH (1936*a*, 1936*b*, 1937), OKULITCH and ALBRITTON (1937), MOORE and JEFFORDS (1941, 1945), JEFFORDS (1942, 1947, 1955), WELLS (1944), NEWELL *et al.* (1953), and Ross and Roos (1962, 1963). In most of the papers listed, Pennsylvanian taxa are described (29 species + 10 species in common with other regions). Nineteen Permian species are described from Texas (among these 1 or 2 continued to occur from the Pennsylvanian) and 5 more species from Kansas and Oklahoma. Some corals mentioned and illustrated by NEWELL *et al.* (1953) may belong to new unnamed taxa.

Descriptions of the Pennsylvanian corals are much more numerous both in number of papers and number of taxa. There are over 40 papers by more than 20 authors. Some of these are mentioned above. Amongst others those of ROWETT and SUTHERLAND (1964) and COCKE (1966, 1969, 1970) provide much new information concerning corals. Several other papers, cited in remarks to particular taxa, are not mentioned here. Many species, especially those described during the nineteen century (e. g. MEEK and WORTHEN 1860; WHITE and WHITEFIELD 1862; WHITE 1875, 1877; WORTHEN 1890) need revision prior to being accepted for modern systematics.

More than 130 Pennsylvanian species have been described from Texas, New Mexico, Oklahoma and Kansas. Many of these taxa were described as species of *Lophophyllidium* and its synonyms. Quite a few of these species are probably synonyms. The second largest group is the dissepimentate solitary rugosans. Other taxa are not numerous. Such a composition is partly incidental, reflecting the main field of interest of the three more productive students Drs. R. C. MOORE, R. M. JEFFORDS and J. M. COCKE), and partly reflects the real composition of the fauna.

Material and methods. — The coral collection here under study is part of a giant collection of Permo-Carboniferous fossils from SW. Texas and adjacent areas made during many years by Dr. G. A. COOPER and his co-workers. The assembly of the collection and methods of preparation are described in detail by COOPER and GRANT (1972).

The collection is the property of the Smithsonian Institution, Washington, D. C. and will be housed in the National Museum of Natural History, Smithsonian Institution. By kind agreement of Dr. G. A. COOPER, individual, non-illustrated specimens of particular species will be left at the Department of Geology, A. MICKIEWICZ University in Poznań, Poland to form a comparative collection. They will be accompanied by duplicate acetate peels of the illustrated specimens where possible.

The rugose corals in the collection consist of many thousands of variably preserved specimens. Almost all of them, except for most from Gaptank Formation and sporadic other samples, were chemically etched from the rocks. The hydrochloric acid applied in this process was in several instances too strong for the rugose coral skeletons. Such corals are extremely fragile and not always available for more detailed studies. Some specimens, perfectly silicified peripherally, were either diagenetically broken or perforated by boring organisms, so that their calcitic interiors were exposed to etching and thus partly or entirely removed. Some of such corals are preserved as empty shells where external characters are sometimes insufficient even for family identification because of homeomorphs, common in the collection. Some specimens were completely or partly impregnated with silica internally. Peripherally well preserved corallites may in extreme instances be structureless, internally glassy artifacts. Whole specimens of the latter kind are not numerous in the collection, but morphology of proximal ends was quite often destroyed by amorphous silica, or less commonly by small quartz crystals. Fortunately, most of the specimens are well preserved, sometimes almost ideal ones, with the ontogenetically youngest part of a tip, a complete calice and the external surface, sometimes with epibionts, exposed.

The state of preservation as described provides a good opportunity but also several difficulties to the student. It was possible to built the ontogenetic series of corallites starting from the almost aseptal cups and ending with the fully mature specimens and to compare such series with the morphology of individual specimens investigated in serial sections. On the other hand, it was necessary to frame many specimens with epoxy resin. The silicified tips made the peel technique often useless and early ontogeny was at the beginning studied on broken tips. A string cutter making possible preparation of three thin sections from one millimeter of thickness, was obtained only some years ago.

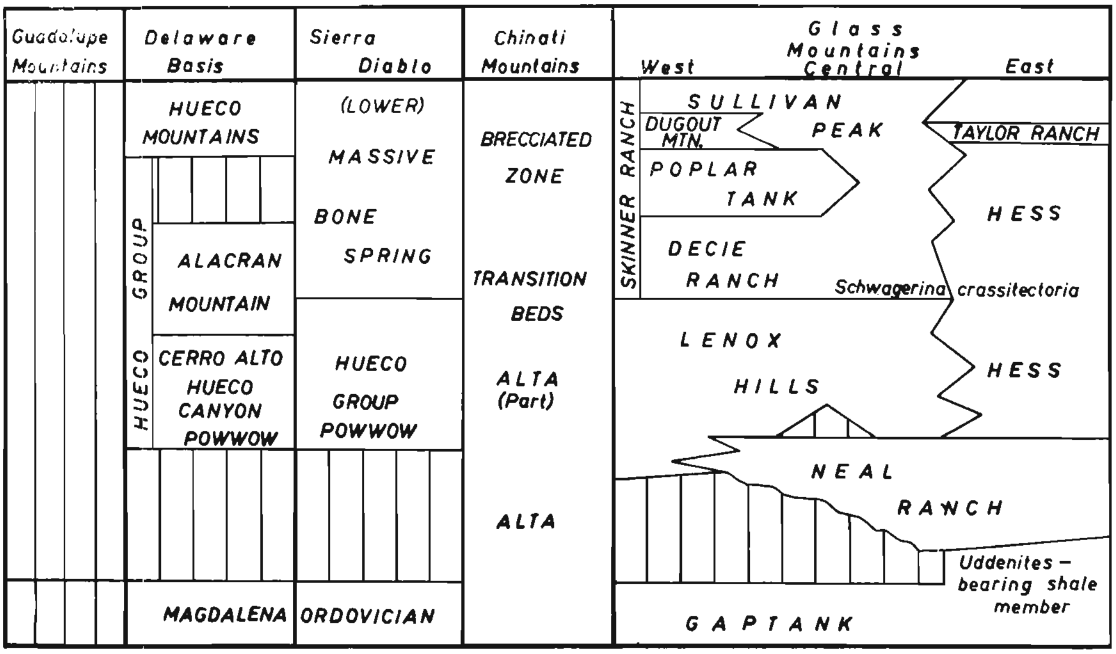
Photographs of thin sections were not always adequately clear due to a complete or partial saturation of many specimens with silica. It was thus necessary to draw on the photographs, which afterwards were bleached with Farmer's solution. These drawings are presented as text-figures. Some proximal ends were drawn using an Abbe's apparatus. Most of the specimens studied were photographed prior to being sectioned. Thus, the part of the collection studied includes an almost complete photographic documentation.

Geological setting. — Detailed discussion of stratigraphic ranges of individual taxa, as well as coral biozonation will be presented in the volume of general considerations. In the systematic volumes, starting from this one, the number of specimens occurring in individual localities and the stratigraphic position of the locality is indicated for each species separately. Parts of the stratigraphic table taken from COOPER and GRANT (1972) will be published in each volume for easier location of individual formations and members in the stratigraphic column. It will be accompanied by the table of occurrence of all taxa described in the given volume. The Gaptank Formation, although containing strata from the Missourian to uppermost Virgilian (? lowermost Wolfcampian) is not subdivided (pl. 1). In each case the finest possible stratigraphic position was indicated in the "Occurrence" for each species and in the table of occurrence (Table 2).

The *Uddenites* bearing member of the Gaptank Formation is most controversial as far as its stratigraphic position is concerned. Although generally accepted by the fusulinid students as uppermost Virgilian it contains brachiopods that indicate a lowermost Permian age (COOPER and GRANT 1972, 1977). Corals of this member also suggest a primitive Permian phase of evolution. Carboniferous taxa dominate in the fauna, but there are several species occurring both in the member discussed and in the Neal Ranch Formation (e. g. *Allotropiochisma* (*Alligia*) *flabellum* sp. n., *A.* (*Abeophyllum*) *texanum* sp. n., ? *Euryphyllum robustum* sp. n., *Actinophrentis columnare* n. sp., *Bradyphyllum counterseptatum* sp. n., *B. postwannense* sp. n., *Monophyllum*

Table 1

WOLFCAMPIAN STRATIGRAPHY (after Cooper & Grant, 1972)



cassum sp. n.). Also *Assimulia* (*Assimulia*) *uddenitense* sp. n., the most primitive representative of this very common Permian genus appeared at this stratigraphic level. I thus accept the *Uddenites* bearing member of the Gaptank Formation as the beginning of Permian phase of evolution of the rugose corals.

A second disagreement concerns the lower part of the Bone Spring Formation. The coral-fauna of this age is almost entirely Wolfcampian and very often identical with that of the Skinner Ranch Formation, which also supports conclusions based on brachiopods. Other correlations are not controversial and need not be discussed here.

Abbreviations used

AMNH — American Museum of Natural History, New York.

n:d ratio — number of septa (n) to diameter of corallite (d) ratio.

USNM — United States National Museum of Natural History, Washington.

USNM 700, 700a, etc. — numbers of the United States National Museum of Natural History localities. For detailed explanations see Cooper and Grant (1972, 1977).

USGS — United States Geological Survey.

VSEGEI — The All-Union Order of Lenin Scientific Research Institute of Geology, Leningrad (Всесоюзный Ордена Ленина Научно-Исследовательский Геологический Институт).

Acknowledgements. — Before acknowledging my friends and colleagues, whose help contributed greatly to completing the present and the following volumes of this monograph, I would like to pay a tribute to the memory of the late Professor Maria Różkowska, my teacher, whose deep understanding of corals, enthusiasm for science and humanitarian behaviour remain a paragon to me.

I am especially indebted and my warmest thanks are due to Dr. G. Arthur Cooper, Smithsonian Institution Emeritus, for offering me his priceless collection for the study and for greatly improving my understanding of American Permo-Carboniferous strata. Dr. R. E. Grant, former Chairman of the Department of Paleobiology, Smithsonian Institution, is warmly acknowledged for his help in that improvement and for organizing, together with Dr. Cooper, a long field trip to the western interior, the Glass Mountains in particular, in order to show me the classic geology of that area. My truly

TABLE 2a

Stratigraphic distribution of coral species

Name of species / Horizon / Locality	Gaptank Formation																Neal Ranch Formation																U.L.H. Fm.
	undivided							M.? Miss.		Virg.	Uddenites bearing member																						
	USNM 704d	USNM 704w	USNM 705ca	USNM 705e	USNM 705f	USNM 705j	USNM 708n	USNM 700	USNM 700a	USNM 700q	701 701e	USNM 701p	USNM 701t	USNM 701u	USNM 701v	USNM 702q	USNM 701	USNM 701a3	USNM 701c	USNM 701d	USNM 701q	USNM 701h	USNM 701k	USNM 701l	USNM 702h	USNM 702t	USNM 704v	USNM 706x	USNM 712z	USNM 721g	USNM 727e	USNM 742c	USNM 716r
Allotropiochisma (? Allotropiochisma) uddenitense sp. n.												2																					
Allotropiochisma (Alligia) flabellum sp. n.												9							1									2					
Allotropiochisma (Abeophyllum) texanum sp. n.												9																	1?				
?Euryphyllum robustum sp. n.												2					2											4					
Actinophrentis columnare sp. n.																	3		1	1						1		1					
Bradyphyllum postwannense sp. n.				1								3															1						
counterseptatum sp. n.				1								11				1	1																
sp. 1												1																					
?Bradyphyllum coagmentum sp. n.												6																					
Lytvolasma aucta sp. n.												15																					
Monophyllum cassum sp. n.												4					1			1						1							
Falsiamplexus delicatus (Ross & Ross, 1963)										many																							
elongatus sp. n.																	7			2	4	15	120					1				4	
reductus sp. n.								4	3																								
?Paralleynia acclinis sp. n.																	4		1	26													
Lophophyllidium (Lophophyllidium) westii (Beede, 1898)						1		8	12		15	1		1														1		1			
distortum (Worthen, 1875)								3	5		5				1																		
dunbari Moore & Jeffords, 1941											6	1	1		1		19		1	19	1		2	1		1		5		7	6		
compressum Jeffords, 1942	1	1?						5	10		1?																						
absitum (Jeffords, 1947)					1	1					2				1																		
plummeri Jeffords, 1947												1													1?			2	1				
wewokanum Jeffords, 1947					2		1?					1		2														1?					
cf. confertum Jeffords, 1942					5	1																											
skinneri Ross & Ross, 1962			5?																							1							
Lophophyllidium (Lophbillidium) sp. 1																																	1
Pseudowannerophyllum solidum (Ross & Ross, 1962)												3			1				1														
Lophotichium rotundiseptum sp. n.																	23	3		22			44							4	7		
sp. 2																												1					
Assimulia (Assimulia) uddenitense sp. n.												1																					
tergida (Ross & Ross, 1962)																	1																
arta sp. n.																												3					
Paraduplophyllum (Vacoea) nealranchense sp. n.																	2	2		2			24							1	3		

Abbreviations M? Miss. = Middle? Missourian U.L.H.Fm. = Upper Lenox Hills Formation Virg. = Virgilian

TABLE 2b

Stratigraphic distribution of coral species

Horizon	Hueco Fm.		Hess Formation					Skinner Ranch Formation																													Lower Bone Spring Formation							Cibolo Fm. Breccia Z.	
	Low. Und.		Und.		Taylor R.		Upp.	Undivided					Base	Lower				Scacchin.		Decie Ranch member					Popl.	Dugout Mt.		Sullivan Peak member						T. Sul.	Upp.	Top									
Name of species / Locality	USNM 721	USNM 720b	USNM 709f	USNM 711g	USNM 702d	USNM 702e	USNM 726n	USNM 707h	USNM 711l	USNM 723o	USNM 724p	USNM 724q	USNM 712p	USNM 714p	USNM 716t	USNM 720f	USNM 720g	USNM 705a	USNM 720e	USNM 707a	USNM 707g	USNM 707w	USNM 715v	USNM 727u	USNM 707ha	USNM 732e	USNM 733l	USNM 707c	USNM 707d	USNM 713c	USNM 722h	USNM 722l	USNM 733j	USNM 707b	USNM 727f	USNM 723l	USNM 725c	USNM 728e	USNM 728f	USNM 728h	AMNH 628	AMNH 631	AMNH 696	USNM 728l	USNM 738r
?*Euryphyllum*																																													
robustum sp.n.																		3																				1							
profundum sp.n.																																						28	3				1?		
Actinophrentis																																													
columnare sp.n.																																1?													
bonespringense sp.n.																																						5		1					
Bradyphyllum																																													
sp. 2																																						1							
Lytvolasma																																													
sp.																																						1							
Monophyllum																																													
sp.																																						5							
Falsiamplexus																																													
flexibilis sp.n.																																1						38							
Lophophyllidium (Lophophyllidium)																																													
dunbari Moore & Jeffords, 1941	2?					1?																			1?																				
absitum (Jeffords, 1947)		13																																											
sp.	1																																												
Lophophyllidium (Lophbillidium)																																													
cyathaxoniaforme sp.n.																													4			53		4	9										
erugum sp.n.	1?																															12					1								
magnocolumnare sp.n.																		44	4		1?		2											5?											
sp. 1			1															1																											
Lophophyllidium (?Lophbillidium)																																													
sp. 2																		4																											
Pseudowannerophyllum																																													
solidum (Ross & Ross, 1962)				1																																									
Lophotichium																																													
rotundiseptum sp.n.									1																																				
dugoutense sp.n.																			2							1			2			1	>300					2							1
simulatum sp.n.					6						1				1			22	56			4	1		3							15	13			1	3	9	4	1				1	1
sp. 1																														1															
Assimulia (Assimulia)																																													
tergida (Ross & Ross, 1962)																6	8	590	18	3			1			1					1	1			36	7		1							
abscessa sp.n.								4						9		9		10					18			1		1				1		40	5		4	1						1	
flexibilis sp.n.						16		1						1				4		6											4	2		2				4	102						1
frequentis sp.n.																			1														1					29							
compacta sp.n.																			1				2															5	2						
sp. 1																																1													
Assimulia (Ericina)																																													
fracta sp.n.	14									2																		2	5			93													
recrea sp.n.																				2											1		1	2	2	4		68	1						
Paraduplophyllum (Paraduplophyllum)																																													
oppositum sp.n.					27														1					1							2	12													
multiplicatum sp.n.																			1	3				1								1													
Paraduplophyllum (Vacoea)																																													
tubaeformis (tubaeformis) subsp.n.																		7		3		12		1	1	1	1					33		7			5	5	80	30	1	1	1	1?	
tubaeformis (reductum) subsp.n.	1																						1															1	16	6					
tubaeformis (lophotichioides) subsp.n.																																						2	9	2					
nealranchense sp.n.						4																																							
vermiculare sp.n.					4			3			172	1	26	1	19	1	1	17	295	165		295	1						2			4	1					1	3	1					284
amplexoides (amplexoides) subsp.n.					2	6	2											1	62																			1?						1	
amplexoides (longiseptatum) subsp.n.											6				1			6	7			1											8					1							5

Abbrevi tions: Dugout Mt.=Dugout Mountain member Fm.=Formation. Low=Lower Popl=Poplar Tank member Scachin=base of Scachinella beds. Taylor R.=Taylor Ranch member. T. Sul=top of Sulliwan Peak member. Und=undivided. Upp.=Upper. Z=Zone.

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SYSTEMATIC PART

Class **Anthozoa** EHRENBERG, 1834
Subclass **Rugosa** MILNE-EDWARDS and HAIME, 1850
Order **Stauriida** VERRILL, 1865
Suborder **Stereolasmatina** HILL, 1981
Family **Hapsiphyllidae** GRABAU, 1928
Subfamily **Hapsiphyllinae** GRABAU, 1928

Type genus: *Hapsiphyllum* SIMPSON, 1900

Remarks. — The family Hapsiphyllidae is one of most frequently mentioned taxa in the rugose coral literature and also one of the most controversial. A recent solution by HILL (1981) is unsatisfactory because it places together such obviously unrelated genera as *Allophyllum* SCHOUPPÉ, 1957, *Clinophyllum* GROVE, 1935, *Longiclava* EASTON, 1962 and *Neozaphrentis* GROVE, 1935 on one side and *Allotropiophyllum* GRABAU, 1928, *Amplexizaphrentis* VAUGHAN, 1906, *Hapsiphyllum* SIMPSON, 1900 and *Zaphrentites* HUDSON, 1941 on the other. The groups mentioned are artificial, because real relationships between individual genera remain unknown. Genera placed in the subfamily, but not mentioned above, may also have quite different connections.

Clarification of the taxonomy of the Hapsiphyllinae is not possible until many taxa are thoroughly investigated. Any present attempt would be restricted to reinterpretation of the same random facts, bringing no new light on the problem. Accordingly, I treat Hapsiphyllinae

GRABAU, 1928 only as a convenient name to group some genera, and I follow WEYER'S (1975) concept of the relation of Hapsiphyllinae to Antiphyllinae ILINA, 1970. This concerns only the genera of both subfamilies discussed in remarks on the Antiphyllinae.

Genus *Allotropiochisma* FEDOROWSKI, 1982

Type species: Amplexizaphrentis longiseptata FLÜGEL, 1973

Subgenera assigned: *Allotropiochisma* FEDOROWSKI, 1982; *Alligia* subgen. n., *Abeophyllum* subgen. n.

Emended diagnosis. — Medium to large solitary corals without dissepimentarium; counter and alar protosepta slightly elongated in early ontogeny; cardinal protoseptum shortened from early maturity or earlier; major septa allotropiophylloidally arranged, having axial ends conjoined directly or by stereocolumn above long, closed cardinal fossula; minor septa present in corallite lumen below calice floor; tabulae hemisphaerical, sagging axially, with incipient biformity at periphery; septa trabecular, aseriate.

Remarks. — The genus was only recently introduced and discussed, but reinvestigation of the Schouppé and Stacul's (1959) collection, the present study of Texas corals, and further analysis of Flügel's (1973) type material made reinterpretation of the genus and supplementary discussion necessary. According to the new concept herein presented, the genus contains three subgenera, and the nominative subgenus is restricted to species closely resembling *A. longiseptata* (FLÜGEL, 1973).

Similarity of *Allotropiochisma* to *Lytvolasma* SOSHKINA, 1925 was not pointed out in the original description (FEDOROWSKI, 1982) because the latter is closer to *Alligia* subgen. n., not investigated at that time. This part of the discussion is presented in remarks on *Lytvolasma.*

Similarity of *Allotropiochisma* to *Actinophrentis* IVANOVSKI, 1967 was also omitted from earlier discussion for the same reason. The main differences between these genera are: 1) Allotropiophylloid morphology of neanic stage in *Allotropiochisma versus* zaphrentoid morphology in *Actinophrentis,* 2) Appearance in *Allotropiochisma s. s.* of a free axial area in the late neanic stage, which was in further growth replaced by a stereocolumn (*Actinophrentis* developed a permanent stereocolumn, which brings it closer to *Alligia* n. subgen in this respect), 3) Formation of a biform tabularium and/or "biform reduction" of minor septa in *Allotropiochisma,* 4) Lack of tendency of strong elongation of a counter septum in maturity of the latter genus, and 5) Pinnate arrangement of major septa in *Actinophrentis* up to the calice floor, versus allotropiophylloid arrangement in *Allotropiochisma.* These differences seem adequate for distinction of these two genera on a subfamily level.

Subgenus *A.* (*Allotropiochisma*) FEDOROWSKI, 1982

Type species: as for the genus

Diagnosis. — *Allotropiochisma s. s.* having major septa withdrawn early from corallite axis; in further growth their axial ends conjoined eccentrically towards counter quadrants; minor septa "biformly reduced".

Remarks. — *Allotropiochisma* is restricted to the type species and *A. postulosa* (FLÜGEL, 1973). "*Bradyphyllum*" *breviconicum* FLÜGEL, 1973, with its incipient stage of "biform reduction" of minor septa, may be a possible offspring of this group. The holotype of this controversial species is re-illustrated in this paper (fig. 3: 4a, b), and it is discussed in more detail under *Lytvolasma* SOSHKINA, 1925.

TABLE 3

Morphologically-comparative table of Hapsiphyllinae Grabau, 1928 described in this paper

Name of genus or subgenus	Cardinal septum	Cardinal fossula	Counter septum	Alar septa	Alar fossulae	Major septa	Minor septa	Axial area	Tabularium
Allotropiochisma (*Allotropiochisma*) Fedorowski, 1982	Shortened from early maturity	Elongated over corallite axis; closed	Slightly elongated early in ontogeny	Slightly elongated early in ontogeny	Absent in maturity	Allotropiophylloidally arranged; conjoined eccentrically	Biformly reduced	In late neanic free; in maturity major septa conjoined around it	Incipient biformity at periphery; sagging axially
Allotropiochisma (*Alligia*) subgen. n.	”	Elongated over corallite axis; closed; slightly widened axially	”	”	Moderately to well developed	As above, but almost zaphrentoid in some	Free in corallite lumen	Stereocolumn permanently present	”
Allotropiochisma (*Abeophyllum*) subgen. n.	In neanic long; in maturity shortened	Open; parallel walls bordered by successively shorter septa	Elongated	Equal to other major septa	Absent	Pinnately arranged with free axial ends	In some loculi may be absent	Free, penetrated by some major septa	Incipient biformity at periphery; deeply sagging axially
Euryphyllum Hill, 1938	Long or shortened late in maturity	Narrow, bordered by successively shortened major septa	Equal to other major septa	May be slightly elongated	Present	Thinner, shorter and accelerated in increase in counter quadrants	Underdeveloped or absent	Stereoplasmic junction of major septa permanently present	Uniform; irregular, domed, sometimes slightly depressed

Two other species, i. e.? *A. birkenmajeri* FEDOROWSKI, 1982 and? *A. uddenitense* sp. n., with their clearly biform tabularium, long, contratingent, contraclined and contrajunct minor septa, and widely open, free axial area, were only temporary placed in the subgenus discussed. All the characters mentioned bring them closely to two poorly known species from the Upper Permian of the Timor Island: *Duplophyllum zaphrentoides* KOKER, 1924 and *Barytichisma*? *permicum* SCHOUPPÉ and STACUL, 1959 (recently reinvestigated by Fedorowski 1986). These four species may eventually be grouped together in *Duplophyllum* KOKER, 1924. This is not recommended here, because the type specimen of *Duplophyllum zaphrentoides* KOKER, 1924 is lost (see FEDOROWSKI, 1986) and no topotype material has been studied that is morphologically close enough to the type to be chosen the neotype. *Allotropiochisma* is thus the closest genus to receive these two species now.

Specimens identified by FOMICHEV (1953) as *Parastereophrentis*? *invalida* sp. n. differ greatly from each other. This is especially well seen in the parts of them closer to calices than those illustrated by FOMICHEV (1953). One of these specimens (fig. 25:5) shows an arrangement of major septa very similar to the holotype of *Allotropiochisma longiseptata* (FLÜGEL, 1973) (compare fig. 2:4 in this paper), but it has no minor septa present inside the corallite lumen and even an incipient stage of the biform tabularium is not developed. It thus has not been included here to *Allotropiochisma*, although such an identification may be accepted by authors. The second corrallite (fig. 25:4) exhibits characters that do not fit fully with any of the here discussed genera. The type specimen of *P. invalida* was not originally chosen.

Relation of *A.* (*Allotropiochisma*) to *A.* (*Alligia*) subgen. n. is discussed with the latter.

? *Allotropiochisma* (? *Allotropiochisma*) *uddenitense* sp. n.

(fig. 1:1a—d, 2a—f; pl. 1:1a, b, 2a, b)

Holotype: Specimen USNM 196695, fig. 1:1a—d, pl. 1:1a, b.
Type locality: USNM 701p.
Type horizon: Gaptank Formation, *Uddenites* bearing member.
Derivation of the name: uddenitense — after type horizon.

Material. — Two specimens without calices and proximal ends preserved. Internal structure crushed in part. The paratype, although preserved up to a calice floor, represents only the early ephebic stage of development. It has been included here conditionally. Maximum n:d ratios: in holotype, 34:19.5×18.5; in paratype, 30:12.0.

Diagnosis. — *Allotropiochisma* having major septa wedgeshaped, radially arranged, slightly shortened; minor septa in early ontogeny developed only at counter septum to form triad, in maturity long, contratingent and contraclined; cardinal septum almost as long as other major septa; tabularium biform.

Description of the holotype. — Major septa in ontogenetically youngest section having n:d ratio 28:9.0 (fig. 1:1a) are slightly bent peripherally. They are arranged radially and do not meet the corallite axis. Length of septa, except for the last pair of slightly underdeveloped ones in counter quadrants, is not differentiated. The cardinal septum and two major septa adjacent to it are thinner than the neighbouring major septa, but they are not shorter and do not form a distinct septal fossula. The cardinal tabular fossula is present, however. The counter septum is equal in length to other major septa. Alar septa and alar pseudofossulae are indistinguishable. Minor septa are not present inside the corallite lumen except for two very long ones, adjacent and contratingent to the counter septum.

The next section cut 8.5 mm above the previous one (fig. 1:1b), having n:d ratio 34:15.5, is characterized by straight major septa, well developed cardinal fossula marked by sections of tabulae, and appearance of long minor septa, often contratingent or contraclined. The

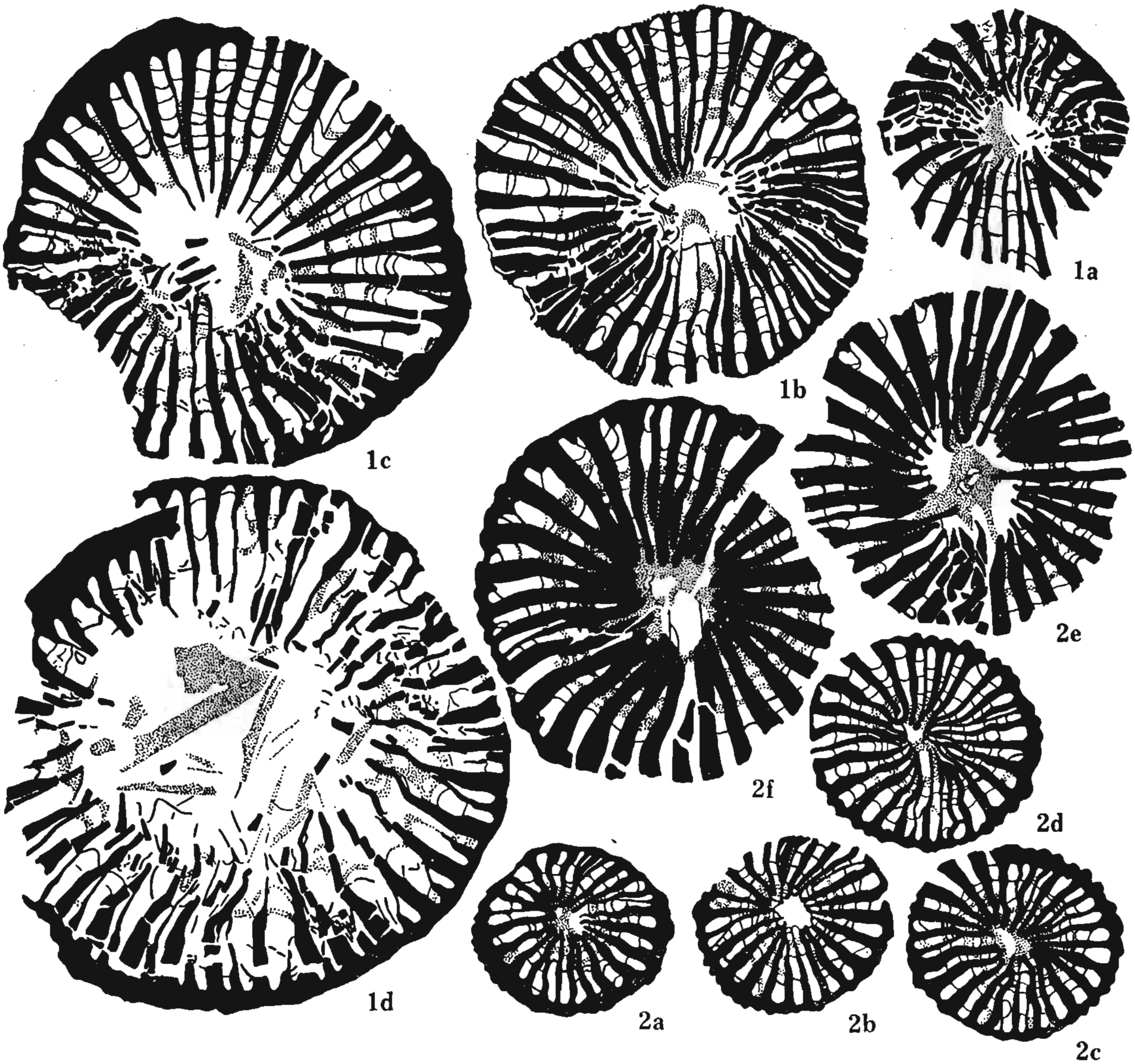

Fig. 1.

? *Allotropiochisma* (? *Allotropiochisma*) *uddenitense* sp. n. 1. Specimen USNM 196695. Holotype. Locality USNM 701p, Gaptank Formation, *Uddenites*-bearing member. Transverse sections; a — late neanic/early ephebic stage; b, c — ephebic stage; d — late ephebic stage. All, ×4. 2. Specimen USNM 196696. Locality and horizon as above. Transverse sections; a—d — neanic stage; e, f — ephebic stage. All, ×4.

morphology of the most advanced part of growth preserved (fig. 1:1c, d; pl. 1:1a, b) differs from that described above only in showing major septa successively more shortened. The cardinal septum almost equals other major septa.

Individual variation. — Only a single specimen was identified as a possible paratype belonging to this species. It differs from the holotype in having more juvenile characteristics. Its ontogenetically most advanced portion, although comparatively large in dimensions, possesses underdeveloped minor septa, having only those adjacent to the counter septum very long. Thick major septa, inconspicuous cardinal septum and elongated alar septa on some sections form additional differences of this stage when compared to the holotype (fig. 1:2e, f; pl. 1:2a). In the younger part of the paratype (fig. 1:2a—d; pl. 1:2b), major septa come very close to the corallite axis. The long cardinal septum can be distinguished due to its lesser thickness and an underdevelopment of the last pair of major septa in cardinal quadrants. Minor septa, contratingent to the counter septum, increase their length successively, but no other minor septa appear in the corallite lumen. The differences mentioned are substantial and the specimen discussed was conditionally included in *A.* (? *A.*) *uddenitense* sp. n. mainly because of its close morphological similarity to the youngest known part of the holotype.

Remarks. — The described species was mentioned in remarks on the genus as a potential member of *Duplophyllum* KOKER, 1924, included in *Allotropiochisma* mainly due to an uncertain situation of the former genus. It may be quite closely compared to *A. birkenmajeri* FEDOROWSKI, 1982 as far as mature morphology is concerned. Ontogeny of these two species differ, however, in the more radial symmetry of major septa in *A.* (? *A.*) *uddenitense* sp. n. and in the late appearance of long minor septa in the latter species. Smaller dimensions and a larger number of peripherally more thickened major septa in *A.* (? *A.*) *uddenitense* sp. n. form additional differences between these two species. Other species assigned so far to *Allotropiochisma* are much less similar and are omitted from this discussion.

Occurrence. — USNM 701p:2, Gaptank Formation, *Uddenites*-bearing member.

Subgenus *A.* (*Alligia*) subgen. n.

Type species: A. flabellum sp. n.

Derivation of the name: lat. *alligo* — to attach, to tie — after permanent conjoining of ends of major septa by stereo column.

Diagnosis. — *Allotropiochisma* having stereocolumn permanently present; minor septa free in corallite lumen; alar fossulae moderately- to well-developed.

Remarks. — Introduction of the subgenus discussed may be questioned as being the result of subjective evaluation of diagnostic characters. Indeed, the similarity of this subgenus to *Allotropiochisma s. s.* is obvious. On the other hand, all three features mentioned in the diagnosis are qualitative in a character. Their rank, especially differences in ontogeny, should thus be evaluated as higher than specific. The subgeneric distinction reflects this relation best.

Several characters, especially the development of the cardinal fossula and alar fossulae, similar length of major septa in cardinal and counter quadrants, and permanent, eccentric conjunction of inner ends of major septa, bring the subgenus discussed close to *Euryphyllum* HILL, 1938, and even more so to the here described? *E. robustum* sp. n., which is temporarily assigned to the latter genus. Although the similarities mentioned may indicate a possible relation of the two taxa discussed, qualitative differences readily distinguish *Euryphyllum* from *Alligia* subgen. n. These are: biform tabularium, early appearance of minor septa in corallite lumen, early shortening of the cardinal septum and axially sagging tabulae. Early growth stages of the type species of *Euryphyllum* have not been investigated so far.

The latter two of the differences mentioned do not occur in? *E. robustum* sp. n., making assignement of this species to *Euryphyllum* doubtful and its similarity to *Abeophyllum subgen.* n. closer. The first two differences mentioned were caused by quite different organization of the polyp bodies, which seem adequate for not considering? *E. robustum* sp. n. a member of *Alligia* subgen. n. The observations discussed are possibly indicative of a close relation of *Abeophyllum* to *Euryphyllum* and *Allotropiophyllum* GRABAU, 1928.

The species content of *Abeophyllum* subgen. n. is not clear. One of the paratypes of "*Amplexizaphrentis*" *excentrica* (FLÜGEL, 1973), reillustrated by FEDOROWSKI (1982, pl. 4:4a, b) may either belong here or be an offspring of this subgenus. Its fairly well alongated minor septa in subtabular regions and biform tabularium at the periphery are accompanied by a free axial area in maturity. A parallel modification was adequate for distinguishing *Amplexizaphrentis* VAUGHAN, 1906 from *Zaphrentites* HUDSON, 1941.

Allotropiochisma (*Alligia*) *flabellum* sp. n.

(figs. 2:1—3, 3:1—3; pls. 1:3—6, 2:2, 4, 3:11)

e. p. 1963. *Amplexizaphrentis* sp. A. Ross and Ross; J. P. Ross and C. A. Ross, p. 412, pls. 48:7, 11, 49:3; *non* pl. 50:5, 13.
Holotype: Specimen USNM 196697, fig. 2:2, pl. 2:2.
Type locality: USNM 701c.
Type horizon: Neal Ranch Formation.
Derivation of the name: lat. *flabellum* — fan — after arrangement of major septa.

Material. — The holotype, 8 paratypes and 3 specimens of Ross and Ross (1963) were available for the study. Tips and calices, except for floors in some corallites, were abraded. Internal structures are mainly calcitic, only slightly silicified.

Some features of representative corallites (in mm):

USNM cat. nos.	n:d ratio	C septum side	Remarks
196697	30:18.3 × 17.3	concave	calice floor
„	29:16.0 × 16.0	„	7 mm below calice floor
„	29:14.7 × 14.2	„	5 mm below the former
„	25: 9.4 × 9.1	„	10 mm below the former
196699	30:17.0 × 14.2	„	calice floor
„	29:14.5 × 12.2	„	9 mm below calice floor
196698	30:18.7 × 14.3	lateral	calice floor
„	30:15.6 × 12.4	„	7 mm below calice floor
„	28:13.7 × 11.7	„	2 mm below the former
„	24: 8.0 × 7.2	„	13 mm below the former
196700	32:23.5 × 19.2	concave	calice floor
„	30:19.0 × 17.6	„	22.5 mm below calice floor

Diagnosis. — *Allotropiochisma* (*Alligia*) having n:d ratio at calice floor as above; major septa either in touch or united by stereocolumn; weakly developed minor septa appearing late in ontogeny.

Description of the holotype. — The corallite is a worn specimen with the tip and part of the external wall abraded. The calice floor (pl. 2:2) is preserved but the cardinal fossula and adjacent septal loculi were infilled with iron stained sediments. The cardinal septum is not seen. The counter septum is slightly longer than the counter-lateral septa, inner ends of which reach periaxial part of the former. Other major septa in counter quadrants bent towards axial end of the counter septum with the nearest of them coming close or reaching that end. Major septa of cardinal quadrants are longer than those of the counter quadrants, with alar septa being the longest and other septa reaching their ends adaxially. Like major septa in the counter quadrants, those in the cardinal quadrants are convex towards the cardinal septum. Such an arrangement made the cardinal fossula peripherally and axially widened (observation made in sections) and the alar fossulae developed better in their axial parts. Minor septa are hardly distinguishable. The surface of the calice floor, i. e. the last tabula, exhibits complex morphology. It generally is hemisphaerical, being higher in the counter than in the cardinal quadrants, however. It rises slightly upwards on both sides of the counter septum, extending its lateral surface higher than the lateral surfaces of other major septa. This is also marked by a skewness of tabulae in transverse sections (fig. 2:2b, c). The calice floor (= the last tabula) dips steeply, almost vertically at the inner border of the cardinal fossula. Similar dipping is observed also in alar fossulae, which may mean that these structures are true tabular fossulae.

The mature morphology in transverse sections (fig. 2:2b, c) does not differ from that observed on the calice floor and only supplementary remarks are required for this part of the description.

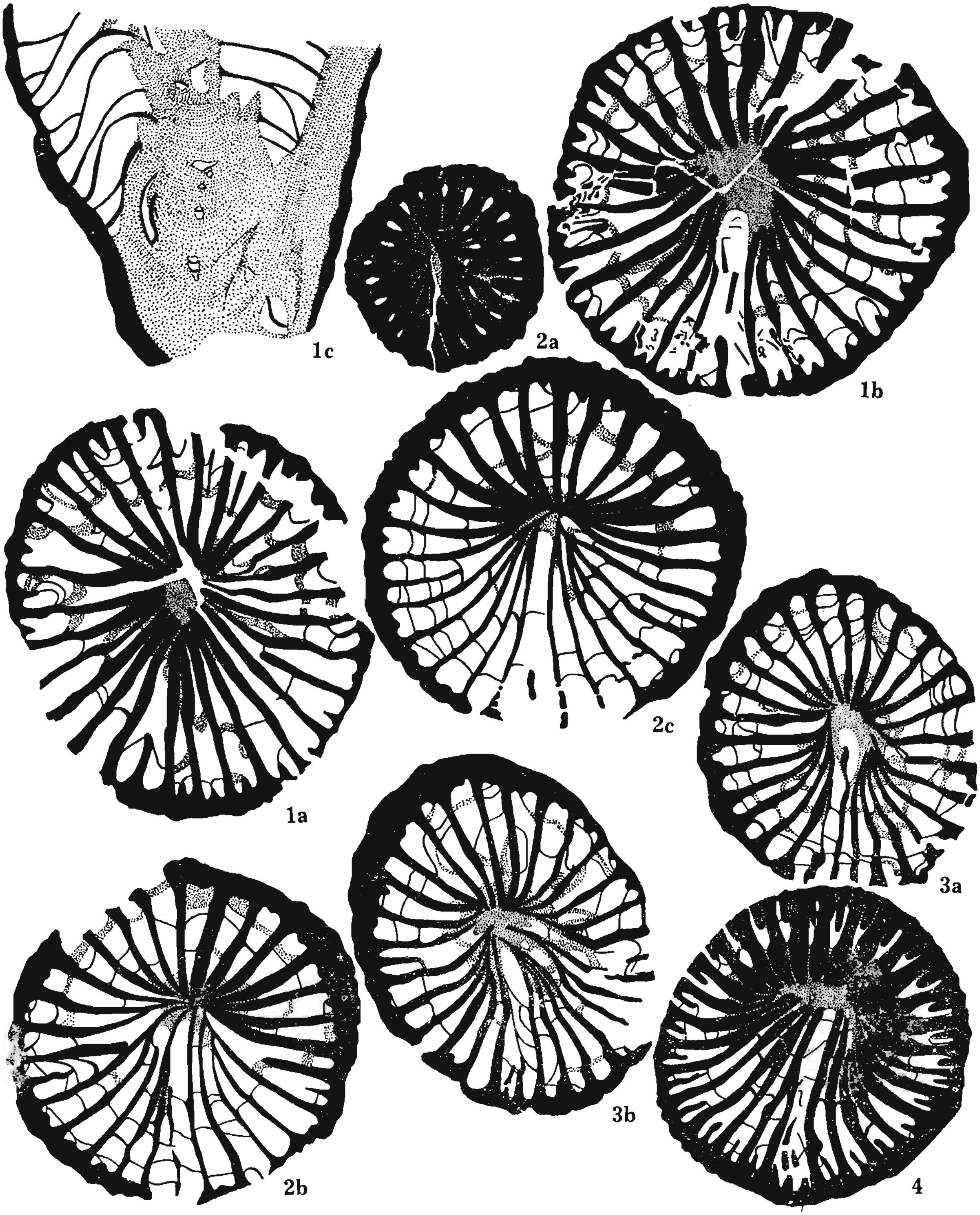

Fig. 2.

Allotropiochisma (*Alligia*) *flabellum* sp. n. Specimen USNM 139775. Locality USNM 701 p, Gaptank Formation, *Uddenites*-bearing member (= *Amplexizaphrentis* sp. *A*. Ross and Ross, 1963, pl. 48:7, 11; pl. 50:5); a, b — transverse sections, ephebic stage; c — longitudinal section. All, ×4. 2. *Allotropiochisma* (*Alligia*) *flabellum* sp. n. Specimen USNM 196697. Holotype. Locality USNM 701 c, Neal Ranch Formation. Transverse sections; a — neanic stage; b, c — ephebic stage. All, ×4. 3. *Allotropiochisma* (*Alligia*) *flabellum* sp. n. Specimen USNM 196698. Locality USNM 706 x, Neal Ranch Formation. Transverse sections; a, b — ephebic stage, ×4. 4. *Allotropiochisma* (*Allotropiochisma*) *longisepta* (FLÜGEL, 1973). Specimen MMH 11948. Holotype. *Productus* Limestone (Upper Permian). East Greenland. Housed in Museum of Mineralogy, University of Copenhagen. Transverse section, ephebic stage, ×4.

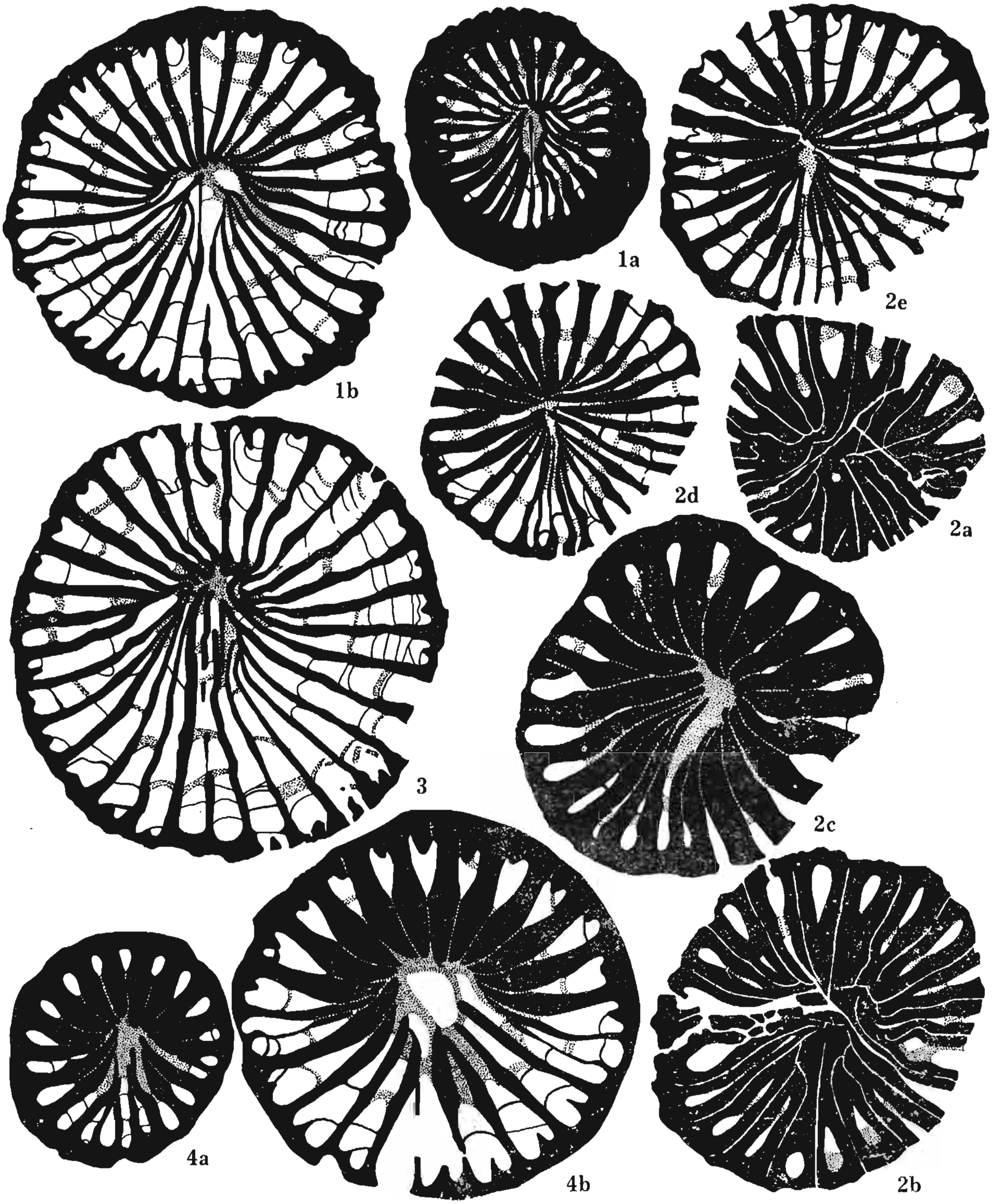

Fig. 3.

1. *Allotropiochisma* (*Alligia*) *flabellum* sp. n. Specimen USNM 139777. Locality USNM 701 p, Gaptank Formation, *Uddenites* bearing member (= *Amplexizaphrentis* sp. *A*. Ross and Ross, 1963, pl. 49:3). Transverse sections; a — neanic stage; b — ephebic stage. All, × 4. 2. *Allotropiochisma* (*Alligia*) *flabellum* sp. n. Specimen USNM 196699. Locality and horizon as above. Transverse sections; a, b — neanic stage, × 8; c — late neanic stage, × 8; d, e — ephebic stage, × 4. 3. *Allotropiochisma* (*Alligia*) *flabellum* sp. n. Specimen USNM 196700. Locality and horizon as above. Transverse section, ephebic stage, × 4. 4. "*Bradyphyllum*" *breviconicum* FLÜGEL, 1973. Specimen MMH 11949. Holotype. *Productus* Limestone (Upper Permian), East Greenland. Housed in Museum of Mineralogy, University of Copenhagen. Transverse sections. a — late neanic/early ephebic stage; b — ephebic stage. Both, × 8.

The arrangement of the major septa remains allotropiophylloid, having the cardinal septum shortened and major septa in counter quadrants thicker than those in the cardinal quadrants. The latter exhibit a kind of twopartite rhythm in decreasing their length towards the cardinal septum: after an increase of three step by step shorter major septa one or two long septa bordering each side of the cardinal fossula appear. The newly inserted septum (fig. 2:2b) quickly reaches a considerable length (fig. 2:2c). The axial stereocolumn is weak, but it occurs permanently up to the calice floor. Sections of tabulae connected to some minor septa or slightly inclined in some loculi indicate that the peripheral part of the tabularium developed an incipient biformity.

In the ontogenetically earliest part of growth observed (fig. 2:2a) the arrangement of septa is pinnate rather than zaphrentoid, with the cardinal septum long, but not reaching the corallite axis, and with the counter septum and alar septa elongated. The ends of major septa are very close to or reach each other, but it has not been established whether their middle lines are united. The specimen is slightly silicified in this part.

Individual variation. — All structural elements vary more or less, but not to such an extent as to be indicative of specific distinction. Ontogenetically youngest sections of paratypes investigated exhibit some variability in thickness of major septa. The latter may either be so thick as to fill in more than 2/3 of the corallite lumen (fig. 3:2a—c) or are fairly weakly thickened (fig. 3:1a). The same corallites may illustrate heterochrony in allotropiophylloid arrangement of major septa, which is observed fairly late in the case of first corallite (fig. 3:2c) and early in the latter (fig. 3:1a). Variability in length of the cardinal septum, independent of other characters discussed, is worth attention. All these differences are slight, however, and proove close relation rather than taxonomic differences between the specimens discussed.

Differences in arrangement of septa in quadrants and development of the cardinal fossulae are most spectacular, if not most important, variations. One of specimens of Ross and Ross (1963, pl. 49:3 and fig. 3:1b; pl. 1:3 in this paper) can be considered an extreme form in development of a long cardinal fossula, slightly widened axially and distinctly broaded peripherally, and in distinct alar fossulae, slightly widened axially. The inner ends of major septa of this specimen are clearly conjoined in quadrants and pinnately arranged to form a kind of half aulos in the counter quadrants. Similar morphology is observed on the calice floor of the holotype (pl. 2:2) and some paratypes (pl. 3:11), although they may be more radial or irregular just beneath the calices (e. g. figs. 2:1b, 3:2e). The opposite situation can be observed in other specimens showing deep axial depression of the cardinal fossula, but weakly marked alar fossulae at the calice floor (pl. 2:4a) while the latter are well developed in sections (fig. 2:3). The holotype may be located on a margin of the group of specimens discussed.

Among specimens with more irregular morphology, some (fig. 3:2d, e) may be closely comparable to the holotype by their calice floor morphology, although they possess major septa less differentiated in length and thickness in quadrants, more inconspicuous cardinal fossula and hardly distinguishable alar fossulae in sections (figs. 2:1a, b; 3:2d, e). These specimens differ also from the holotype in not accentuating differentiation in length of major septa of cardinal quadrants. One of them (fig. 2:1a, b) exhibits also the widest axial stereocolumn not penetrated by major septa, and symmetry most close to radial.

There are also other characters, not exactly correlated with those discussed above, but often so with each other. These are the length of minor septa and the arrangement of the most peripheral parts of tabulae. As shown by some specimens with minor septa well developed (figs. 2:1a, b; 3:3), the peripheral parts of tabulae may bridge septal loculi corresponding to Position II of Sutherland (1965). In other instances, they are inclined in a way indicating deeper sinking of them to the major septa located towards the cardinal septum from them. The identical situation, observed also in other transverse sections (pl. 1:5; fig. 3:1), is best illustrated by the weathered lower surface of a tabula of young part of a corallite (pl. 2:4b). Transverse sections of this specimen (fig. 2:3a, b) show weak development of minor septa, seen a little better only on the ontogenetically oldest section, and also weak accentuation of oblique positions of tabulae in the peripheral part of the corallite.

The above observations permit explanation of some important interrelations within the group of specimens discussed. It seems proven that all specimens of *A.* (*A.*) *flabellum* sp. n. possess the most peripheral part of the tabularium biform, although this character is weakly accentuated in the case of the underdevelopment of minor septa. On the other hand, however, such an underdevelopment does not prove an absence of a biform or at least oblique arrangement of most peripheral parts of tabulae.

Such characters as different thickness of major septa along all their length or in individual portions of them, and development of more or less thick stereocolumn, may be less important, but should be mentioned. These characters are not correlated directly with any features discussed earlier. However, specimens indicated as extreme in development of pinnate versus semiradial arrangement of major septa are extreme also in this a character (figs. 2:1a, b; 3:1a; 2d, e).

Morphology in the longitudinal section shows very little variability. Presence of peripheral tabellae (fig. 2:1c) and more or less deep axial depression of tabulae are main differences.

Remarks. — The species discussed is probably the only one in *Alligia* subgen. n. in this moment, but another possible species is mentioned in remarks on the subgenus. Thus, the species has to be compared to the type species of the nominative subgenus and to similar (related?) species of other genera. Principal differences in the first case are the same as for the subgenera.

? *Euryphyllum profundum* sp. n. can be closely compared to *A.* (*A.*) *flabellum* sp. n. in the arrangement and length of major septa, development of alar fossulae, and, in lesser degree, the cardinal fossula. The latter, although so deep as to reach inner ends of major septa in counter quadrants, invariably contains at least one underdeveloped major septum, which is not the case in *A.* (*A.*) *flabellum* sp. n. The main differences between these taxa are qualitative ones: disappearance of minor septa in the inner part of calices in ? *E. profundum* sp. n., where they became incorporated into the external wall, and lack of biformity of the most peripheral tabularium. There are also such quantitative differences as different n:d ratio and different position of the cardinal fossula.

A. (*A.*) *flabellum* sp. n. is also closely similar to ? *Euryphyllum robustum* sp. n. In addition to the qualitative differences in development of the tabularium and minor septa, the latter species differs in having more robust major septa, less well developed alar fossulae and a stronger stereocolumn. Variability in all these elements brings the extreme specimens fairly close to *A.* (*A.*) *flabellum* sp. n., indicating a possible relationship of these two species.

A. (*A.*) *flabellum* sp. n. exhibits also some similarity to *Lytvolasma aucta* sp. n., which is discussed in remarks on the latter genus.

Occurrence. — Locality USNM 701p:9, Gaptank Formation., *Uddenites*-bearing member; 701c:1 706x:2, Neal Ranch Formation.

Subgenus *A.* (*Abeophyllum*) subgen. n.

Type species: *A.* (*A.*) *texanum* sp. n.

Derivation of the name: lat. *abeo, ii, itum, ire* — to separate — after common lack of connection of inner ends of major septa.

Species assigned: *Euryphyllum hispanicum* de GROOT, 1963; *A.* (*A.*) *texanum* sp. n.

Diagnosis. — *Allotropiochisma* with counter septum elongated, cardinal septum in maturity shortened, in neanic stage long; open cardinalossula, having parallel walls bordered by successively shorter major septa reach corallite axis; peripheral biformity of tabularium inconspicuous.

Remarks. — The subgenus proposed herein to include the American and Spanish species emphasizes best a kind of similarity between these species and species of other two subgenera.

The main characters typical for the new subgenus and distinct from both the subgenera mentioned are: the elongated counter septum in all growth stages, slightly elongated cardinal, counter and alar septa in the neanic stage, different shape and morphology of the cardinal fossula and lack of the allotropiophylloid arrangement of major septa in any growth stage. The characters listed may possibly be adequate for considering the corals discussed as belonging to an independent genus. They show at the same time the incipient stage of biformity of the most peripheral part of the tabularium, very similar to that in *A.* (*A.*) *flabellum* sp. n. Almost all corallites of *A.* (*A.*) *texanum* sp. n. do not possess a stereocolumn. There are two corallites, however that developed this element (fig. 4:3a—c). Also, the corallites described by de GROOT (1963) as *Euryphyllum hispanicum* sp. n. show weak stereoplasmic infillings between inner ends of at least some major septa. This character is a rare but phenomenon.

Corallites of *A.* (*A.*) *hispanicum* (de GROOT, 1963) show also some distinction in early ontogeny. Major septa are strongly thickened in all quadrants or only in the cardinal ones (de GROOT, 1963, pl. 4:10a, b, 9a). The latter character is just opposite to that observed in the nominative subgenus and in *Alligia* subgen. n. It is also not observed in *A.* (*Abeophyllum*) *texanum*. Also, arrangement of septa in this early stage in the Spanish species is more radial than in the American one, but both of them show a similar elongation of the cardinal, counter and alar septa. Mature portions of the Spanish specimens show all diagnostic characters of the subgenus, although the biformity of their most peripheral tabularium is very slight, and marked only by oblique positions of transverse sections of tabulae in some loculi.

De GROOT (1963:46) pointed out the elongated counter septum present in her specimens as being non-typical for *Euryphyllum* HILL, 1938. Different shape and morphology of the cardinal septal fossula in transverse sections, different morphology of axial parts of corallites, and presence of incipient biformity in the most peripheral part of the tabularium in *Abeophyllum* subgen. n. are further qualitative differences from *Euryphyllum* HILL, 1938.

Some characters of *Abeophyllum* subgen. n., especially the elongated counter septum and the subradial arrangement of major septa, bring it close to the subfamily Antiphyllinae ILINA, 1971. Indeed, differences between it and such representatives of that subfamily as *Lytvolasma* SOSHKINA, 1925; *Bradyphyllum* GRABAU, 1928; *Rotiphyllum* HUDSON, 1942; *Monophyllum* FOMICHEV, 1953; and *Actinophrentis* Ivanovski, 1967 are not great. Morphology of the most peripheral part of the tabularium, biform in *Abeophyllum* subgen. n. has to be evaluated as a taxonomic character of a rank higher than those of morphology of axial areas of corallites or long-versus short-lasting elongation of the cardinal septum. Also, morphology of the cardinal septal fossula in *Abeophyllum* subgen. n. may be compared to the fossulae of some specimens of ? *Euryphyllum* described in this paper, but not to the fossulae of any Antiphyllinae.

Genera having a long counter septum, placed by HILL (1981) with Hapsiphyllinae GRABAU, 1928 (*Clinophyllum* GROVE, 1935; *Neozaphrentis* GROVE, 1935; *Longiclava* EASTON, 1962), are in fact either of an unknown relation and taxonomic position (the former two) or were herein included in Antiphyllinae (the latter). The taxonomic position of *Abeophyllum* subgen. n. may appear doubtful in such a situation. I cannot find any closer subfamily in which to place it, however, and its relation to *Allotropiochisma* and the other subgenus of that genus seems most possible.

The Westphalian D Spanish species is geologically oldest of all species assigned to *Allotropiochisma* FEDOROWSKI, 1982 *sensu lato*. The probable position of Spain during the Carboniferous period (FEDOROWSKI 1982*b*) and the supposed directions of migrations of the coral fauna during that period make reconstructions of the migration route of *Abeophyllum* subgen. n. difficult. An absence of species intermediate in time and space between the Texas and Spanish taxa makes any supposition speculative. An origin of *A.* (*A.*) *texanum* sp. n. from a species similar to some paratypes of "*Hapsiphyllum*" *retusum* MOORE and JEFFORDS, 1945 should not be excluded

Allotropiochisma (*Abeophyllum*) *texanum* sp. n.

(figs. 4:1—5; pl. 1:7—9)

Holotype: USNM 196705, fig. 4:4a, b; pl. 1:8a, b.
Type locality: USNM 701 p.
Type horizon: Gaptank Fm., *Uddenites*-bearing member.
Derivation of the name: texanum — after the type area.

Material. — Ten specimens, some with calice floors and most parts of proximal ends preserved. Internal structure calcitic.

Some features beneath calices (in mm):

USNM cat. nos.	n:d ratio average	C septum position
196705	36:21.0	concave
,,	34:17.0	
196706	34:14.2	convex
196703	34:15.5	,,
196707	32:16.8	?convex
,,	32:15.0	
196704	36:22.1	?convex

Diagnosis. — *Abeophyllum* with n:d ratio beneath calice as above; tabulae deeply sagging in corallite axis.

Description of the holotype. — The corallite is a worn specimen, preserved only in its subcalicular part. In transverse section (fig. 4: 4b; pl. 1:8b), the major septa are thin, slightly widened peripherally, almost straight, arranged in easily distinguishable quadrants, and slightly differentiated in length. Inner ends of majority of them come close to the corallite axis to form a kind of a weak net. Some of them are temporarily in contact, but they are not rhopaloid, not united, and do not form an axial column. The counter septum is slightly elongated. Its elongation is better expressed by a slight shortening of counter-lateral septa. A shortening of the last pair of major septa in counter quadrants and elongation of alar septa make the alar fossulae visible, but not conspicuous. The shortened cardinal septum is located in the conspicuous cardinal fossula, opened towards the corallite axis. Nearly parallel walls of the fossula are formed by the last pair of the shortened major septa of cardinal quadrants and by inner ends of some successively shorter major septa of those quadrants. Length of major septa is here differentiated. Between those adjoining the cardinal fossula, but not in all loculi, there are shorter major septa either joining lateral sides of neighbouring ones, or free. Minor septa are distinguishable mainly in the microstructure of rather thin external wall and by septal furrows on the corallite surface, if not abraded. Only two or three pairs of them adjacent to the counter septum and to the counter-lateral septa extend a little into the corallite lumen, where they are joined by oblique sections of peripheral parts of tabulae in a way indicating biformity of this part of the tabularium.

In the neanic stage (fig. 4:4a; pl. 1:8a), the counter, cardinal and alar septa are longer than the neighbouring major septa, with the first one being also a little rhopaloid. All these and also some metasepta, are in touch in the corallite axis, but they are not united by their middle lines. An arrangement of major septa is similar to the zaphrentoid plan, but septa in counter quadrants are shorter than those in the cardinal quadrants and some of them are slightly rhopaloid. The very wide cardinal fossula narrows axially and peripherally. No traces of minor septa have been noted.

The holotype has not been longitudinally sectioned. In the section of the paratype, made perpendicular to the cardinal fossula (fig, 4:1b) the peripheral parts of the tabulae vary in shape.

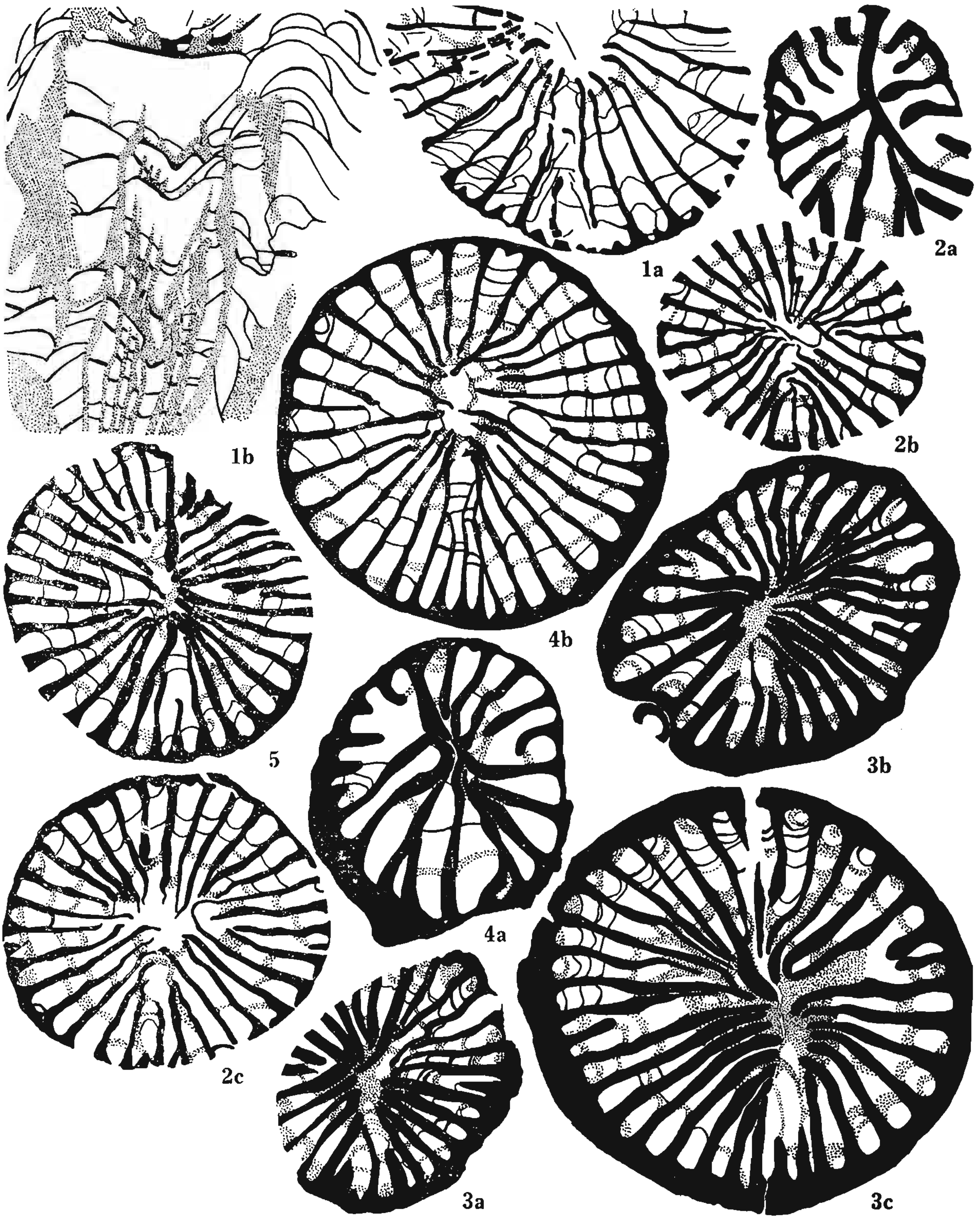

Fig. 4.

Allotropiochisma (*Abeophyllum*) *texanum* sp. n. 1. Specimen USNM 196702. Locality USNM 701p, Gaptank Formation, *Uddenites* bearing member; a — transverse section of cardinal quadrants, ephebic stage; b — longitudinal section, perpendicular to cardinal-counter septa plan. Both, ×4. 2. Specimen USNM 196703. Locality and horizon as above. Transverse sections. a — neanic stage; b — ephebic stage. Both, ×8. 3. Specimen USNM 196704. Locality and horizon as above. Transverse sections; a — late neanic/early ephebic stage; b, c — ephebic stage. All. ×4. 4. Specimen USNM 196705. Holotype. Locality and horizon as above. Transverse sections; a — neanic stage, ×8; b — ephebic stage, ×4. 5. Specimen USNM 196706. Locality and horizon as above. Transverse section, ephebic stage, ×4.

Those sectioned in the part corresponding to Position II of Sutherland (1965) rise more or less steeply upwards towards the periaxial area, where they become hemispherical, sloping down into the axial depression. Tabulae sectioned in Position I are almost horizontal (fig 4:1b, lower left). Also, the periaxial parts of the tabulae sectioned in this position are not so highly domed. In the upper part of the section in question there is a thick, only slightly sagging tabula with sections of septa on it. This is a longitudinal section of a shallow axial rejuvenation.

Individual variation. — In spite of the small number of corallites, several variations in morphology of corallites have been observed. The majority of corallites possess major septa that approach more or less closely a corallite axis, but mainly are not connected there either directly or by a stereocolumn (fig. 4:2b, c, 5; pl. 1:9a, b). Some may form a fairly wide, free axial area in late maturity (fig. 4:1a; pl. 1:7), but all of them except for two have no axial stereocolumn. Of these two exceptions, the stereocolumn is only a temporary body in one, but it is permanent in the other (fig. 4:3a—c). The main morphological characters of this specimen, and especially an arrangement of the major septa, the elongated counter, and the shortened cardinal septum, as well as the morphology of the cardinal septal fossula differ from the holotype in no more than subspecific level, which is not recognized herein. The greater thickness of all structural elements together with the presence of a stereocolumn is interpreted as being ecologically caused.

There are also several differences observed in length and arrangement of major septa. Although the majority of the specimens possess a counter septum and alar septa fairly well elongated, there are some (fig. 4:2b, c; pl. 1:9a, b) possessing the latter septa permanently or temporary shorter than the first pair of major septa of the cardinal quadrants, and the counter septum not longer than the counter-lateral septa. Axial ends of major septa are always bent towards the cardinal fossula, but in some corallites or in some sections, they bend so as to either meet each other (fig. 4:5; pl. 1:7) or to alternate over the cardinal septum (fig. 4:2b). Both these structures may be temporary, as illustrated by more mature sections of two of the specimens cited. The morphology of the cardinal fossula of one of those specimens (pl. 1:7) forms an intermediate step towards the fossula of the late ephebic stage of another specimen (fig. 4:1a) showing an absence of the successive shortening of major septa of the cardinal quadrants. Only the inner ends of the major septa in the cardinal quadrants are inclined there towards the cardinal septum. The small number of corallites available for the study prevents to determine whether differences listed may be considered important enough for specific distinction.

Remarks. — "*Euryphyllum*" *hispanicum* de GROOT, 1963 is the only comparable species. It differs from the species here described in having a weak stereocolumn in all corallites illustrated and in a small dimension of the largest specimen. The number of septa similar in both species makes their n:d ratios different. Smaller corallites of both species are more similar to each other in this respect. Several morphological and ontogenetic differences were mentioned in remarks on the subgenus.

Occurrence. — Locality USNM 701p:9, Gaptank Formation, *Uddenites*-bearing member; ? 712z:1, Neal Ranch Formation.

Genus *Euryphyllum* HILL, 1938

Type species: E. reidi HILL, 1938

Diagnosis. — See HILL (1981:F315).

Remarks. — The diagnosis cited is only a slightly modified version of the original diagnosis (HILL 1938:25). It is cited here because of easier accessibility. Lack of major modifications in this diagnosis means that HILL (1981) did not change her original concept of that genus and did not accept modifications proposed since her first paper was published (e. g. SCHOUPPÉ and

STACUL 1959; de Groot 1963; Kato 1976). I follow the concept of Hill, although the species here described do not fully agree with the diagnosis.

SCHOUPPÉ and STACUL (1959), proposed the greatest modifications of the generic concept of *Euryphyllum*. These authors not only accept a possibility of formation of more or less wide axial area free of septa, but also a presence of species with rhopaloid major septa (*E. breviseptatum* SCHOUPPÉ and STACUL, 1959), shortened cardinal septum (*E. cainodon* (KOKER, 1924), *E. coniculiforme* SCHOUPPÉ and STACUL, 1959), and convex, highly domed tabularium with no kind of axial depression (*E. coniculiforme* SCHOUPPÉ and STACUL, 1959). In such a broad concept of the genus, one can hardly find any characters in common, except for those mentioned by SCHOUPPÉ and STACUL (1959:240) in the diagnosis proposed for the genus *Duplophyllum* KOKER, 1924, i. e. two cycles of septa with dark middle lines; long, thick major septa with lateral contiguity present up to advanced stage of growth; and presence of the cardinal fossula. According to these authors *Euryphyllum* is a subgenus of *Duplophyllum* that differs from the latter only in having short minor septa in the calices (SCHOUPPÉ and STACUL, 1959:254, subgeneric diagnosis of *Euryphyllum*). Many solitary rugose corals may well fit such a diagnosis.

The genus *Duplophyllum* KOKER, 1924 in SCHOUPPÉ and STACUL's (1959) concept has recently been re-investigated and re-interpreted by FEDOROWSKI (1986). None of the species identified by these authors as *Duplophyllum* is congeneric with the lectotype of *Duplophyllum zaphrentiforme* (KOKER, 1924). Some of them, namely those possessing two or three kinds of carinae and showing a very specialized way of increase and development of minor septa, were separated in a new genus, not related to *Duplophyllum*. *Duplophyllum schindewolfi* SCHOUPPÉ and STACUL, 1959 has not been revised because of lack of adequate ontogenetic data. This species possesses minor septa fairly well developed, although appearing late in ontogeny, and differentiated in length. It developed no carinae, however, and several other of its morphological characters are similar to those of *Euryphyllum cainodon* (KOKER, 1924). The two species discussed may well be related on the generic level, although it remains uncertain whether the latter one can truly be placed within *Euryphyllum*. I found a few minor septa inside the corallite lumen in the section Sé 182, i.e. beneath the calice floor of this specimen, while minor septa are absent in the ontogenetically youngest existing section of the holotype of *D. schindewolfi* and in the paratype Sé 180 of the latter species.

De GROOT (1963) accepted the concept of SCHOUPPÉ and STACUL (1959) except for the subgeneric status of *Euryphyllum*. She found early development of long minor septa in *Duplophyllum* adequate for generic distinction. The species described by her as *Euryphyllum hispanicum* sp. n. exhibits several characters that disagree with the diagnosis of *Euryphyllum*. This is discussed in remarks on *Abeophyllum* subgen. n.

KATO (1976) seems to follow SCHOUPPÉ and STACUL's (1959) and de GROOT's (1963) opinions, expressed by his synonymy and his acceptance of a shortened cardinal septum in *Euryphyllum*. FONTAINE (1961:65) did not mention a SCHOUPPÉ and STACUL's (1959) concept, although their paper was cited by him. He emended the synonymy proposed originally by HILL (1938), eliminating *Stereolasma minus* SOSHKINA, 1925 from *Euryphyllum*. He pointed out that SOSHKINA, DOBROLJUBOVA and PORFIRIEV (1941:70) had placed that species in synonymy with *Polycoelia karpinskyi* STUCKENBERG, 1898. I agree with FONTAINE (1961) that "*Stereolasma*" *minus* should be removed from *Euryphyllum*, but its true taxonomic position remains uncertain to me. The characters shown in pl. 1:6 of SOSHKINA 1925 are not convincing for any final conclusion, and I was not able to trace the specimen illustrated when reinvestigating SOSHKINA's collections.

The majority of specimens described by FONTAINE (1961) broaden the original concept of *Euryphyllum* only a little (e. g., *E. alloiteaui* FONTAINE, 1961, with fairly long minor septa, or *Euryphyllum* sp., with minor septa shorter in cardinal quadrants). *E. alloiteaui* is a strange species, but it is not quite certain to me whether the modifications observed, the free axial area in the counter quadrants in particular, are original or diagenetic.

Although "*Stereolasma*" *minus* SOSHKINA, 1925 was not accepted as a member of *Euryphyllum*, *Lytvolasma* sp. No. 2 and *Meniscophyllum* cf. *minutum* SIMPSON, 1900, both of DOBROLJUBOVA (1936) from the Lower Permian of the Northern Urals, may possibly fit the diagnosis of that genus. Both these species are from the same locality and probably belong to a single species. These immature specimens were briefly restudied and are assigned herein, with some restrictions, to *Euryphyllum*. The relation of them to *Lytvolasma* was negated by SOSHKINA, DOBROLJUBOVA and PORFIRIEV (1941:105).

The specimens described in the present paper show several main characters of *Euryphyllum*. These are: underdevelopment of minor septa, lack of biformity of tabularium, development of the cardinal fossula and alar fossulae, acceleration in increase of major septa and their shorter length in counter quadrants, similar kind of reduction of thickness of major septa, and similar stereoplasmic junction of them in a corallite axis. Differences are only two, but they may be considered important: 1) Different morphology of tabularium, which in some specimens does not show an axial depression and can be compared to that in *Amplexizaphrentis* VAUGHAN, 1906 when sectioned in the cardinal-counter septa plan. In perpendicular section, the tabulae are almost horizontal or irregular (HILL 1938, pl. 1:3, 7, 11). Two other sections illustrated by HILL (1938, pl. 1:5, 9) show direction of growth lines of septa indicating a possible axial convexity of tabulae. If this is true, the presence or lack of axial depressions of tabulae may eventually be treated as an individual variation. 2) Shortening of the cardinal septum comparatively early in ontogeny. This character mentioned as absent in the generic diagnosis, is seen on pl. 1:6, 10 of HILL (1938) and even better on pl. 1:3 of HILL (1943). All these specimens were identified as belonging to the type species of the genus. The latter specimen is especially convincing in this respect, leaving almost no doubts that the section was made below the calice floor. This means that the cardinal septum was truly shortened within the fossula and not only along the calice wall.

The early ontogeny of *E. reidi* HILL, 1938 remains unknown. Thus, the species here described are only conditionally included in this genus, although their main differences may not be of large taxonomic importance, because of their possible variability in the type species of the genus.

There are several species assigned to different genera that may in fact be members of *Euryphyllum*. Lack of precise descriptions and illustrations made correct identifications of these species impossible. These are for instance some specimens described by WU (1975) and LIAO (1983) as *Lytvolasma* from the Lower Permian of Tibet; the early Upper Permian *Bradyphyllum longiseptatum* ZHAO, 1981 from Sichuan, China, may also be pointed out as belonging to this group.

The synonymy of *Euryphyllum* has not been completed because of lack of data on the ontogeny of its type species and because of the inadequate level of investigation of all its potential synonyms.

? *Euryphyllum robustum* sp. n.

(figs. 5:1—3, 6:1, 2; pls. 3:3, 4, 4:1—4)

e. p. 1963. *Amplexizaphrentis* sp. A. Ross and Ross; J. P. Ross and C. A. Ross, p. 412.

Holotype: Specimen USNM 196712, fig. 6:2a—d, pls. 3:3, 4:4.

Type locality: USNM 705a.

Type horizon: Lower Skinner Ranch Formation.

Derivation of the name: lat. *robustus, a, um* — robust, strong — after thickened structural elements.

Material. — The holotype, 11 paratypes and one unillustrated specimen of Ross and Ross (1963), USNM 139776 were available for the study. Several corallites possess partly preserved calices and proximal ends. Internal morphology is often well preserved in calcite.

Some features of representative corallites (in mm):

USNM cat. nos.	n:d ratio (average)	Remarks
196708	32:19.4	approx. 12 mm below calice floor
„	32:16.4	middle part of growth
„	27:11.6	late neanic stage
196709	32:14.5	9 mm below calice floor
196710	33:13.7	approx. 5 mm below calice floor
196711	31:17.3	4 mm below calice floor
196712	32:15.5	approx. 5 mm below calice floor
„	31:12.2	middle part of growth
„	25: 7.5	late neanic stage

Diagnosis. — ? *Euryphyllum* with n:d ratio as above; major septa thickened, joined eccentrically by stereocolumn; alar septa slightly elongated; tabulae concave axially.

Description of the holotype. — The specimen is slightly curved in the juvenile part and erect in the mature portion (pl. 3:3), with the cardinal septum located on its convex side. The partly broken calice is 18 mm deep, occupying approximately 1/3 of the corallite length. Foundations of the major and minor septa, equally developed in the marginal part of the calice, became differentiated gently towards its inner portion. The external surface of the corallite bears growth lines and delicate septal furrows.

Morphology of individual sections of the erect part of the corallite is similar up to the calice floor (fig. 6:2c, d). Major septa are pinnately arranged in quadrants, having those of the counter quadrants shorter, slightly thicker and accelerated in increase. In the counter quadrants, up to the calice floor and in the cardinal quadrants almost as long as that, the major septa are laterally contiguous along more than 1/3 of their inner portions. Initially small and not always present discontinuities (fig. 6:2a—c) enlarge successively in the course of growth, especially in the cardinal quadrants. Major septa in these quadrants become eventually much thinner than those in the counter quadrants (fig. 6:2d). Already in early maturity (fig. 6:2b) the cardinal septum is slightly shortened and much thinner than other major septa. It bisected the whole peripheral part of the cardinal fossula, not infilled with stereoplasm. In the uppermost sections (fig. 6:2c, d), the very deep cardinal fossula was sectioned above the last tabula. The cardinal septum and the last pair of the major septa in the cardinal quadrants are very short. The latter septa increased their length a little upwards.

The counter septum is slightly thicker and, in some sections, may be slightly longer than the adjacent major septa of counter quadrants (fig. 6:2c). The alar septa are the longest. Major septa in the cardinal quadrants tend to join inner ends of them, being either slightly irregular in length (fig. 6:2c) or pinnately arranged and successively shorter towards the cardinal septum (fig. 6:2d). The pinnate, allotropiophylloid arrangement of major septa in quadrants, the elongation of the alar septa and the underdevelopment of the last pair of the major septa in the counter quadrants, made the alar fossulae recognizable. The axial area of the corallite is occupied by a strong stereocolumn, present up to the calice floor. Minor septa are absent from the corallite lumen, but they are sometimes seen in the microstructure of the external wall.

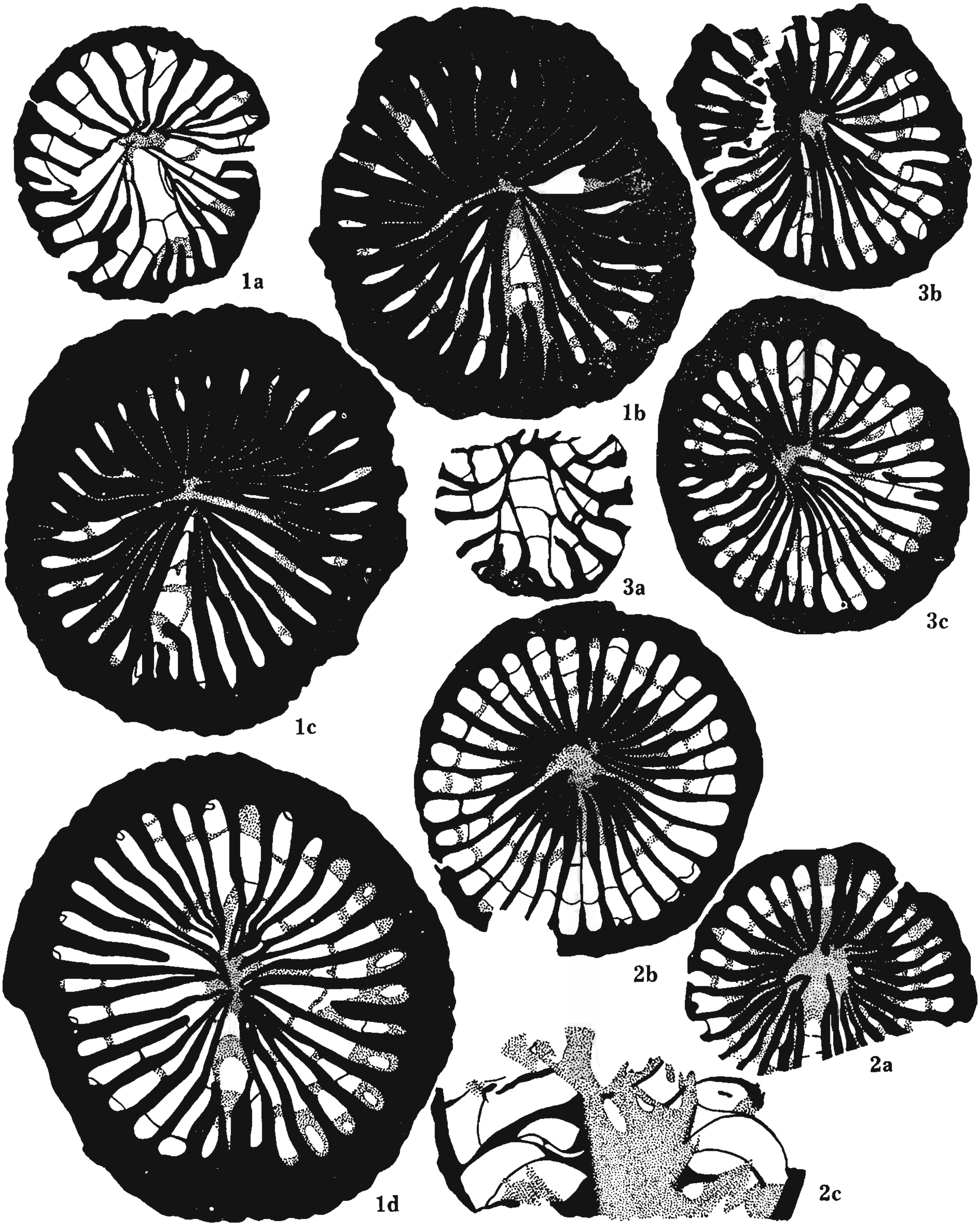

Fig. 5.

? *Euryphyllum robustum* sp. n .1. Specimen USNM 196708. Locality USNM 706x, Neal Ranch Formation. Transverse sections; a — late neanic stage; b, c — early ephebic stage; d — ephebic stage. All, ×4. 2. Specimen USNM 196709. Locality and horizon as above; a — transverse section, early ephebic stage; b — transverse section, ephebic stage, c — longitudinal section perpendicular to cardinal-counter septa plan. All, ×4. 3. Specimen USNM 196710. Locality and horizon as above. Transverse sections; a — neanic stage, ×8; b, c — ephebic stage, ×4

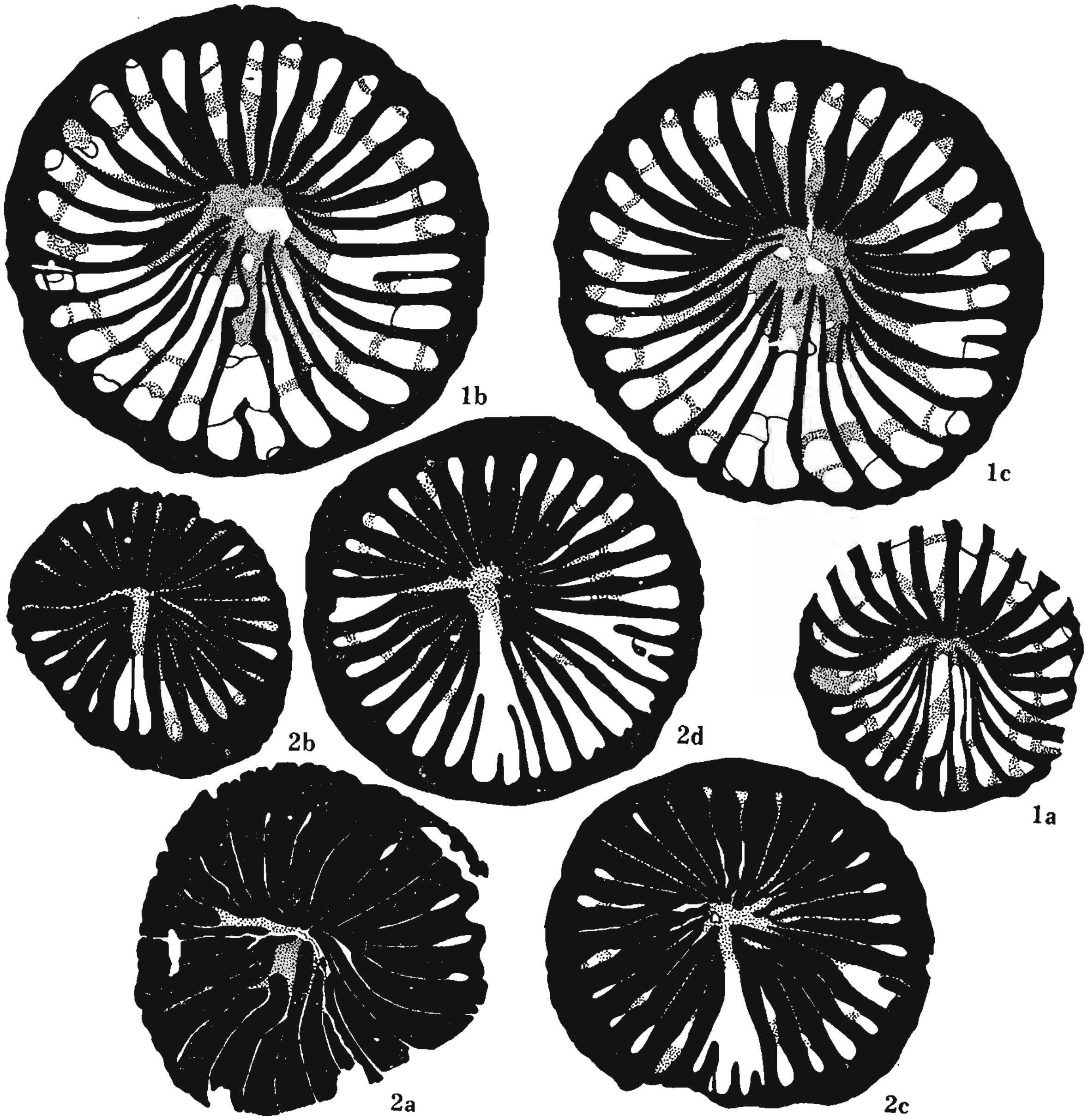

Fig. 6.
? *Euryphyllum robustum* sp. n. 1. Specimen USNM 196711. Locality USNM 706x, Neal Ranch Formation. Transverse sections. a — late neanic stage; b, c — ephebic stage. All, × 4. 2. Specimen USNM 196712. Holotype. Locality 705a, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse sections; a — neanic stage, × 8; b — early ephebic stage, × 4; c, d — ephebic stage; cardinal fossula sectioned above last tabula, × 4.

The ontogenetically youngest stage preserved (fig. 6:2a) with n:d ratio 23:7.2 shows the arrangement of the contiguous major septa allotropiophylloid with the septa of the counter quadrants convex towards the already shortened cardinal septum and directed towards the end of the counter septum. The latter dominates a little over the adjacent septa. The major septa in the cardinal quadrants are pinnately arranged. The cardinal fossula is completely filled in with stereoplasm and only one alar fossula is distinguishable.

Individual variation. — In spite of a small number of specimens available for the study, the species discussed exhibits considerable but disorderly individual variation. The specimens illustrated (figs. 5:1—3, 6:1; pls. 3:4, 4:1—3) exemplify the most important variants. One of them (fig. 5:3a—c; pl. 4:3a, b), with rather thin major septa through the whole preserved part of the corallite, may be compared (related?) to either? *E. profundum* sp. n. or *Allotropiochisma* (*Alligia*) *flabellum* sp. n. It does not possess minor septa in the lumen and its tabularium is not biform up to the calice floor, but it has highly uprising tabulae adjacent to the counter septum, a character observed in the holotype of the latter species. Another specimen (fig. 6:1a—c; pl. 4:2a, b) possesses most clearly allotropiophylloid arrangement of major septa with very short cardinal septum, but it has also the shortest major septa of all corallites in question.

The next specimen (fig. 5:1a—c) shows a symmetry closest to radial and the fairly long cardinal septum in the uppermost transverse section (fig. 5:2b). Its ontogenetically younger section differs from the former one in having a comparatively short cardinal septum destroyed by sectioning and the major septa disorderly arranged.

The last specimen discussed (fig. 5:1c—d; pls. 3:4, 4:1a—c) was doubtfully placed within this species, because of its axially narrowing cardinal fossula containing not only the early shortened cardinal septum, but also a permanently present pair of underdeveloped major septa. The section of this specimen made a few millimeters below the calice floor (fig. 5:1d) shows almost bilateral symmetry and only a very small stereocolumn. No other specimens within the collection studied compare more closely.

The ontogenetically earliest known transverse sections of all specimens discussed, the holotype included, show several characters in common. This is especially well seen in the arrangement of major septa and in early shortening of the cardinal septum. The early decrease in thickness of the major septa, permanent in one corallite (fig. 5:3a—c; pl. 4:3a, b) and replaced by a stage of thickened major septa in the other (fig. 5:1a—d) suggests that this character is possibly less important diagnostically.

The longitudinal sections studied do not differ in main characters from the illustrated one (fig. 5:2c). The tabulae are always widely spaced, hemisphaerical in periaxial parts and sagging axially. Tabellae may be present.

Remarks. — Several characters of the species discussed were mentioned in remarks to the genus, making further comparison with the type species and the Timor Island species unnecessary. It has also been compared to *Allotropiochisma* (*Alligia*) *flabellum* sp. n. and *Lytvolasma aucta* sp. n., the species showing some similarity to it. It differs from? *E. profundum* sp. n. in having calices much shallower when compared to the length of a corallite, much larger dimensions below calices, different n:d ratio, strongly thickened major septa and robust stereocolumn.

Occurrence. — Locality USNM 701p; 2; Gaptank Formation, *Uddenites*-bearing member; 701:2, 706x:4, Neal Ranch Formation; 705a:3, Lower Skinner Ranch Formation.

? *Euryphyllum profundum* sp. n.

(fig. 7:1—5; pls. 2:1, 3, 5—13, 4:5—7)

Holotype: Specimen USNM 196716, fig. 7:4a, b; pl. 2:13a, b.
Type locality: USNM 728f.
Type horizon: Lower Bone Spring Formation.
Derivation of the name: lat. *profundus, a, um* — deep — after very deep calices.

Material. — 32 silicified corallites; many with well preserved proximal ends and calices. Internal structure silicified. Majority of specimens immature.

Some features of representative specimens (in mm):

USNM cat. nos.	n:d ratio	Depth of calice	C septum side	Remarks
196719	28:17.2×17.2	15.0	?lateral	calice margin
„	23:11.0× 9.2			calice floor
196713	26:12.7×11.7	11.5	lateral	calice margin
„	19: 7.8× 6.7			calice floor
196716	22:12.3×12.3	12.0	convex-lateral	calice margin
„	19:11.2×10.2			calice floor
196723	19: 9.7× 9.0	7.0	concave	calice margin
„	16: 7.0× 6.0			calice floor
196715	16: 6.7× 5.0	4.0	convexlateral	calice margin

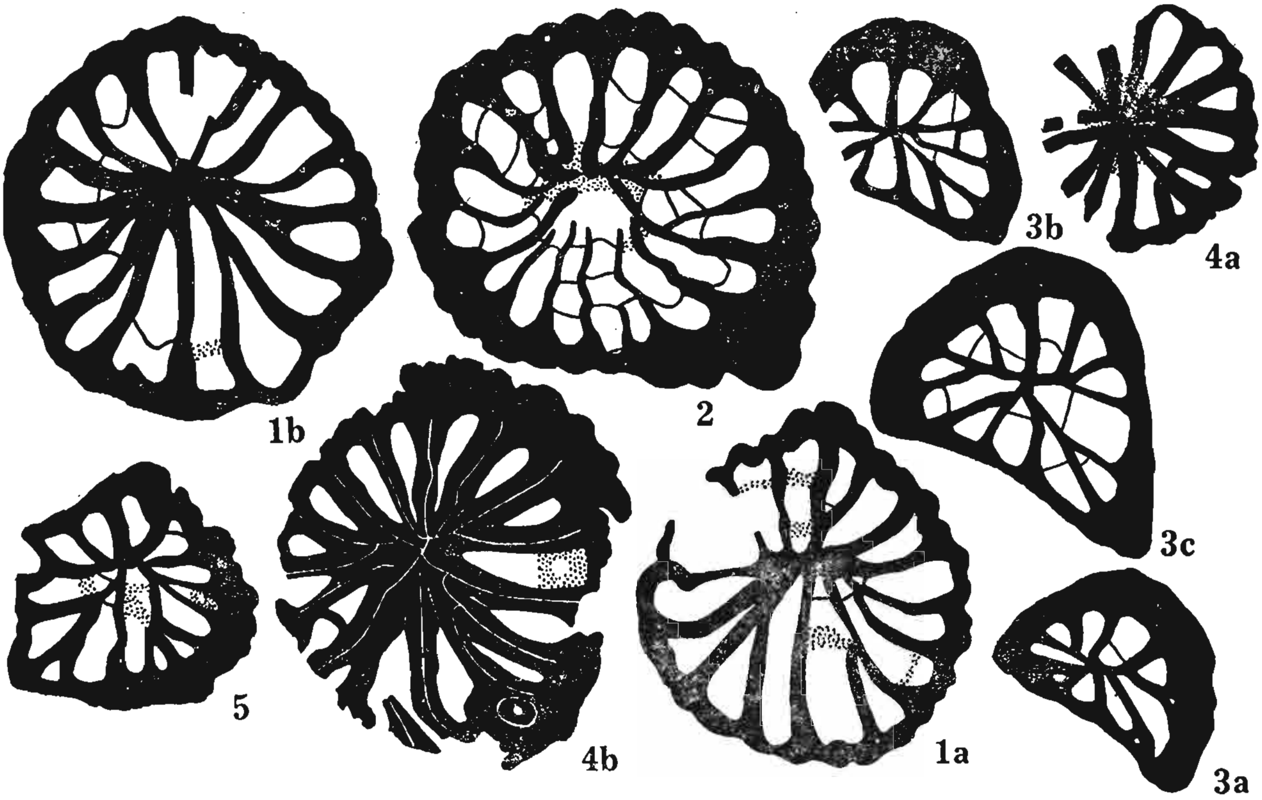

Fig. 7.

? *Euryphyllum profundum* sp. n. 1. Specimen USNM 196713. Locality USNM 728e, Lower Bone Spring Formation; a, b — transverse sections, neanic (?) stage, ×10. 2. Specimen USNM 196714. Locality and horizon as above. Transverse section, ephebic stage, ×10. 3. Specimen USNM 196715. Locality and horizon as above; a—c — transverse sections, neanic stage, ×20. 4. Specimen USNM 196716. Holotype. Locality USNM 728f, Lower Bone Spring Formation. Transverse sections; a — neanic stage, b — late neanic/early ephebic stage. Both ×10. 5. Specimen USNM 196717. Locality USNM 728e, Lower Bone Spring Formation. Transverse section, late neanic stage, ×10.

Diagnosis. — ? *Euryphyllum* with n:d ratio as above; calice very deep; major septa permanently thin; cardinal fossula closed axially, laterally bordered by successively shortened major septa.

Description of the holotype. — The preserved part of the corallite is 22.5 mm long at its convex counter side. Most of the surface is weathered out. Septal furrows on the preserved part are delicate and shallow (pl. 2:13a). The ontogenetically youngest part of the corallite is missing.

The calice (pl. 2:13b) is fairly well preserved, having a fragment of the topmost part present. Foundations of the major and minor septa at the calice margin are well developed, with the latter forming a kind of short blades at the lower margin of the peripheral zone of the calice. Due to an increase in thickness of the external wall, they become much less prominent in the inner zone of the calice, being recognizable almost to its floor, however. The major septa increase their length regularly downwards eventually closing the corallite axis. The cardinal septum, distinctly shortened on the corallite wall, is elongated along the cardinal fossula floor almost to the axial part of it. It does not form a distinct blade there but rather an elongated protuberation of the cardinal fossula floor. The counter septum is distinguishable by being a little longer than the counter-lateral septa. The latter join it laterally near its inner end. Inner ends of the remaining major septa of the counter quadrants are directed toward the end of the counter septum to form an inner border of the cardinal fossula, located a little eccentrically towards the counter septum. The last pairs of major septa in the counter quadrants are distinctly underdeveloped and the alar fossulae are well seen, although their axial parts are narrow.

The cardinal quadrants begin with the alar septa that are the longest septa of all. Their axial ends are slightly bent aside to reach inner ends of one to the last or earlier major septa of the counter quadrants to form a slightly widened inner end of the cardinal fossula. The following major septa are step by step shorter than the alars, having their inner ends bent aside similarly to the latter. Each of them meet the inner lateral part of the earlier increased major septum. In spite of the described decrease of length, the three first pairs of major septa in the cardinal quadrants are so long as to reach the inner part of the cardinal fossula. Only the last pair is more clearly underdeveloped. The cardinal fossula is closed axially and laterally owing to such an arrangement and shape of major septa.

In sections made from the youngest preserved part of the corallite (fig. 7:4a, b), the major septa are moderately thick, having the middle lines of almost all of them united in a zaphrentophylloid pattern. The cardinal septum located in the axially narrowing cardinal fossula meets the corallite axis. The alar fossulae are distinct, although the last pair of major septa in the counter quadrants are only slightly underdeveloped.

Individual variation. — Most of the specimens identified here as belonging to this species are ontogenetically young corallites (pl. 2:3a, b, 5a, b, 6a, b, 8a, b, 9a—c). Only a single specimen (pl. 2:1a—c) is larger than the holotype. It differs from the latter in having a different relation of the depth of the calice to the length of the corallite, because its calice is deeper. The morphology of the major septa in the cardinal quadrants and that of the cardinal fossula is in that specimen very similar to those in the holotype. The great shortening of the cardinal septum is apparent and was caused by dissolution (?) or damage (?) to the floor of the cardinal fossula. Major septa in the counter quadrants differ from those in the holotype by being more irregular and less clearly bent towards the counter septum. This is especially well seen in the left quadrant, where one of the metasepta is as long as the alar septum. Also, the counter septum is longer than other major septa on the celice floor. It does not differ from them in other portions of the calice, however. This elongation might have been caused by some asymmetry of the calice. No columella was formed, and the structure discussed was not evaluated herein as diagnostically important. The minor septa, well developed in the upper part of the calice, decrease to disappearance near its floor.

Underdevelopment of the minor septa in calices depends on the ontogenetic stage of corallites. The younger they are, the less well developed minor septa they possess in the inner portions of their calices. This tendency is observed also in the cross sections. Foundations of both cycles of septa are invariably present at calice margins of all well preserved corallites (pl. 2:1a—c, 5a, b, 7b, 8b, 10, 11b, 12a).

Some variation is observed in the development of the alar fossulae and in the morphology of the cardinal fossula, which may not contain any underdeveloped major septa in the early ontogenetic stage (pl. 2:3a, 7b). Being similar in this respect, they differ slightly in length of the cardinal septum. Some specimens have a rather long cardinal septum at this stage of growth (pl. 2:5b, 6a, 8b).

The early neanic stage (fig. 7:3a—c) is typically zaphrentoid and has a long cardinal septum. In further growth, observed on different corallites, the arrangement of major septa may be allotropiophylloid (fig. 7:1a—b, 2). The former specimen differs from the comparable stage of the holotype in having major septa in the counter quadrants much shorter than those in the cardinal quadrants, but accelerated in number. Also, the alar fossulae are less distinct in that specimen. The differences mentioned, as well as a slightly different calice morphology (pl. 2:11b), may eventually form the basis for elimination of this and similar corallites from the species discussed.

Remarks. — The described species differs from the type species first of all in not showing any strong thickening of structural elements. This has been observed at a fairly early growth stage, as well as in calices. Although I do not agree with OEKENTORP's (1980) concept that the thickening of the structural elements is totally inorganic (FEDOROWSKI 1986), I cannot accept a higher than specific value for this character, also, the subsequent shortening of major septa in the cardinal fossula and a tendency to shorten the cardinal septum are characters said to be absent in *E. reidi* HILL, 1938 (HILL 1938, 1981). These problems are discussed together with remarks on the genus. They form the main reason for the uncertainty of the generic status of the species described. The role of these characters is lowered by their variability in the early growth stage. Lack of information concerning the morphology of calices and early growth stages in *E. reidi* and the unknown morphology of the tabularium in ? *E. profundum* sp. n. made further comparison of these two species impossible.

Discussion on the similarity and/or relationship and differences of? *E. profundum* sp. n. to/from? *E. robustum* sp. n. and *Allotropiochisma* (*Alligia*) *flabellum* sp. n. are discussed under remarks on these species.

Occurrence. — Locality USNM 728e:28, 728f:3, AMNH 696:1, Lower Bone Spring Formation.

Subfamily Antiphyllinae ILINA, 1970
emend. WEYER, 1975 and in this paper

Type genus: Antiphyllum SCHINDEWOLF, 1952 = *Claviphyllum* HUDSON, 1942

Diagnosis. — Hapsiphyllidae with counter septum commonly elongated, never shortened; cardinal septum shortened late in ontogeny or only on calice wall; stereocolumn of early ontogeny often replaced by free axial area.

Remarks. — WEYER's (1975) concept of the subfamily status of Antiphyllinae within Hapsiphyllidae GRABAU, 1928, as well as several of his ideas concerning genera were adopted in this paper. Some differences with him and with HILL (1981), as well as some other data or deductions, required explanations that follow.

A group of genera included in this subfamily exhibits several morphological and ontogenetic characters in common. The characters most important diagnostically were composed in the table enclosed. Such features as distinct septal furrows and tabulae highly uprised adaxially but sagging in corallite axis were omitted from this table as either common for all genera (the former) or uncomparable due to the lack of data (the latter). Also the genus *Pseudobradyphyllum* DOBROLJUBOVA, 1940, a possible younger synonym of *Paracaninia* CHI, 1937 (WEYER and ILINA 1979), was excluded from this discussion. One of the characters selected by HILL (1981) as diagnostic, i. e. location of the cardinal septum on the convex side of corallites was confirmed in the species of *Bradyphyllum* GRABAU, 1928 here described as being variable even on a species level.

TABLE 4

Morphologically-comparative table of Antiphyllinae Ilina, 1970

Name of genus	Cardinal septum	Cardinal fossula	Counter septum	Alar septa	Major septa
Actinophrentis Ivanowski, 1967	Shortened on calice floor	Reaching corallite axis, narrowing adaxially	Slightly to distinctly elongated	Slightly elongated or equal to major septa	Pinnately arranged, almost reach corallite axis
Bradyphyllum Grabau, 1928	"	Triangular, not reaching corallite axis	Slightly elongated at least in neanic stage	Often slightly elongated in neanic stage	Radially arranged, leave free axial area
Claviphyllum Hudson, 1942	"	"	Elongated to form incipient columella	Shortened	Zaphrentoidally or radially arranged; often rhopaloid
Falsiamplexus gen. n.	Variable	Inconspicuous, shallow	May be slightly elongated	Equal to other major septa	In maturity short, radially arranged; aulos in neanic part
Lytvolasma Soshkina, 1925	Shortened on calice floor	Key-hole in maturity	Slightly elongated at least in neanic stage	In neanic stage slightly elongated	Pseudoradial; often thicker in cardinal quadrants; straight
Monophyllum Fomichev, 1953	"	Widened adaxially, reaching corallite axis	Elongated to form incipient columella	"	Radially or pseudoradially arranged; meet in axis
Rotiphyllum Hudson, 1942	Shortened on calice wall, long on floor	Reaching corallite axis, narrowing adaxially	More or less elongated	Longest of quadrants in neanic stage	Radially arranged; meet in axis; may tend to shorten

Genus *Claviphyllum* Hudson, 1942 and its younger synonym *Antiphyllum* Schindewolf, 1952, emended by Weyer (1974), are best characterized by underdevelopment of alar septa in the ephebic stage. Underdevelopment of the counter-lateral septa, elongation of some metasepta in quadrants and the rhopaloid character of a counter septum and ats elongation, stressed by Hill (1981:F310), are not always well developed but may serve as supplementary characters. Contratingent versus shortened minor septa as a possible generic (subgeneric) character should not be considered because of the late and step by step appearance of them in ontogeny. A concept by Hill (1938—1941, 1981) and Hudson (1942) supported by Weyer (1975) including specimens with and without contratingent minor septa in this genus is thus followed also in this paper.

The characters listed above make *Claviphyllum* a readily distinguishable genus. *Clavilasma* Weyer, 1975 is also distinct except for its close similarity to *Claviphyllum*. In this respect its independent generic status may well be questioned. Metriophylloid carination, the only character distinguishing it from *Claviphyllum* may not be adequate for generic distinction. Lack of carinae in all known sections of two paratypes of the type species of this genus, Weyer (1975:764), with only five specimens studied also casts doubt. Carination in this instance may well be a specific character. This question is left open, however, because of its more general meaning concerning subjectivity in evaluation of rank of diagnostic characters in rugosans.

Rotiphyllum HUDSON, 1942, recently discussed by Weyer (1975, 1977), was widely interpreted by authors, which might have resulted from inadequate knowledge of the morphology of the type specimen of its type species. Shortening of major septa and development of a free axial area in *Bradyphyllum* GRABAU, 1928 were stressed by HUDSON (1942:258) as such an important distinction that "the similarity of structure in early growth stage in *Bradyphyllum* to that in the adult *Rotiphyllum* may be due to the operation of similar trends and does not necessarily imply a *Rotiphyllum* to *Bradyphyllum* lineage or even any genetic relationship". However, the same author, (HUDSON 1944) introduced subspecies *R. rushianum cavum* characterized by a free axial area of an aulos type. The diagnostic importance of shortening versus non-shortening of major septa was acknowledged also by HILL (1981: F312), but it has not been accepted by WEYER (1977), who placed the short-septal *Fasciculophyllum simplex* SCHINDEWOLF, 1952 in *Rotiphyllum.* Also, species assigned to *Rotihyllum* by de GROOT (1963) possess narrow free axial areas. The cardinal septum, not shortened at a calice floor would remain the only difference of such species from *Bradyphyllum.* This kind of interpretation leads towards considering all *Bradyphyllum*-like corals with a cardinal septum shortened only on a calice wall as members of *Rotiphyllum.* All specimens described as *Bradyphyllum* by de GROOT (1963) are good examples. Such an approach emphasizes the diagnostic value of elongation of a cardinal septum along a fossula floor over such characters as shortening of major septa and equalling of a counter septum to the length of other major septa. In spite of the singularity of this a character, I will follow that concept, because the latter two characters change also in other genera included in the subfamily discussed, while the former must be so far considered constant. The long cardinal septum shown by a single transverse section of the holotype of *Bradyphyllum bellicostatum* GRABAU, 1928 (pl. 2:11d) may be either an ontogenetic remnant or an incidentall, short lasting elongation. In indicating variability also in this a character, i. e. the last one to distinguish *Bradyphyllum* from *Rotiphyllum,* we have to accept a very broad genus concept. Such a concept, although possible, is not accepted here because of too many different morphotypes being included in it. I suspect that given combinations of characters, established as generic, appeared independently several times within this group of corals, which makes a linear generic concept doubtful.

Observations on the species described in this paper, as well as better confirmed literature data, permit the conclusion that the type species of *Bradyphyllum* GRABAU, 1928 and *Rotiphyllum* Hudson, 1942 adequately prove their distinct generic identifications, but several other species included in either of these genera show more and more intermediate characters, a mosaic-like occurrence of which retouches the sharpness of the inter-generic boundary. This may be exemplified starting with *Bradyphyllum differentiatum* FEDOROWSKI, 1973 from the *Wocklumeria* or *Gattendorfia* stage of Poland. This geologically oldest known species of bradyphylloid morphology exhibits shortening of major septa and slight elongation of the counter septum typical for *Bradyphyllum,* having at the same time the cardinal septum only slightly shortened. Such a morphology may indicate its origin from a hypothetical *Rotiphyllum*-like species by means of shortening of major septa, but true rotiphylla are not known to occur at this geological level. WEYER (1975:756) mentioned a presence of non-typical rotiphylloid species having long minor septa at the counter septum in the *Gattendorfia* Stage in the Rheinisch Schiefergebirge. On the other hand, however, well accentuated elongation of the counter septum and alar septa brings *B. differentiatum* close to the oldest known soshkineophylla and the family Polycoeliidae de FROMENTEL, 1861 as a whole, which has already been discussed earlier (FEDOROWSKI 1973:105), offering a reason for including *Bradyphyllum* in Polycoeliidae. Such a trend has not been observed in true rotiphylla, but its remnats may be found in several but not all bradyphylla, those described in the present paper included. Several trends of development or morphotypes of early ontogeny observed in *Bradyphyllum* (see discussion of this genus) makes possible an origin of them from different ancestors.

Also, *Rotiphyllum* HUDSON, 1942, if its concept and synonymy of WEYER (1975) and HILL

(1981) is accepted, contains species so distinct morphologically as Tournaisian *R. omaliusi* (M.-E. and H., 1851), Namurian *R. simplex* (SCHINDEWOLF 1952) or Moscovian *R. sokolovi* (FOMICHEV 1953). No direct linkeage between these species is possible to presume. There is also no other common lineage or stock of *Rotiphyllum;* the mentioned or other species could have been derived from each other on a different geological level which is the only way to accept the natural relation within the genus. Composition of similar morphotypes, whose relation may or may not be close even on the discussed subfamily level is thus preasumed as it was in the case of the *Bradyphyllum.* Each appearance should therefore be treated individually, but the common generic name may be convenient to use on the recent level of knowledge of these taxa, unless their distinct origin is established.

The type specimen (not seen) of *R. rushianum* (VAUGHAN 1908), as well as the specimens of this species described by HUDSON (1944) and housed in the British Museum (Natural History) examined by me, exhibit characteristic peripheral thickenings of major septa. In transverse section the microstructure of these thickenings show disjunction of the middle lines of septa and formation of structures similar to those called "Stirnen" by SCHOUPPÉ and STACUL (1955). Similar disjunctions were interpreted by OEKENTORP (1980) as diagenetically caused. Such an interpretation cannot be accepted in the case discussed, because none of the numerous taxa found in the same locality and influenced by the same diagenetic factors exhibits similar alterations of septa. It should rather be natural, of biological not diagenetic origin, and might have resulted from specialised growth of major septa. Only observations in calices may fully confirm the above interpretation. The taxonomic rank of such a character may well be considered lower than generic, however.

In contrast to de GROOT (1963), WEYER (1975) and HILL (1981), I do not consider *Monophyllum* FOMICHEV, 1953 a junior synonym of *Rotiphyllum* HUDSON, 1942. As mentioned above, the long cardinal septum remains in fact the only constant difference between *Rotiphyllum* and *Bradyphyllum* GRABAU, 1928. If the synonymy mentioned above is accepted, this difference also disappears and we have to accept a single genus that contains most genera and species included by HILL (1981) in Antiphyllinae (ILINA 1970) and lasts from the uppermost Devonian or lowermost Carboniferous to Upper Permian. This is unacceptable in the context of the discussion so far. Differences between *Monophyllum* and most closely related genera are discussed with that genus.

Actinophrentis IVANOVSKI, 1967 was unambigously synonymized by WEYER (1975) with *Rotiphyllum* HUDSON, 1942. Also HILL (1981) supposed it a possible synonym of that genus. My position on this question is opposite, which is discussed under remarks on that genus.

Two genera included by WEYER (1975) in Antiphyllinae ILINA, 1970, namely *Saleelasma* WEYER, 1970 and *Drewerelasma* WEYER, 1973 were synonymized and included by HILL (1981: F309) in the family Stereolasmatidae FOMICHEV, 1953. The concept of this family and its content proposed by FOMICHEV (1953) cannot be followed and was completely changed by HILL (1981) in accordance with the morphology and possible relations of its type genus *Stereolasma* SIMPSON, 1900. Omitting further remarks on Stereolasmatidae, I follow HILL's (1981) concept in excluding *Saleelasma* and *Drewerelasma* from Antiphyllinae. This is again without comments on their synonymy, which does not seem certain to me. Two characters of these genera advocate for excluding them from Antiphyllinae: a tendency to shorten a counter septum and elongation of counter-lateral minor septa so as to form a triad. The latter is not accompanied by a tendency of any other minor septa to elongate. WEYER (1975, fig. 1) tried to lessen the value of the first trend by showing a picture of an otherwise rhopaloid specimen that has the counter septum withdrawn from the corallite axis. Being slightly shorter than some other major septa in this calicular section, this septum remains longer than the septa adjacent to it, which is not the case of *Saleelasma* (e. g. WEYER, 1970, pls. 2:6, 7; 4:4, 5, 10; 5:6—8). It may be shortened also beneath the last tabula, which is shown on pl. 7:6 of the same paper. *Drewerelasma* sp. of

WEYER 1975 does not show such a shortening, but the holotype of the type species of this genus exhibits a rapid shortening of all septa in counter quadrants in the calice (WEYER 1973, figs. 3—6). Without considering how these characters fit with the Devonian Stereolasmatidae it has to be said that such a trend is opposite to that commonly observed in Antiphyllinae.

Development of a triad, a second questioned character of the genera discussed, can appear in Antiphyllinae, but only as a result of step by step enlargement of the length of the minor septa, beginning with the counter-lateral minor septa. It thus has to be classified as a trend opposite to that observed in the genera discussed, where it is rudimentary from earlier existing contratingent minor septa, reduced already on the level of development of these genera.

The situation is different as far as so-called *Stereolasma* of FOMICHEV 1953 *non* SIMPSON 1900 is concerned. At least some, of not all, species attributed to this genus by FOMICHEV (1953) should be left in Antiphyllinae, although the generic status of them *Rotiphyllum* (?), *Bradyphyllum* (?), *Monophyllum* (?), other genera (?) is mainly disputable and is left open in this paper.

HILL (1981: F316) chose *Parastereophrentis virgata* FOMICHEV, 1953 as the type species for the subgenus. She simultaneously put it in synonymy with *Zaphrentites* HUDSON, 1941. Reexamination of the remaining part of the holotype of *P. virgata* (fig. 25:6) shows its close relation to *Lytvolasma* SOSHKINA, 1925, which is supported also by younger stages of this specimen, illustrated by FOMICHEV (1953, pl. 7:5a—v), closely comparable to younger portions of the corallites here described (see discussion of *Lytvolasma*). Paratypes of *P. virgata* show large differences in morphology, and at least some of them belong to other taxa. *P.* ? *invalida* FOMICHEV, 1953 (fig. 25:4, 5 in this paper) discussed together with *Allotropiochisma* FEDOROWSKI, 1982, may probably be included in that genus.

Genus *Actinophrentis* IVANOVSKI, 1967

Type species: A. donetziana FOMICHEV, 1953

Synonyms: ? e. p. *Stereolasma* FOMICHEV, 1953 *non* SIMPSON, 1900, ? *Longiclava* EASTON, 1962.
Geographic and stratigraphic range: USSR, Donetz Basin, Upper Moscovian; USA ? Montana, ? Upper Mississipian Texas, Wolfcampian.

Diagnosis.— Small, solitary corals without dissepimentarium; major septa pinnately arranged up to calice floor, united axially by stereocolumn; cardinal septum shortened from early maturity; counter septum permanently elongated, distinctly or moderately; cardinal fossula meets or almost meets corallite axis; minor septa underdeveloped.

Remarks. — This genus, introduced by FOMICHEV (1953), was invalid until IVANOVSKI (1967:40) designated *A. donetziana* FOMICHEV, 1953 as its type species. Its synonymy with the Lower Carboniferous *Densiphyllum* of Britain (= *Rotiphyllum* HUDSON, 1942), suspected by FOMICHEV (1953:70), was fully accepted by IVANOVSKI (1967:40) and WEYER (1975:759). The latter author qualified this genus as an unambiguous synonym of *Rotiphyllum*. HILL (1981:F310) accepted this synonymy with an interrogation mark. Two characters of *Actinophrentis* support that synonymy: presence of a constant stereocolumn and pinnate arrangement of major septa. The latter character is true only if corals of the "*Zaphrentis*" *omaliusi* M.-E. and H., 1851 group of species is considered congeneric with *R. rushianum* (VAUGHAN, 1908).

Characters diagnostically more important, in my opinion, advocate against such a synonymy. Two of them are derived from the holotype of the type species of the genus. These are: 1. Early shortening of the cardinal septum that only reaches stereoplasmic column in the immature transverse section (FOMICHEV 1953, pl. 1:23a) and does not penetrate it to the corallite axis as all unambiguous rotiphylla do. Shortening of this septum increases with growth. The uppermost section illustrated by FOMICHEV (1953, pl. 1:23v), although incomplete, shows an axial part of the cardinal fossula with no trace of the cardinal septum. The section of a tabula crossing the cardinal fossula at the limit of the preserved part of the section proves the supratabular position of at least this part of the section. Also two sections of tabulae seen in a well preserved septal loculus in one of the counter quadrants may indicate that the strange fabric that fills in interseptal loculi does not necessarily prove the calicular position of the whole section. Shortening of the cardinal septum in true rotiphylla may take place only in calices or, strictly speaking, along calice walls, not along their floors. This makes a substantial qualitative difference when compared e. g. to *Bradyphyllum*, possessing a truly shortened cardinal septum, i. e. the septum not reaching a corallite axis along the floor of a cardinal fossula. It seems necessary to point out that in accordance to the concept here accepted of the subfamily Antiphyllinae ILINA, 1970, similar to that of WEYER (1975) and HILL (1981), the shortening versus non-shortening of the cardinal septum is considered of generic rank. 2. In contrast to *R. rushianum* (VAUGHAN 1906) and other unambiguous rotiphylla, the holotype of *A. donetziana* retains a pinnate arrangement of septa up to its topmost part illustrated.

The next argument against synonymy of *Actinophrentis* with *Rotiphyllum* is a trend of development of a very strong counter septum, observed in geologically youngest specimens placed within *Actinophrentis*, but never developed in *Rotiphyllum* to such an extent.

The characters listed above form a set of features closely comparable to *Allotropiochisma* (*Alligia*) subgen. n., bringing *Actinophrentis* together with *Lytvolasma* SOSHKINA, 1925 close to Hapsiphyllinae Grabau, 1928. There are no strong arguments, except for comparative ones — for considering *Actinophrentis* a member of Antiphyllinae rather than Hapsiphyllinae. These comparative arguments are based on a close similarity of that genus to *Monophyllum* FOMICHEV, 1953 and *Rotiphyllum* HUDSON, 1942, i. e. the genera it was synonymized with by authors. A trend towards an increase of length and size of the counter septum is most important for this comparison. Columnate genera placed within Hapsiphyllinae are not comparable to the type genus of this subfamily and should be eliminated from it.

An arrangement of septa in the neanic stage of *A. donetziana* FOMICHEV, 1953 described as radial by HILL (1981:F310) should in fact be called pinnate. The reexamined thin section, poorly illustrated by FOMICHEV (1953, pl. 1:23a) shows this unambiguously at least as far as the cardinal quadrants and right counter quadrant are concerned. Lack of distinct lateral pseudofossulae may be the only reason for not regarding this morphology as truly zaphrentoid. It is better accentuated in the species here described (figs. 8, 9). Such an arrangement of septa in early ontogeny is frequent in Hapsiphyllinae as well as in Antiphyllinae and cannot advocate for placing *Actinophrentis* in either subfamily.

Stereolasma monophylloides FOMICHEV, 1953, in contrast to its name, is a species closer to *A. donetziana* FOMICHEV, 1953 than to other species. Better accentuated zaphrentoid arrangement of major septa in the neanic stage and almost unelongated counter septum are the main differences between these two species. More careful restudy of the FOMICHEV's (1953) collection is required to establish a true relation of these corals.

Genus *Longiclava* EASTON, 1962 was introduced by that author for small, solitary corals with "... a long counter septum... (axially swollen)", and "the cardinal fossula on the convex side of the corallite". These characters and rhopaloid septa near the counter septum allowed EASTON (1962) to place his new genus within the family Plerophyllidae KOKER, 1924 and to compare it most closely to *Fasciculophyllum* THOMSON, 1883, *Claviphyllum* HUDSON, 1942, and *Rotiphyllum* HUDSON, 1942. Such a family assignment is not supported by any significant morphological characters, while elongation of a counter septum in this genus is in contradiction to the diagnosis of this family. Any detailed discussion in this respect is thus not required. A comparison on the generic level made by EASTON (1962) is important, however, as being indicative of the suspected relation of *Longiclava*. All three genera compared belong to Antiphyllinae ILINA, 1970 in the sense of WEYER (1975) and HILL (1981), accepted in its main part in this paper. Also, *Longiclava* should be placed in this subfamily rather than in Hapsiphyllinae GRABAU, 1928, as proposed by HILL (1981).

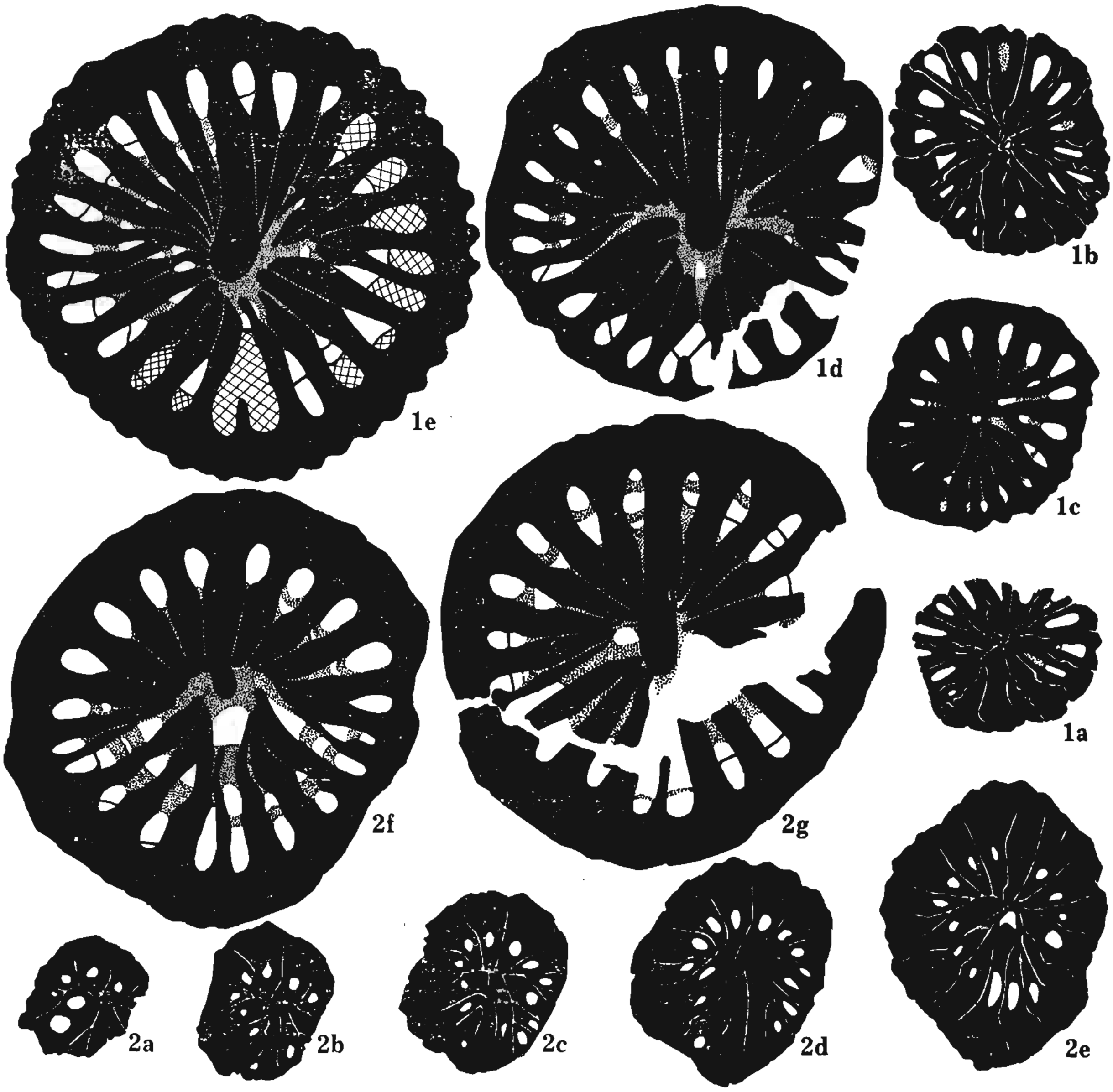

Fig. 8.

Actinophrentis columnare sp. n. 1. Specimen USNM 196726. Locality USNM 702t, Neal Ranch Formation. Transverse sections; a—c — neanic stage; d — ephebic stage; e — ephebic stage; parts above last tabula shaded. All, × 8. 2. Specimen USNM 196727. Holotype. Locality USNM 706x, Neal Ranch Formation. Transverse sections; a—e — neanic stage; f, g — ephebic stage. All, × 8.

The main characters of this genus are in agreement with the diagnosis of *Actinophrentis*, except for shortening of some major septa near the cardinal fossula on a calice floor. This character, shown by the paratype illustrated by EASTON (1962, pl. 3:23b), is confirmed by the section of the holotype (fig. 25:7 in this paper) made above those illustrated by EASTON (1962, pl. 3:21a, b). Evaluation of it may be different: either as unimportant, which will confirm synonymy of this genus with *Actinophrentis*, or as having some taxonomic value. In the latter case, the Chesterian *Longiclava* may be considered ancestral for *Actinophrentis*.

Actinophrentis columnare sp. n.

(fig. 8:1, 2; pls. 3:1, 2, 5, 6, 4:8, 9, 11)

Holotype: Specimen USNM 196727, fig. 8: 2a—g, pl. 4:9a, b.
Type locality: USNM 706x.
Type horizon: Neal Ranch Formation.
Derivation of the name: columnare — after strong, elongated counter septum in maturity.

Material. — Eight specimens having proximal ends and calices at least in part preserved. Internal structure mainly calcitic, in some corallites silicified. A cardinal septum located on the concave side in six corallites, in one on the convex side and in one on the lateral side. N:d ratio at calice floor vary from 20:8.0 in the holotype to 24:9.5 in the largest parytype.

Diagnosis. — *Actinophrentis* having maximum n:d ratio at calice floor 24:9.5; counter septum thick at maturity, elongated so as to meet corallite axis; cardinal septum shortened from early maturity; neanic stage zaphrentoid, having long cardinal septum.

Description of the holotype. — The corallite is a worn specimen whose external surface is slightly abraded and whose upper part of the calice is broken. The better preserved parts of the thick external wall bears distinct furrows of major and minor septa, although the latter are undistinguishable inside the corallite even in the lower and middle parts of the calice. The upper portion of the corallite was partly broken diagenetically by a strong mechanical impact. A distinct counter septum is the main character of the calice. It occupies an axial part of the corallite, forming a weak columella touched by almost all major septa.

The mature morphology seen in transverse sections (fig. 8:2f, g) is characterized by a pinnate arrangement of long major septa thickened adaxially along 1/3 of their inner length to contiguity. Their peripheral parts are also thickened. The described arrangement of major septa is reflected in development of alar pseudofossulae that are more prominent in the ontogenetically younger section (fig. 8:2f). They are emphasized here by an underdevelopment of the last pair of major septa of the counter quadrants. An increase in septa is distinctly accelerated in these quadrants.

Lengths of the cardinal and counter septa exhibit opposite tendencies in the course of mature growth of the corallite: the cardinal septum became quickly and distinctly shortened, while the counter septum, only slightly elongated on the ontogenetically younger section (fig. 8:2f), became overwhelmingly dominating upwards (fig. 8:2g). The cardinal fossula extends to the corallite axis. Its inner part, widened in early maturity, narrowed adaxially upwards, which is also seen in the calice.

Ontogeny. — An arrangement of septa in the ontogenetically youngest portion of the corallite was disturbed by a commensal organism (fig. 8:2a, b). Because of this the arrangement of septa became more clearly zaphrentoid starting only from the next section (fig. 8:2c). Acceleration in increase of septa was not obvious at the beginning of growth, being marked only be the first appearance of septa in counter quadrants (fig. 8:2a—d). Separation of middle lines of septa, the cardinal and the counter in this number, seems to be diagenetic in character. Elongation of the latter two septa is seen as early as on this stage (fig. 8:2c, d). Starting from the stage that can be called late neanic (fig. 8:2e), the cardinal septum tends to shorten. The same section shows elongation of the alar septa that meet an axial end of the slightly elongated counter septum. The cardinal fossula and the alar pseudofossulae are already distinct.

Individual variation.— The majority of paratypes do not show strong elongation of the counter septum (pl. 3:1, 5, 6). This resulted from the fact that development of the counter septum was more strongly accentuated only in late maturity, while majority of specimens studied did not reach such an advanced stage of growth. The fully mature corallites (fig. 8:1a—e; pl. 3:2) have the counter septum strongly elongated without losing the pinnate arrangement of major septa up to the calice floors.

Zaphrentoid arrangement of major septa in the neanic stage described for the holotype was confirmed by the morphology exposed on the tips of some paratypes and in series of transverse sections of one paratype (fig. 8:1a—c; pl. 4:8a, b).

Remarks. — The species described differs from the type species in the strong thickening and elongation of the counter septum and in the more clearly zaphrentoid arrangement of septa in the neanic stage. The first of these characters was discussed above as being developed only in advanced maturity, which indicates that it is a specific character. The zaphrentoid ontogeny may be interpreted as a distinctly quantitative character.

A. columnare sp. n. shows some similarity to *Monophyllum cassum* sp. n., which is especially well seen in the late neanic and early ephebic growth of some specimens of the latter and especially in its holotype (fig. 23:1c, d). Both ontogenetically earlier and later growth stages of that species differ distinctly enough from *A. columnare* sp. n. to confirm different systematic positions of these taxa. As in some other species and genera of the subfamily discussed, the similarity mentioned documents the relation of American representatives of these taxa.

Occurrence. — Locality USNM 701:3, 701c:1, 701d:1, 702t:1, 706x:1, Neal Ranch Formation, ?7221:1, Skinner Ranch Formation, Sullivan Peak member.

Actinophrentis bonespringense sp. n.

(fig. 9:1a—e; pls. 3:8, 9, 13, 15, 4:10)

Holotype: Specimen USNM 196731, fig. 9a—e; pls. 3:8a—d, 4:10a—d.
Type locality: USNM 728e.
Type horizon: Lower Bone Spring Formation.
Derivation of the name: bonespringense — after the type stratum.

Material. — Six externally silicified corallites with well preserved calices, but with proximal ends and internal structure either silicified or slightly destroyed by etching.

Some features of representative corallites (in mm):

USNM cat. nos.	n:d ratio	C septum side	Length	Depth of calice	Remarks
196731	21:9.5	lateral	14.0	7.2	calice margin
»	18:5.0				„ floor
196733	17:5.5	concave	12.0	6·0	„ margin
»	15:3.0				„ floor
196734	16:7.0	lateral	15.0	7.3	„ margin
»	15:5.2				„ floor
196735	16:7.0	convex	11.0	6.0	„ margin
»	15:4.1				„ floor
196732	15:4.3	lateral	9.0	5.0	„ margin

Diagnosis. — *Actinophrentis* having n:d ratio up to 21:9.5 and calices occupying 1/2 length of corallite; counter septum moderately elongated; minor septa seen only at calice margin.

Description of the holotype. — The broadly ceratoid corallite widens suddenly upperwards. Deep septal furrows at the corallite surface are separated by wide, hemispherical interseptal ridges. Growth striae, except for the strongest ones, were destroyed by silicification (pl. 3:8b).

The major part of the calice volume is empty because the blades of the major septa do not extend more than 0.7—1.0 mm from the external wall (pl. 3:8c, d). They are comparatively longer on the calice floor, where the calice itself is also narrower, making connection of their inner ends possible. The arrangement of major septa is typical for the genus: radial on the calice wall and pinnate on its floor. The deep cardinal fossula, bordered by two major septa only, reaches the inner end of the elongated and slightly thickened counter septum. The latter does not form a columella but its domination is clear. The cardinal septum penetrates approximately 1/2 the length of the cardinal fossula. The alar fossulae are inconspicuous but recognizable. Foundations of the minor septa, seen on the calice margin, do not transfer into septal blades and disappear completely inside the calice.

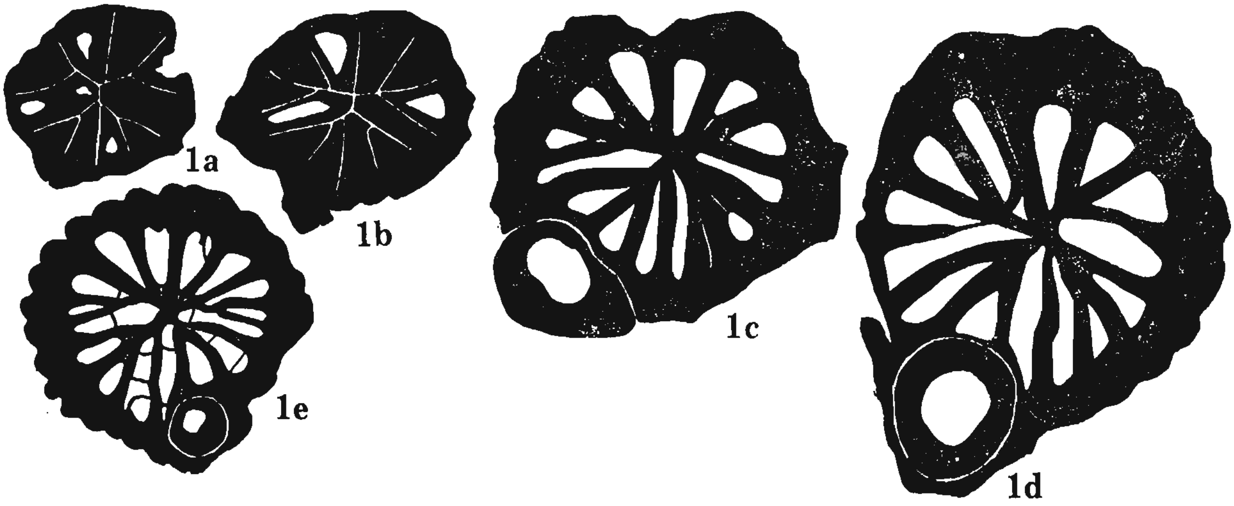

Fig. 9.

Actinophrentis bonespringense sp. n. Specimen USNM 196731. Holotype. Locality USNM 728e, Lower Bone Spring Formation. Transverse sections; a, b — early neanic stage, ×20; c, d — neanic stage having worm tube embedded into external wall, ×20; e — late neanic/early ephebic stage, ×10.

In the transverse section made approximately 1.5 mm below the calice floor, the morphology is slightly deformed by a commensal worm. The arrangement of the major septa is otherwise zaphrentoid, with the cardinal fossula and alar fossulae well developed. The long cardinal septum bisects the fossula to reach the corallite axis. The cardinal septum, although reaching the same region and being slightly thicker than other major septa, does not dominate (fig. 9:1e). Serial transverse sections of the neanic portion of the corallite (fig. 9:1a—d) show zaphrentoid morphology, with the new major septa increasing first in the counter quadrants but with no acceleration in these quadrants.

Individual variation.— All paratypes are ontogenetically younger than the holotype, showing such juvenile characters as very little elongation of the counter septum and an advanced underdevelopment of minor septa. In two corallites the counter septum is either slightly better developed (pl. 3:9a) or may form a kind of axial knob (pl. 3:12b). Variability in this a character and in position of the cardinal septum (see table) are of major importance. The better developed counter septum was located either on a convex or on a lateral side of the corallites.

Remarks. — The described species more closely resembles *A. columnare* sp. n. than *A. donetziana* Fomichev, 1953 which is best reflected in its early ontogeny. It differs from both these species in having a different n:d ratio, a weaker stereocolumn, thinner major septa and, first of all, in possessing very deep calices, causing the juvenile character of the morphology in sections. *A. bonespringense* sp. n. differs additionally from *A. columnare* sp. n. in not developing a very strong counter septum and from *A. donetziana* Fomichev, 1953 in having narrower cardinal fossula.

Occurrence. — Loc. USNM 728e:5, 728h:1, Lower Bone Spring Formation.

Genus *Bradyphyllum* GRABAU, 1928

Type species: B. bellicostatum GRABAU, 1928

Synonyms:

Zaphrentis WHITE, 1884; NEWELL, 1935; DEMANET, 1943
non RAFINESQUE CLIFFORDS, 1820
Hapsiphyllum GIRTY, 1915; e. p. HERITSCH, 1941, ? e. p. MOORE and JEFFORDS, 1945 *non* SIMPSON, 1900
? *Meniscophyllum* HERITSCH, 1940, *non* SIMPSON, 1900
? *Zaphrentoides* HERITSCH, 1941, *non* STUCKENBERG, 1895
? *Paracaninia* MOORE and JEFFORDS, *non* CHI, 1937
e. p. *Allotropiophyllum* FOMICHEV, 1953, *non* GRABAU, 1928
Fasciculiamplexus EASTON, 1962
e. p. *Amplexizaphrentis* ROSS and ROSS, 1963; ROWETT and SUTHERLAND, 1964, *non* VAUGHAN, 1905
Non Bradyphyllum HERITSCH, 1936, 1937, 1939; ? de GROOT, 1963; ROWETT, 1969; HOMANN, 1971; FLÜGEL, 1973; LO and ZHAO, 1962; ZHAO, 1981

Diagnosis. — Antiphyllinae having cardinal septum long in early ontogeny, shortened in maturity below calice floor; cardinal fossula triangular, not reaching corallite axis, located on various sides; counter septum slightly elongated, at least in early ontogeny; major septa radially arranged, shortened to form free axial area; tabulae highly rising adaxially, sagging in axial portions.

Remarks. — The list of synonyms proposed is only approximate. Most of suspected synonyms are only conditional because of the lack of precise descriptions and illustrations and the possibility of different identifications. Their relation or similarity to *B. bellicostatum* GRABAU, 1928 is not discussed here in detail.

More completely investigated species of *Bradyphyllum* exhibit characters in their mature morphology and, more importantly in their ontogeny that permit hypotheses of their possible origin. The geologically oldest species known so far, *B. differentiatum* FEDOROWSKI, 1973, was discussed in remarks on the subfamily as showing some connections to the oldest Polycoeliidae rather than to other groups of corals. Such a strong accentuation of a calophylloid elongation of four protosepta has not been met in the geologically younger species, which considerably separates the species discussed.

Occurrence of any bradyphylla in the Tournaisian and Lower part of the Viséan are not certain. They appeared in the Upper Viséan in Europe (e. g. FEDOROWSKI 1968; POTY 1981) and in the transitional Mississipian-Pennsylvanian Cameron Creek Formation of the United States (EASTON 1962). These corals, and especially the European ones, exhibit strong similarity, or rather relation to *Rotiphyllum* HUDSON, 1942. This has been stressed by composition of the name *B. rotiphylloides* POTY, 1981 and in the description of both European species. *Rotiphyllum granulatum* (THOMSON, 1881), redescribed by HUDSON and FOX (1943) from the Lower Namurian of Scotland, is probably the earliest *Rotiphyllum* showing the bradyphylloid shortening of the major septa. Thus the trends to shorten the cardinal septum and the major septa are heterochronous and may form another proof for the complex relations within the groups of species discussed.

As far as American taxa are concerned, I consider *Fasciculiamplexus* EASTON, 1962 a junior synonym of *Bradyphyllum* rather than a member of Hapsiphyllidae GRABAU, 1928, as proposed by WEYER (1975: 755) or of Zaphrentoidiinae SCHINDEWOLF, 1938 as postulated by HILL (1981: F318). Morphology in longitudinal section, the nearly triangular shape of the cardinal fossula, bordered in maturity by two septa only, the radial arrangement of major septa in maturity, typical for *Bradyphyllum* but not met in Zaphrentoidiinae and in true Hapsiphyllinae, advocate for this opinion. The early ontogeny of this genus may be comparable to representatives of either of these subfamilies, pointing out relation of at least some members of them. The elongation of the counter septum clearly seen on pl. 3:13d of EASTON (1962) may be additional proof of synonymy of *Fasciculiamplexus* with *Bradyphyllum*. Its nonrhopaloid, thin axial ends of major septa in mature portions (EASTON 1962, pl. 3:13a, e) is the only feature that can be considered atypical of most Antiphyllinae, but quite common, e. g., in *Amplexizaphrentis* VAUGHAN, 1906. However, a similar shape of septa is also present in the uppermost known transverse section of *B. bellicostatum* GRABAU, 1928, (pl. 2:11e), which negates the diagnostic value if this character on a generic level. It may only mean that major septa, thickened on a surface of tabula or just above it, thin considerably upperwards, which is well seen on pl. 3:13e, (left side) of EASTON (1962).

The discussed period of geological history (Upper Viséan — equivalents of Lower Namurian) was probably a period of appearance of the bradyphylla derived from rotiphylla. This derivation was probably not a single evolutionary event, leading to a further parallel development of both genera, but possibly several events taking place in different times. However it was, one can observe a close relation in morphology and ontogeny of many of the Middle and Upper Carboniferous species of either bradyphylloid or rotiphylloid morphology. Species of de GROOT (1963) attributed to either of these genera, some species described by FOMICHEV (1953), e. g. *B. bellicostatum* GRABAU, 1928; *B. oppositum* FOMICHEV, 1953; *B. slavianovi* FOMICHEV, 1953, and possibly also *Zaphrentis* aff. *postuma* SMITH of DEMANET, 1943 and *B. bellicostatum* GRABAU, 1928 are examples.

The group of species here described from the Carboniferous — Permian boundary possess an ontogeny comparable to *Lytvolasma* SOSHKINA, 1925 in the here accepted meaning and to *Allotopiophyllum* GRABAU, 1928. Roots of this group may go back as far as to the Middle Pensylvanian "*Zaphrentis*" *wannensis* NEWELL, 1935. The mature morphology is differentiated within this group and may lead also to *Monophyllum* FOMICHEV, 1953 which is postulated in this paper.

Permian bradyphylla are much less common than the Carboniferous ones. Several indications of their occurrence were based on misinterpretations (e. g. HERITSCH 1936, 1939; ROWETT 1969; ZHAO 1981). Some may possibly belong to this genus, but knowledge of them is inadequate to judge (e. g. HUANG 1932; HERITSCH 1937). *B. gracilium* HOARE, 1964 originally described as derived from the Wolfcampian of Nevada USA appear to be Virgilian (Dr. W. J. SANDO, written commun., 1984 based on fusulinid determinations by Dr. R. C. DOUGLAS) It seems to belong most certainly to this genus. Its revised morphology shows the cardinal septum shortened in maturity but below a calice floor, radial arrangement of septa at maturity, and close to rotiphylloid morphology in earlier stages of growth. Elongation of either the counter or the alar septa does not occur.Dissepiments described by HOARE (1964:498) are sections of the peripheral parts of tabulae; arrangement and shape of the latter are also typical for the genus. The species discussed, with all its specific characteristics, shows relation to rotiphyllum-like corals rather than to the group of bradyphylla discussed in the previous paragraph. Thus, the stock tending towards rotiphylloid morphology seems to be most constant and most important for the history of many species included in *Bradyphyllum* GRABAU, 1928.

Bradyphyllum postwannense sp. n.

(fig. 10:1—3; pl. 3:7)

Holotype: Specimen USNM 196736, fig. 10:1a—k.
Type locality: USNM 704v.
Type horizon: Neal Ranch Formation.
Derivation of the name: postwannense — geologically younger than "*Zaphrentis*" *wannensis* NEWELL, 1935.

Material. — Five specimens; one having calice, three having proximal ends only slightly broken apart. Internal structures well preserved.

Diagnosis. — *Bradyphyllum* having n:d ratio 20—24:7.0—10.5; neanic stage allotropio-

TABLE 5

Morphologically-comparative table of species of *Bradyphyllum* GRABAU, 1928 described in this paper

Name of species	Major septa	Minor septa	Cardinal septum	Cardinal fossula	Counter septum	Tabularium	N: d ratio
Bradyphyllum postwannense sp. n.	Long, straight, rhopaloid, leaving narrow free axial area	Absent in corallite lumen and external wall	Shortened	Triangular	Equal to other major septa	Peripheral parts of tabulae steeply declined towards narrow, concave axial ones	20:7.0 to 24:10.5
Bradyphyllum counterseptatum sp. n.	Straight, more or less shortened	"	Distinctly shortened late in ontogeny	Triangular, almost closed	Thickened; elongated at least in early ephebic	As above; shallow axial depression transferred in cardinal fossula	19:6.6 to 22:7.2
Bradyphyllum (?) *coagmentum* sp. n.	Meet zaphrentoidally at corallite axis; some may be rhopaloid	Absent up to calice, or small knobs beneath calice	Thin, slightly shortened in maturity	Indistinct, narrow	Equal to other long major septa	Not investigated	18:6.2 to 19:6.5
Bradyphyllum sp. 1.	Arranged radially, rhopaloid on tabulae surface	Absent in corallite lumen and external wall	Slightly shortened beneath, distinctly above calice floor	Tabular well developed, septal indistinct	Slightly longer than adjacent major septa	"	23:9.1 at calice floor
Bradyphyllum sp. 2	Straight, nonrhopaloid and nonamplexoid	May be absent	Distinctly shortened	Septal triangular and tabular well developed	"	Tabulae trapezoid with depression of cardinal fossula	17:7.3

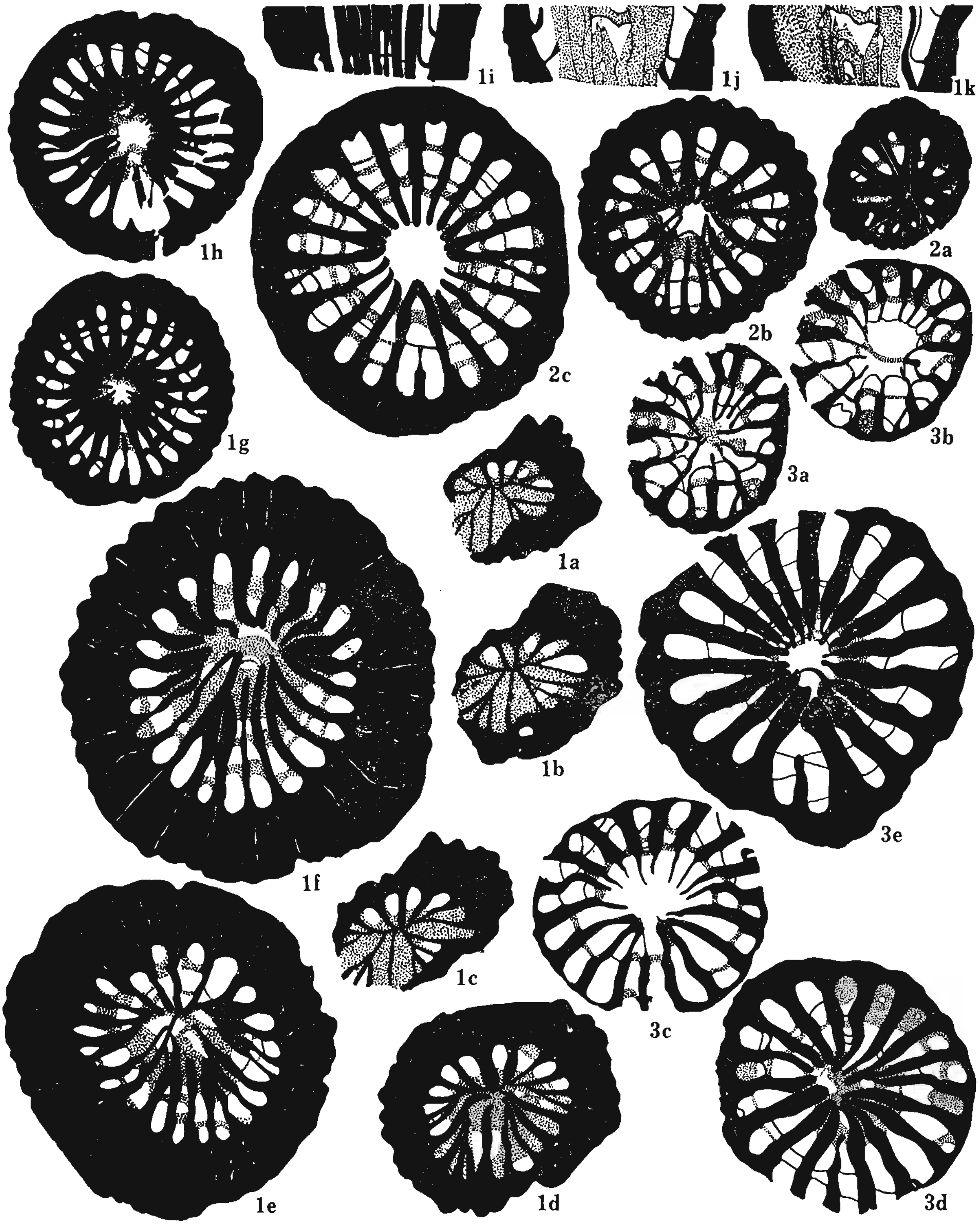

Fig. 10.

Bradyphyllum postwannense sp. n. 1. Specimen USNM 196736. Holotype. Locality USNM 704v, Neal Ranch Formation; a—c — transverse sections, early neanic stage, ×8; d—f — transverse sections, late neanic stage, ×8; g, h — ephebic stage, ×4; i—k — successive longitudinal sections made from corallite periphery to its axis, ×4. 2. Specimen USNM 196737. Locality USNM 705e, Gaptank Formation. Transverse sections; a — neanic stage; b — late neanic stage; c — ephebic stage. All, ×8. 3. Specimen USNM 196738. Locality USNM 701p, Gaptank Formation, *Uddenites*-bearing member. Transverse sections; a—c — short septal neanic stage; d — long septal neanic stage; e — ephebic stage. All, ×8.

phylloid; major septa long, straight, rhopaloid; counter septum not elongated; short cardinal septum closed in triangular septal fossula.

Description of the holotype. — The corallite is widely ceratoid, slightly curved, having the cardinal septum located on its concave side. The moderately thick external wall bears distinct furrows of major and minor septa.

The ontogenetically youngest part preserved, having n:d ratio 14:3.3×2.6 (septal formula $\frac{3}{2}\,\frac{3}{2}$ and two following transverse sections having n:d ratios 16:4.3×2.5 and 16:4.2×2.9 (septal formula $\frac{4}{2}\,\frac{3}{3}$ show zaphrentoid arrangement of septa and heavy coating by stereoplasm, which almost completely fills in the corallite lumen (fig. 10:1a—c). The arrangement of septa within some quadrants gives the impression that the metasepta, not the protosepta, are the longest. This inconstant a character is best distinguishable in the cardinal quadrants, but may temporarily be seen also in the counter quadrants. All or most of the septa seem to be united by their middle lines. The cardinal septum, located in the distinct and wide cardinal fossula, is united with septa of the counter quadrants, but does not form a straight and direct axial septum with the counter septum, which is located slightly to the side (fig. 10:1a—c). The latter may be slightly thicker than major septa, but it is not longer.

The following transverse section, having n:d ratio 20:5.1 and septal formula $\frac{5}{3}\,\frac{5}{3}$ (fig. 10:1d), begins an allotropiophylloid morphology of the species discussed. This is the only section exposing the counter septum dominating by its strong thickness, without being elongated, however. The major septa in the counter quadrants remain in direct contact, but they become shorter than the already disconnected major septa in the cardinal quadrants. The long cardinal septum loses its direct contact with septa of the counter quadrants.

The allotropiophylloid arrangement of septa is best exposed in two following sections (fig. 10:1e, f) having n:d ratios 22:7.1×6.5 and 22:8.5×7.8 and septal formula $\frac{6}{3}\,\frac{6}{3}$. All major septa are free, with the rather long cardinal septum located in the narrow cardinal fossula. The acceleration in increase of septa in the cardinal quadrants, started at this growth level, is maintained up to the end of growth of the corallite.

In the mature portion of the corallite, having n:d ratio 23:9.6 and 24:10.5, and with septal formula $\frac{6}{3}\,\frac{7}{3}$ and $\frac{7}{3}\,\frac{7}{3}$ respectively (fig. 10:1g, h), the major septa are all rhopaloid, arranged radially and almost equal in length, except for the thin and short cardinal septum. The narrow axial area free of septa is a little wider just beneath the calice (fig. 10:1h). The triangular cardinal fossula is bordered by the axial ends of two major septa adjacent to the cardinal septum. The minor septa remain absent in the fine structure of the external wall, but their distinct furrows are present on the corallite surface. Short knobs of them are present only in the upper part of the calice, where the major septa lose their rhopaloid character.

In the longitudinal section made along the mature parts of the corallite (fig. 10:1i—k), the peripheral-most parts of the tabulae are horizontal, but they curve sharply to rise steeply and vertically. The top areas of them coincide with the internal ring of axial ends of major septa that round the free axial area. Inside this area the tabulae are concave or sagging.

Individual variation. — The paratypes are fairly similar to the holotype in their mature morphology. Two of them (e. g. fig. 10:2a—c) show also similar morphology in ontogenetically younger portions and the cardinal septa located on their concave sides. The illustrated corallite differs from the holotype in smaller dimensions (maximum n:d ratio beneath the calice 22:7.1×6.6) less rhopaloid major septa, and in the appearance of small knobs of minor septa near the counter septum inside the corallite lumen.

A third specimen (fig. 10:3a—e) differs from the holotype not only in smaller dimensions and n:d ratio (20:7.4×7.1) but also in having the cardinal septum located on the convex side of the corallite, in the morphology of early ontogeny (fig. 10:3a—c) and in the equal development of septa in all quadrants (septal formula $\frac{4}{3}\,\frac{4}{3}$). These differences resulted in questionable placing of the specimen discussed within *B. postwannense* sp. n.

Remarks. — The species discussed resembles most closely "*Zaphrentis*" *wannensis* NEWELL, 1935 from the Upper Missourian of Oklahoma. It differs from the latter in having a smaller diameter a smaller septal number and a much smaller axial area free of septa. This area seems to be a natural continuation of the cardinal fossula in "*Z.*" *wannensis*, while the fossula is closed in *B.* (*B.*) *postwannense* sp. n. *B.* (*B.*) *postwannense* sp. n. differs from the other species described in this paper in not having the counter septum elongated in any growth stage, in possessing a short cardinal septum located in the closed cardinal fossula and, to a lesser degree, in the n:d ratio and larger dimensions of the largest specimens.

Occurrence. — 701p:3 — Gaptank Formation, *Uddenites*-bearing member; 705e:1 — Gaptank Formation, undivided; 704v:1 — Neal Ranch Formation.

Bradyphyllum counterseptatum sp. n.

(figs. 11:1, 2, 12:1, 2, 13:1, 2; pl:6:1a, b)

1963. *Amplexizaphrentis* Ross and Ross; J. P. Ross and C. A. Ross: 413; pl. 50:2, 4, 6, 7, 9, 11.
Holotype: Specimen USNM 196745, fig. 13: 2a—i.
Type locality: USNM 701p.
Type horizon: Gaptank Formation, *Uddenites*-bearing member.
Derivation of the name: counterseptatum — after elongated counter septum.

Material. — 11 worn specimens without calices or calice margins and with broken or abraded tips. Some corallites externally abraded and/or having structures of calices diagenetically broken. Internal structure well preserved in calcite. The restudied specimens of Ross and Ross (1963) were also considered.

Some features of representative specimens in mm:

USNM cat. nos.	n:d ratio	width of axial area	Remarks
196743	22:7.3×7.0	3.0×2.3	beneath calice
„	20:6.5×5.7	1.0	beneath calice
196742	22:7.2×7.2	1.0×0.6	just beneath calice
196740	20:8.0×8.0	1.8×1.5	calice floor
„	20:7.6×6.5	2.9×1.9	beneath calice
„	17:5.3×5.3	0.6×0.4	late neanic stage
196744	20:7.2×6.5	1.8×1.8	just beneath calice
„	20:6.0×5.7	0.5	early ephebic stage
196741	20:6.8×6.0	3.3×3.0	just beneath calice
„	20:6.5×5.3	2.5×2.3	beneath calice
196745	19:7.0×6.2	1.4×0.7	just beneath calice
„	18:5.8×4.8	0.9×0.4	early ephebic stage

Diagnosis. — *Bradyphyllum* with maximum n:d ratio 22:7.5; counter septum well elongated at least in late-neanic — early ephebic stage; cardinal septum shortened late in ontogeny; minor septa absent from corallite lumen.

Description of the holotype. — The externally eroded specimen is slightly over 20 mm long without a lost apex. Its calice, 6 mm deep without a broken margin, is filled in with matrix and was diagenetically flattened.

The ontogenetically earliest section (fig. 13:2a) shows the *Allotropiophyllum* — like arrangement of septa, but only slight acceleration of a little shorter and thicker major septa in the counter quadrants. The cardinal septum is not yet shortened and the counter septum does not differ from other major septa in lenght and thickness.

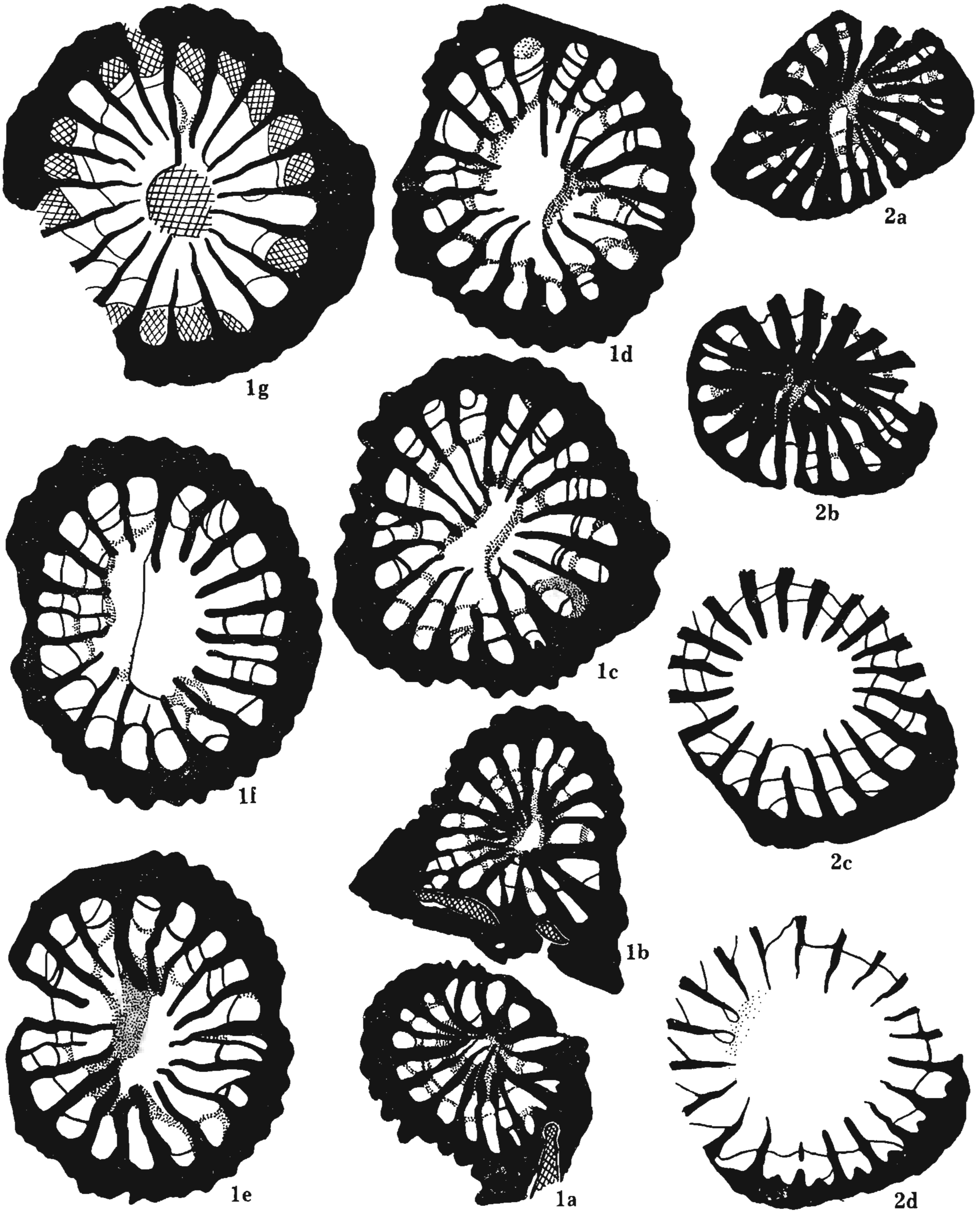

Fig. 11.

Bradyphyllum counterseptatum sp. n. 1. Specimen USNM 196740. Locality USNM 701 p, Gaptank Formation, *Uddenites*-bearing member. Transverse sections; a, b — late neanic stage of corallite attached to bryozoan colony; c—f — ephebic stage, g — ephebic stage; portions above last tabula shaded. All, × 8. 2. Specimen USNM 196741. Locality and horizon as above. Transverse sections; a, b — late neanic stage; c, d — ephebic stage; major septa distinctly shortened. All, × 8.

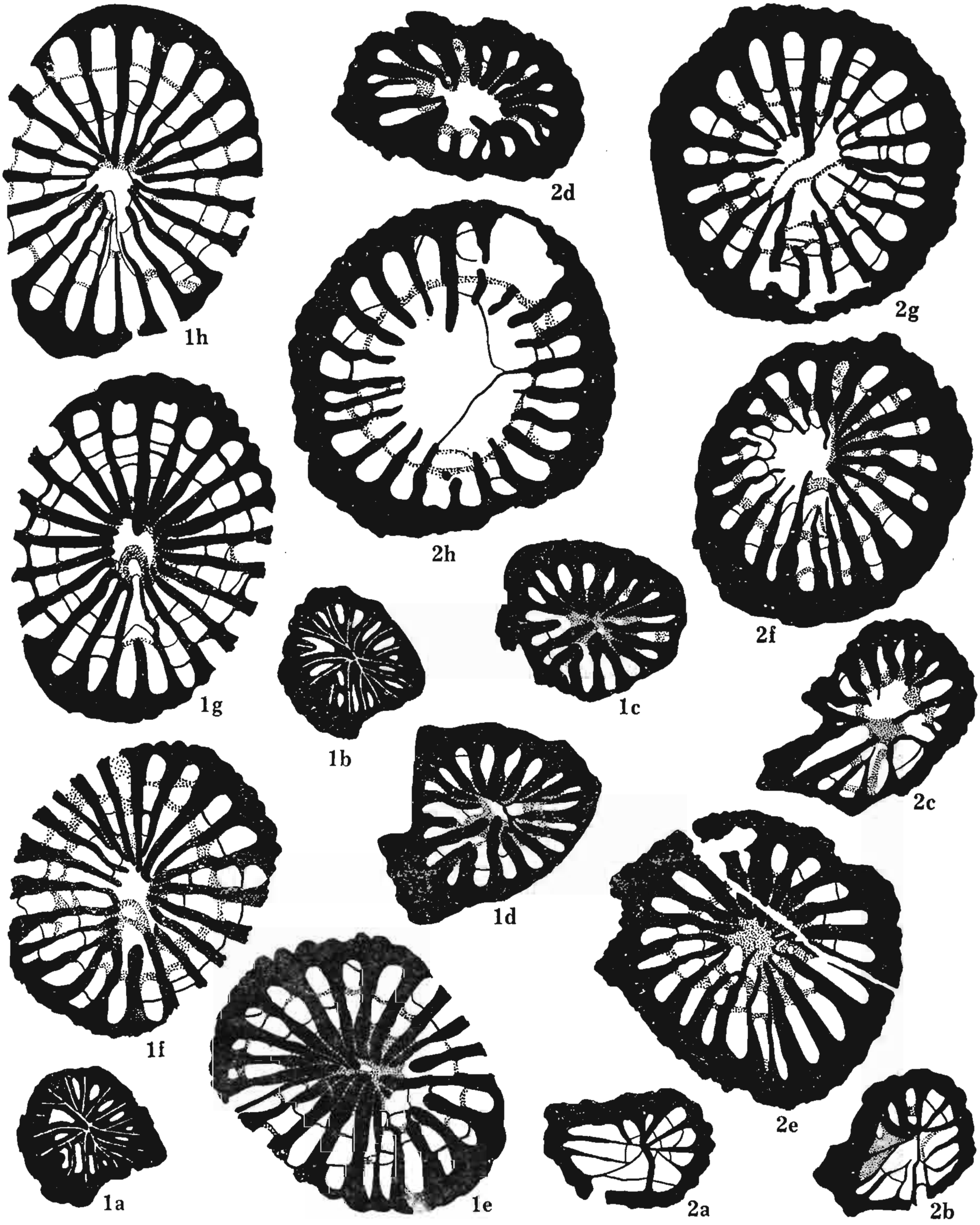

Fig. 12.

Bradyphyllum counterseptatum sp. n. 1. Specimen USNM 196742. Locality 701 p, Gaptank Formation, *Uddenites*-bearing member. Transverse sections; a, b — early neanic stage, c—e — late neanic stage; f—h — ephebic stage. All, ×8. 2. Specimen USNM 196743. Locality USNM 701, Neal Ranch Formation. Transverse sections; a, b — early neanic stage; c—f — late neanic stage; g, h — ephebic stage. All, ×8.

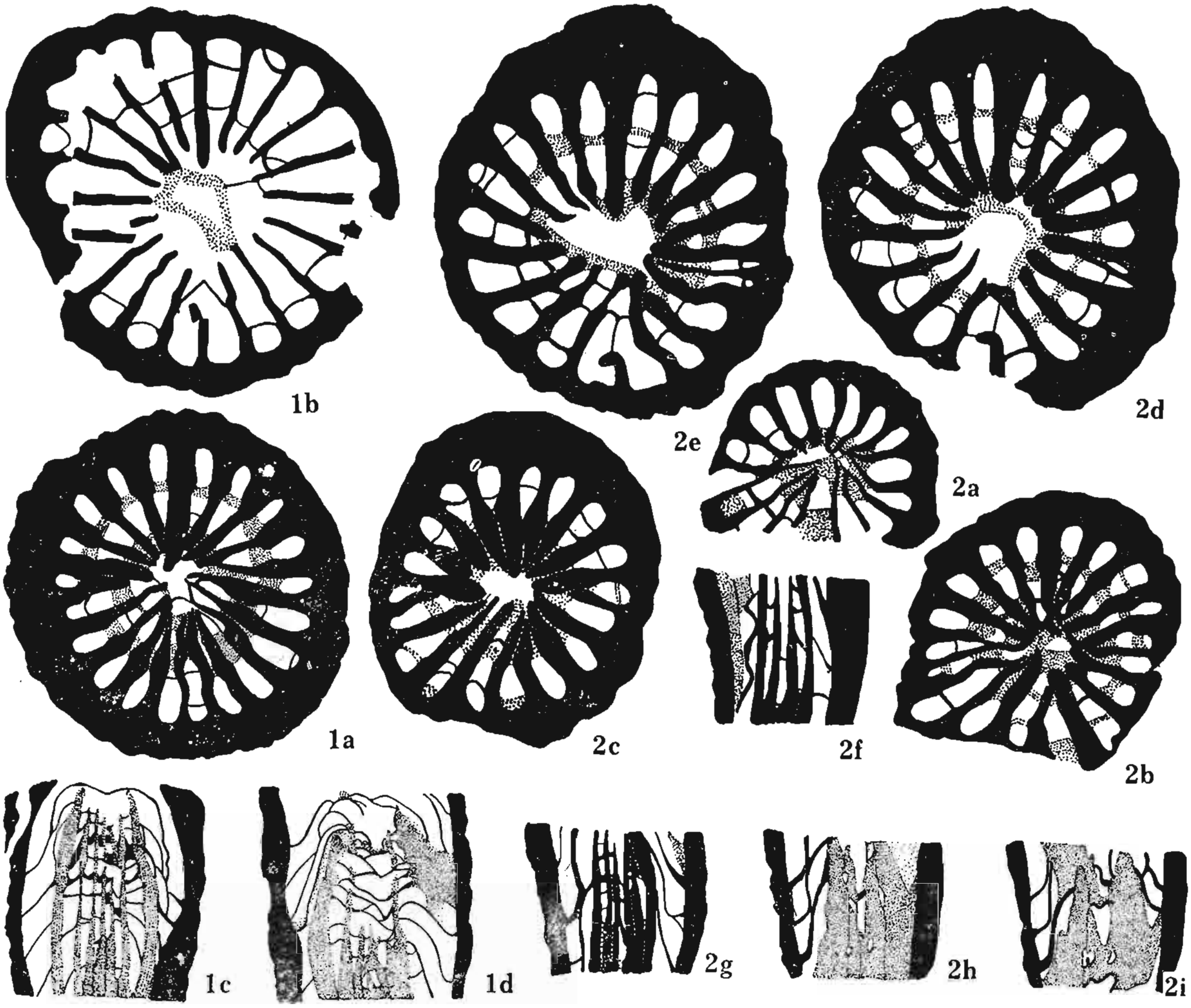

Fig. 13.

Bradyphyllum counterseptatum sp. n. 1. Specimen USNM 196744. Locality USNM 701 p, Gaptank Formation, *Uddenites*-bearing member. a — transverse section, early ephebic stage, × 8, b — transverse section, late ephebic stage, × 8; c, d — successive longitudinal sections perpendicular to cardinal-counter septa plan, × 4. 2. Specimen USNM 196745. Holotype. Locality and horizon as above; a, b — transverse sections, late neanic stage, × 8; c — transverse section, early ephebic stage, × 8; d, e — transverse sections, ephebic stage, × 8; f—i — successive longitudinal sections perpendicular to cardinal counter septa plan, × 4.

Two subsequent sections (fig. 13:2b, c), made in a distance of approximately 4 and 5.5 mm-respectively, show a subradial symmetry in the arrangement of septa and slight elongation of the counter septum. The cardinal septum is slightly longer than the neighbouring major septa. The ontogenetically older of these two sections shows the first opening of an axial area that became free of septal ends and of stereoplasmic infillings.

Sections of the mature portion of the corallite remain irregularly radial in symmetry although new septa may appear (fig. 13:2d, e).

The cardinal septum, located in the triangular, almost completely closed cardinal fossula, is distinctly shortened. The counter septum, thicker than other major septa, is also slightly longer than them. The minor septa are absent from the corallite lumen; they are also not traceable in the remaining part of the thick external wall, which is mainly built of strongly widened, peripheral parts of major septa.

In longitudinal section, (fig. 13:2g—i) the tabulae, spaced approximately 0.5 mm apart at the peripheral wall, rise steeply upwards to form a ring that more or less coincides with the axial ends of the major septa. Inside that ring the tabulae form a shallow axial depression, open or slightly inclined towards the cardinal fossula.

Individual variation. — In spite of the small number of corallites available for the study, differences between them are so large that some of them may eventually be considered unrelated on the species level. From established differences two trends are most important: widening versus narrowing of an axial area free of septa and elongation of a counter septum. These two trends may in some specimens be mixed or separately developed in the others.

One specimen (fig. 11:2a—d) possesses an extremely wide, free axial area with all major septa more or less equal in length at maturity, except for the cardinal septum, which is located on the concave side of the corallite and permanently shortened in this stage (fig. 11:2c, d). This "amplexoid" morphology follows the ontogenetically younger sections, showing traces of calophylloid elongation of the cardinal, counter and alar protosepta, with domination of the former two (fig. 11:2b). This specimen, with most advanced shortening of the minor septa at maturity, shows at the same time a long-lasting juvenile stage where the major septa meet zaphrentoidally in its axis. An opposite extreme in formation of a free axial area is illustrated by another specimen having the cardinal septum located on its convex side (fig. 12:2a, b; Pl. 5:1a, b). After a short early stage of growth with major septa united axially, and with a strong axial septum (fig. 12:2a, b) this corallite developed an almost permanently free axial area (fig. 12:2c, d, f—h). Only sections of it made on the surfaces of thickened tabulae show stereoplasmic infillings in this part (fig. 12:2e). Such sections demonstrate also the slightly amplexoid character of the major sepia. The counter septum in the mature portion is better developed in this corallite than in other specimens. This is again in contrast to the previously discussed one, although the free axial area is here the next widest within the species.

There are also corallites, however, mainly possessing a cardinal septum on their concave side (e. g. fig. 11:1a—g), that can be placed between the two discussed above in development of the counter septum and appearance of the free axial area. They are at the same time, intermediate between the former and the holotype in width of that area in maturity. Some specimens (e. g. fig. 11:1a—g) possessing the cardinal septum located on the concave side, (i. e. opposite to the holotype), shows allotropiophylloid arrangement of septa in the neanic stage.

Corallites representing an opposite trend, i. e. development of a narrow axial area free of septa, have their cardinal septa either on the convex or concave (fig. 12:1a—h) side. As in the specimens with wide axial areas, the development of a counter septum varies greatly, being quite distinct on individual sections of some corrallites (e. g. fig. 12:1a—h).

Specimen USNM 139772, described by Ross and Ross (1963, pl. 48:1, 2) as *Amplexizaphrentis* sp. B., is here considered member of the species discussed, but it seems to lead towards *B.* (?) *coagmentum* sp. n., possessing an axial area that is very narrow and almost completely filled in with stereoplasm, but having at the same time the counter septum elongated.

As shown by the representative specimens discussed and illustrated, several characters considered otherwise as diagnostically important may form a kind of a mosaic in the species discussed, appearing in variable combinations within individual corallites. Among these, location of the cardinal septum on either side of a corallite seems of special value, because Hill (1981) considers it constant for the whole family Antiphyllidae Ilina, 1970. I do not suppose that individual specimens discussed herein can be placed in different families only because of differences in this a character. This concerns also an allotropiophylloid versus zaphrentoid arrangement of major septa in the neanic stage appearing with no obvious dependence on the location of a cardinal septum and mature morphology of specimens.

Remarks. — The great variability described makes the species discussed similar in different characters to different species. The holotype and the corallites with the prominent counter septum differ by this character from all other bradyphylla, but may be compared to individual sections of some, (e. g., pl. 12:11d) of *B. bellicostatum* Grabau, 1928 in this number.

The corallite with the wide axial area and the unelongated counter septum is somewhat similar to some specimens of *B. kamyschnense* FOMICHEV, 1953, being distinguishable by a different n:d ratio and much smaller dimensions. Differences from other species of bradyphylla described in this paper are discussed with the latter.

Occurrence. — Locality USNM 701:1, Neal Ranch Formation; 701p:9+2 of Ross and Ross (1963) collection, Gaptank Formation, *Uddenites*-bearing member; 702g:1, 705e:1, Gaptank Formation, undivided.

Bradyphyllum (?) *coagmentum* sp. n.

(fig. 14:1 –3)

Holotype: Specimen USNM 196747, fig. 14:2a—h.
Type locality: USNM 701p.
Type horizon: Gaptank Formation, *Uddenites*-bearing member.
Derivation of the name: lat. *co-agmento* — to unite, to cement — after stereoplasmic cementation of septa in corallite axis.

Material — Six worn specimens with well preserved internal structures. Calices diagenetically broken or damaged during transporation. Ontogenetically youngest parts of tips lost.

Some features of representative specimens (in mm):

USNM cat. nos.	N:d ratio	Remarks
196747	19:7.0×5.8	calice floor
„	19:5.7×5.5	beneath calice
„	18:5.2×4.0	early ephebic stage
196746	18:6.2×5.8	calice floor
„	18:5.3×5.1	ephebic stage
196748	18:6.2×6.2	calice floor
„	18:5.9×5.2	ephebic stage

Diagnosis. — Bradyphylloid specimens having n:d ratio 18—19:6.0—6.5 major septa cemented by stereoplasm in corallite axis; cardinal septum moderately shortened from early maturity; counter septum not elongated.

Description of the holotype. — The corallites is a worn specimen with external surface, major part of a calice, and a tip abraded. A strong attachment process (fig. 14:2b, c) follows a flattening of the ontogenetically youngest portion (fig. 14:2a) located in the convex side of the corallite.

The arrangement of septa in the neanic stage resembles allotropiophylloid, having the cardinal septum located on the convex side of the corallite and extended to the axis, where it meets the counter septum. Middle lines of all major septa are united zaphrentoidally, but a curvature of the latter, except for septa in the cardinal quadrants of the ontogenetically youngest section observed, is opposite to *Zaphrentites* HUDSON, 1941, i.e. they are convex towards the cardinal septum. Acceleration of septal increase in the counter quadrants is not yet seen. It took place within approximately 2 mm of further growth, (fig. 14:2d) together with a rearrangement of septa into a subradial symmetry, i. e., reaching an early ephebic stage. Septa lost their direct contact there, but they remained cemented by stereoplasm. The cardinal, counter, and alar septa are not distinguishable by length (fig. 14:2d, e).

The mature portion of the corallite is characterized by a successive thinning and shortening of the cardinal septum, located in the indistinct cardinal fossula, bordered by two major septa, except when a new septum is inserted. Thickening of septa is unequal both along them and in

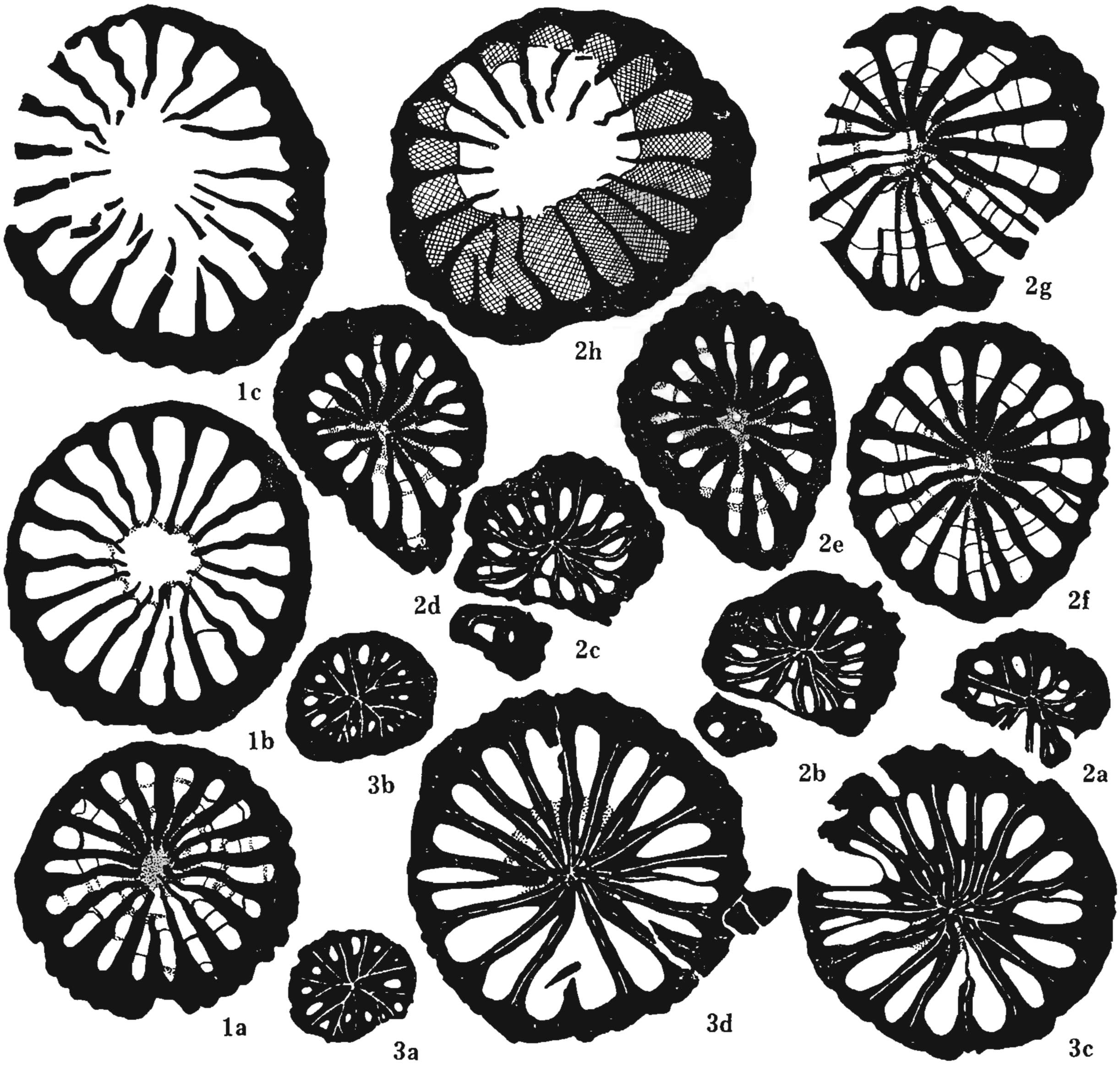

Fig. 14.
Bradyphyllum coagmentum sp. n. 1. Specimen USNM 196746. Locality USNM 701p, Gaptank Formation, *Uddenites*-bearing member. Transverse sections; a — ephebic stage; b — calice floor having axial rejuvenation (?); c — middle of calice. All, × 8. 2. Specimen USNM 196747. Holotype. Locality and horizon as above. Transverse sections; a—c — neanic stage, d, e — early ephebic stage; f, g — ephebic stage; h — lower part of calice; portions above last tabula shaded. All, × 8. 3. Specimen USNM 196748. Locality and horizon as above. Transverse sections; a, b — neanic stage; c, d — ephebic (?) stage. All, × 8.

the individual portion (but not quadrants) of the corallite (fig. 14:2f, g). All of them are peripherally widened, some are rhopaloid. Thickening is slightly reduced in the uppermost section, made just beneath the calice floor (fig. 14:2g). This is also the only section showing a slight elongation of the counter septum. This character is not seen in the calice, however (fig. 14:2h), where all septa, except for the shortened cardinal septum, are more or less equal in length. The minor septa up to this stage are not traceable.

Individual variation. — Differences between individual specimens are small in both dimensions (see table) and morphology. Most specimens possess major septa reaching or almost reaching their axes, but only occasionally united. Even in the latter case the middle lines of them are separated. Only a single specimen (fig. 14:3a—d) is different in this respect, possessing major septa truly united by their middle lines up to the calice floor. The arrangement of septa in this specimen may be considered juvenile, and it thus has been included in this species. More or less thickened major septa and the cardinal septum variable in length but always shortened, are other small differences. The minor septa may be absent up to the lower part of a calice or may in this and in the middle part of a calice be seen as small but distinct knobs on the inner surface of the external wall. Only a single specimen shows these knobs as present in the uppermost section beneath the calice.

Remarks. — The described species disagrees with the generic diagnosis as far as morphology of corallite axes are concerned. Lack of an open axial area may be compared to typical representatives of *Rotiphyllum* HUDSON, 1942. However, the latter genus shows elongation of a counter septum, very late and slight shortening or no shortening of a cardinal septum, and peculiar growth of major septa, discussed above in remarks on the genus *Bradyphyllum* GRABAU, 1928. None of these characters are observed in *B.* (?) *coagmentum* sp. n.

The arrangement of septa in the mature portions of specimens of this species, the ontogeny and the variable position of the cardinal septum, which may be located on the convex, concave or lateral side of a corallite, are closely comparable to those of *B. counterseptatum* sp. n. The latter differs from *B.* (?) *coagmentum* sp. n. in having a well-elongated counter septum and in the development of a more or less wide, free axial area. *B. postwannensis* sp. n., another species of similar morphology and development, differs from *B.* (?) *coagmentum* sp. n. in developing a typical, bradyphylloid free axial area and in slightly different dimensions. Such a close comparison to other species assigned herein to *Bradyphyllum*, as well as the fact that the major septa are mainly cemented to each other by stereoplasm, i. e. by a secondary sheet of calcium carbonate secretion, make the species discussed related to them rather than to any other species. It thus has been decided to place the species discussed questionably within *Bradyphyllum* GRABAU, 1928.

Occurrence. — USNM Loc 701p:6 Gaptank Formation, *Uddenites*-bearing member.

Bradyphyllum sp. 1

(fig. 15:1a-d)

Material. — A single specimen USNM 196749 having well preserved internal structure and the lowermost part of the calice and neanic portion present. N:d ratio at calice floor 23: 9.5×8.7, septal formula $\frac{6}{3}\frac{7}{3}$; in early ephebic stage n:d ratio 21:6.0, septal formula $\frac{5}{3}\frac{6}{3}$.

Description. — The ceratoid corallite bears distinct septal furrows on its moderately thickened external wall. Morphology of the neanic portion with n:d ratio 16:3.0×2.8 and septal formula $\frac{4}{2}\frac{4}{2}$ is zaphrentoid, with the cardinal and the counter septum directly united to form an axial septum and with other major septa in contact (fig. 15:1a). Septal increase is slow and the late neanic stage possesses n:d ratio 17:4.8×4.5, and septal formula $\frac{5}{2}\frac{4}{2}$. In the latter stage, almost all septa lose their direct contact, without forming a distinct allotropiophylloid arrangement, however (fig. 15:1b). The counter septum is a little longer than the neighbouring major septa. The slightly shortened cardinal septum is located in a distinct, open cardinal fossula. Alar pseudofossulae are well developed.

The morphology of the mature portion of the corallite differs slightly from section to section (fig. 15:1c—g). The major septa are arranged radially, but more regularly so in the ontogenetically younger sections (fig. 15:1c—e). Their tendency to become rhopaloid is stressed on surfaces of the tabulae. This is especially well seen in a section made through tabulae, where axial ends of septa in the subtabular region are distinctly thinner than portions of them cut on a tabular level (fig. 15:1e, left and 15:1g, left). The cardinal septum, almost unshortened in early maturity,

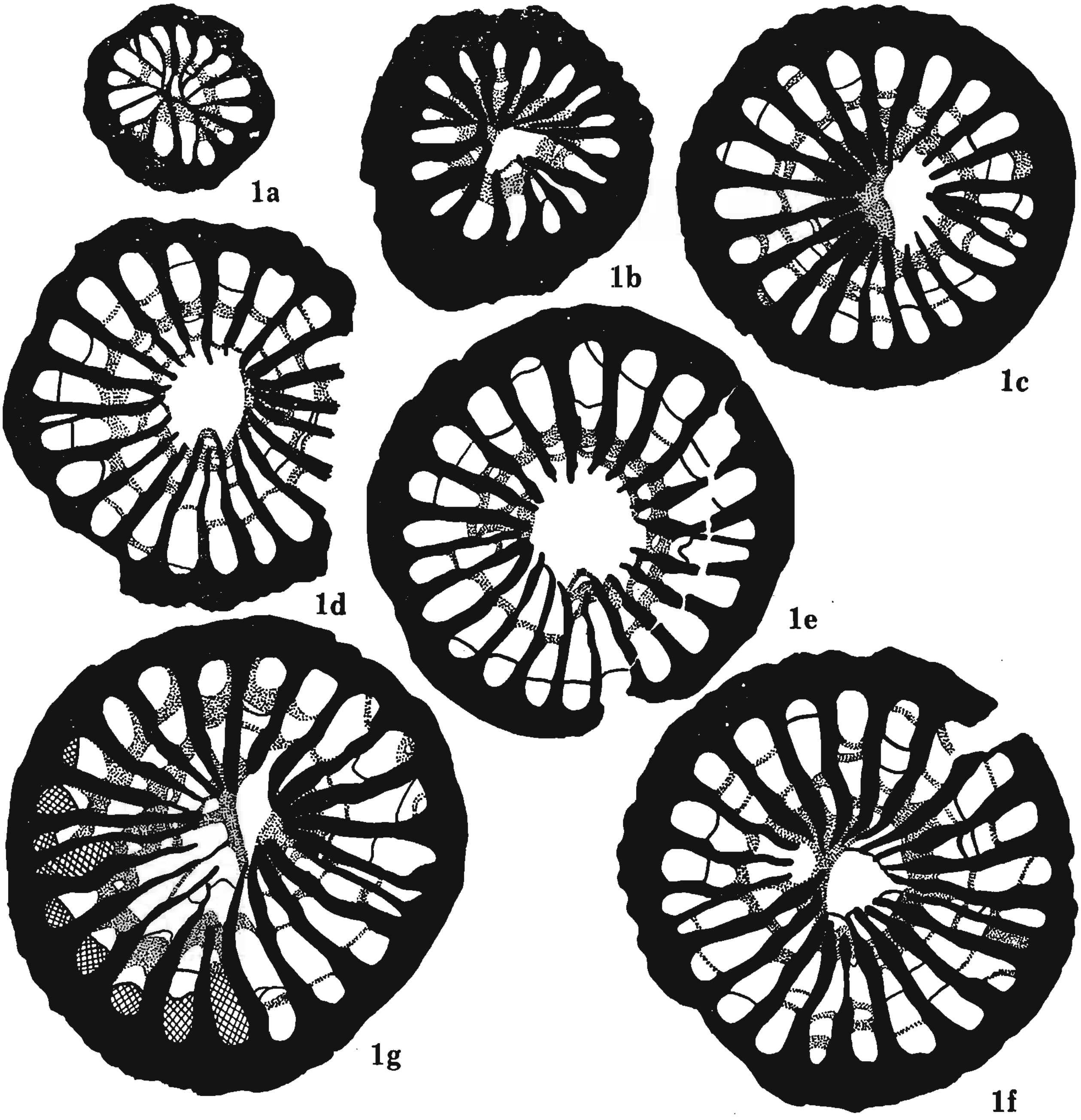

Fig. 15.
Bradyphyllum sp. 1. Specimen USNM 196749. Locality USNM 701 p, Gaptank Formation, *Uddenites* bearing member. Transverse sections; a — neanic stage; b — late neanic stage; c — ephebic stage; d — lowermost part of calice. Portions above last tabula shaded. All, × 10.

became moderately shortened upperwards (fig. 15:1 g) and distinctly shortened above the calice floor. The counter septum may be a little longer than the neighbouring major septa, (fig. 15: c—e, g) but it does not dominate. The cardinal tabular fossula is well marked by sections of tabulae arching above the axial end of the cardinal septum. The septal cardinal fossula, invariably bordered by two major septa, is inconspicuous. The minor septa are not seen either in the corallite lumen or in the fine structure of the external wall up to the middle part of growth of the corallite, but their furrows are as distinct as those of the major septa.

Remarks. — The specimen described shows some characters either intermediate between species of *Bradyphyllum* described in this paper, or typical for some of them. The late and indistinct shortening of the cardinal septum, located in the open cardinal fossula, and fairly wide free axial area may well be compared to *B. counterseptatum* sp. n., but the unelongated counter septum, larger dimensions, and the acceleration of septal increase in the counter quadrants are in disagreement with the diagnosis of the latter. All these characters bring the specimen discussed close to *B. postwannense* sp. n. The closed cardinal fossula with the distinctly shortened cardinal septum, the more regularly radial arrangement of septa, much more advanced underdevelopment of the minor septa, and the allotropiophylloid stage in ontogeny are differences from the latter. It may be possible that the specimen described forms an extreme morphology of *B. postwannense* sp. n. and may be eventually placed within it when intermediate forms are found.

Occurrence. — Loc. USNM 701p:1, Gaptank Formation, *Uddenites*-bearing member.

Bradyphyllum sp. 2

(fig. 16:1a-d; pl. 5:1a-c; pl. 6:2)

Material. — A single, almost complete corallite USNM 196750 having the internal structure partly silicified. N:d ratio at the calice margin 17:7·3.

Description. — The ceratoid corallite was 16.7 mm long when measured along the convex, i. e. the counter septum side. The external wall, 0.5—0.7 mm thick, bears distinct furrows of major and minor septa, although the latter are totally absent inside the corallite lumen and in the microstructure of the external wall. Their very weak foundations can be seen in some loculi of the partly preserved margin of the calice.

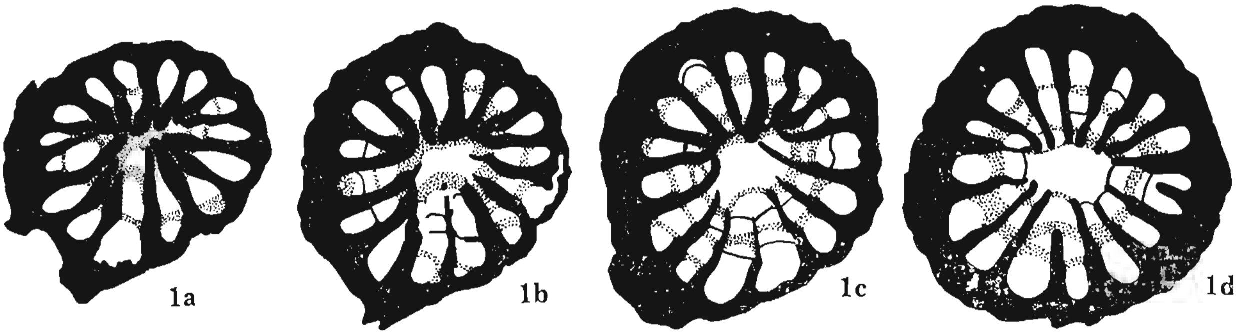

Fig. 16.
Bradyphyllum sp. 2. Specimen USNM 196750. Locality USNM 728e, Lower Bone Spring Formation. Transverse sections; a—c — late neanic to early ephebic stage; d — ephebic stage. All, ×8.

The calice (pl. 6:2) is 7.7 mm deep when measured to its 2.5 mm wide free axial area and 1.5—2 mm deeper around its periphery. The cardinal tabular fossula forms an additional depression, which is only slightly marked on the marginal part of the free axial area. The major septa increase their length regularly, starting from the peripheral foundations, which are of the same thickness as the remaining parts of the septa, and ending at the border between the flat and dipping portions of the tabula. Such an arrangement may suggest a presence of an aulos, but in fact it results from the shape of the tabulae and the non-amplexoid character of the septa, which cross dipping parts of the tabulae, but stop their growth at the boundary of flat portions of the latter. The counter septum is slightly elongated over that flat area. The cardinal septum is clearly shortened and located in a triangular cardinal septal fossula. Also, the last pair of major septa of the cardinal quadrants are slightly underdeveloped (pl. 6:2).

Morphology in the transverse sections of the mature portion of the corallite (fig. 16:1c, d; pl. 5:1c) confirms observations made in the calice and demonstrates a permanent increase of septa and their acceleration in the counter quadrants. The earliest growth stage is typically zaphrentoid with the cardinal septum elongated so as to meet the counter septum. Also, the illustrated portion of the neanic stage (fig. 16:1a; pl. 5:1a) shows zaphrentoid morphology with the counter septum better developed than the adjacent major septa and with one or both alar septa slightly elongated. Such morphology can hardly be called calophylloid, however. There is no true aulos developed on this portion of growth either.

Remarks. — The slightly elongated counter septum in younger ontogenetic stages and the open cardinal fossula are characteristics which link the morphology of the corallite discussed to *B. counterseptatum* sp. n. Its main differences are: slightly amplexoid character of the counter septum, which is equal to the adjacent major septa in maturity; different n:d ratio; more regularly zaphrentoid arrangement of major septa in early growth stages and their much thinner peripheral portions.

Open cardinal fossula, a better elongated counter septum in early growth stage and its slightly amplexoid character in maturity, smaller dimensions and different n:d ratio are characters distinguishing the specimen discussed from *B. postwannense* sp. n. Other species of *Bradyphyllum* GRABAU, 1928 are less similar and need not be discussed.

Occurrence. — USNM 728e: 1, Lower Bone Spring Formation, Upper Wolfcampian.

Genus *Lytvolasma* SOSHKINA, 1925

Type species: *L. asymmetrica*, SOSHKINA, 1925

Synonyms: e. p. *Actinophrentis* IVANOVSKI, 1967
e. p. *Allotropiophyllum* FOMICHEV, 1953 *non* GRABAU, 1928
e. p. *Bradyphyllum* FOMICHEV, 1953 *non* GRABAU, 1928
? *Bradyphyllum* FLÜGEL, 1973 *non* GRABAU, 1928
? *Zaphrentites* XU, 1980 *non* HUDSON, 1941
e. p. *Parastereophrentis* HILL, 1981
Non Lytvolasma DOBROLJUBOVA, 1936, FLÜGEL, 1973; WU, 1975; GUO, 1980

Species assigned: *L. asymmetrica* SOSHKINA, 1925, e. p. *Allotropiophyllum irregulare* FOMICHEV, 1953, e. p. *Actinophrentis nikitovkensis* var. *nana* FOMICHEV, 1953, e. p. *Bradyphyllum caninoideum* FOMICHEV, 1953 *non* HUANG, 1932, *Parastereophrentis virgata* FOMICHEV, 1953. ? *Zaphrentites constrictus* XU, 1980, *L. aucta* sp. n.

Geographic and stratigraphic range: USSR, Ural Mts, Lower Permian, Artinskian, Donets Basin Upper Carboniferous C_2^3—C_3^3; USA, Texas, Gaptank Formation, *Uddenites*-bearing member.

Emended diagnosis. — Small solitary corals without dissepimentarium; deep, key-hole cardinal fossula often bordered by half-aulos in counter quadrants; cardinal septum shortened late in ontogeny; counter septum slightly elongated; arrangement of major septa semi-radial; calices deeper in cardinal quadrants; minor septa very short; microstructure of septa trabecular.

Remarks. — The type species of *Lytvolasma* is represented by a single, incomplete specimen. No topotype material has even been described. The type is a worn specimen, thus its part filled in with strange fabric (text-fig. 2, left side) is interpreted here as diagenetically damaged, but not as being sectioned above the calice floor. The section discussed represents the ontogenetically oldest retained part. It can be interpreted as mature, but not the latest growth of the coral. The section is slightly oblique, which results in asymmetry of its morphology. Almost two thirds of the corallite (right side of the picture) was sectioned just above or on a surface of a tabula and one third in a subtabular region (left side of the picture). Better orientation of the section might have resulted in increase of symmetry, but not in change of length of septa, which obviously stay short of the corallite axis. One of the here described specimens (fig. 17:4a—c) demonstrated a similar situation.

The ontogenetically younger section of the holotype of the type species represents the early ephebic stage. A bradyphylloid morphology, similar to this can rarely be observed in post-neanic portions of growth of American corals described in this paper (figs. 17:4b, c; 18:1c—f) and has not been observed in the Donets Basin corals included herein in *Lytvolasma*.

The existing fragment of the type specimen of *L. asymmetrica* Soshkina, 1925 is too incomplete either for certain generic recognition or for establishing a final generic diagnosis. On the other hand, however, it exhibits a set of characters allowing its fairly close comparison to other specimens, although without full confidence. The radial arrangement and the lack of domination of any septa in early ontogeny (Soshkina 1925, Pl. 1, Fig. 1b) contrasts with comparable growth stages of the corals discussed here, but this may be only an individual character of this particular section, not a feature of the whole growth stage. In such a situation I decided to acknowledge Soshkina's (1925) genus, supporting its emendation with data provided by the Texas corals described here and by the Donets Basin specimens briefly re-examined. Such an emended genus *Lytvolasma* has rather weak status, and a close examination of good topotypes may demonstrate the necessity of a different solution, i. e. separation of the Texas and the Donets Basin specimens into a new genus.

The name *Lytvolasma* has been used in the literature several times for descriptive purposes, but all these instances seem incorrect to me. Dobroljubova (1936) described *Lytvolasma* sp. No. 1 and No. 2 from the Lower Permian of the Ural Mts. Re-examination of these specimens demonstrated that *Lytvolasma* sp. No. 1 exhibits all the characters of *Ufimia*. *Lytvolasma* sp. No. 2 does not differ from *Meniscophyllum* aff. *minutum* Simpson of Dobroljubova, 1936. Both these specimens show an allotropiophylloid neanic stage and major septa permanently united near the corallite axes. They are here considered a single species and included in *Euryphyllum* Hill, 1938. *Lytvolasma* (?) sp. cf *L. geinitzi* (Toula, 1875) of Flügel (1973) was revised and included in *Tachylasma rhizoides* Soshkina, 1925 (Fedorowski 1982: 77, 78). The specimens included in *Lytvolasma* by Wu (1975) and Guo (1980) do not belong to that genus, but some of them may belong to *Euryphyllum*.

Several specimens attributed by Fomichev (1953) to different genera and species (pl. 2:5; pl. 5:5; pl. 7:9, 11(?)) exibit morphology closely similar, and in my opinion related to *Lytvolasma*. From the specimens described by that author as *Actinophrentis*, a single, illustrated corallite (Fomichev 1953, pl. 2:5) is considered conspecific with *L. aucta* sp. n. Other specimens of this genus either do not show characteristics of *Lytvolasma* or their state of preservation is inadequate for revision. Similarity of *Lytvolasma asymmetrica* Soshkina, 1925 to the type specimen of *Actinophrentis donetziana* Fomichev, 1953 chosen the type species of the genus by Ivanovski (1967), has already been pointed out by Fomichev (1953:73, 74). Shortening of the major septa in the early ontogeny of *Lytvolasma* was, according to him, the only difference between the two species in question, i. e. between the genera discussed. Additional important differences between these two genera are: different shape of the cardinal fossulae, narrowing axially in *A. donetziana* on all existing sections of its holotype, and lack of a half phyllotheca, which is caused by the different arrangement of the major septa, pinnate in all quadrants of *Actinophrentis*. A possible synonymy of *Actinophrentis* with *Euryphyllum* Hill, 1937, postulated by Fomichev (1953:72) is not accepted here, because of the clearly elongated counter septum in the holotype of *Actinophrentis donetziana*. It seems possible, however that some paratypes of it may be identified with that genus.

Hill (1981: F310) considered *Lytvolasma* a possible junior synonym of *Bradyphyllum* Grabau, 1928. This may be one possible solution. The latter genus exhibits several trends of development (see remarks on *Bradyphyllum*), and *Lytvolasma* may be recognized as one of them. There are also species or specimens assigned to *Bradyphyllum* (e. g. *B. bellicostatum* GRABAU, 1928 of FOMICHEV 1953, Pl. 5, fig. 2a—g; *B. postwannense* sp. n.) that are close to *Lytvolasma*, as well a such species (*B. caninoides* FOMICHEV, 1953 *non* HUANG, 1932) that were transferred here to *Lytvolasma*. With all these transition forms and similarity in several characters, *Lytvolasma* is not regarded here as a junior synonym of *Bradyphyllum*. Such characters of it as a key-hole fossula, opened towards a corallite axis, commonly rounded by a half-aulos, a pseudoradial symmetry resulting from a permanent increase of major septa during the entire ontogeny, and calices deeper in cardinal quadrants seem adequate for distinguishing these two genera. Secondly I agree with WEYER's (1975:765) opinion that *Bradyphyllum* itself should be considered as amplexoid endings of polyphyletic lines occurring several times within the Hapsiphyllidae. Admittedly, *Bradyphyllum* is a well established genus as far as its type species *B. bellicostatum* GRABAU, 1928 is concerned, but one cannot be sure of the relation of the latter to other species assigned to this genus. The bradyphylla here discussed are obviously more closely related to *Lytvolasma aucta* sp. n. than to *B. bellicostatum* GRABAU, 1928, but with all data available, I cannot exclude relationship of them also to the latter. A similar situation may be observed also in the case of some other species of bradyphylloid morphology, which forces me to use this generic name, but with the restriction discussed.

Lytvolasma SOSHKINA, 1925, as used in this paper, exhibits some similarity to *Allotropiophyllum* GRABAU, 1928, *Euryphyllum* HILL, 1928 and *Allotropiochisma* FEDOROWSKI, 1982. It is readily distinguishable from the first genus mentioned by having the counter septum and the alar septa elongated in the early growth stage, a slightly but permanently elongated counter septum at maturity, the cardinal septum shortened late in ontogeny, and the calice floor deeper in the cardinal quadrants. The holotype of *Allotropiochisma longiseptata* (FLÜGEL 1973) is pretty far from *Lytvolasma*, representing a line of development parallel or related (?) to *Allotropiophyllum*. The narrow cardinal fossula, the lack of elongation of the counter septum, the "biform reduction" of minor septa, and the biform peripheral-most tabularium easily distinguish it from *Lytvolasma*.

However, some specimens included herein in *L. aucta* sp. n. exhibit an incipient stage of "biform reduction" of the minor septa (fig. 18:1b—f, 2a, b). These specimens suggest that "*Bradyphyllum*" *breviseptatum* FLÜGEL, 1973 reillustrated in this paper (fig. 3:4a, b) is either a member of *Lytvolasma* or a species between this genus, the genus *Allotropiochisma*, and the representatives of *Euryphyllum* described in this paper. It seems doubtful, however, whether the shape of its cardinal fossula, the elongated counter septum and the formation of the free axial area — all characters of *Lytvolasma* — may predominate over the pinnate arrangement of major septa, the fairly well accentuated "biform reduction" of minor septa and the elongation of alar septa, which do not occur in typically developed representatives of *Lytvolasma*.

The morphology of some specimens of *L. aucta* sp. n. is also close to *Alligia* subgen. n., and more precisely to *A.* (*A.*) *flabellum* sp. n. The lack of a free axial area, the pinnate arrangement of major septa, and the biform peripheral-most tabularium in the former species and subgenus distinguish also these two taxa on the generic and subfamily level.

Parastereophrentis virgata FOMICHEV, 1953 was chosen by HILL (1981:F316) as type species of this genus. Such an established genus was in turn included by her in the synonymy of *Zaphrentites* HUDSON, 1941. Restudy of the type material, and especially the morphology of the upper portion of the holotype of *P. virgata*, (fig. 25:6) not illustrated by FOMICHEV (1953), reveals three main differences from the latter genus: 1) Allotropiophylloid morphology in the early growth stage, 2) A free axial area, widely opened towards the cardinal fossula, 3) The counter septum elongated and thickened (fig. 25:6). All these characters fit better with *Lytvolasma* in the meaning here accepted. It thus has been proposed to transfer a part of this genus, represented by its type species, to synonymy with *Lytvolasma*.

Lytvolasma aucta sp. n.

(figs. 17:2—4, 18:1—4; 19:1—3, 20; pls. 3:10, 14; 5:3, 4, 6, 8, 9)

e. p. 1953. *Actinophrentis nikitovkensis* var. *nana* FOMICHEV; V. D. FOMICHEV, pl. 2, fig. 5 only.
Holotype: Specimen USNM 196751, fig. 17: 2a—j.
Type locality: USNM 701 p.
Type horizon: Gaptank Formation, *Uddenites*-bearing member.
Derivation of the name: lat. *auctus, a, um* — enlarged, elevated — after elevation of calice floor in counter quadrants.

Material. — 15 corallites having well preserved internal structures. Some having more or less complete calices and apical parts. Several are worn specimens.

Some features of representative specimens (in mm):

USNM cat. nos	n:d ratio	C septum side	Remarks
196760	18:7·7	lateral	ephebic stage
196757	18 × 7.9	concave	calice floor
„	18 × 6.3	„	ephebic stage
196762	20 × 6.8	„	ephebic stage
„	20 × 7.5	„	calice floor
196751	20 × 8.8	„	calice floor
196761	20 × 9.0	lateral	calice floor
„	20 × 7.2	„	ephebic stage
196755	21 × 8.1	concave	calice floor
196759	22 × 9.1	convex	middle of calice
„	22 × 7.8	„	ephebic stage

Diagnosis. — *Lytvolasma* 6—9 mm in diameter having 18—22 major septa frequently more thickened in counter quadrants; cardinal septum distinctly shortened.

Description of the holotype. — The specimen is conico-cylindrical, slightly concave on the cardinal side, with an external wall almost completely abraded from septal furrows. The calice, filled in with matrix, is slightly damaged diagenetically.

In the youngest known stage (fig. 17:2a), 2.4×2.1 mm in diameter, 11 thick major septa meet with all protosepta near the corallite axis. The metasepta appeared first in the counter quadrants. About 0.3 mm above section described above, with n:d ratio 13:2.8×2.5 and septal formula $\frac{3}{1}|\frac{3}{1}$, all 12 protosepta are long and united near the corallite axis by their middle lines. Direct connection of the middle lines of all other septa is also observed (fig. 17:2b). The following portion of growth of the corallite is illustrated by sections made 4.8 and 6.0 mm above the previous one, respectively (fig. 17:2c, d). They show transmission from the zaphrentoid neanic stage with some elements of allotropiophylloid morphology (fig. 17:2c) to the arrangement of septa typical for the genus. The axial ends of septa remain connected by sclerenchyme, but their middle lines became separated. Septal formulae are $\frac{4}{3}|\frac{4}{3}$ and $\frac{4}{3}|\frac{5}{3}$ and septal ratios 18:4.9××4.5 and 19:5.6×5.1, respectively. The counter septum and the alar septa continue to dominate a little in length, with the former being the thickest septum of all. The cardinal septum is only slightly shortened, but it is thinner than other major septa, except for the newly inserted ones.

The mature portion of the corallite, is illustrated by a section made just beneath the calice floor, except for the cardinal tabular fossula that was sectioned above the last tabula (fig. 17:2e). The cardinal septum is thin and distinctly shortened. The counter septum is slightly longer than the neighbouring major septa, but it is not thicker. The arrangement of the major septa is radial and their thickness is symmetrically reduced from the counter towards the cardinal septum. Axial ends of the major septa in the cardinal quadrants are bent to the sides, with those of two

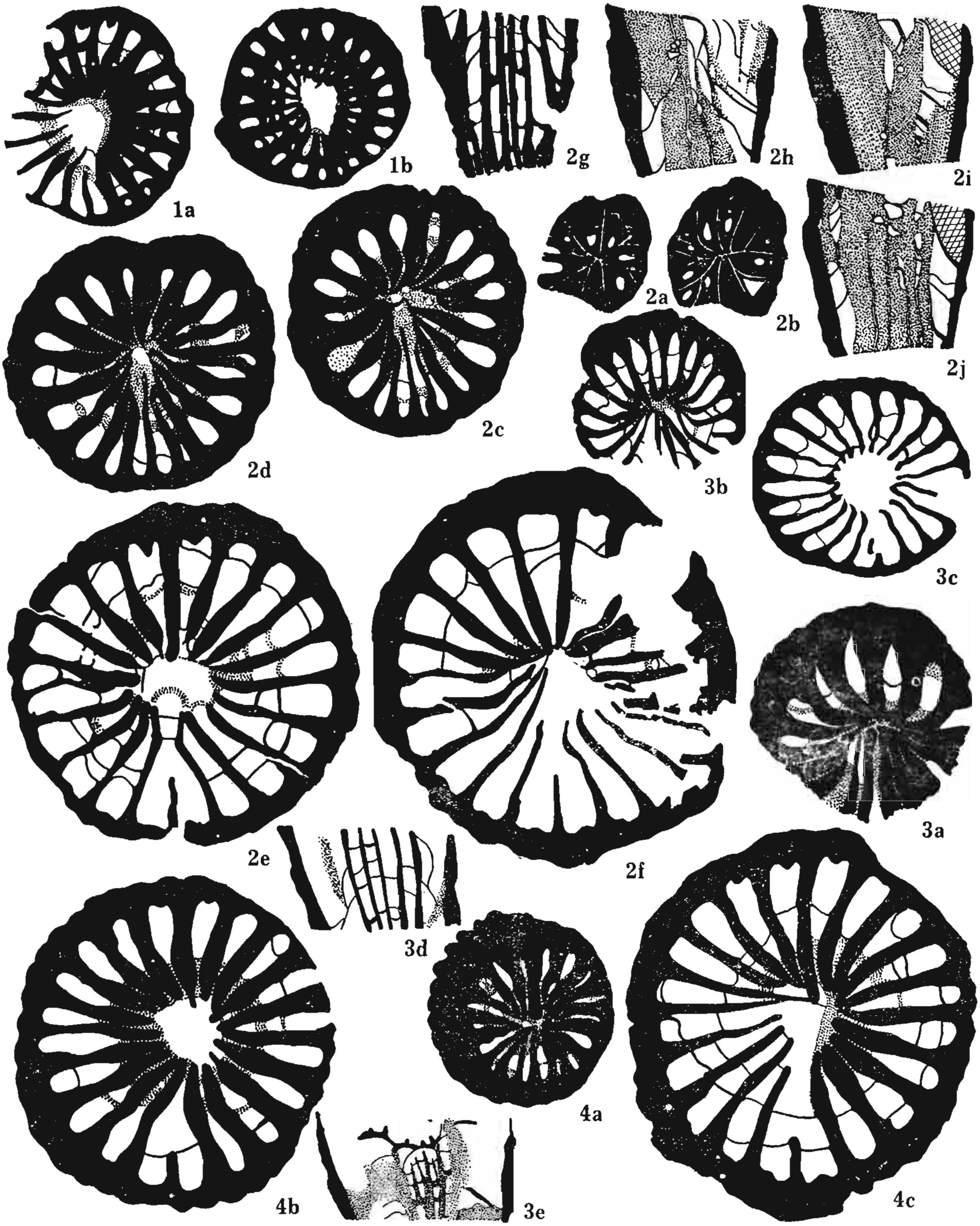

Fig. 17.

1. *Lytvolasma asymmetrica* Soshkina, 1925. Specimen 803/146. Holotype. Housed in Paleontological Institute of the Acad. Sci. USSR, Moscow. Transverse sections; a — early ephebic stage (= Soshkina 1925, pl. 1:1a); b — ephebic stage (= Soshkina 1925, pl. 1:1). 2—4. *Lytvolasma aucta* sp. n. Locality USNM 701 p, Gaptank Formation, *Uddenites* bearing member. 2. Specimen USNM 196751. Holotype; a, b — transverse sections, early neanic stage, × 8; c, d — transverse sections, late neanic stage, × 8; e — transverse section, ephebic stage, × 8; f — transverse section, lower part of calice, x8; g—j — successive longitudinal sections in cardinal-counter septa plan; cardinal fossula shaded. All × 4. 3. Specimen USNM 196752; a — transverse section, late neanic stage, × 8; b — transverse section, ephebic stage, × 4; c — transverse section through calice having shallow axial rejuvenation, × 4; d, e — successive longitudinal sections perpendicular to cardinal-counter septa plan, × 4. 4. Specimen USNM 196753. Transverse sections; a — late neanic stage, b, c — ephebic stage. All, × 8.

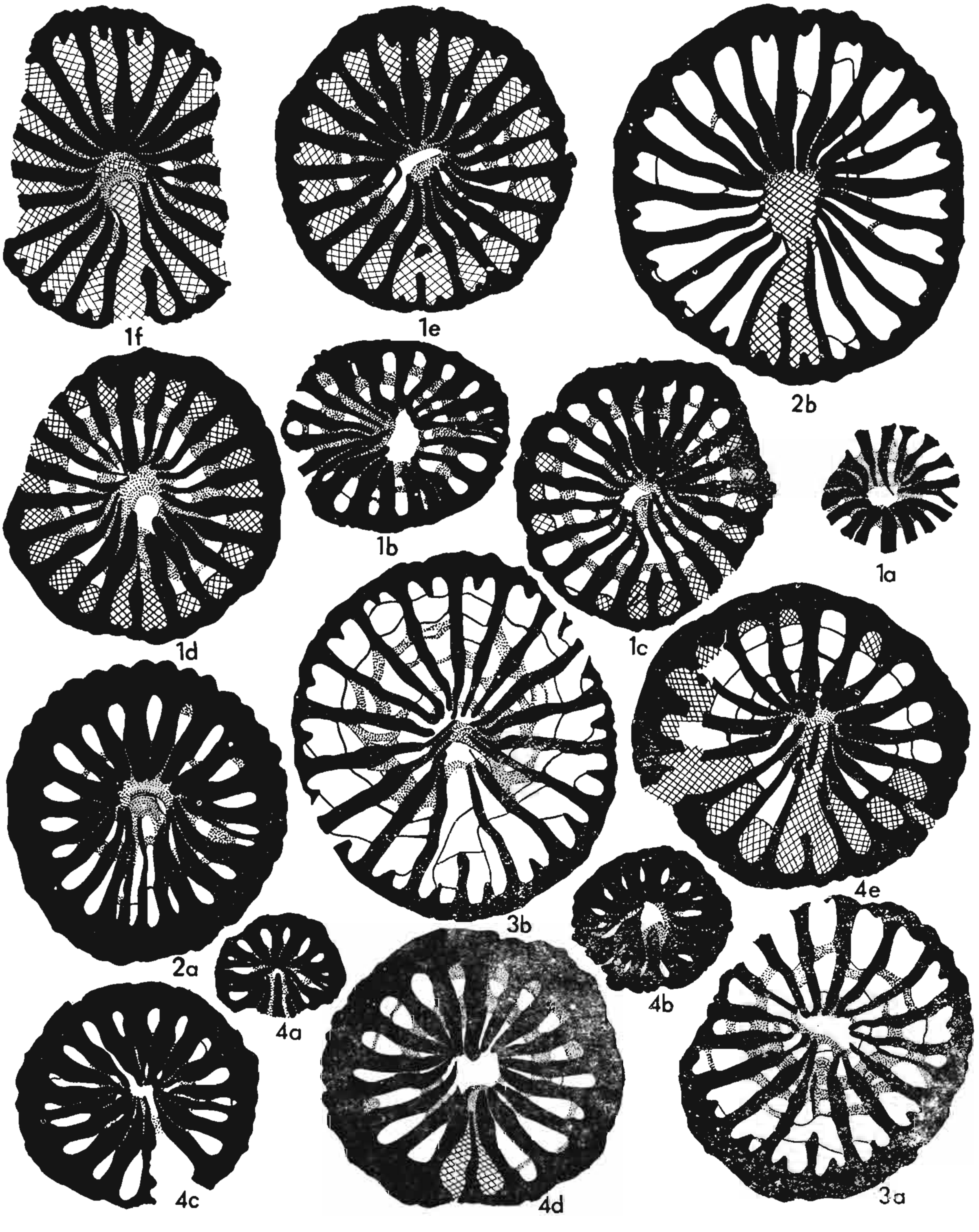

Fig. 18.

Lytvolasma aucta sp. n. 1. Specimen USNM 196754. Locality USNM 701 p, Gaptank Formation, *Uddenites* bearing member. Transverse sections; a — late neanic stage; b — early ephebic stage; c—f — ephebic stage; portions above last tabula shaded. 2. Specimen USNM 196755. Locality and horizon as above. Transverse sections; a — early ephebic stage; b — ephebic stage; portions above last tabula shaded. 3. Specimen USNM 196756. Transverse sections; a, b — ephebic stage. 4. Specimen USNM 196757. Locality and horizon as above. Transverse sections; a, b — neanic stage; c — early ephebic stage; d, e — ephebic stage; portions above last tabula shaded. All. ×7.

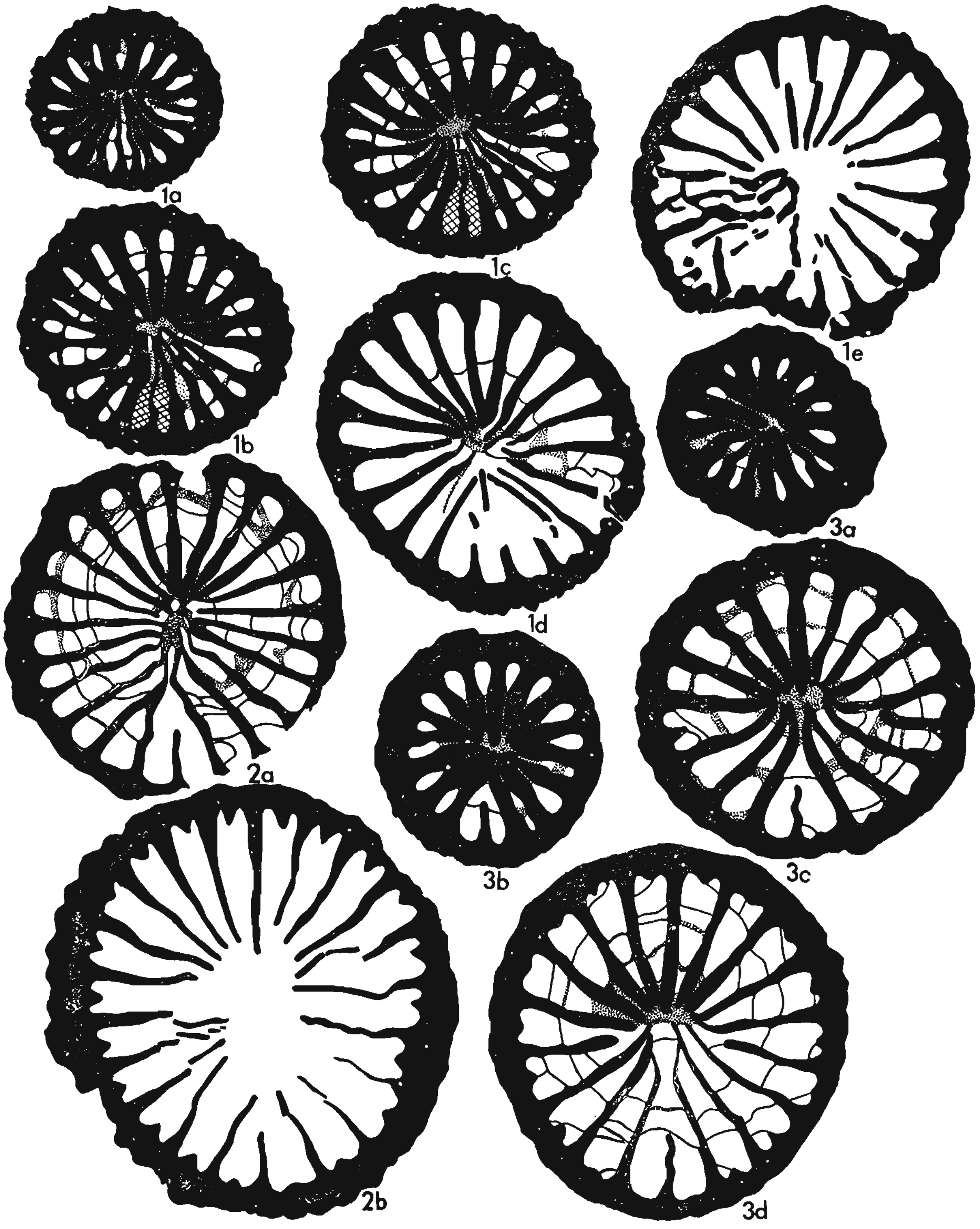

Fig. 19.

Lytvolasma aucta sp. n. Locality USNM 701p, Gaptank Formation, *Uddenites* bearing member. Transverse sections. 1. Specimen USNM 196758; a — early ephebic stage; b, c — ephebic stage; portions above last tabula shaded; d — lower part of calice; e — middle part of calice. 2. Specimen USNM 196759; a — ephebic stage; b — calice. 3. Specimen USNM 196760. a — late neanic/early ephebic stage; b — early ephebic stage; c, d — ephebic stage. All, ×7.

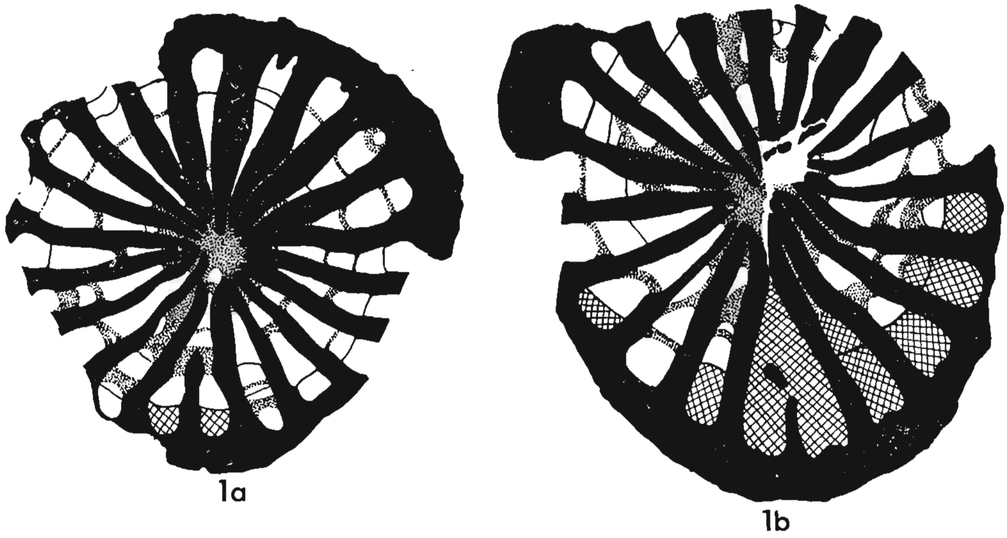

Fig. 20.
Lytvolasma aucta sp. n. Specimen USNM 196761. Locality USNM 701 p, Gaptank Formation, *Uddenites* bearing member. Transverse sections, ephebic stage; portions above last tabula shaded. Both, ×7.

major septa adjacent to the cardinal septum curved most distinctly. Such a morphology of septa makes the cardinal fossula open towards the free axial area. This is the stage of appearance of small knobs of the minor septa inside the corallite lumen. In the middle part of the calice (fig. 17:2f) the major septa of the cardinal quadrants are thin and became shortened towards the cardinal septum. Those of the counter quadrants and the counter septum itself, located beneath the last tabula, remain thickened.

The longitudinal section, oriented in the cardinal — counter septa plan (fig. 17:2g—j) was made in the upper part of the corallite between the transverse sections illustrated on fig. 17:2d, 2e. The tabulae observed in the ontogenetically younger part of the section seem to incline equally towards the septotheca in the cardinal and counter quadrants. The upper part of the same section corrects such an impression showing a deep depression of the cardinal fossula and the tabulae of the counter quadrants continuing to elevate. This morphology corresponds clearly with the transverse sections (fig. 17:2e, f) and proves a very unequal depth of the calice, which is highly elevated in the counter quadrants, flat or slightly oblique in the axial part, and deeply deflecting in the cardinal quadrants, with the cardinal tabular fossula additionally depressed.

Individual variation. — The species discussed exhibits considerable variation in almost all morphological characters, in demensions and in n:d ratio (see table of features and figs. 17—20). Differences in n:d ratio are independent of morphology and, to some extent, of growth stage. Some corals with a late neanic morphology may possess more septa than specimens showing morphology considered as mature.

The holotype and some paratypes (figs. 17:3a—e; 18:2a, b) possess a free axial area that is moderately well developed. There are also numerous corallites, whose axial area forms in fact only a boundary of the axially widened cardinal fossula (figs. 18:3a, b, 4a—e; 19:2a, b, 3a, d; 20). In all these specimens, the half aulos (a term introduced by FEDOROWSKI, 1986) is well developed in the counter quadrants.

The cardinal tabular fossula may be very deep, being marked by strange fabric infillings, seen in the transverse sections made some distance below the calice floor (figs. 18:4d, e; 20:1b). This deep depression may extend to the corallite axis (fig. 18:2b). In other specimens, the cardinal fossula may be comparatively shallow (fig. 19:2a, 3c, d) or moderately deep.

The cardinal septum is always shortened. Small differences in its length are not important. The counter septum, always a little longer and/or thicker than other major septa in the late neanic/early ephebic stage, may be equal to them in the calice (fig. 17:3c).

In some specimens this elongation may be seen clearly also in the ephebic stage (figs. 18: 4c—e; 19:3b—d), in others it is hardly recognizable in that stage (figs. 18:1d, f, 2b; 19:1a—e)

Stereoplasmic thickenings of the major septa decrease regularly from the counter towards the cardinal septum (figs. 18:2a, c; 19:1a—e, 3b—d). There are corallites, however, with major septa of all quadrants almost equally thickened. This thickening may either be slight (figs. 18:3a, b; 19:2a, b), moderate (fig. 18:1c—f) or strong (fig. 20:1a, b). Asymmetrical thickening is sporadically observed (fig. 17:4b, c).

Differences in development of the minor septa are large. They do not occur in the corallite lumens up to the early ephebic stage. In some specimens they are not seen (figs. 18:4c—e; 20:1a, b) or are weakly marked (fig. 19:1d—e) also in calices, while in the other ones their development is fairly differentiated. The allotropiophylloid arrangement of septa may often be not recognizable, being replaced by a more radial (fig. 19:3a, b, pl. 5:3a—c) or irregular arrangement, with a free axial area opened early in ontogeny (fig. 18:1a, b). A slight elongation of the counter septum and the alar septa is invariably present in this stage of growth, as well as the long cardnal septum. Similar differentiation in ontogeny has also been observed in species assigned in thisi paper to *Bradyphyllum* GRABAU, 1928. The taxonomic rank or value of this character for thse group of specimens discussed was left open by the recent level of knowledge. It has been temporarily accepted as expressing individual variation to the extent identical with any other morphological character. Further investigation may show its virtual value for taxonomy, however. The latter is true also for a wide individual variation of other characters discussed above. At least some of them may eventually appear to be adequate for specific separation.

Remarks. — A comparison of morphology of *L. aucta* sp. n. and *L. asymmetrica* SOSHKINA, 1925 is difficult because of the incompleteness of the latter. The nearly radial arrangement of septa in the ontogenetically youngest known section of the holotype of *L. asymmetrica* (SOSHKINA, 1925, pl. 1:1b) and the early appearance of the free axial area in this specimen (fig. 17:1a) seem to be most important differences when compared to *L. aucta* sp. n. However lack of the uppermost portion of the holotype of *L. asymmetrica* reduced comparison to the late neanic and early ephebic stage of both species in question.

Among species described by FOMICHEV (1953) as possessing morphology similar to *Lytvolasma*, à single specimen of *Actinophrentis nikitovkensis nana* FOMICHEV, 1953 (pl. 2:5) from the Upper Gshelian of the Donets Basin was here included with some restriction in *L. aucta* sp. n. These restictions were caused by some geographic isolation of both areas of occurrence and by a lack of information about the ontogeny of the Donets Basin specimen. The morphology of its illurstrated portion exhibits a striking similarity to the specimens here described.

A great similarity to *L. aucta* sp. n. is seen in some specimens of *Allotropiophyllum irregulare* FOMICHEV, 1953 (e. g. pl. 7:9.11). They are geologically older (Upper Moscovian) than any of the so far known specimens of lytvolasmid morphology and show different n:d ratio, with larger number of septa. One of them (FOMICHEV 1953 pl. 7:11) passes through a bradyphylloid morphology on some parts of its growth.

Bradyphyllum caninoides FOMICHEV, 1953 (e. g. pl. 5:5), *non* HUANG, 1932 shows some, but not so distinct similarity to *Lytvolasma*. Early appearance of a free axial area brings this specimen close to *L. asymmetrica*, but the arrangement of septa in cardinal quadrants, gradually shortened towards the cardinal septum distinguish it from other specimens of *Lytvolasma* and makes its assignment to this genus a little doubtful.

A group of species assigned here to *Bradyphyllum* GRABAU, 1928, and especially *B.* (?) *coagmentum* sp. n. and *B. postwannense* sp. n., is morphologically closest and, in my opinion, most closely related to *Lytvolasma*, and *L. aucta* sp. n. in particular. They differ mainly or exclusively in the morphology of the ephebic stage and especially in the structure of the cardinal fossula and its relation to a free axial area (if present); in morphology of the calice floors and in lesser degree in the arrangement of the major septa. Mature portions of specimens of this group are morphologically closest to early ephebic stages of *L. aucta* sp. n.

Occurrence. — Loc. USNM 701p:15 Gaptank Formation, *Uddenites*-bearing member.

? *Lytvolasma* sp.

(fig. 21a—d; pls. 5:7a, b, 8:1)

Material. — A single, almost complete, partly silicified corallite No. USNM 196763 having n:d ratio at the calice margin 19:6.5.

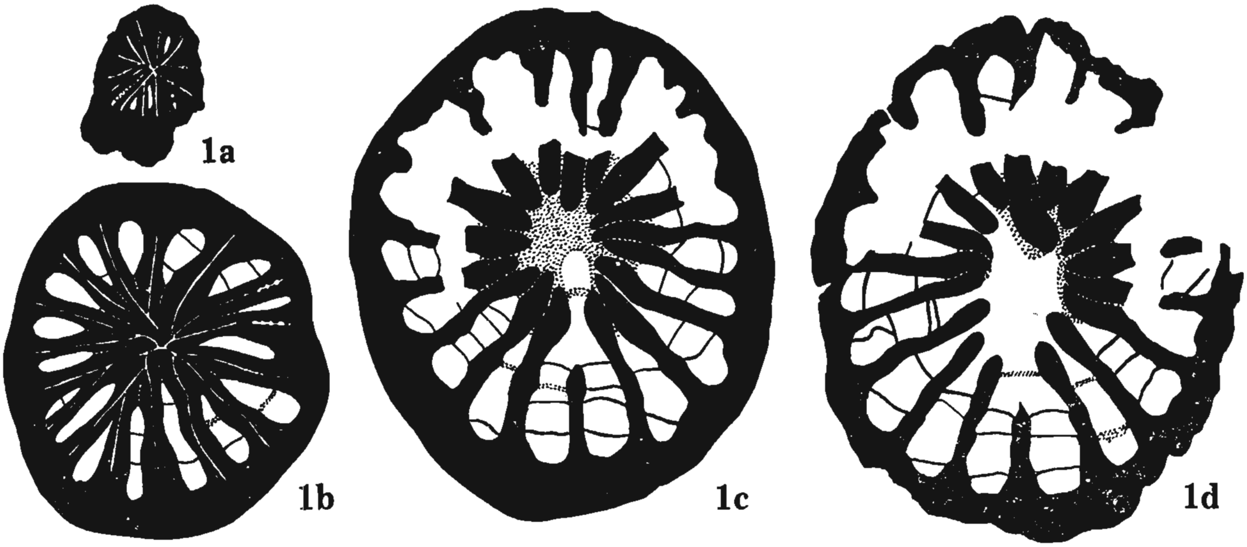

Fig. 21.
? *Lytvolasma* sp. Specimen USNM 196763. Locality USNM 728e, Lower Bone Spring Formation; a, b — transverse sections, neanic stage; c, d — transverse sections, ephebic stage. All, × 10.

Description. — The corallite was 15.5 mm long, ceratoid, with the cardinal septum located on its concave side and with the surface of the attachment moderately well developed near the apex. The external wall, measuring 0.5—0.8 mm bears delicate, shallow septal furrows. The almost complete, well-preserved calice (pl. 8:1) is 6 mm deep when measured in the free axial area. Its morphology is altered by a commensal (?) tube crossing one of the cardinal quadrants and being overgrown by some major septa, including the slightly shortened cardinal septum. The arrangement of the major septa is irregularly radial with no one dominating. They are all thin and short, extending from the external wall towards the centre for approximately 1 mm. Their lower inner ends stop short of the calice axis, reaching a wide, flat part of the last tabula. The peripheral portion of that tabula dips steeply to reach the external wall approximately 2.5mm lower down. The cardinal tabular fossula is not recognizable in the calice. In most loculi, the minor septa are absent but their foundations are developed along the marginal part of the calice and also in four or five septal loculi in its middle part. There are no minor septa present near the calice floor and beneath it.

The early growth stage is irregularly zaphrentoid. The middle lines of the major septa do not form any easily recognizable quadrants. Those of the cardinal and counter septa, united directly at the beginning (fig. 21:1a), became separated soon after (fig. 21:1b). An underdevelopment of the counter-lateral major septa, seen in the latter section, can also be recognized in the sections of the mature portion of growth (figs. 21:1c, d). The minor septa are not developed either inside the corallite or in the external wall, but their furrows from the neanic stage are present.

From two sections of the mature portion of growth, the ontogenetically younger one is more typically lytvolasmid because of the shape of the cardinal fossula, the inner part of which widens axially in spite of the presence of the stereocolumn. In the section made just beneath the lowermost portion of the calice floor the stereocolumn is almost completely absent. Its remanents connect the inner, rhopaloid ends of some major septa, including the elongated counter septum, to form a kind of fragmentary aulos around a part of the free axial area. The cardinal septum is distinctly shortened. The presence of the cardinal fossula is marked by the position and shape of sections of peripheral parts of tabulae, but it may not form any kind of depression in the paraxial part of the corallite, because the cross section of the most central tabula is straight (fig. 21:1d). There are no minor septa in the corallite lumen, but they were probably present inside of the external wall. The latter is mostly silicified at present and its structure is not clear.

Remarks. — The specimen discussed was described for two reasons as an example for a symbiosis (?) (this topic will be discussed in more detail separately) and as being similar to both *Lytvolasma* SOSHKINA, 1925 and *Bradyphyllum* GRABAU, 1928. Such a similarity, although striking, is interpreted in this paper as resulting from a close relation, but not as synonymy (see discussion to the mentioned genera). The species discussed is especially similar to *Bradyphyllum counterseptatum* sp. n. (e. g. fig. 12:1a—h). It should be pointed out, however, that the latter species also differs in some important details from the type species of the genus.

The similarity of the specimen discussed is, nevertheless, closer to *Lytvolasma* SOSHKINA, 1925 and especially to *L. aucta* sp. n. from which it differs in not having minor septa developed inside the corallite lumen, in a more rhopaloid character of the major septa, in a shallower cardinal tabular fossula in the middle part of growth and its absence on the calice floor in maturity.

Occurrence. — USNM 728e:1, Lower Bone Spring Formation, Upper Wolfcampian.

Genus *Monophyllum* FOMICHEV, 1953

Type species: M. sokolovi FOMICHEV, 1953

Synonym: e. p. *Stereolasma* FOMICHEV, 1953 *non* SIMPSON, 1900.

Species assigned: M. sokolovi FOMICHEV, 1953; ? *M. parvum* FOMICHEV, 1953; *M. cassum* sp. n.

Geographic and stratigraphic range: USRR, Donets Basin, Moscovian; USA, Texas, Gaptank Formation, *Uddenites*-bearing member to Upper Wolfcampian.

Diagnosis. — Small solitary corals without dissepimentarium; major septa radially arranged, in maturity may withdraw a little from corallite axis; cardinal septum shortened from early maturity; counter septum permanently elongated to corallite axis; alar septa slightly elongated at least in some portion of growth; minor septa underdeveloped; tabulae steeply elevated adaxially, sagging in axial part; septa trabecular, aseriate.

Remarks. — The genus discussed was univocally included in synonymy with *Rotiphyllum* HUDSON, 1942 (HILL 1956, 1981; de GROOT 1963; WEYER 1975). All opinions and remarks of the authors mentioned were based on the type material. No other fauna of monophylloid morphology has been described until this paper. The combination of characters shown by *M. sokolovi* FOMICHEV, 1953 (compare also fig. 22:1 in this paper) and by the specimens here described and assigned to this genus, permits consideration of it as a genus very close to *Rotiphyllum* and *Actinophrentis* FOMICHEV, 1953, which has been pointed out by authors through the various combinations of synonymy. Its close relation to *Bradyphyllum* has not yet been discussed. The following differences made me consider it an independent taxonomic unit:

1. It differs from *Rotiphyllum* in three important, qualitative characters: a) The strong

counter septum, permanently reaching a corallite axis, present there also on a calice floor, where it may form an incipient columella; b) The cardinal septum shortened not only on a calice wall as in *Rotiphyllum*, but also on its floor; this is documented by a shortening of the cardinal septum in the subtabular regions of the mature portions of the corallites; c) The triangular shape of at least peripheral parts of the cardinal fossula at maturity. None of the characters listed can be attributed either to the type specimen of *Rotiphyllum rushianum* (VAUGHAN 1908) or to those species of *Rotiphyllum* that can unambiguously be compared to it.

2. *Monophyllum* differs from *Bradyphyllum* by a single character only — the permanently elongated counter septum, reaching a corallite axis and tending to form an incipient columella in a calice. Like most of the genera included in Antiphyllinae (ILINA 1970), *Monophyllum* developed a tendency to form an axial area free of septa. Even then, however, a counter septum remains elongated, which is not the case in *Bradyphyllum*. It may be disputable whether such a single character is adequate for generic or only subgeneric distinction. At any rate, it has to be evaluated higher than specific rank.

3. Two main characters distinguish *Monophyllum* from *Actinophrentis* FOMICHEV, 1953: a) The pinnate arrangement of the major septa lasting up to a calice floor in *Actinophrentis versus* radial arrangement of septa in the mature portions of *Monophyllum;* b) Lack of tendency in *Actinophrentis* to form a free axial area. Small openings observed in this area in the type specimen of *A. donetziana* FOMICHEV, 1953 and in the specimens here described are rather local disconnections of the stereoplasmic column than true free areas. The two characters mentioned bring *Actinophrentis* close to *Allotropiochisma* FEDOROWSKI, 1982, which is discussed in remarks on the former genus. The characters listed may be unimportant for generic distinction, because at least American species of *Monophyllum* pass in their ontogeny a stage of morphology similar to *Actinophrentis*. Such an argument may only indicate a close relationship of given taxa, not their synonymy, however.

De GROOT (1963), following HILL (1956), regarded *Stereolasma* FOMICHEV, 1953 non SIMPSON, 1900 and *Monophyllum* FOMICHEV, 1953 as synonyms of *Rotiphyllum* HUDSON, 1942. Such an opinion makes synonyms of the former two genera automatically. I can only in part follow this opinion. It may be true for a single specimen of "*Stereolasma*" *grande* FOMICHEV, 1953, illustrated by that author on pl. 4, figs. 2a—e, but not for the holotype of this species. The latter may represent a peculiar species of *Barytichisma* MOORE and JEFFORDS, 1945. "*S*". *monophylloides* FOMICHEV, 1953 is closer to the holotype of *Actinophrentis donetziana* FOMICHEV, 1953 than any other species described by FOMICHEV (1953). The same may be true for "*S*". *gapeevi lophophylloides* FOMICHEV, 1953. All these species, as well as the others of similar morphollogy, need careful revision based on the existing, but not fully considered, specimens in FOMICHEV's (1953) type collection. They are only provisionally included in the genera here discussed in order to pay more attention to possible solutions other than presented so far by authors.

There exists also a not yet mentioned question of similarity of *Monophyllum* FOMICHEV, 1953 to *Lophophyllidium* GRABAU, 1928. As in several other instances, the differences between the type species of both genera are fully adequate for distinction on the generic or family level. Some species of *Lophophyllidium*, however, showing radial symmetry of thick, long, equal major septa and simple monoseptal columella, may be mixed with *Monophyllum*. Early ontogeny is in such a case the best distinguishing criterion. Comparatively late elongation and weak domination of a counter septum in this stage, accompanied by elongation of alar septa, characteristic for *Monophyllum* may best help in this distinction. Differentiation of length of major septa, commonly observed in mature portions of *Lophophyllidium*, may be also helpful, if its most characteristic feature: a compound, distinct columella does not occur.

Monophyllum cassum sp. n.

(figs. 22:2—5, 23; pls. 5:5, 11, 12; 6:6, 11)

Holotype: Specimen USNM 196767, fig. 23: 1a—f; pl. 5:12.
Type locality: USNM 702t.
Type horizon: Neal Ranch Formation.
Derivation of the name: lat. *cassus, a, um* — empty — after formation of small axial area free of septa.

Material. — Seven corallites having fairly well preserved internal structure, but without tips and upper portions of calices or without calices. Four specimens have the cardinal septum on the convex, two on the concave side. In the case of the Ross and Ross (1963) corallite this position was not established.

Some features of representative corallites (in mm):

USNM cat. nos.	N:d ratio	Septal formula	Position of C sep.	Remarks
196767	22:9.3	$\frac{5\,|\,7}{3\,|\,3}$	convex	calice floor
»	22:8.5	»		just beneath calice
»	20:6.3	$\frac{5\,|\,5}{3\,|\,3}$		early ephebic stage
196768	21:7.2	$\frac{5\,|\,6}{3\,|\,3}$	concave	calice floor
196765	18:6.7	$\frac{5\,|\,5}{2\,|\,2}$	convex	middle of calice
»	18:5.4	»		calice floor
196766	18:6.4	»	concave	just beneath calice
»	16:4.7	$\frac{4\,|\,4}{2\,|\,2}$		early ephebic stage

Diagnosis. — *Monophyllum* having maximum n:d ratio 22:9.5; major septa form small free axial area occupied only be elongated counter septum; cardinal septum moderately shortened.

Description of the holotype. — The specimen was 20 mm long on its convex side. Well preserved parts of the thick external wall bear distinct furrows of the major and minor septa. In spite of the presence of furrows of the latter, they are distinguishable in the structure of the external wall only starting from the early ephebic stage.

The calice floor documents domination of the counter septum that is rhopaloidally thickened axially, but does not form an upstanding columella. The cardinal fossula is narrow, open, bordered by two major septa. The thin cardinal septum reaches approximately 1/2 the length of the fossula. The minor septa are distinct due to the reduction in thickness of the external wall to approximately one half of this below the calice.

The morphology beneath the calice (fig. 23:1d—f) does not differ from that seen on its floor. Only the symmetry changes from radial to pseudoradial and then pinnate when going down towards the successively younger part of the corallite. The pinnate arrangement of septa seen in the early ephebic stage is accompanied by slightly less accentuated domination of the counter septum. Slight underdevelopment of a single alar septum, clearly seen on this section (fig. 23:1c, right side) is noteworthy.

The morphology of the early part of growth of the specimen discussed (fig. 23:1a, b) was disturbed by a commensal organism. A weak accentuation of elongation of the counter septum and early disconnection of the major septa are observed also in the undisturbed paratypes

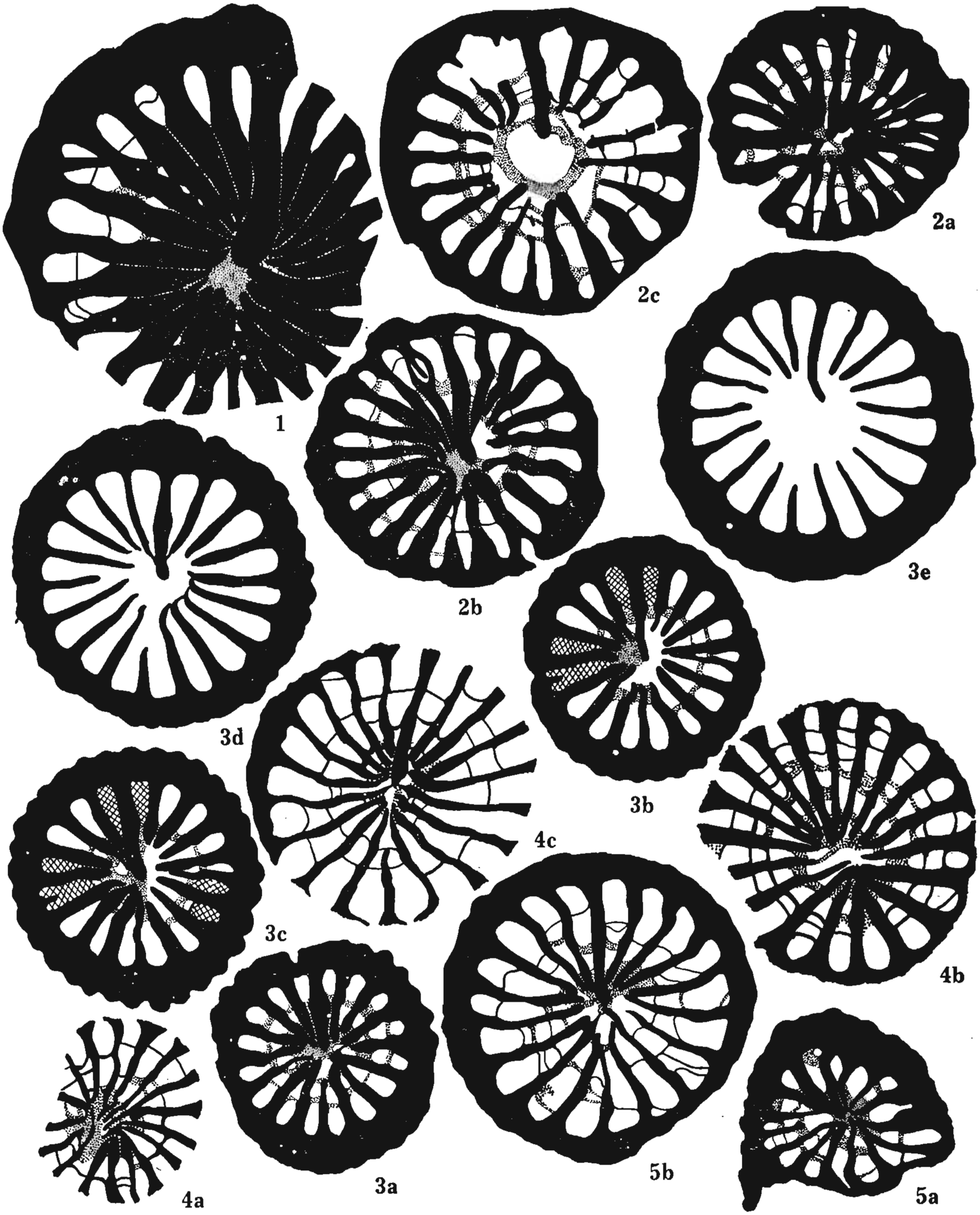

Fig. 22.

1. *Monophyllum sokolovi* Fomichev, 1953. Specimen 506b. Holotype. Middle Moscovian, Limestone L_7. Housed in VSEGEI Museum, Leningrad. Transverse section, early ephebic stage. 2—5. — *Monophyllum cassum* sp. n. Locality USNM 701p, Gaptank Formation, *Uddenites*-bearing member. Transverse sections. 2. Specimen USNM 196764; a — early ephebic stage; b — ephebic stage; c — ephebic stage having shallow axial rejuvenation. 3. Specimen USNM 196765; a—c — ephebic stage; portions above last tabula shaded; d — middle of calice. 4. Specimen USNM 139778. Sections not illustrated by Ross and Ross, 1963, except for fig. 22:4b = pl. 50:4 of those authors; a — late neanic stage; b, c — ephebic stage. 5. Specimen USNM 196766; a — neanic stage; b — ephebic stage. All, × 8.

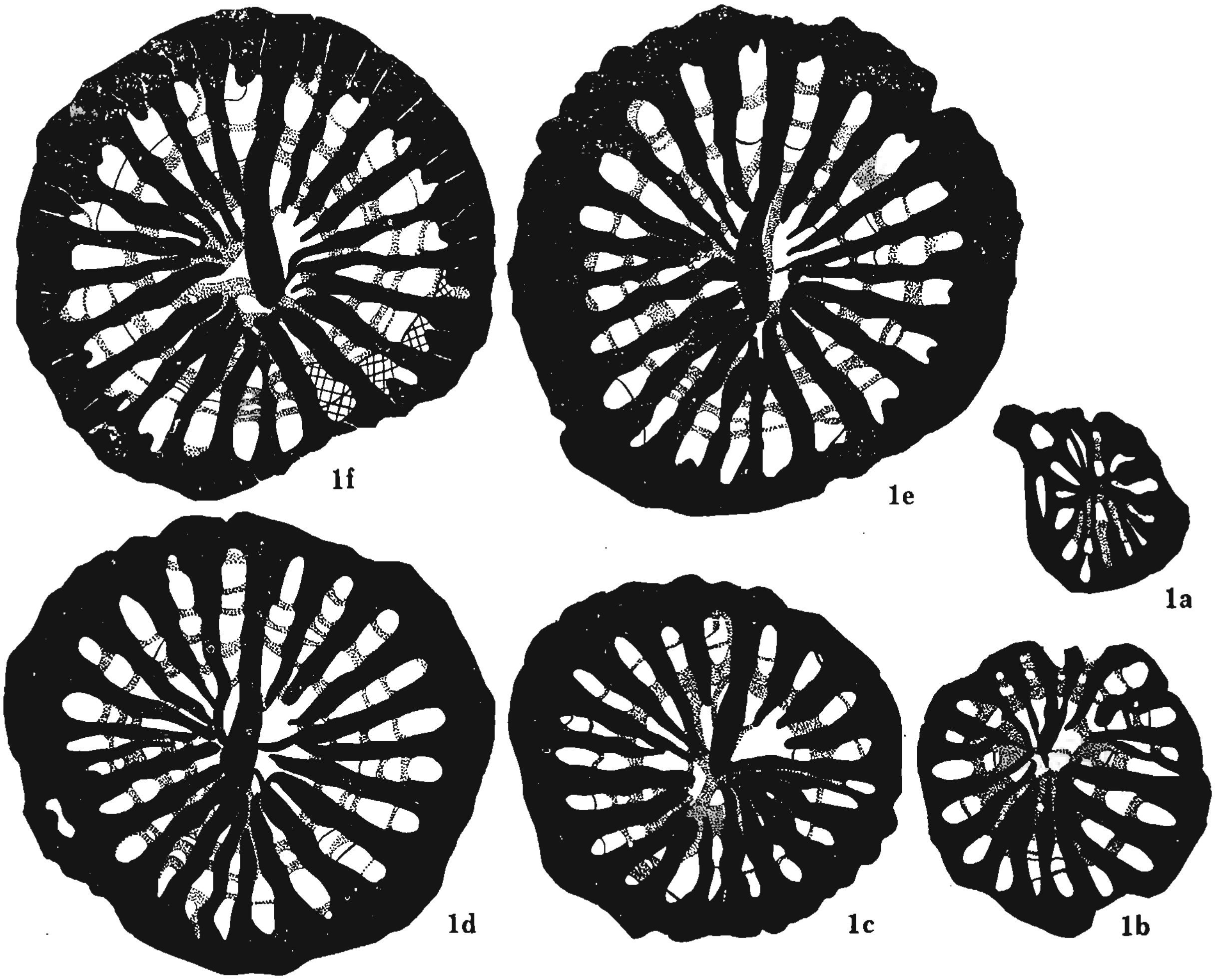

Fig. 23.
monophyllum cassum sp. n. Specimen USNM 196767. Holotype. Locality USNM 701t, Neal Ranch Formation. Transverse sections; a, b — neanic stage; c — early ephebic stage; d—f — ephebic stage. All, ×8.

(fig. 22:3a, b, 5b; pl. 5:5b) and should thus be considered typical for this species but not for the genus. The growth stage discussed is characterized also by pinnate arrangement of the major septa, slight but obvious elongation of the alar septa and the long cardinal septum that was united with the counter septum during the early neanic stage (fig. 23:1a) and remained long for some portion of growth of the corallite after disconnection of the major septa (fig. 23:1b).

Individual variation. — The collection studied is small and illustrates only some aspects of variation. Most important is a trend of development leading towards *Bradyphyllum* GRABAU, 1928 or, strictly speaking, towards *B. counterseptatum* sp. n. It is characterized by having domination of the counter septum and its elongation late in ontogeny slightly weaker than in the holotype (fig. 22:3a—d, 5b; pl. 5:b). In some early mature sections it may be almost equal to major septa (fig. 22:4b). The main difference between these corallites and any specimens identifiable as *Bradyphyllum* is a constant and clear elongation of the counter septum in the mature portion of growth of specimens, well accentuated on the calice floor and also above it (figs. 22:3c, d).

Small differences in number, thickness, length, and arrangement of the major septa, length of the cardinal septum that is shortened to a different extent in individual specimens, more or less widely open cardinal fossula, etc., are of very minor importance for taxonomy. A single specimen (fig. 22:2c; pl. 5:11b) forms a kind of axial tube that did not cause shortening of the counter septum. This may either be a steeply elevated, thickened tabula, or an initial stage of an unsuccessful axial rejuvenation, having again no taxonomic value.

Remarks. — The species discussed differs from the type species of *Monophyllum* in the morphology of the late neanic/early ephebic stage. In contrast to *M. sokolovi* FOMICHEV, 1953, it shows withdrawing of major septa from the corallite axis and rather weak elongation of the counter septum in this stage of growth. This can either be interpreted as resulting from more advanced phylogeny — the type species is Upper Moscovian in age — or from the relation of the species discussed to *Bradyphyllum*, *Lytvolasma* and *Actinophrentis* described in this paper, but not to the Donets Basin type. If the second possibility is accepted, all American specimens here attributed to *Monophyllum* and to the three genera mentioned may form a group of species related to the main stock of Antiphyllinae, but only parallel to the Middle and Upper Carboniferous Euro-Asiatic representatives of these four genera. Although such a solution is probable, the traditional way of identification in accordance with diagnostic characters is followed in this paper.

Occurrence. — USNM 701p:4, Gaptank Formation, *Uddenites*-bearing member; 701:1, 701d:1, 702t:1, Neal Ranch Formation, Lower Wolfcampian.

Monophyllum sp.

(fig. 24; pl. 6:7)

Material. — Among five possibly conspecific or related specimens, only one, USNM 196770 is complete enough for detailed description. Its n:d ratio at the calice margin is 21:8.

Description. — The ceratoid corallite is 20.5 mm long. Its well preserved external surface bears shallow, but conspicuous, septal furrows and delicate growth striae (pl. 6:7a, b).

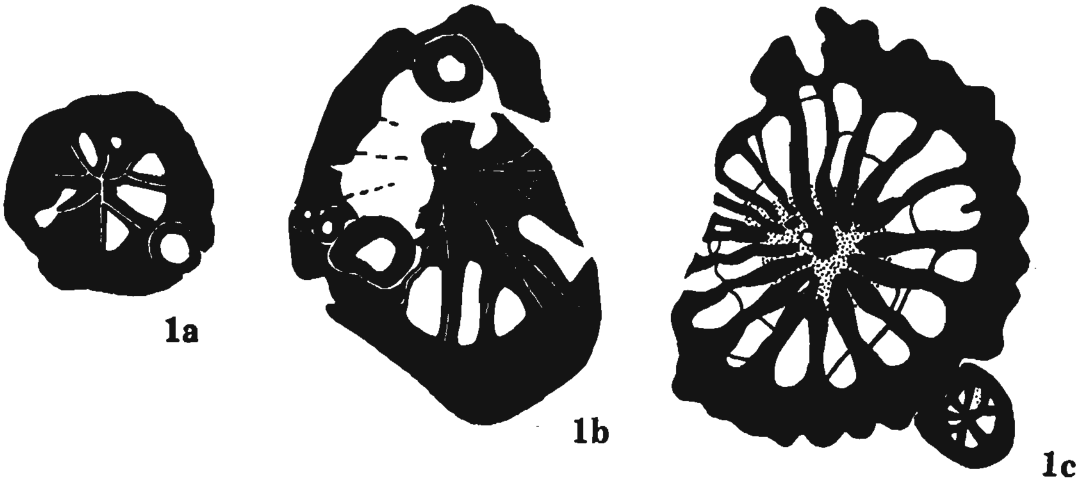

Fig. 24.
Monophyllum sp. Specimen USNM 196768. Locality USNM 728e, Lower Bone Spring Formation. Transverse sections; a, b — neanic stage; commensal worm tubes incorporated; c — ephebic stage having other corallite in neanic stage attached. All, × 10.

The calice (pl. 6:7c) is approximately 7.5 mm deep. Its margin is formed by the hemispherical foundations of major and minor septa that soon become flattened to form septal blades. Those of minor septa are continued downwards to approximately 2/3 of depth of the calice, becoming successively shorter and eventually disappearing in the increasing thickness of the external wall. The major septa form an inconspicuous intermediate zone beneath which they slope almost vertically downwards toward the calice floor. Their arrangement is almost exactly radial. This results in formation of an open, triangular cardinal fossula and an almost complete absence of the alar fossulae. The latter may be marked only when a new major septum is inserted (fig. 24:1 c, right). The shortened cardinal septum and the elongated counter septum form a symmetry axis. The latter is prominent, but the columella has not been separated from its inner end.

The ontogenetically oldest section, was made approximately 2.5 mm below the highest, periaxial part of the calice floor, but above the last tabula at its periphery (fig. 24:1 c). The arangement of the major septa is here similar to that observed in the calice, except for the more evident alar fossulae and slightly less clear radial symmetry in the counter quadrants. Major septa, especially those in the cardinal quadrants are rhopaloid. The morphology of the counter septum does not differ from that described above in the calice, but the cardinal septum is longer here. Minor septa are not yet present either in the corallite lumen or in the structure of the external wall. In this, and even more so in earlier sections of the corallite, there are several small tubes of the commensal vorms present. The internal morphology of the corallite and the increase of major septa is irregular due to this commensalism (fig. 24:1 a—c).

Remarks. — The corallite described here differs from *M. cassum* sp. n. in the rhopaloid character of the major septa and their more radial symmetry, in the ontogenetically later increase of the minor septa and in smaller dimensions. *M. sokolovi* FOMICHEV, 1953 has a different n:d ratio, more clearly elongated counter septum in early ontogeny (fig. 22:1), and stronger stereocolumn.

Occurrence. — USNM 728e:5 Lower Bone Spring Formation, Upper Wolfcampian

Genus *Falsiamplexus* gen. n.

Type species: F. elongatus sp. n.

Synonyms: Amplexus MATHER, 1915; EASTON, 1945 e. p.; WORTHEN, 1890 *non* SOWERBY, 1814. *Amplexocarinia* MOORE and JEFFORDS, 1945; ROSS and ROSS, 1962 ROWETT and SUTHERLAND, 1964; *non* SOSHKINA, 1928 ? *Pinacophyllum* KOKER, 1924 *non* FRECH, 1890.

Derivation of the name: lat. *falsi* — false — after apparent similarity to *Amplexus* SOWERBY, 1814.

Species assigned: Amplexus geniculatus WORTHEN, 1890; *Amplexus corrugatus* MATHER, 1915; ? *Pinacophyllum jonkeri* KOKER, 1924; *Amplexus adnatus* EASTON, 1945; ? *Amplexus dilatatus* EASTON, 1945; *Amplexocarinia delicata* ROSS and ROSS, 1963; *F. elongatus* sp. n.; *F. flexibilis* sp. n.; *F. reductus* sp. n.

Geoprahic and stratigraphic range. — North America, Morrowan to Lower Wolfcampian.

Diagnosis. — Solitary corallites without dissepimentarium; early neanic stage zaphrentoid, with long cardinal septum; in late neanic stage incomplete aulos may occur; ephebic stage amplexoid with cardinal tabular fossula present; cardinal septum varies in length; counter septum commonly longer than other major septa, some of which may be temporary elongated; minor septa restricted to external wall; tabulae complete, trapezoid; microstructure of septa trabecular.

Remarks. — The family status of the genus discussed is not obvious, showing characters intermediate between Amplexocariniinae SOSHKINA, 1941 and Antiphyllidae ILINA, 1970. In spite of the occurrence of a weak aulos in the late neanic stage, *Falsiamplexus* gen. n. has been placed within the latter family. Such an identification was determined mainly by the tendency of the cardinal septum to vary in length up to the elongation and by the commonly elongated counter septum. The appearance of a weak aulos was thus evaluated as a character of a rank lower than the former two. Such an interpretation is subjective and may well be reversed by other students. Because of this the amplexocariniid genera are here discussed as well.

The appearance of an aulos has already been evaluated by WEYER (1979) as a taxonomically unimportant character in *Ufimia tricyclica* SCHINDEWOLF, 1942. However, in the latter case the aulos may well be interpreted as a simple section of highly elevated tabulae (WEYER 1979, pl.

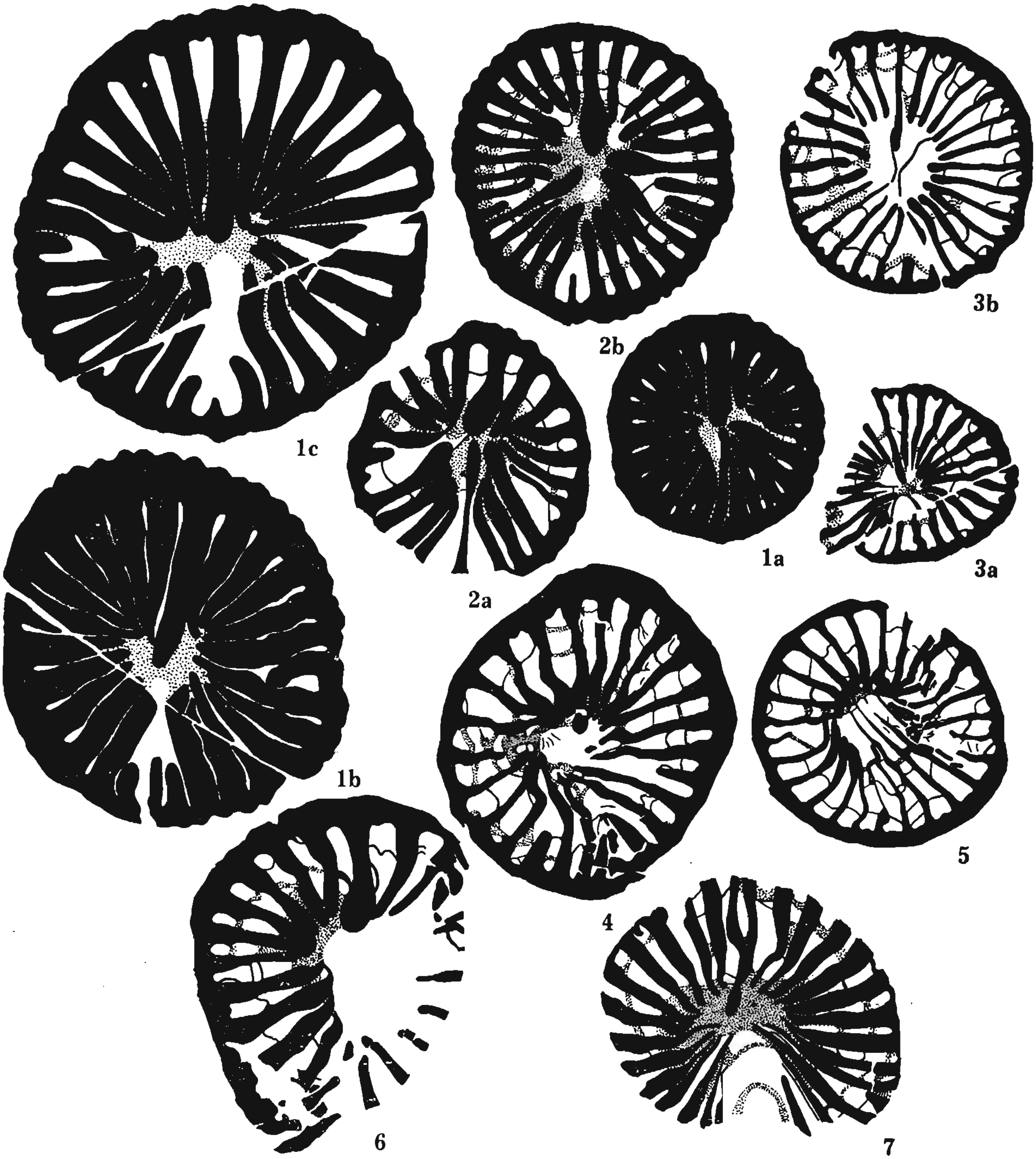

Fig. 25.

1. „*Hapsiphyllum*" *crassiseptatum* MOORE and JEFFORDS, 1945 (= *Actinophrentis* FOMICHEV, 1953). Specimen KU 57365. Holotype. Hale Formation, Morrowan, Oklahoma. Housed in Kansas University Museum. Transverse sections; a — neanic stage; b — ephebic stage; c — lower part of calice. All × 8. 2. „*Hapsiphyllum*" *crassiseptatum* MOORE and JEFFORDS, 1945 (= *Soshkineophyllum* (*Empodesma*) MOORE and JEFFORDS, 1945). Specimen KU 59711. Paratype (?). (According to MOORE and JEFFORDS, 1945: 129 paratypes were not found.) Depository as above. Transverse sections; a — late neanic stage, × 8; b — ephebic stage, × 4. 3. „*Hapsiphyllum*" *tumidum* MOORE and JEFFORDS, 1945 (= *Lophophyllidium* GRABAU, 1928 or *Monophyllum* FOMICHEV, 1953). Specimen KU 57364. Paratype. Smithwick shale, Bendian, Texas. Depository as above; a, b — transverse sections, ephebic stage, × 4. 4. *Parastereophrentis* (?) *invalida* FOMICHEV, 1953. Specimen 257. Holotype. Lower Bashkirian, Limestone H_1. Donets Basin. Housed in VSEGEI Museum, Leningrad. Transverse section made just beneath calice and above pl. 7:1 b of FOMICHEV (1953). 5. *Parastereophrentis* (?) *invalida* FOMICHEV, 1953. Specimen 532. Paratype. Upper Bashkirian, Limestone I_2. Depository as above. Transverse section made above pl. 7:2 of FOMICHEV (1953), × 4. 6. *Parastereophrentis virgata* FOMICHEV, 1953. Specimen 575. Holotype. Uppermost Bashkirian, Limestone K_7. Depository as above. Transverse section made partly above calice floor, × 8. 7. *Longiclava tumida* EASTON, 1962. Specimen USNM 118729. Holotype. Otter Formation, Upper Mississippian, Montana. Transverse section made above pl. 3:21 b of EASTON (1962).

1:1). In contrast to the almost entirely septal aulos in *Falsiamplexus* gen. n., a participation of septa in formation of the aulos in *U. tricyclica* is reduced almost to none. Being evaluated as not indicative for the family, the appearance of the aulos is here accepted as an important generic character for *Falsiamplexus* gen. n., distinguishing it clearly from all other genera considered members of Antiphyllidae. *Bradyphyllum* GRABAU, 1928 with its major septa shortened at maturity, the tendency of the counter septum to elongate, and the cardinal septum long in early ontogeny, is closer to *Falsiamplexus* gen. n. than most other genera of this family. It differs from the latter, first of all, in not developing an aulos, in having the cardinal septum shortened at maturity, and in not possessing such distinctly trapezoid tabulae.

Lytvolasma SOSHKINA, 1925 has the corallite axis free of septa and surrounded by a half aulos formed from the septa of the counter quadrants. The key-hole cardinal fossula, opened towards the corallite axis, the different organization of the calice, the different arrangement of major septa, and the absence of a true aulos at any growth atgse are main distinguishing characters of that genus.

"*Lophamplexus*" MOORE and JEFFORDS, 1945 might have been another genus of this family corresponding to *Falsiamplexus* gen. n. in some features of its mature growth stage. An independent status of that "genus" is questioned in this paper. *Lophamplexus* is here considered only a growth stage of *Lophophyllidium* GRABAU, 1928. The latter genus, with no traces of an aulos on any stage of growth but with a distinct, often complex columella, has to be eliminated as a possible ancestor or older synonym of *Falsiamplexus* sp. n.

The genus discussed resembles several Upper Devonian and Permo-Carboniferous genera showing so called amplexoid morphology at maturity. As indicated by its name, *Falsiamplexus* gen. n. is possibly not related to the Lower Carboniferous genus *Amplexus* SOWERBY, 1814. The latter remains undetermined although many authors have used its name for rugose corals of Ordovician to Permian age inclusively. The holotype of *Amplexus* was investigated only in its mature, amplexoid part. The ontogeny of either the type or topotypes is unknown. This reduces our knowledge of the coral of such kind of morphology almost to nothing.

Several amplexocariniid genera should be more closely discussed as being similar to *Falsiamplexus* gen. n. The seemingly closest genus *Amplexocarinia* SOSHKINA, 1928 has recently been reinterpreted FEDOROWSKI (1985) is incompletely known and thus uncertain. Mature portions of *Falsiamplexus* gen. n. differ from that genus in possessing a variable cardinal septum located in the cardinal tabular fossula, and the counter septum often elongated, sometimes distinctly. The early ephebic stage of *Amplexocarinia* possesses a complete aulos, while in *Falsiamplexus* gen. n. only an incomplete aulos was developed for a very short period of growth just following the neanic stage. In some corallites observed this morphological stage might have already been reduced from the ontogeny.

A group of species of *Amplexocarinia* described by SOSHKINA (1932, 1936, 1941) from the Ufa Platform and Southern Urals show characters that bring them close to the American species of *Falsiamplexus* gen. n. All these species, i. e. *A. irginae* SOSHKINA, 1932, *A. yakovlevi* SOSHKINA, 1932, and *A. ruzhencevi* SOSHKINA 1936 possess trapezoidal tabulae, sometimes highly elevated. A cardinal septum may be either permanently (*A. ruzhencevi*) or temporarily (*A. irginae*) shortened. In *A. yakovlevi* some septa, including the cardinal septum, may be elongated in the early growth stage. None of the species in question possesses a true aulos developed on any section illustrated or available for examination by me. They also never show an elongation of the counter septum. Individual major septa in some of these sections are declined towards each other, however. Several transverse sections show aulos-like structures. A comparison with trapezoid tabulae advocates for the analogy of these structures to that shown by calices of American specimens of *Falsiamplexus* gen. n. i. e. the nonamplexoid or only slightly amplexoid character of septa that end at the border of the flattened parts of tabulae without penetrating surfaces of the latter.

Paralleynia SOSHKINA, 1936 was discussed by FEDOROWSKI (1986) on the basis of the type material. *Paralleynia* seems to be close to *Falsiamplexus* gen. n. in several aspects of morphology and especially in early ontogeny. Both genera possess a zaphrentoid early neanic stage transferred into an aulos. In both taxa, the latter structure is of mixed cyatho- and phyllo-theca kind, but in contrast to an ephemerid appearance in *Falsiamplexus* gen. n., this is a long lasting structural element in *Paralleynia*. It is not only present in calices, but forms the highest elevation of floors of the latter.

Periaxial tabellae were said to be absent in the original description of *Paralleynia permiana* (SOSHKINA 1936:34, 1941:107), but their presence as infrequent and abaxially inclined was mentioned by HILL (1981:F200). The presence of periaxial tabellae is accepted also in this paper. Differences in structure and changes of axial areas in *Paralleynia* and *Falsiamplexus* gen. n. form one of most important differences between the two genera discussed. The long-lasting aulos in *Paralleynia* is well separated by its wall from the rest of the calices, being commonly open towards the cardinal fossula. Such a structure is not present in *Falsiamplexus* gen. n. except in some parts of early ontogeny of some specimens, where a weak and temporary aulos is present. Trapezoid, complete tabulae in *Falsiamplexus* gen. n. differ clearly from those in *Paralleynia*, which are divided into two distinct and possibly semi-independent parts. Axial tabellae in the aulos of the latter genus are horizontal and are fairly closely spaced in its type species. Badly preserved periaxial tabellae do not bring enough information concerning their relation to the axial ones.

Differentiation in length of the major septa in some sections of *Falsiamplexus* gen. n. is the next character distinguishing the two genera discussed. This character has not been seen in any section of the type material of *Paralleynia permiana*. Its presence in *Falsiamplexus* gen. n. is ephemeral and, what is most important, it does not concern constant septa, although the cardinal, counter and alar septa are most commonly elongated. In some species (e. g. *F. delicatus* (ROSS and ROSS, 1963)) and in some sections of *F. elongatus* sp. n., the cardinal and the counter septum may dominate. Being adequate for use as a supporting distinguishing character for *Falsiamplexus* gen. n., the discussed differentiation of septa seems insufficient to place this genus within Polycoeliaceae.

The cardinal septum is one of most variable septa in *Falsiamplexus* gen. n. Its slight elongation or shortening is thus considered only a specific character (see diagnoses of species). Wide variability does not lead clearly towards its shortening, but rather towards elongation or equalling to other major septa. This tendency is opposite to that observed in *Paralleynia*, where shortening of a cardinal septum is a permanent, well distinguished and ontogenetically early character, making it important for generic distinction.

Very deep calices in *Paralleynia*, occupying 1/2 to 2/3 of length of specimens, may serve as an additional distinguishing character between the genera discussed.

The characters and trends of development mentioned represent a qualitative level and are here considered adequate for generic distinction.

Gorizdronia RÓŻKOWSKA, 1969, described from the Famennian of the Ural Mts. and Poland, should also be analysed as a potential senior synonym of *Falsiamplexus* gen. n. or an ancestor of it. In the first place, early ontogeny of the holotype of the type species of this genus chosen by RÓŻKOWSKA (1969:89) is not preserved. Thus, its synonymy with the Polish specimens almost completely investigated, may be apparent, although very probable. The shortening of the major septa, the distinctly shortened cardinal septum and the presence of a cardinal tabular fossula in the holotype of *G. profunda* (SOSHKINA, 1951), renamed *G. soshkinae* by RÓŻKOWSKA (1974), may be compared to given characters of *Falsiamplexus* gen. n. Longitudinal sections of *G. profunda* differ completely from those in *Falsiamplexus* gen. n. in the arrangement and shape of the tabulae.

Polish specimens of *G. soshkinae* differ slightly from the holotype in longitudinal sections, where the tabular cardinal fossula is possibly absent and the tabulae are more diversified in shape and arrangement.

The Ural Mts. specimens are closer to *Falsiamplexus* gen. n., but differences in the longitudinal sections mentioned, lack of differentiation of length of the major septa at any growth stage, and temporary or non-existent zaphrentoid arrangement of septa (the latter two characters observed only in the Polish material) distinguish *Gorizdronia* from *Falsiamplexus* gen. n. A long time span between the occurrence of these two groups of species (Famennian to Morrowan) advocates also for considering them unrelated generically.

Some transverse sections of *Nalivkinella* SOSHKINA, 1939 are also similar to *Falsiamplexus* gen. n. This is especially true in the case of slight shortening of the cardinal septum. The morphology of the tabularium, commonly bipartite in *Nalivkinella*, the very early appearance of a cyathathecal aulos, the possible absence of zaphrentoid arrangement of septa early in ontogeny, and the major septa not differentiated in length at any stage of development are the main characters distinguishing *Nalivkinella* from *Falsiamplexus* gen. n.

A review of species assigned to *Falsiamplexus* gen. n. does not show any distinct trend of development. No geologically older genus can be pointed out, as ancestral for it. The trapezoid tabularium, constantly present in *Falsiamplexus* gen. n., can hardly be linked from the more specialized, bipartite tabularia of the late Devonian Amplexocariniinae, except maybe for *Gorizdronia* RÓŻKOWSKA, 1969. Differences discussed above and a long gap in occurrence made linkage to that genus unacceptable to me.

The metriophylloid rather than zaphrentoid arrangement of septa in the early ontogeny of the geologically oldest known species of *Falsiamplexus*, i. e. *F. corrugatus* (MATHER, 1915) may point to the Metriophyllidae as a possible ancestral group. There is no particular genus in that family that can be directly pointed out as ancestral for *Falsiamplexus* gen. n. The Devonian genus *Metrioplexus* GLINSKI, 1963, with its highly domed tabulae and shortened major septa, represents a final, rather than initial, step of evolution. Lack of tendency to elongate any major septa eliminates this genus from the *Falsiamplexus* gen. n. evolutionary line.

Some of the Chesterian amplexoid corals of Illinois and Arkansas (EASTON 1945) are possibly close to ancestral forms of the genus discussed. The morphology in the mature portions of corallites, the early ontogeny, and shape of the tabulae are in agreement with its diagnosis. EASTON'S (1945) illustrations do not show an aulos at any growth stage of these corals, which may argue against considering them congeneric with the geologically younger ones. *Amplexus expansus* EASTON, 1945, with its axially sagging tabulae, is excluded from these considerations.

The Upper Permian "*Pinacophyllum*" *jonkeri* KOKER, 1924 is possibly a member of *Falsiamplexus* gen. n. Its more important morphological characters are discussed by FEDOROWSKI (1986)

Falsiamplexus delicatus (ROSS and ROSS, 1963)

(figs. 26, 27; pls. 6:3, 7:1, 2)

1963. *Amplexocarinia delicata* ROSS and ROSS; J. P. ROSS and C. L. ROSS, p. 409, pl. 48:5, 10.
non 1984. *Amplexocarinia delicata* ROSS and ROSS; S. RODRIGUEZ, p. 155, fig. 55, pl. 2:10.

Type designation. — The species discussed was originally described by ROSS and ROSS (1963) as colonial and the whole sample USNM 139769 was chosen the holotype. Because there are dozens of specimens present in that sample, it is necessary to indicate one of them as the type. I choose here the upper specimen of the two illustrated by ROSS and ROSS (1963, pl. 48, fig. 5). In spite of its smaller diameter, it is more advanced ontogenetically than the second specimen shown on the same figure, which has the major septa joined at the axis.

TABLE 6

Morphologically-comparative table of species of *Falsiamplexus* gen. n.

Name of species	Major septa	Minor septa	Cardinal septum	Cardinal fossula	Counter septum	Aulos	Tabularium	N: d ratio at calice margin
Falsiamplexus delicatus (Ross and Ross, 1963)	Thin or slightly thickened; some slightly rhopaloid	Restricted to external wall	In early growth dominates; in maturity varies in length	Tabular present; septal inconspicuous	May be slightly elongated	Composed of bent inner ends of septa and of tabulae; short-lasting	Trapezoid tabulae often resting on underlying ones in some portions	13:2.4 to 18:4.5
Falsiamplexus elongatus sp. n.	Thin, nonrhopaloid; alar may be slightly elongated	As above or absent	Shortened; temporarily equal to other major septa	Tabular shallow; septal often well marked	”	As above, but commonly incomplete and long-lasting	Trapezoid, highly domed, rarely spaced; box-shaped may occur	18:5.3 to 27:10.8
Falsiamplexus flexibilis sp. n.	Thin, amplexoid, commonly reach boundary of inner tabularium	Short, appeared late in ontogeny	Shortened; rarely equal to other major septa	Tabular well developed; septal differently marked	Varies from equal to other major septa to well elongated	Inconstant; built of bent inner ends of major septa; short-lasting	Trapezoid, complete	16:6.7 to 20:9.0
Falsiamplexus reductus sp. n.	Very thin, short, slightly vary in length; inner ends of some bent	Absent	Equal to other major septa	Not developed	Equal to other major septa	Not developed	Trapezoid, complete, widely spaced; slightly sagging axially	16:4.4 to 20:5.8

Material. — The samples of Ross and Ross (1963) and several other fragments of rock from biohermal limestone at the type locality. All are crowded with dozens of well preserved specimens.

N:d ratio of specimens considered mature:

USNM cat. nos.	n: d ratio in mm	USNM cat. nos.	n: d ratio in mm
196770 1	17:3.7	196769 1	15:5.4
„ „	17:4.8	„ 2	17:5.1
„ 2	14:2.0	„ 3	15:3.2
„ 3	16:4.6	„ 4	18:3.7
„ 4	13:2.4	„ 5	18:4.7
„ 5	15:4.0	„ 6	18:4.5
„ 6	14:3.5	„ 7	13:2.8
„ 7	16:3.6	„ 8	15:2.8
		„ 9	14:2.8

Diagnosis. — *Falsiamplexus* having 15—18 major septa and diameter up to 6 mm at calice margin; minor septa restricted to thick external wall.

Ontogeny. — Although investigated on several specimens, the ontogeny of this species is described in detail. The earliest growth stage, preserved as a flattened solid rod of calcite attached to the inner surface of a dead calice of another specimen, (fig. 26:6a) might have once formed a laterally flattened cup. Its morphology might have resulted from calcium carbonate secretion taking place prior to the formation of the first tabula.

The axial septum, not divided into the cardinal and the counter septum, is the first septum inserted and recognizable in the stereoplasmic mass (fig. 26:6b). Only half of the corallite lumen is free of stereoplasm at this early growth stage. The first lateral septa, probably the counter-lateral ones, appeared only after about 1,5 mm of further growth of the corallite discussed (fig. 26:6f). The ontogenetically older part of this specimen is not preserved. A slow increase of the major septa in the early and late neanic stage was observed in several specimens, not all of which are illustrated in this paper. The sharply curved proximal ends of some corallites (e. g. figs. 26:5a—f; 27:2a—f) allow simultaneous observations on the very early neanic stage as well as the morphology of the longitudinal section by means of the same series of sections.

All corallites in which only the first metaseptum is inserted are very small in diameter, while variation in n:d ratio among corallites possessing 10—12 major septa is considerable.

N: d ratio of juvenile corallites

USNM cat. nos.	n: d ratio	USNM cat. nos.	n: d ratio
196770/16	7:0.6×0.9	196770/15	10:1.1×1.7
„ 9	7:0.6×1.0	„ 17	12:1.7×2.0
„ 14	7:0.7×1.0	„ 12	12:1.9×2.6
„ 18	9:1.0×2.1	„ 11	13:1.6×1.6
„ 13	10:9.0×1.0	„ „	14:2.1×2.8

The morphology of the neanic stage is similar in all corallites. The cardinal and the counter septum meet at the corallite axis, but their medial lines are not always united. The cardinal septum dominates in length. the other major septa are long and, except for the last pairs in quadrants, either meet at the corallite axis or are zaphrentoidally arranged. The cardinal fossula

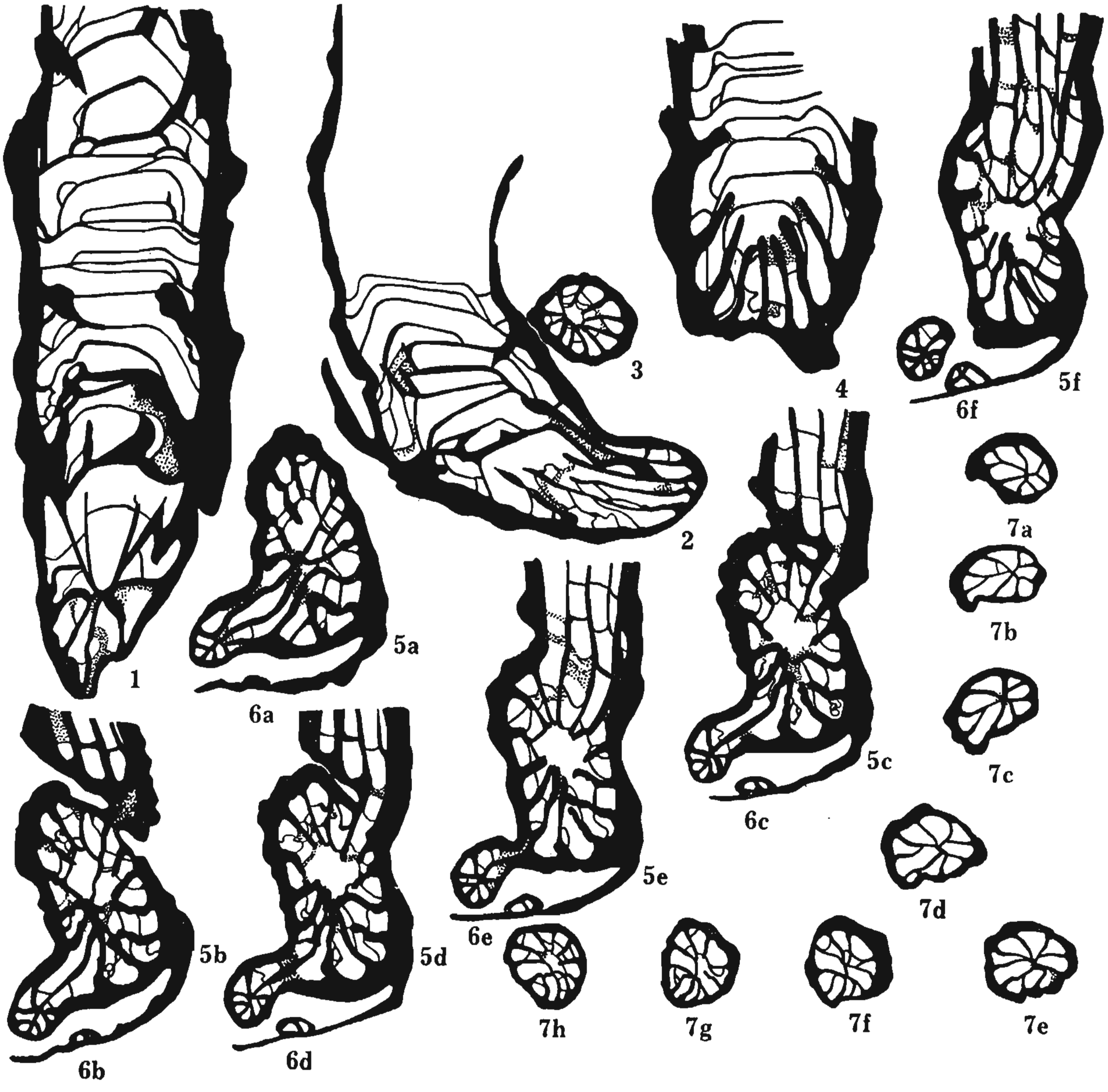

Fig. 26.
Falsiamplexus delicatus (Ross and Ross, 1963). 1—4. Individual corallites of specimen USNM 196771 (fragment of biohermal limestone). Locality USNM 700g, Gaptank Formation, Virgilian. 1. Corallite 1, slightly oblique longitudinal section. 2. Corallite 3, slightly oblique longitudinal section showing deep calice. 3. Corallite 4, transverse section, late neanic stage. 4. Corallite 2, slightly oblique longitudinal section. 5—7. Individual corallites of specimen USNM 196772. Locality as above. Another fragment of the same bioherm. 5. Corallite 1, a—f — successive sections of strongly bent specimen. 6. Corallite 2, transverse sections of very early ontogeny; a — basal plate; b—e — axial septum, f — appearance of first lateral septa. 7. Corallite 6, a—h — transverse sections, early to late neanic stage. All, × 10.

is well marked and possesses either parallel or bow-shaped walls. Such a bow-shaped curvature of the septa is characteristic for several of the specimens observed, consequently the counter — lateral septa may be convex towards the cardinal septum. The major septa are a little rhopaloid at this and at the beginning of the next growth stage.

At the end of the neanic stage, the zaphrentoid connection of major septa disappears (fig. 26:7g, h). The axial ends of several of them remain in contact, rounding a part of the free axial area of the corallite. This newly developed aulos is always supplemented by the tabulae, which

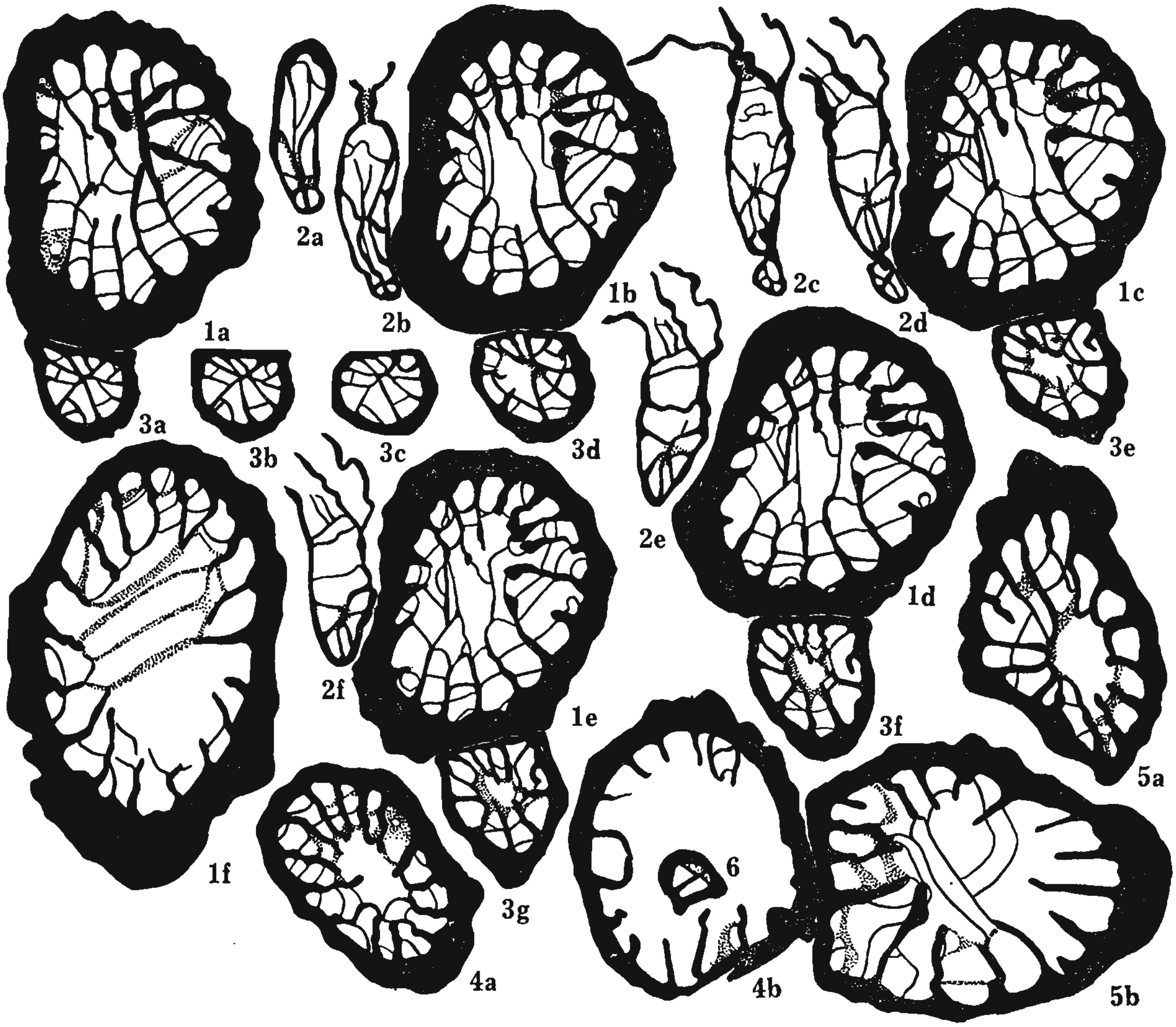

Fig. 27.

Falsiamplexus delicatus (Ross and Ross, 1963). Specimen USNM 196772. Locality USNM 700g, Gaptank Formation Virgilian. Corallites embedded in biohermal limestone. 1. Corallite 3, a—f — transverse sections, early to late ephebic stage. 2. Corallite 5, a—f — successive sections of young, weakly developed corallite with lateral rejuvenation in upper portion. 3 — corallite 4; a—g — transverse sections; successive stages of development of aulos. 4 — corallite 7, transverse sections; a — ephebic stage; b — calice. 5 — corallite 8, transverse sections; a, b — early and late ephebic stage. 6 — transverse section of very young corallite developed in calice of older corallite 7. All, ×10.

complete the portions of it not occupied by the united axial ends of the major septa. The minor septa are not yet present in the microstructure of the external wall, except for their external furrows.

Each specimen having the major septa withdrawn from the corallite axis and not having their axial ends incorporated in an aulos is here considered morphologically mature, independent of its n:d ratio. The considerable differences in that character are shown on the table (see above). Also, a wide morphological variety is observed within the species discussed. A good sample of this is shown on the pl. 7:1b, 2, where the major septa of individual specimens may be short, thin and almost equal in length or thickened and differentiated in length with a prominent cardinal septum. The counter septum may be elongated or equal to other major septa. At least some major septa in many specimens are slightly rhopaloid. They only terminate sporadically at the sides of the tabulae. The minor septa do not penetrate lumens of the corallites. Their presence may be established only in the microstructure of the wall of better preserved specimens. Because of the irregular shape of most corallites, none of the longitudinal sections illustrated (figs. 26:1, 2, 4; 27:2e, f; pl. 7:1a, c) is exact. The tabulae are often complete, trapezoidal, and very high, with the top parts flattened. On one side of a corallite, they are often attached to the external wall, but on the underlying tabula on the other side. These positions of the attachment alternate in particular tabulae, which prevents formation of a regular cyathotheca of GRABAU 1922. The arrangement described is not constant, however, and 2—3 successive tabulae may rest on each other (fig. 26:1; pl. 7:1a). Additional peripheral and elongated axial tabellae are fairly common.

The microstructure of the septa is fine trabecular and/or multitrabecular. The wall defined middle lines of the septa can only sporadically be observed. The tiny details of the septal microstructure are poorly preserved.

Remarks. — The species described seemingly resembles *Amplexocarinia* SOSHKINA, 1928 and was originally described by ROSS and ROSS (1963) under that generic name. More detailed study of the American specimens and a brief restudy of the type material of *A. muralis* SOSHKINA, 1928 (FEDOROWSKI 1986) revealed several differences between these taxa, discussed earlier in remarks on the genus *Falsiamplexus* gen. n.

The original description of ROSS and ROSS (1963) contains several misunderstandings, which are corrected as follows:

1. All corallites derived from the USNM 700 g locality, i. e. all specimens described by ROSS and ROSS (1963) and in the present paper are solitary corallites. In spite of this they are one of main components of the small bioherm illustrated by COOPER and GRANT (1972, pl. 16:1). They form gregaria that give the impression of being colonial (pl. 6:3).
2. Neither in the type material nor in the topotypes are the major septa in the counter quadrants longer than those in the cardinal quadrants, although the counter septum may occasionally be slightly elongated. The morphology described by ROSS and ROSS (1963) resulted from the obliqueness of the section.
3. The inner edges of septa are, or may be, connected mainly by the top parts of the tabulae. Even then there is never a complete ring (aulos) formed. The septa are differentiated in length, which is not terminated by the tabulae in a transverse section.
4. Minor septa do not extend to the corallite lumen. Their presence is marked in the structure of the external walls of corallites.

Falsiamplexus delicatus (ROSS and ROSS, 1963) differs from *F. corrugatus* (MATHER 1915) in smaller dimensions, slightly different n: d ratio, thicker external wall, better accentuated and longer lasting zaphrentoid morphology in the ontogeny, longer major septa, with their differentiation in length better accentuated, and by more densely spaced tabulae that are also not so highly trapezoidal as in *F. corrugatus* and are supplemented by tabellae, sometimes frequently.

Several of the characters mentioned distinguish *F. delicatus* also from *F. elongatus* sp. n. These are: smaller demensions, different n: d ratio, and the arrangement of the tabulae with fairly frequent tabellae. Shortening of the cardinal septum and a well accentuated differentiation of the length's of the major septa, common in *F. elongatus* sp. n., are rare in *F. delicatus*. In addition to the generic features, the thick external wall and a tendency to form the slightly rhopaloid major septa are characters in common for these two species.

A. delicata ROSS and ROSS of RODRIGUEZ, 1984 has not been accepted a member of this species. Lack of information concerning ontogeny of the Spanish specimen made its generic status unknown.

Occurrence. — USNM 700 g, Gaptank Formation, Virgilian. Dozens of specimens in several pieces of the biohermal limestone.

Falsiamplexus elongatus sp. n.

(figs. 28—30; pls. 6:9; 7:3, 6; 8:2—15)

Holotype: Specimen USNM 196773, fig. 28:a—s; pl. 8:6a, b.
Type locality: USNM 701 h.
Type horizon: Neal Ranch Formation.
Derivation of the name: lat. *longus, a, um* — long. After elongated shape.

Material. — Over 130 specimens with silicified external portions. Internal structures often calcitic. Proximal ends and calices often preserved.

Some features of representative specimens (in mm):

USNM cat. nos.	n:d ratio	Length of specimen	Depth of calice	Remarks
196773	27:10.8	≈25.5	≈11.5	calice margin
„	24:7.5			lower part of calice
196779	25:9.2	≈20.0	9.5	calice margin
196774	23:9.2	≈22.0	≈12.0	„ „
„	21:9.3			lower part of calice
196778	22:8.2	28.0	9.0	calice margin
196783	21:7.4	≈17.5	9.8	„ „
196784	20:7.0	17.8	6.8	„ „
196776	18:5.3	≈16.5	≈ 4.5	„ „

Diagnosis. — *Falsiamplexus* having n: d ratio at calice margin up to 27:10.8; major septa straight, shortened; weak incomplete aulos in early ontogeny present, in maturity absent.

Description of the holotype. — **External characters.** — The corallite is approximately 25 mm long, ceratoid (pl. 8:6a), having an apex ornamented by growth striae only, but with well developed septal furrows upperwards. The apical part of the corallite is slightly flattened and irregular on its convex, cardinal side, armed with small attachment processes, some of which are developed on a distance of almost half the corallite length (pl. 8:6a).

The calice, approximately 8.5 mm deep, partly infilled with matrix and poorly preserved (pl. 8:6b), exhibits a deep axial rejuvenation. Its margin bears foundations of major and minor septa, but only the former form the septal blades below. The coral had been exposed post mortem above the sea floor, becoming a base for the settlement of several sessile organisms on ist surface and inside its calice.

Internal characters. — In partly silicified section made just beneath the calice (fig. 28:1n), the major septa are free, withdrawing from the corallite axis for a distance of approximately 1—2 mm. The shortened cardinal septum is located in a cardinal fossula marked by strong shortening of the last pair of septa of the cardinal quadrants. The last septa of the counter quadrants are also underdeveloped in length. The rest of the major septa are slightly and irregularly differentiated in length, with the counter septum and the alar septa slightly elongated. Minor septa are undistinguishable. The other (lower) side of the same section, 0.6 mm away and the next section, (fig. 28:11, m) exibit similar arrangement and differentiation in length of the major septa, but the latter come slightly closer to the corallite axis. The axial end of the counter septum is elongated so as to meet an axial end of one of the metasepta in the counter quadrants. Middle lines of these two septa are united, but not the middle lines of some other septa that join the lateral side of the elongated counter septum. There are also some other axial ends of septa either bent to each other or connected by axial sections of the tabulae. Several major septa are free axially, however, and a continuous aulos is absent.

The section made approximately 1,2 mm below (fig. 28:1k) differs from the upper three sections in having the cardinal and counter septa equal to other major septa and having an aulos

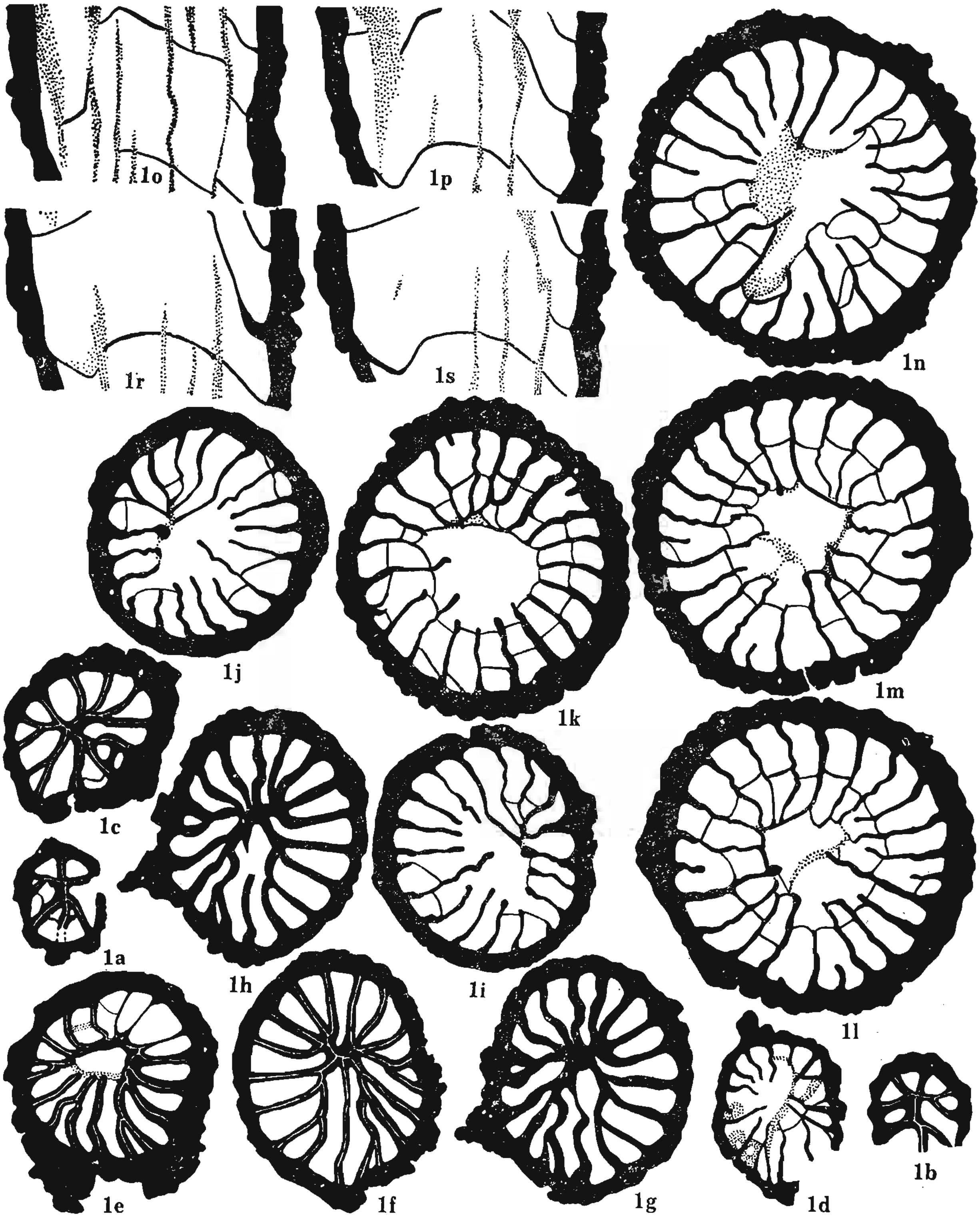

Fig. 28.

Falsiamplexus elongatus sp. n. Specimen USNM 196773. Holotype. Locality USNM 701h, Neal Ranch Formation; a—c — transverse sections, early neanic stage, × 16, d—h — transverse sections, late neanic stage, × 8, i—n — transverse sections, early to late ephebic stage, × 8, o—s successive longitudinal sections, × 8.

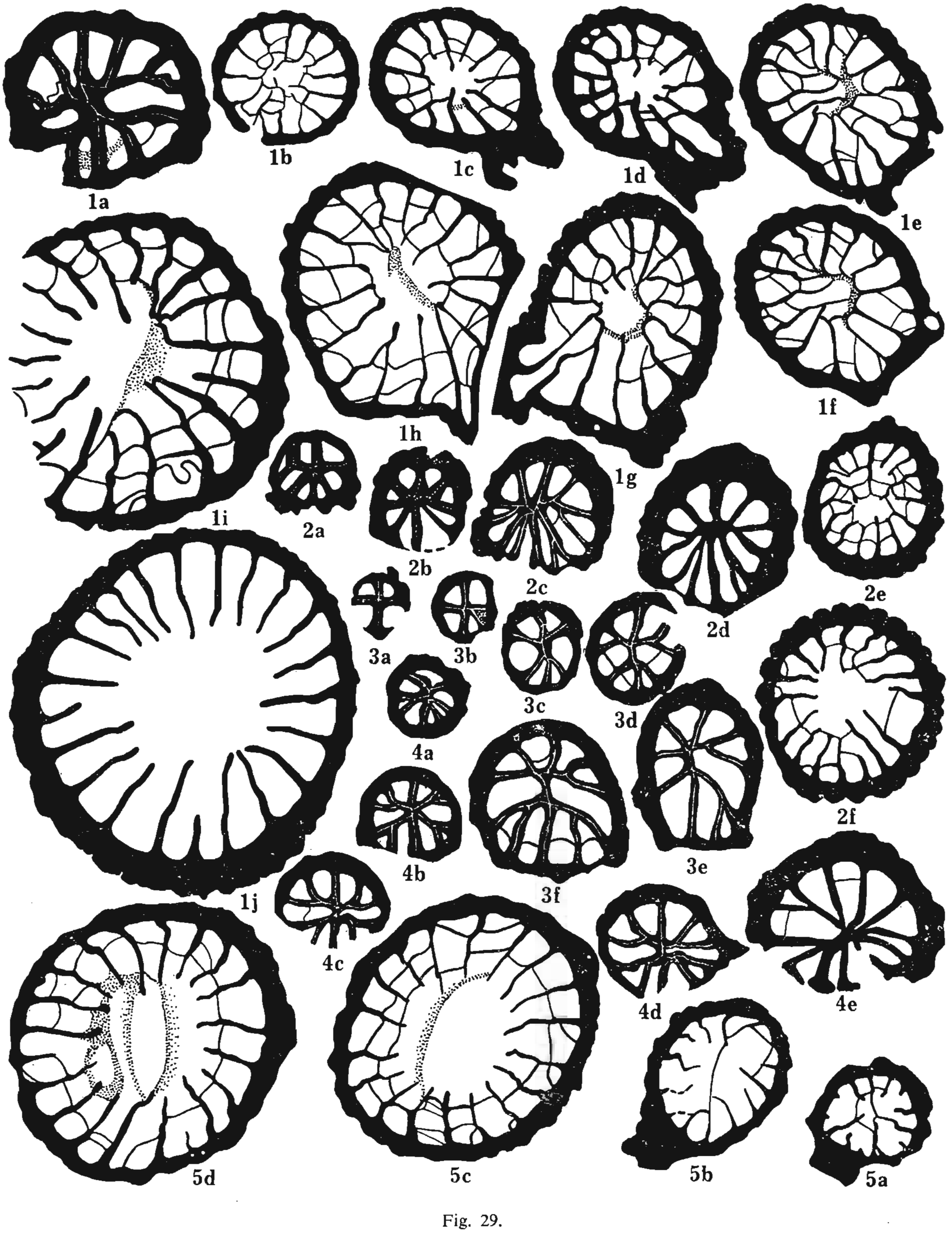

Fig. 29.

Falsiamplexus elongatus sp. n. Transverse sections. 1. Specimen USNM 196774. Locality USNM 701k, Neal Ranch Formation; a — early neanic stage, ×16; b—f — late neanic stage, ×8; g—h — early ephebic stage, ×8; i — ephebic stage, ×8; j — calice, ×8. 2. Specimen USNM 196776. Locality and horizon as above. a—d — early neanic stage, ×16; e — late neanic stage, ×8; f — ephebic stage, ×8. 3. Specimen USNM 196775. Locality and horizon as above. a—f — early neanic stage, ×16. 4. Specimen USNM 196777. Locality and horizon as above; a—e — early neanic stage, ×16. 5. Specimen USNM 196778. Locality USNM 701h, horizon as above. Transverse sections; a, b — late neanic stage; c, d — ephebic stage. All, ×8.

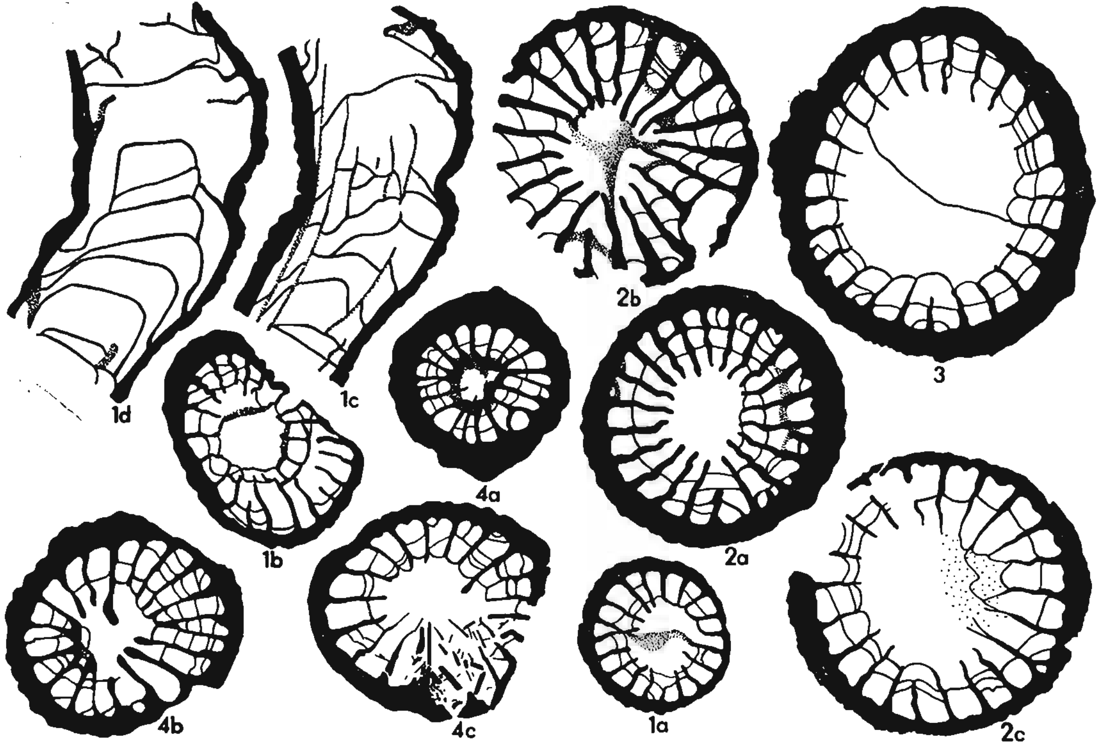

Fig. 30.
Falsiamplexus elongatus sp. n. 1. Specimen USNM 196781, Locality USNM 701h, Neal Ranch Formation; a, b — transverse sections, ephebic stage; c, d — successive longitudinal sections. 2. Specimen USNM 139782. Locality USNM 701p, Gaptank Fm., *Uddenites*-bearing member (= *Amplexocarinia* sp. *B* Ross and Ross, 1963, pl. 48:4). Transverse sections; a—c — neanic stage. 3. Specimen USNM 196780. Locality USNM 701h, Neal Ranch Formation. Transverse section; ephebic stage. 4. Specimen USNM 196782. Locality USNM 706x, Neal Ranch Formation. Transverse sections; a — late neanic stage; b — early ephebic stage; c — ephebic stage. All, × 5.

of partly cyatho- partly phyllo- theca kind developed in more than half the section. This section illustrates well a dependence of morphology on even slight skewness of a section. It also shows that septa are generally not amplexoid, although some may slightly elongate on the tabulae surfaces (fig. 28:1k) and that the cardinal septum varies in length. The latter observation is of a special importance for taxonomy.

Observations on the early ontogeny of the holotype started from the obliquely broken and polished tip having n: d ratio 7:1.1 × 0.7 (fig. 28:1a). The arrangement of major septa is irregular oving to skewness of the section. All protosepta are united in a manner typical for Rugosa and one metaseptum in a cardinal quadrant had already been inserted. Tabulae are present, but no minor septa are seen. This and two following sections (fig. 28:1b, c) were made from part of the corallite without septal furrows.

The following 5.5 mm of growth of the corallite shows considerable changes in morphology, starting from the amplexoid one with almost all major septa free (fig. 28:1d) through aulate with the aulos of the phyllo-cyathotheca kind (fig. 28:1e) to zaphrentoid with the cardinal septum long (fig. 28:1f, g) and shortened (fig. 28:1h).

Further change leads towards loss of contact of the majority of septa (fig. 28:1i, j), more accentuated shortening of the cardinal septum, elongation of the counter septum and one of the alar septa. The second one is rhopaloidally thickened. The section described imitates the morphology of *Soshkineophyllum* Grabau, 1928. The longitudinal section was made between (fig. 28:1j) and the next transverse section described as mature.

The longitudinal section (fig. 28:1o—s) was prepared from the early ephebic part of the corallite having some septa still elongated. It was oriented in the cardinal-counter septa plan to check for presence of the cardinal fossula. Depression of the latter is shallow and seen only in close vicinity of the cardinal septum (fig. 28:1 p—s, lower left). The tabulae in the plan discussed are complete, highly domed, and very widely spaced.

Individual variation and supplementary description. — Quite a few specimens within the collection possess completely preserved proximal ends. These parts are invariably flattened on the cardinal septum side and slightly widened laterally. This flat and thickened part was not sectioned due to technical difficulties. The section made just above it (fig. 29:3a) shows four septa united at the corallite axis, with an axial septum dominant and with two counter. lateral septa. It thus can be deduced that the flattened, youngest part has to be armed with at least the axial septum. The following thin sections were cut from the septal furrows less apex of the corallite, parallel to the growth lines thus the serial, not cyclic insertion of the alar septa observed cannot be explained as a result of skewness of the sections. Insertion of the first alar septum is of special importance (fig. 29:3b). It appeared not at or from the axial septum, but was inserted as attached to the lateral, cardinal side of the counter-lateral septum, i. e. in a manner typical for any metaseptum. A stage of increase of the second alar septum was cut out during preparation of the next thin section, but the morphology of the latter (fig. 28:3c) and the insertion of first, single metaseptum in a counter quadrant, and then in the second counter and first cardinal quadrant, etc. (figs. 28:3d—f) confirm, that all septa older than the first four were inserted in series. This may also be true for the counter-lateral septa, which has not been checked. Hence, there is no difference in increase of four lateral protosepta when compared to the increase of metasepta, and they can be called protosepta only because of their earliest appearance. This problem with a comparison of an increase of septa in other taxa will be discussed in more detail separately.

The early stages of growth of all specimens studied are similar in n:d ratio, zaphrentoid arrangement of septa and their increase in sequence although first metaseptum may be inserted either in a cardinal (fig. 29:4a) or in a counter quadrant (fig. 29:2a, b). Further ontogeny became more or less differentiated, but none of the specimens studied shows it so complex as the holotype. All of them possess an amplexoid morphology with an incomplete aulos developed along some distances of their growth, but never permanently. This amplexoid morphology is not identical for all corallites, being more or less short-septal (fig. 29:5a, b) or showing elongation of some septa. These elongated septa may change in the same specimen. For instance, a single specimen (fig. 29:1b—d) shows elongation of the cardinal and the counter septum in early sections and the elongation of one alar septum and one metaseptum on slightly higher sections (fig. 29:1e, f). The same specimen shows very weak development of an aulos that is never complete and occurs in some sections only. Most of the specimens observed have the major septa free along almost all of their post-early neanic growth.

Observations in young calices were restricted because of some destruction of the youngest of them due to coarse silicification. The better preserved young specimens (e. g. pl. 8:9a, b; 15a, b) represent the neanic stage and may serve for the following characteristics: 1. Calices are very deep and funnel-shaped, with septal blades strongly underdeveloped or absent on their inner walls, but present near their floors. 2. The arrangement of septa in the calices is similar to that observed in sections. Their height above the last tabulae is not large, thus the morphology of sections although slightly heterochronous, may be closely parallelized by the given growth stages. 3. An absence of septal furrows on the tips of young specimens does not correspond to the absence of septa in the corallite lumens or in the calices. 4. Development of septal furrows is more or less simultaneous around a calice margin and at its beginning involved only the latter. The undulations of it form foundations of septa on this stage, but septal blades may be absent or hardly recognizable on the upper portions of inner walls of calices (pl. 8:9a, 15a). The latter were developed in a course of further growth of the skeleton, being always observed in slightly more developed calices. As in the mature stage, septal blades may be slightly more elongated on the surface of the calice floor.

The calices of mature specimens are similar in morphology (pls. 6:9; 8:2a, 7, 13b), having blades of the major septa radially arranged, short or very short, leaving almost the entire interior of the calice empty. The minor septa may sometimes be seen along more than half the depth of a calice in the form of slight protuberations between the major septa, (pl. 8:2a, 8a) but in several calices (e. g. pl. 8:4, 7) they are lacking except for slight traces upperwards. The cardinal septum is slightly shortened and the counter septum may be a little longer than other major septa on the surface of the last tabula. The other major septa either reach the peripheral margin of the flattened, axial part of the calice floor (the last tabula) or are very slightly elongated on it, without being so long as to penetrate the corallite axis, however (pl. 8:2a, 7, 13b). Peripheral parts of calices (last tabulae) dip steeply and equally in all septal loculi, except for the slightly marked depression of the cardinal fossula. The described morphology of calices is reflected in the morphology of sections of mature parts of corallites (figs. 29:1i; 5c, d; 30:1a, b; 3; 4c; pl. 7:3, 6), which differ from each other only in more or less shortened major septa and in shortening of the cardinal septum. The latter equals other major septa in some sections, or its shortening in some specimens is very weakly marked.

A longitudinal section made perpendicular to the cardinal—counter septa plane (fig. 30:1c, d) shows tabulae widely spaced, 6—7 in 5 mm of growth, trapezoidal and of an arrangement generally attributed to the genus *Amplexocarinia*. The latter is especially true for the middle part of the corallite sectioned (fig. 30:1d), where box — like tabulae rest on each other. This structure corresponds to the narrowed part of the corallite and is adjacent to a wide break in tabular secretion ended by shallow rejuvenation of the corallite (fig. 30:1b) and with a complete, horizontal tabula (fig. 30:1d, upper). Thus, it must be altered by extrinsic factors. The morphology of the lower part of the section, showing trapezoidal tabulae attached to the external wall, is normal for the species and genus.

Remarks. — Because the species discussed was chosen the type species for *Falsiamplexus* gen. n., comparison is given in remarks on the other species described in this paper. *Amplexus corrugatus* MATHER, 1915, transferred by MOORE and JEFFORDS (1945) and ROWETT and SUTHERLAND (1964) to *Amplexocarinia* SOSHKINA, 1928, differs from *F. elongatus* sp. n. in having shorter and more clearly amplexoid major septa, a more distinctly elongated counter septum, metriophylloid rather than zaphrentoid arrangement of septa in early ontogeny, a thin external wall, smaller dimensions and number of septa, and a slightly different n: d ratio.

Occurrence. — USNM Loc. 701:7; 701d:2; 701g:4; 701h:15; 701k:120; 706×:1; 742c:4, Neal Ranch Formation.

Falsiamplexus flexibilis sp. n.

(figs. 31, 32; pls. 6:4, 5, 8, 10, 12; 7:4, 5, 7—10)

Holotype: specimen USNM 196798, fig. 31: 4a—e; pls. 6:8a—c; 7:10a—c.
Type locality: 728e.
Type horizon: Lower Bone Spring Formation.
Derivation of the name: lat. *flexibilis* — variable, flexible — after variability of shape and morphology.

Material. — More than 30 silicified corallites, some with calices and or proximal ends preserved. Most specimens incomplete. Commensal worms common.

Some features of representative specimens (in mm):

USNM cat. nos.	n:d ratio	Depth of calice	Remarks
196795	16:6.7	?	calice margin
„	16:5.4		lower part of calice
196796	18:6.0	?	below calice
196804	18:6.7	5.5	calice margin
196801	18:7.0	?	calice floor
„	18:6.4		below calice
196799	18:8.7	?	calice margin
„	16:7.0		above calice floor
„	16:5.4		below calice floor
196798	20:7.8	≈ 7.5	calice margin
„	19:8.5		calice floor
„	19:7.2		below calice
196797	20:9.0	≈ 10.0	calice margin
„	20:8.0		calice floor
„	19:7.3		below calice

Diagnosis — *Falsiamplexus* with n:d ratio at calice margin up to 20:9.0; cardinal septum variable in length, commonly shortended; cardinal tabular fossula well developed.

Description of the holotype. — The corallite was more than 4.5 m long measured along its convexity, irregularly subcylindrical, with several narrowings. The shallow septal furrows are well preserved, but growth striae are missing owing to silicification (pl. 6:8a). A part of the corallite was exposed *post mortem* to the settlement of sessile organisms, mainly sponges, rootlets of which penetrated the corallite wall.

The nearly complete calice (pl. 6:8c) is pipe-like because of the cylindrical shape of this part of the corallite and because of the almost equal length of the major septa on the calice wall. They are radially arranged, extending more than 1 mm into the calice lumen. Only the cardinal septum and the newly inserted major septa in the counter quadrants are a little shorter. The calice floor is formed by a single tabula. The middle, almost flat part of it is oriented a little obliquelly towards the cardinal septum. The depression of the cardinal fossula extends almost to the corallite axis, but it is better exposed only at the periphery (pl. 6:8c, lower left). The peripheral part of the tabula dips obliquely towards the external wall to form a trapezoid when longitudinally sectioned. The border of the flat, inner part of the tabula is correlated with the inner ends of the major septa. Only the cardinal septum is shorter, and the counter septum extends visibly inward on the surface of the tabula. The minor septa are not seen in the calice, but they are present in the transverse section made approximately 3 mm below the calice floor (fig. 31:4e).

Observations on the lower, broken part of the corallite prove the slight amplexoid character of all major septa but the cardinal septum. They are elongated mainly along the oblique portions of the tabula, which makes this a character not obvious in the calice. The relation of the major septa to the lower surface of a tabula and to the shape of the cardinal fossula is best illustrated by the opposite side of the broken, empty part of the corallite (pl. 6:8a).

The silicified tip of the corallite, weathered out in part, was not sectioned. The sectioned part of the neanic stage is zaphrentoid in its ontogenetically youngest portion (fig. 31:4a), having a long cardinal septum. Already 0.2 mm above the previous section, the morphology changes a little (fig. 31:4b; pl. 7:10a) and after 0.4 mm of further growth, a free axial area is formed (fig. 31:4c; pl. 7:10b).

The morphology of this area is in part phyllothecal and in part it is bordered by free ends of the major septa. The cardinal septum is slightly shortened. The counter septum is one of the longest septa, but it does not dominate in length. The minor septa are absent from the corallite

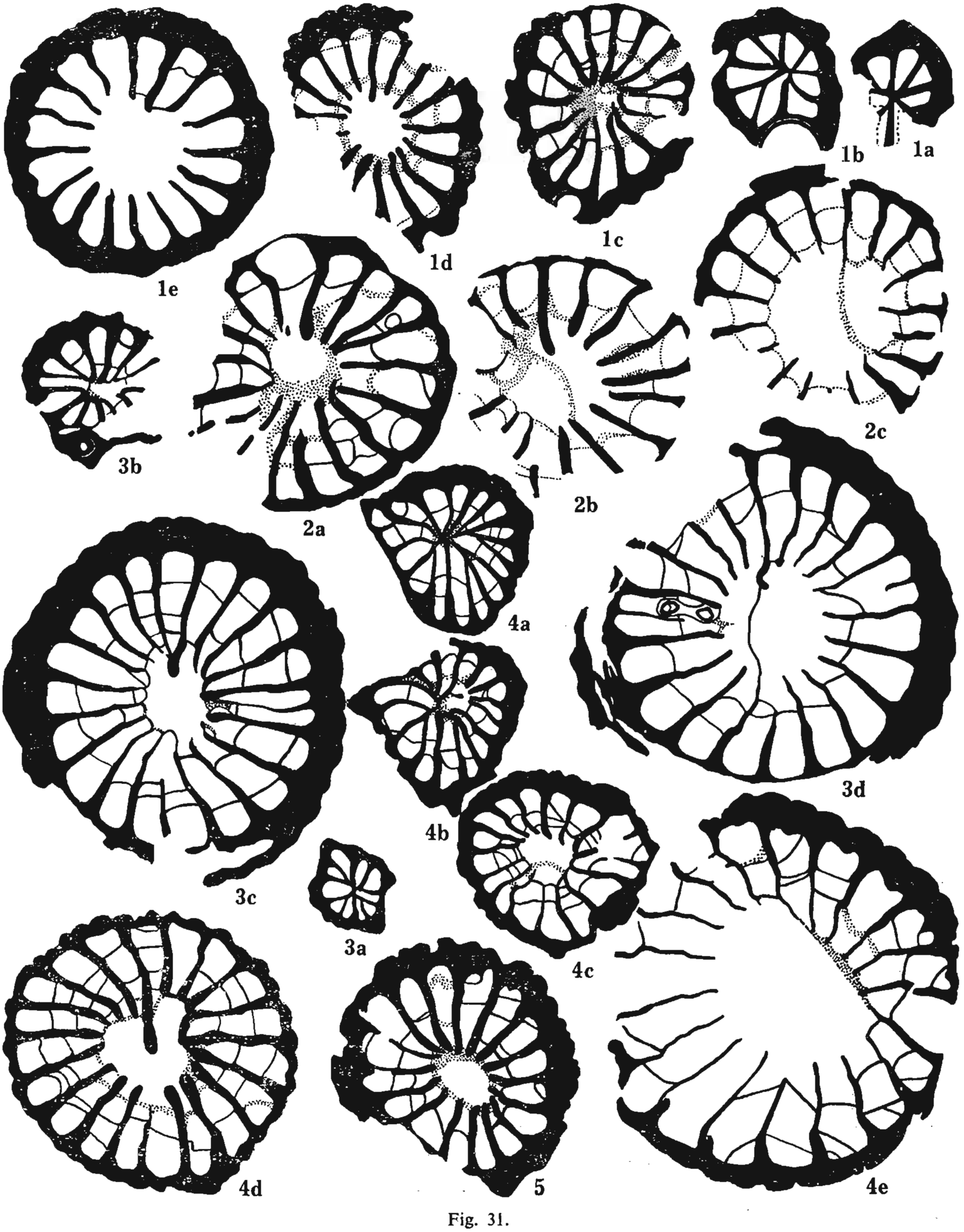

Fig. 31.

Falsiamplexus flexibilis sp. n. Locality USNM 728e, Lower Bone Spring Formation. Transverse sections. 1. Specimen USNM 196795; a, b — early neanic stage, ×16; c — late neanic stage, ×8; d — ephebic stage, ×8; e — just above calice floor, ×8. 2. Specimen USNM 196796. a—c — early to late ephebic stage, ×8. 3. Specimen USNM 196797; a — early neanic stage; b — late neanic stage; c, d — ephebic stage having commensal organism between septa. All, ×8. 4. Specimen USNM 196798. Holotype; a, b — neanic stage; c — early ephebic stage; d — ephebic stage with distinctly elongated counter septum; e — partly above calice floor. All, ×8. 5. Specimen USNM 196799. Early ephebic stage, ×8.

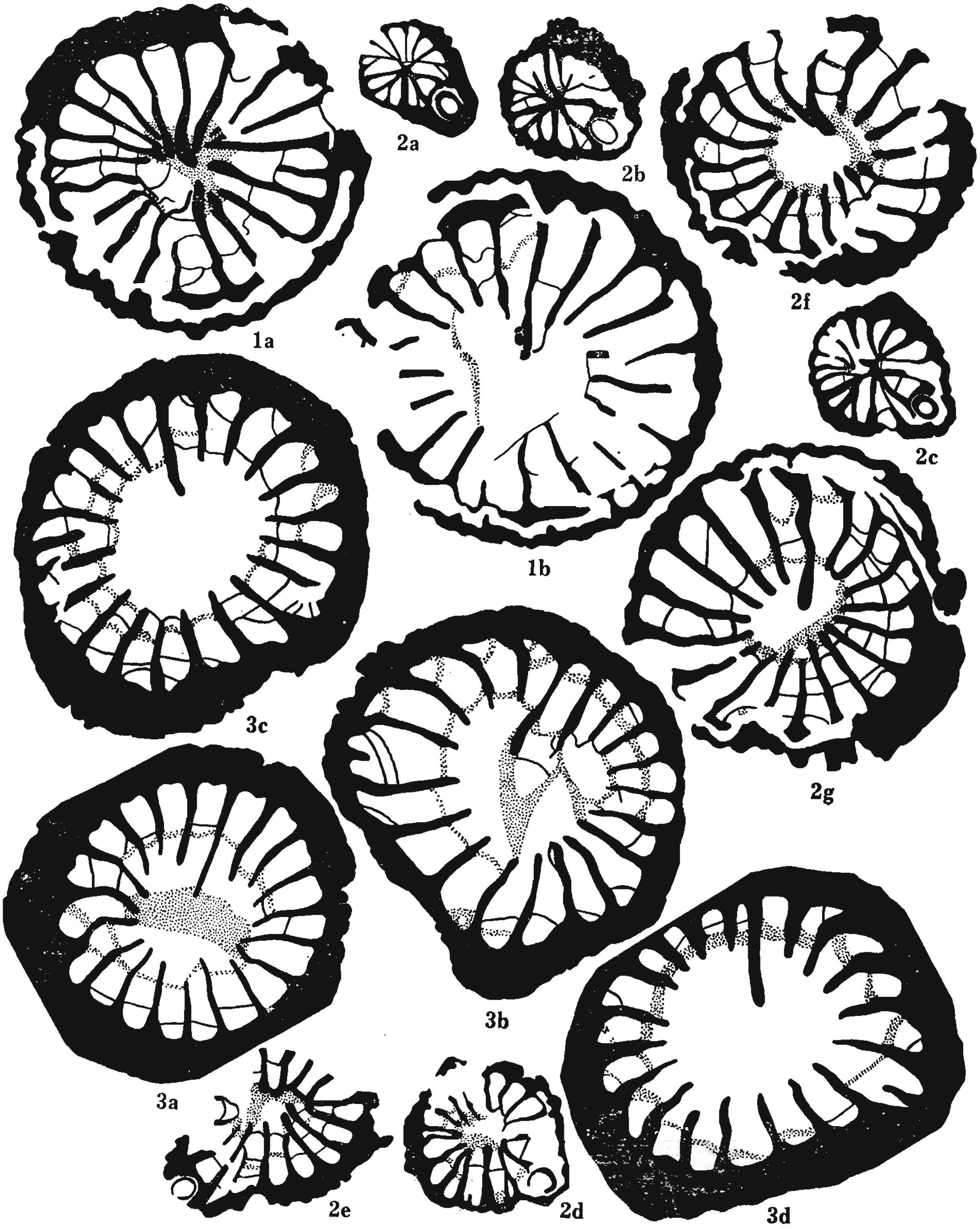

Fig. 32.

Falsiamplexus flexibilis sp. n. Transverse sections. 1. specimen USNM 196800. Locality USNM 728e. Lower Bone Spring Formation; a, b — ephebic stage. 2. Specimen USNM 196801. Locality and horizon as above; a—c — early neanic stage having commensal worm tube; d, e — late neanic stage; worm tube continued to occur; f, g — ephebic stage. 3. Specimen USNM 196802. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member; a—d — ephebic stage. All, × 8.

lumen and in the structure of the external wall, but their furrows are present on the corallite surface.

Individual variation. — Most of the paratypes do not show any important variation, especially as far as the morphology of their calices is concerned (pl. 6:4a, 5, 10, 12). The morphology observed in the cross sections is more variable, but this is true also when the individual sections of a single specimen are compared (e. g. fig. 31: 2a—c; 3c, d; 32:1a, b; 2f, g; 3a—d). Variable length of the major septa and width of the free axial area correlated to it, are the easiest variants to recognize (e. g. figs. 31:1d, 3c; 32:1a versus fig. 31:2b, c; pl. 7:4a, b, 7 versus 5d, e).

Length of the counter septum is either equal to other major septa or only slightly larger (fig. 31:1c—e; 2a—c, 3d). Only rare specimens (fig. 32:1a, b; 2f, g; pl. 7:5d) have this septum distinctly elongated. Shortening of the cardinal septum varies. Being commonly more or less shortened, it may, in rare specimens, be equal to other major septa (fig. 31:1c—e) or shortened very late in ontogeny (fig. 32:2a—g; pl. 7:5a—e).

Apart from the main group of corallites discussed above, individual specimens are quite distinct morphologically.

The corallite, derived from a different locality and formation (fig. 32:3a—d; pls. 6:12a, b; 7:7) is very irregular in the increase of major septa, which might have been caused partly by lateral rejuvenation. Also, the length of its cardinal septum varies from section to section. The wide free axial area left by a comparatively short major septa and the elongated counter septum are constant.

Remarks. — The species described resembles most closely *F. elongatus* sp. n., being different from it in n:d ratio and in the smaller number of major septa. Early ontogeny and trends of development are similar, except possibly for the slightly rhopaloid character of the major septa, often present in *F. elongatus* sp. n and absent from the typically built specimens of *F. flexibilis* sp. n. Such a slight difference may be evaluated by authors as inadequate for specific distinction. There are samples, however, of a general recognition of this a character.

Occurrence. — USNM 728e:38, Lower Bone Spring Formation, 7221:1 Skinner Ranch Formation, Sullivan Peak Member, Upper Wolfcampian.

Falsiamplexus reductus sp. n.

(fig. 33; pls. 5:10, 13—15; 8:16, 17)

Holotype: Specimen USNM 196806, 33:1a—1; pls. 5:15a—h; 8:16.
Type locality: USNM 700a.
Type horizon: Gaptank Formation, Upper (?) Missourian.
Derivation of the name: lat. *re — duco, duxi, ductum* — to pull back, after very shortened major septa.

Material. — The holotype and 6 well preserved paratypes.

N: d ratio of representative corallites (in mm):

USNM cat. nos.	n: d ratio
196806	16:4.6 × 4.2
196809	16:4.4 × 4.0
196807	20:4.7 × 4.3
,,	20:6.4 × 5.2

Diagnosis. — *Falsiamplexus* having n: d ratio 16—20:4.0—6.0; major septa short, thin; external wall thin; tabulae widely spaced, complete.

Description of the holotype. — External characters are shown in pl. 8:16, 17a, b. The corallite

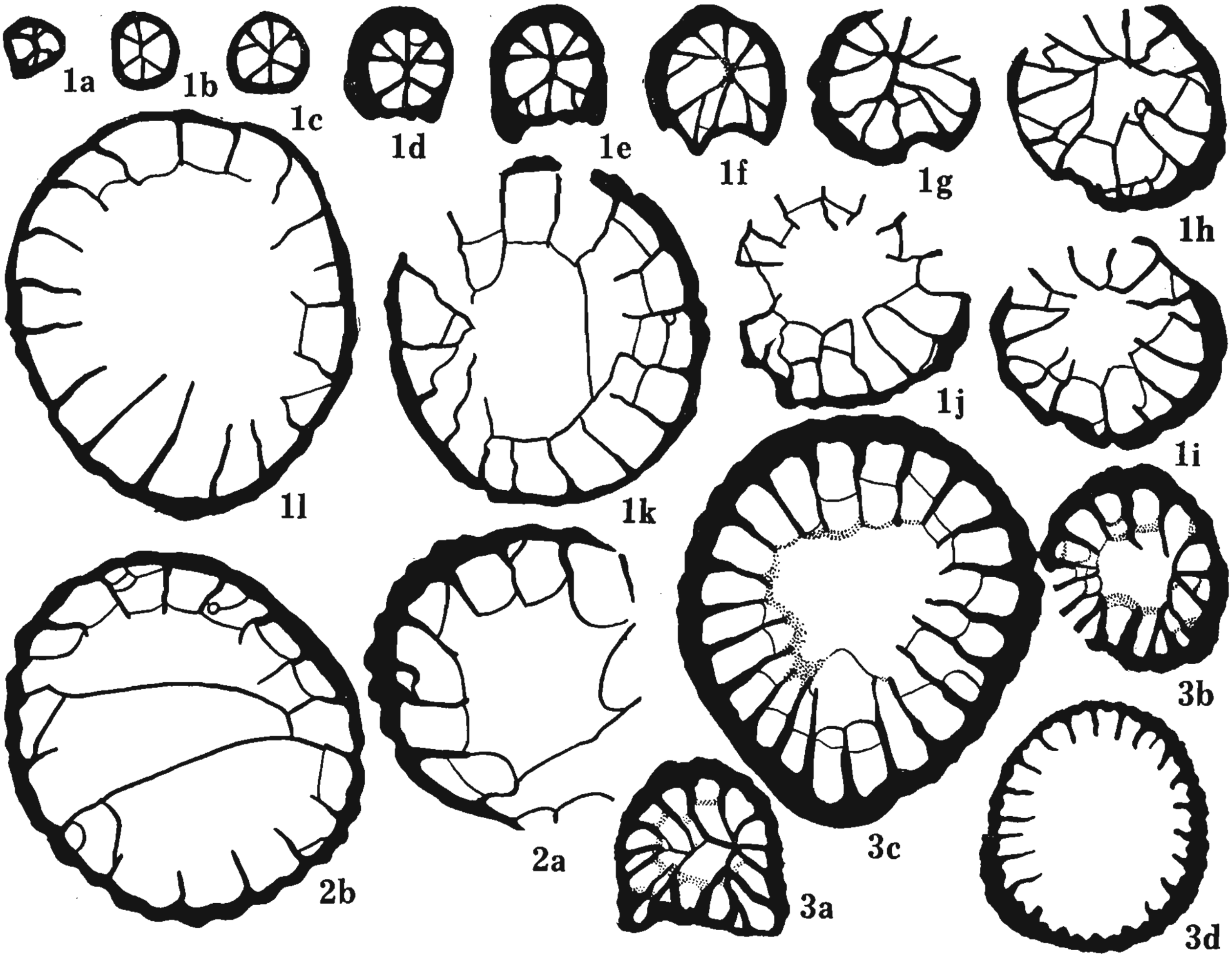

Fig. 33.
Falsiamplexus reductus sp. n. Transverse sections. 1. Specimen USNM 196806. **Holotype.** Locality USNM 700a, Gaptank Formation, Upper (?) Missourian; a—g — neanic stage; h — late neanic stage; i—l — early to late ephebic stage. All, × 10. 2. Specimen USNM 196809. Locality USNM 700, Gaptank Formation, Upper (?) Missourian; a, b — ephebic stage, × 10. 3. Specimen USNM 196808. Locality and horizon as above; a — late neanic stage; b — early ephebic stage; c — ephebic stage. All, × 10. d — calice, × 5.

is geniculate, conical in its juvenile part and cylindrical upperwards. The thin external wall is covered by delicate growth striae and shallow septal furrows. The major part of the calice is missing.

In the transverse section made just above the calice floor (fig. 33:1l), the major septa are thin, slightly and irregularly differentiated in length, with none of the protosepta either prominent or diminished. The last major septum inserted remains very short up to this stage of growth. Sections of lateral parts of the last tabula are still present between some septa. In the section made beneath the calice floor (fig. 33:1k; pl. 5:15h), the major septa are thin, slightly wavy, with their axial ends mainly free. Only some of them are inclined toward the neighbouring septa. No kind of axial tube or cardinal fossula is developed, and none of the protosepta is either elongated or shortened. The cardinal septum may be indicated only by comparison of the ontogenetically earlier stages of growth.

Ontogeny. — The brephic stage was observed at a diameter of 1 mm and a septal complement of 6 protosepta. The neanic stage started at a diameter of 1.2 mm with an increase of first metasepta in counter quadrants (fig. 33:1c). The well developed axial septum is seen along

2.5 mm of corallite growth. Increase in septa is accelerated in the counter quadrants and the appearance of the new septa is mainly (exclusively?) in sequence (fig. 33:1c—g; pl. 5:15a—e). The arrangement of the major septa in the late neanic stage (fig. 33:1g; pl. 5:15e) is irregularly zaphrentoid, with the alar fossulae well accentuated. In the late neanic/early ephebic stage (fig. 33:1h, i; pl. 5:15f, g), when the major septa only started losing direct contact, those of the cardinal quadrants are slightly longer and become free earlier than those of the counter quadrants.

The longitudinal section (pl. 5:14b) was investigated on a single paratype only. Tabulae are trapezoidal, widely spaced, and complete with their oblique parts short and the middle parts wide and slightly sagging. The section made through the peripheral part of the corallite indicates that some of them may alterate similar to those of the type species of the genus, resting in some portions on the subjacent tabulae.

Individual variation. — Differences in n: d ratio (see table) and in length of the major septa are most important variations. In contrast to the rather long-septal holotype, the majority of the paratypes have major septa restricted to the peripheral parts of the corallites (fig. 33:2b; pl. 5:13a, b; 14a). One specimen (fig. 33:3a—d) has comparatively thick major septa and the minor septa seen in a form of knobs near the calice margin (fig. 33:3d).

Remarks. — The species described differs from *F. delicatus* (Ross and Ross 1963) in having a slightly different n: d ratio, thinner, shorter, never rhopaloid and more equalized major septa, a thin external wall, and more widely spaced, less tall, often complete tabulae.

F. reductus sp. n. is morphologically most similar to *Amplexus corrugatus* MATHER, 1915 from the Morrowan of Oklahoma. This species, described as *Amplexocarinia corrugata* (MATHER) by MOORE and JEFFORDS (1945) and ROWETT and SUTHERLAND (1964), is here transferred to *Falsiamplexus* gen. n. Short and thin major septa, geniculate growth form and complete tabulae are the main common characters of these two species. *F. reductus* sp. n. differs from the Morrowan species first of all in not possessing either the cardinal or the counter septum elongated. This character and the clearly zaphrentoid arrangement of septa in the neanic stage seem adequate for specific distinction.

The species described is closer to *Amplexocarinia* SOSHKINA, 1925 than any other species included in this paper in *Falsiamplexus* gen. n. Its long-lasting zaphrentoid ontogeny, passing into an amplexoid morphology without an aulos being produced, forms the main character distinguishing it from *A. muralis* SOSHKINA, 1925. Complete underdevelopment of an aulos, lack of differentiation of length of the major septa and their delicate structure are interpreted here as simplifications, with the latter character being possibly ecologically controlled.

Occurrence. — USNM Loc. 700:4, 700a:3, Gaptank Formation, Upper (?) Missourian.

Suborders uncertain

Family **Lindstroemiidae** POČTA, 1902

Genus *Paralleynia* SOSHKINA, 1936

Type species: P. permiana SOSHKINA, 1936

Synonym: Amplexocarinia SOSHKINA, 1936, e. p.; SOSHKINA, 1941, e. p.; SCHOUPPÉ and STACUL, 1959, e. p. *non Amplexocarinia* SOSHKINA, 1928.

Geographic and stratigraphic range: USSR (Ural Mts.), ? USA (Texas), Lower Permian; Timor Island, Upper Permian.

Diagnosis. — See FEDOROWSKI 1986.

Remarks. — Discussion of the type species of *Paralleynia* (FEDOROWSKI 1986) and of *Falsiamplexus* gen. n. (in this paper) necessitates only the following remarks on the relation of the species here described to the type species of the genus. An unequivocal conclusion is impossible because of the very large variability of this species and because of the inadequate preservation of corallites, which have been investigated mainly in calices. There are several differences that may eventually change its generic classification. These are: thick external wall with septal furrows almost indistinguishable; comparatively shallow calices; differentiation of length of major septa in many specimens and arching of the long septa above the underdeveloped ones; the sometimes unclear position of the cardinal septum, the often observed lack of its shortening, and not clearly proven development of the cardinal fossula. Some of these characters lead toward *Amplexocarinia* SOSHKINA, 1928 or toward the species assigned to that genus by authors, indicating once more the close similarity of these two genera (two morpho-types?). Evaluation of some other characters must be subjective at the level of investigations achieved. To avoid this as much as possible, I conditionally placed the species discussed within *Paralleynia*, although its independent generic status seems possible. However, some corallites (e. g. pl. 20:8a, b) show all generic characters in common with *P. permiana* SOSHKINA, 1936, thus stressing a possible congeneric status of these two taxa.

? *Paralleynia acclinis* sp. n.

(fig. 34; pls. 17:10, 12—14; 18:8; 20:2—11, 13)

Holotype: Specimen USNM 196810, pl. 20:2a, b.
Type locality: USNM 701d.
Type horizon: Neal Ranch Formation, Lower Wolfcampian.
Derivation of the name: lat. *acclinis*, — to lean, the rest — after morphology of axial ends of major septa.

Material. — The holotype and 28 paratypes were available for study. All specimens are silicified. In most of them, the interiors were etched out, but the calices remainded well preserved

Some features of representative corallites (in mm):

USNM cat. nos.	Length	N:d ratio at calice margin	Length of major septa
196818	8.2	16:4.6	differentiated
196810	9.0	15:4.5 × 3.8	differentiated
196954	?	15:3.6 × 3.2	almost equal
196956	9.3	14:4.1	differentiated
196816	?	14:3.8	almost equal
196957	10.2	13:4.8 × 4.2	differentiated
196820	5.7	12:3.6 × 3.3	differentiated

Diagnosis — ? *Paralleynia* 3.5—5 mm in diameter at calice margin having 13—16 major septa often differentiated in length, commonly arching above some other major septa; cardinal septum commonly long, sometimes slightly shortened; external wall thick, almost smooth.

Description of the holotype. — The corallite, slightly curved and rapidly widened at the tip, is almost cylindrical in its upper portion (pl. 20:2a). Traces of attachment are seen on its surface up to the floor of the calice, i. e. approximately 3.5 mm beneath the margin of the latter. Only growth lines are seen on the corallite surface (pl. 20:2a). On the better preserved marginal part of the calice, the foundations of major and minor septa are present (pl. 20:2b). Deeper in the calice the minor septa became incorporated into the thick external wall and disappeared from the corallite lumen. The major septa became elongated toward the corallite axis and differentiated in length. The periaxial ends of the longest seven septa are inclined towards each other to form a narrow aulos. The cardinal septum is long but free. Its position is indicated by two slightly underdeveloped major septa. Five major septa are disorderly shortened and arched by axial ends of the adjacent, long major septa (pl. 20:2b).

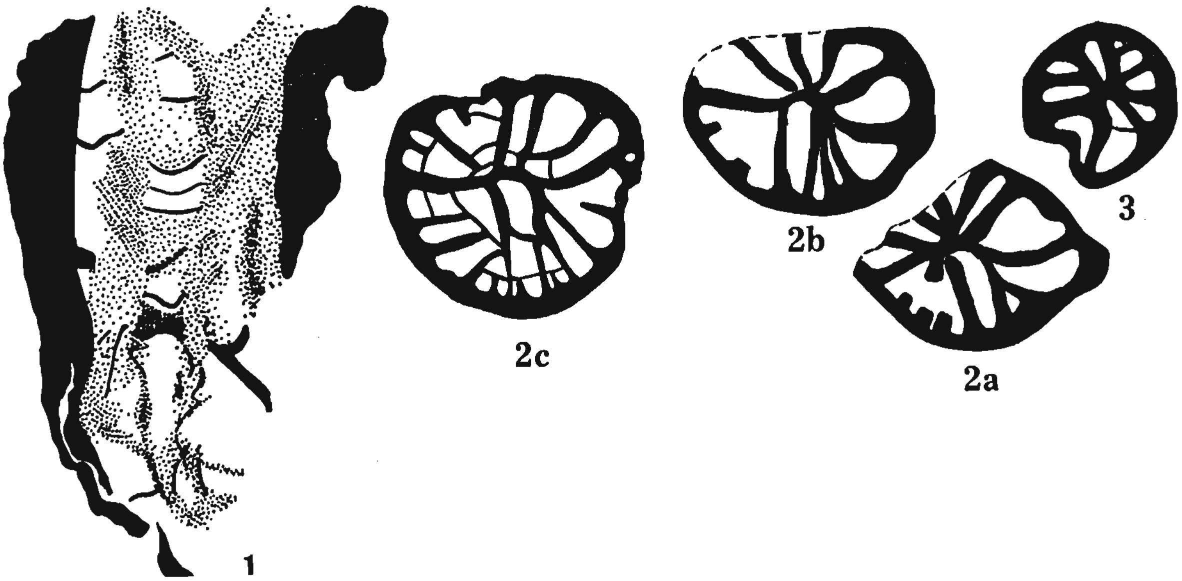

Fig. 34.
? *Paralleynia acclinis* sp. n. Neal Ranch Formation. 1. Specimen USNM 196814. Locality USNM 701d. Longitudinal section, × 10. 2. Specimen USNM 196821. Locality as above. Transverse sections; a, b — neanic stage; c — ephebic stage. All, × 10. 3. Specimen USNM 196817. Locality USNM 701. Transverse section, neanic stage, × 20.

Ontogeny. — The deep silicification of the tips and lack of well preserved interiors of corallites precluded study of the ontogeny in detail. The restricted observation in thin sections (fig. 34:3) and on the broken tip of the corallite (pl. 20:9b) document a normal, zaphrentoid increase and arrangement of the major septa in the early ontogeny of the corallites. The minor septa are not present in the corallite lumen. These observations were confirmed by partly preserved tips of some other corallites. There is a single corallite within the collection, however, that has the aulos developed as early as this stage (pl. 20:5c). Also the mature portion of it (pl. 20:5b), discussed in the section on individual variation, is qualified as an extreme variant. Such an early development of the aulos should therefore be considered nontypical for the species discussed.

Three serial polished sections of the other specimen show the fasciculophylloid arrangement of the septa in the late neanic stage (fig. 34:2b), a part of the incipient aulos is formed due to the slight withdrawal of the axially united septa towards the counter septum. The shallow concavity formed that way is on the lateral parts supplemented by periaxial ends of major septa of the cardinal quadrants. Those of the right quadrant are a little bent aside. The cardinal septum is still long.

During further growth, the axial ends of some major septa bent more distinctly, while some other major septa ceased to grow. This differentiation of growth, supplemented by development of axial tabulae, leads toward formation of the aulos. The morphology of the specimen investigated is similar to that of the holotype at this stage of growth (fig. 34:2c). Unfortunately, the development described above was observed on a badly preserved specimen, and some details might have been misinterpreted. It has also not been checked against other specimens because of lack of adequate material.

Longitudinal section. — One specimen has been longitudinally sectioned (fig. 34:1), but most of the information comes from the specimen broken lengthwise (pl. 17:12). The widely spaced tabulae are divided into peripheral and axial parts. Peripheral parts are declined obliquely adaxially, but their portions adjacent to the wall may be concave (fig. 34:1). The axial parts of tabulae, located inside the aulos, are horizontal, slightly convex, or sagging (fig. 34:1; pl. 17:12).

The broken specimen (pl. 17:12) shows that the peripheral parts of tabulae may be horizontal. It also documents the interrelation and close similarity between vertical and horizontal structural elements. Although the axial end of a septum (pl. 17:12) upper right bends towards the adjacent septum, this is the protuberance of the tabula that closes the aulos in its other side. In the case of a very narrow fold of ectoderm, such a protuberance may get the septal microstructure and may form cross-bars (die Querriegeln of SCHOUPPÉ and STACUL 1959:338).

Individual variation. — Two main groups of specimens within the collection under discussion may be distinguished as different taxa: 1. A group of specimens with major septa almost straight, coming close to the corallite lumen and forming a narrow, not clearly distinguishable aulos (pls. 17:10, 13a, b; 20:11). 2. A group with inner ends of septa bent to form an outstanding aulos (pl. 20:2a, 3a, 4a, 5b, 8b, 9a). Both these groups show further individual variation, whose characters may in some cases appear parallel. The more or less clearly accentuated shortening of the cardinal septum is most important among them (pls. 17:13a; 20:8b, 9a). All specimens of both groups possess thick external walls with septal furrows either absent or hardly distinguishable; the minor septa started weakly at calice margins and disappeared completely in the middle parts of calices beneath the last tabula; the calices of the mature corallites shallow. There are some specimens of the intermediate morphology, but extreme specimens of both groups can hardly be compared (e. g. pls. 17:10; 20:5b).

Individual variation within the first group is rather small. In addition to the variable length of the cardinal septum, the differentiation of length of other major septa also may be noted (pls. 17:13a; 20:10b), a characteristic important for the further comparison with the second group of specimens. The latter is more differentiated in morphology. There is, first of all, the trend of development of a complete aulos. This trend ends with the corallites showing it clearly in the calices, with the cardinal septum distinguishable only by the arrangement of the other major septa (pl. 20:4a, 5b). One of the corallites mentioned (pl. 20:5a—c) is here included in the species discussed mainly because of some secondary characters in common and because of the presence of corallites that may be considered morphologically intermediate (pl. 20:4a, b; 8a, b, 9a, b). However, the very early development of the aulos, together with the characters of the mature portion of its growth may eventually be adequate for placing it within the genus *Amplexocarinia* SOSHKINA, 1928.

Rare specimens with a broad and well developed aulos (e. g. pl. 20:9a) have a kind of carination of septa. Septal blades are not smooth laterally, but form some secondary foldings, which are not so advanced as to form the metriophylloid carinae, however. Similar structures are present in the cardinal quadrants of the specimens showing the most typical paralleyniid morphology of its very deep calice (pl. 20:8b). The aulos is open towards the slightly shortened cardinal septum in the upper portion of the calice, but it is closed lower down. The cardinal septum reaches the aulos there.

In most of the specimens of the second group discussed so far (e. g. pl. 20:5b, 8b, 9a) all the major septa but the cardinal septum are equal in length. There are several specimens in this group, including the holotype, that have the major septa differentiated in length, with some arching above the other or others (pls. 17:14b; 20:2b, 4a). This phenomenon has been described for the holotype and will not be repeated. A single, immature corallite (pl. 20:13a, b), however has this trend of development so distinct that it can hardly be compared to other corallites discussed. There is no aulos developed, the counter septum joins the wide arch formed by two metasepta, and the slightly shortened cardinal septum is arched over by two major septa that may be the alar septa. This distinct specimen has been conditionally placed within the species discussed because of the secondary characters in common and because its partly etched out interior precludes more detailed study.

Remarks. — The broad discussion above was introduced for two reasons: a) To show that the specimens grouped here under the common specific name may in fact belong to different taxa. *P. acclinis* sp. n. should thus be treated as an artificial unit created to show the possible directions of further investigations on more complete and better preserved topotypes.

b) To point out once more a close similarity of *Amplexocarinia* Soshkina, 1928 and *Paralleynia* Soshkina, 1936. Of the distinctive characters of their type species, discussed by Fedorowski (1986), only the long lasting aulos and the possible presence of a cardinal fossula distinguish the extreme specimens included here in *Paralleynia* from *Amplexocarinia.*

The tendency of some major septa to arch over the adjacent ones although not mentioned by Soshkina (1936) may be seen in some of her specimens (e. g. figs. 4, 5a—b). Thus the character exhibited by several specimens of the species discussed is not unique within the genus. Being especially well developed here, it may serve as the distinguishing specific feature. The different n: d ratio, comparatively long major septa and widely spaced tabulae readily distinguish most of the corallites described here under the common name *P. acclinis* sp. n. from all other species of *Paralleynia* known outside North America.

Occurrence. — USNM loc. 701:4, 701c:1, 701d:26, Neal Ranch Formation, Lower Wolfcampian.

Family **Lophophyllidiidae** Moore and Jeffords, 1945

Type genus: Lophophyllidium Grabau, 1928

Genera assigned: *Lophophyllidium* Grabau, 1928; *Lophocarinophyllum* Grabau, 1922; *Pseudowannerophyllum* Flügel, 1975; ? *Sugiyamaella* Yabe and Minato, 1944.

Diagnosis. — Solitary corals without dissepimentarium; early ontogeny zaphrentoid, with cardinal and counter septa united; none but counter septum dominates in post early neanic stage; columella originated from counter septum, simple or complex, sometimes perforate, may disappear in maturity; minor septa inserted short and free, may then be elongated; microstructure of septa fine trabecular; metriophylloid carinae may occur; tabularium may be biform; tabulae declined from axial structure.

Remarks. — Hill (1981) synonymized family Lophophyllidiidae Moore and Jeffords 1945 with Lophophyllidae Grabau, 1928 and placed the latter in the subordo Plerophyllina

TABLE 7

Morphologically-comparative table of Lophophyllidiidae Moore and Jeffords, 1945 described in this paper

Name of genus or subgenus	Cardinal septum	Cardinal fossula	Columella	Major septa	Minor septa	Tabularium
Lophophyllidium (*Lophophyllidium*) Moore and Jeffords, 1945	Shortened	Triangular, open	Simple or compound; may disappear in maturity	Often rhopaloid and differentiated in length	Free, may be reduced	Uniform
Lophophyllidium (*Lophbillidium*) Fedorowski, 1986.	Shortened; often late in ontogeny	As above; may be inconspicuous	Strong, permanently present, protruded up to inner zone of calice	Often rhopaloid; come close or reach columella	Biformly reduced, free or contrajunct	Biform
Pseudowannerophyllum Flügel, 1975	Shortened	Triangular, open	Perforated; composed of primary and secondary lamellae	Often rhopaloid; slightly differentiated in length	Free or contrajunct	,,

Neither of these solutions is accepted in the present paper. The main reason for not accepting the synonymy mentioned is simply an absence of more complete information concerning the morphology of *Lophophyllum* M. — EDWARDS and HAIME, 1850. The lectotype is known only from its calice. There is also no information concerning the ontogeny and other diagnostic characters of the paratypes. Presence of the columella is the only character permitting placement of *Lophophyllum* in the same family as *Lophophyllidium*, which seems inadequate to me. Any further discussion must be based on subjective suppositions only and is thus omitted.

None of the genera here included in Lophophyllidiidae (poorly known *Sugiyamaella* is excluded from the discussion) exhibits a plerophylloid character in early ontogeny and at maturity. An elongation of the counter septum itself is inadequate for placing these corals together with other *Plerophyllina* in spite of the fact that e. g. *Soshkineophyllum* GRABAU, 1928 may, in its mature portion, be closely comparable to some Lophophyllidiidae. The early ontogeny of the latter is clearly of the stereolasmatid kind. The family character — the columella, is achieved only in early maturity. Elongation of the counter septum is not uncommon in Stereolasmatina, from which Antiphyllinae ILINA, 1970 may be indicated as a closest taxon.

Genus *Lophophyllidium* GRABAU, 1928

Type species: Cyathaxonia prolifera Mc CHESNEY, 1860

Diagnosis. — See FEDOROWSKI 1974 or HILL 1981 but supplemented with the sentence: biform tabularium may occur.

Remarks. — The genus *Lophophyllidium* and most of its supposed synonyms were discussed in detail by FEDOROWSKI (1974). The new data achieved herein suggest suppression of the genus *Lophamplexus* MOORE and JEFFORDS, 1941. Its close relation to the genus *Lophophyllidium* was pointed out in the original description by MOORE and JEFFORDS (1941), but the synonymy of these two genera has not been proposed so far.

Presence or absence (reduction) of a columella is the only quantitative, generic character dividing these two genera. However, in specimens of some species the columella may disappear and reappear several times (JEFFORDS 1947, Pl. 23, fig. 4b; Pl. 24, Fig. 7e). Some other groups of specimens do not show any considerable differences in morphology, except for the more or less well developed columella, or absence of that structure. For construction purposes, the problem concerning *Lophamplexus* is more widely discussed in remarks on *L. westii* (BEEDE, 1898).

A review of the diagnostic characters of *Lophophyllidium* and its synonyms shows that the morphology of the columella, its juction with or separation from a counter septum, as well as its reduction, is not a constant feature. Thickening and length of the major septa, length of the minor septa, depth of calices (a seeming absence of tabulae in enormously deep calices of "*Malonophyllum*"), as well as a combination of all these characters, also cannot be treated as constant generic characters. On the other hand, there are obviously distinct groups of species present within *Lophophyllidium* in which domination of given characters may be observed, e. g. the group of "*Stereostylus*" JEFFORDS, 1947 or the group of "*Lophamplexus*" MOORE and JEFFORDS, 1941. To what extent these groups differ genetically from each other and from the type species and how constant these differences are, remain uncertain.

Because all possible combinations of the listed characters have been realized several times and obviously independently in the history of *Lophophyllidium*, the existing status of this genus is most probably a mosaic evolution with many directions of development of individual characters, opposite in some instances (e. g. reduction versus complexity of the columella). Individual groups of species (= genera in the previous sense) might have also been differentiated a few times from the main developmental line to form short genetic offshoots (iterative evolution).

Recent investigations by WEBB (1984) of a new species of *Lophophyllidium* from the uppermost Mississipian Imo Formation shows an extraordinarily large individual variation in several characters, particularly in the columella. This is the geologically oldest species of well documented stratigraphic position known so far, but its advanced morphology indicates a long earlier history. Another species of typically lophophylloid morphology described by IVANOVSKI (1967) as *Rotiphyllum* sp. comes from the lower part of the Taksin Series at the mouth of the Lena river. Unfortunately, its stratigraphic position is not quite certain and only a single specimen was described. It may, nevertheless, confirm a wide distribution of *Lophophyllidium* fairly early in Carboniferous strata.

WEBB's (1984) study seems to show the uselessness of the columella as a diagnostic character. It may well be so in the group of specimens described by him, which points out the necessity of a very careful application of this character to systematics. Its usefulness for species determination cannot be excluded in many instances, however. It may be constant in some groups of specimens as well as variable in others.

The number of North American species of *Lophophyllidium* and its synonyms introduced so far is very large. This does not necessarily reflect the real specific variety of this genus, but resulted at least in part from its extreme variability in almost all morphological and rational characters, except for the early ontogeny and the microstructure of septa, common for all specimens investigated in these respects so far. It seems also obvious to me from the personal re-examination of some type collections and from the literature as well, that at least some species were introduced mainly because of geographic or stratigraphic differences in their occurrence. It may also be true, however, that the criteria mentioned reflect a natural mosaic or iterative evolution. Taking all these uncertainties into account I treat the specific concept of *Lophophyllidium* broadly, avoiding introduction of new species as much as possible. The enormously large number of specimens included to almost each species (?) of this genus needs special morphological and, perhaps, a computer study for real specific determinations. This has been impossible to do in the present paper. Some specimens having long minor septa exhibit a kind of peripheral tabularium that may be considered as the introductory step to the biform tabularium and thus to the subgenus *Lophbillidium* FEDOROWSKI, 1986. This phenomenon, described in *L. absitum* (JEFFORDS, 1947), is not a fully developed morphological character and its bearer has been left in the nominative subgenus. Appearance of such an underdeveloped feature stresses a close relation between both groups of species and advocates for a subgeneric rank of *Lophbillidium*. For further discussion see FEDOROWSKI (1986).

The very wide variation in traditionally diagnostic characters made me look for other characters to be used for systematics. Observations on the abundant American collections and on the literature seem to indicate internal symmetry of corals as one of the important characters of this kind. It has been stated that radial versus bilateral symmetry in the arrangement of major septa is rather constant, although there are also species having semi-radial or semi-bilateral symmetry caused by elongated columella. The symmetry was thus applied here as one of the basic distinction between species. The total length of the major septa in comparison to the corallite diameter and the differentiation in their length on a given transverse section should also be considered quite important in many cases.

Species of *Lophophyllidium* and its synonyms outside America have not been discussed. They are present on all continents, but are not so diverse and common as in North America. Several of them exhibit a close similarity to American species. Again, however, on the basis of present knowledge, it is impossible to judge whether these are synonyms or homeomorphs.

TABLE 8

Morphologically-comparative table of species of the subgenus *Lophophyllidium* Grabau, 1928 described in this paper

Name of species	Symmetry	Major septa	Minor septa	Cardinal septum	Cardinal fossula	Counter septum	Columella	Tabularium	N: d ratio
Lophophyllidium westii Beede, 1898	Radial	Thin, nonrhopaloid, often very short	Short; often completely reduced	Slightly shortened	Tabular weak, septa may not occur	In maturity equal to other major septa; earlier long	Absent	Trapezoid; axial parts correlated with columella	16:5.5 to 30:13.1
Lophophyllidium distortum Worthen, 1875	”	Thin, nonrhopaloid, variable in length, commonly short	Short to very short	Shortened	Inconspicuous, tabular and septal	Elongated; may not reach columella	Simple, irregular, or composed of 2—4 short lamellae	Tabulae densely spaced, tent-shaped	22:8.5 to 34:17.0
Lophophyllidium dunbari Moore and Jeffords, 1941	”	Thin, differentiated in length; may be rhopaloid	Well developed in calices, very short beneath	Very short	Triangular, well developed	Elongated, commonly up to reaching columella	Often thick, composed of several coarse lamellae	Tabulae slightly sagging near columella	20:7.0 to 30:13.9 and 31:12.2
Lophophyllidium compressum Jeffords, 1942	Semi-bilateral	Slightly to distinctly rhopaloid, vary in length	Short	Short to very short	Triangular or narrowing axially	Elongated, directly united with columella	Monoseptal, elongated, moderately thickened	”	22:7.7 to 33:13.5
Lophophyllidium absitum Jeffords, 1947	Radial	Rhopaloid, differentiated in length, short	Well developed	”	Triangular	Elongated, tending to separate from columella	Thick, rounded, monoseptal or long lamellae	As above; incipient biformity may occur	25:11.0 to 38:21.0
Lophophyllidium plummeri Jeffords, 1947	”	Thick, rhopaloid, slightly differentiated in length	Up to 1/2 of major septa; may be laterally contiguous	Long in early growth, short in mature	Triangular, narrow	Elongated to reach columella	Almost circular with many short lamellae	Tabulae slightly sagging near columella	28:16.5 to 34:24.5
Lophophyllidium wewokanum Jeffords, 1947	Bilateral	Thick, come very close to columella	Short to very short	”	”	Reach columella with middle lines often united	Elongated, with a few lamellae; may be perforated in maturity	”	26:15.4 to 32:16.5
Lophophyllidium cf. *confertum* Jeffords, 1942	”	Long, distinctly rhopaloid, differentiated in length; some reach columella	Absent in corallite lumen and in external wall	Moderately shortened	”	Directly united, often by middle lines, with columella	Elongated, monoseptal, moderately thickened	”	30:17.0
Lophophyllidium skinneri Ross and Ross, 1962	”	Moderately thin, rhopaloid, do not reach columella	Short	Shortened	”	Elongated to reach columella	Monoseptal, slightly thickened	?	21:7.0 to 23:6.5
Lophophyllidium sp.	Radial	Thin, almost equal in length, pinnately arranged at calice floor	Well developed	Not shortened	Inconspicuous	Elongated, slightly thickened axially, almost reach cardinal septum	Only elongation of counter septum	?	24:7.6

Subgenus *L.* (*Lophophyllidium*) GRABAU, 1928

Type species: as for the genus.

Synonym: *Lophamplexus* MOORE and JEFFORDS, 1941.
Further synonymy see FEDOROWSKI 1974.

Diagnosis. — *Lophophyllidium* with normal tabularium.
Remarks. — As for the genus.

Lophophyllidium (*Lophophyllidium*) *westii* (BEEDE, 1898)

(figs. 35, 36; pls. 9:1—11; 10:1—3; 11:1, 4, 10, 11)

1898. *Amplexus westii* BEEDE; J. W. BEEDE, p. 17, pl. 1.
1900. *Lophophyllum westii* BEEDE; J. W. BEEDE, p. 18, pl. 2:8, 8b; pl. 3:12; pl. 5:7.
e.p. 1908. *Lophophyllum distortum* WORTHEN; G. H. GIRTY, p. 318, fig. 37:3 in this paper.
1945. *Lophamplexus captiosus* MOORE and JEFFORDS, 1945; R. C. MOORE and R. M. JEFFORDS, p. 120, figs. 83—85, 95.
1945. *Lophamplexus* sp. A. MOORE and JEFFORDS; R. C. MOORE and R. M. JEFFORDS, p. 122, figs. 86, 91.
1945. *Lophamplexus* sp. B. MOORE and JEFFORDS; R. C. MOORE and R. M. JEFFORDS, p. 122, figs. 87, 94.
1947. *Lophamplexus brevifolius* JEFFORDS; R. M. JEFFORDS, p. 66, figs. 4, 9; pl. 23:1—16; pl. 25:2, 6.
1947. *Lophamplexus westii* (BEEDE); R. M. JEFFORDS, p. 68, fig. 9; pl. 24:1—8; pl. 25:4, 5; pl. 26:5.
1947. *Lophamplexus ulius* JEFFORDS; R. M. JEFFORDS, p. 72, fig. 9; pl. 25:3; pl. 26:1; pl. 27:1—7.
1947. *Lophamplexus phractus* JEFFORDS; R. M. JEFFORDS, p. 74, fig. 9; pl. 22:6, 7; pl. 25:1.
1947. *Lophamplexus vagus* JEFFORDS; R. M. JEFFORDS, p. 76, fig. 9; pl. 27:8, 9.
1967. *Lophamplexus* sp. COLSON; C. T. COLSON, p. 234, pl. 1:6a—c.
1971. *Lophamplexus* sp. SCRUTTON; C. T. SCRUTTON, p. 205, pl. 2:3—6.

Material. — More than 40 mainly incomplete specimens having the internal structure often well preserved in calcite. Some specimens with proximal ends. Calice floors rarely preserved.

Some features of representative corallites (in mm)

USNM cat. nos.	n:d ratio	No of specimen	n:d ratio
196837	16: 5.5	USNM 196833	27:13.0
196824	18: 6.2	USNM 196842	28:12.4
196840	22: 7.4	USNM 196835	29:11.4
196823	25:11.0	USNM 196842a	30:13.1

Diagnosis. — *Lophophyllidium* having simple thin columella or elongated counter septum in early growth stage disappearing at early or late maturity; major septa at maturity thin, nonrhopaloid often very short; shortening of cardinal septum better accentuated in pre-amplexoid growth stage.

Individual variation. — The specimens analysed were collected in almost equal number from the Upper Missourian (21 corallites) and from the *Uddenites*-bearing shell member (18 corallites) of the Gaptank Formation. Three specimens are of Lower Wolfcampian age. Trends of variation are similar in both main groups of specimens, although very short major septa, stronger reduced minor septa, and thinner external walls are more common among the Missourian specimens. The latter are also much more differentiated in dimensions. In fact, two almost entirely separated groups of specimens may in this respect be distinguished: a group of very small corallites (6 specimens) the largest one having n: d ratio 22:7.4 and a group of comparatively large ones. The smallest corallite of the latter group has a n: d ratio 24:11.2. The group of small corallites, with their very thin and short major septa, a common absence

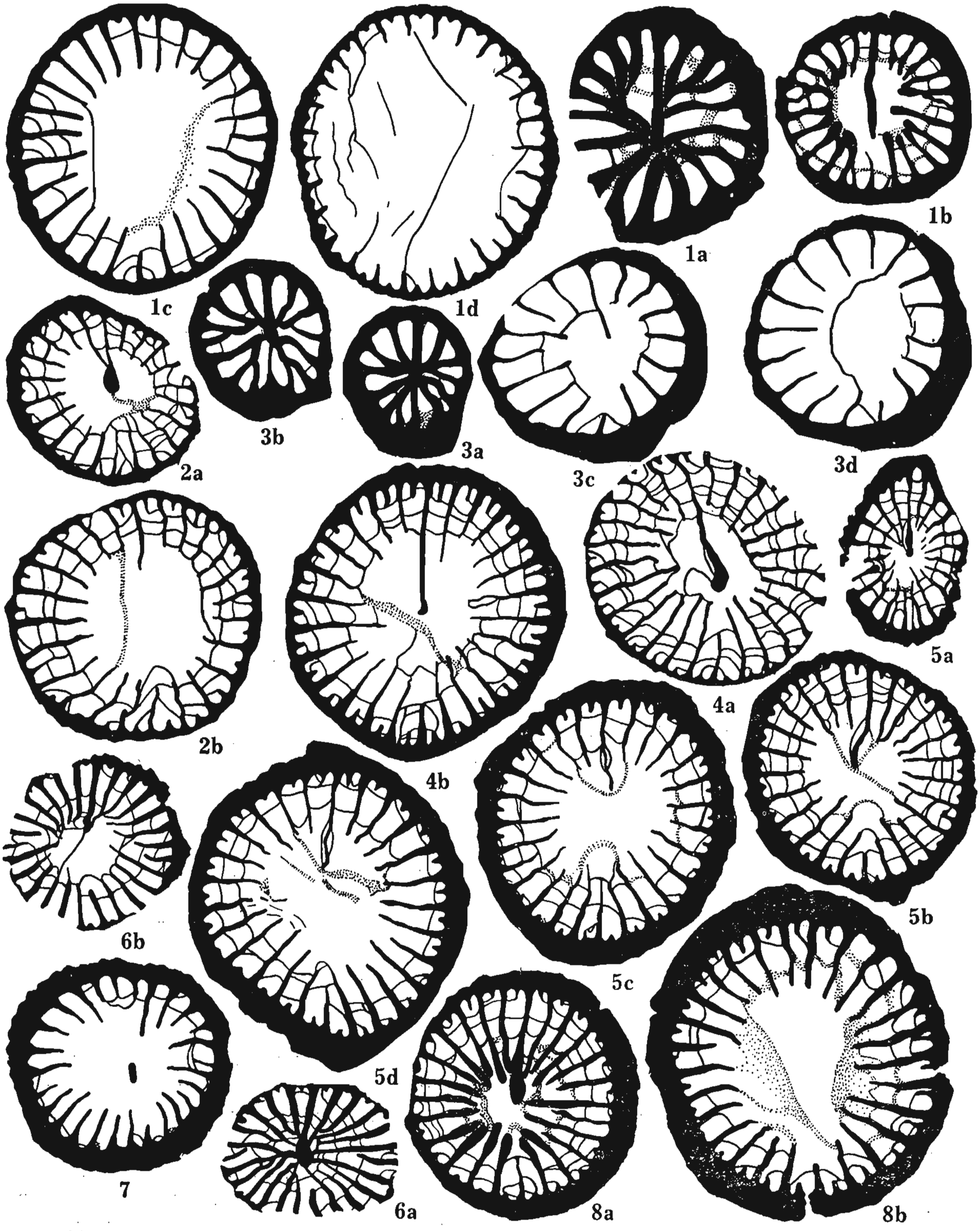

Fig. 35.

Lophophyllidium (*Lophophyllidium*) *westii* (Beede, 1898). Transverse sections. 1. Specimen USNM 196822. Locality USNM 700a, Gaptank Formation, Upper (?) Missourian; a — late neanic stage, × 8; b — early ephebic stage, × 4; c, d — ephebic stage, × 4. 2. Specimen USNM 196823. Locality USNM 701e, Gaptank Formation, *Uddenites*-bearing member; a — early ephebic stage; b — ephebic stage. Both, × 4. 3. Specimen USNM 196824. Locality USNM 700a, Gaptank Formation, Upper (?) Missourian; a, b — neanic stage; c, d — ephebic stage. All, × 8. 4. Specimen USNM 196825. Locality USNM 701e, Gaptank Formation, *Uddenites* bearing member; a, b — early (?) ephebic stage, × 4. 5. Specimen USNM 196826. Locality and horizon as above; a, b — early ephebic stage, c, d — ephebic stage. All, × 4. 6. Specimen USNM 196827. Locality USNM 721, Lower Hueco Formation; a — early ephebic stage; b — ephebic stage. Both, × 4. 7. Specimen USNM 196828. Locality USNM 700, Gaptank Formation, Upper (?) Missourian. Ephebic stage, 6.5 mm

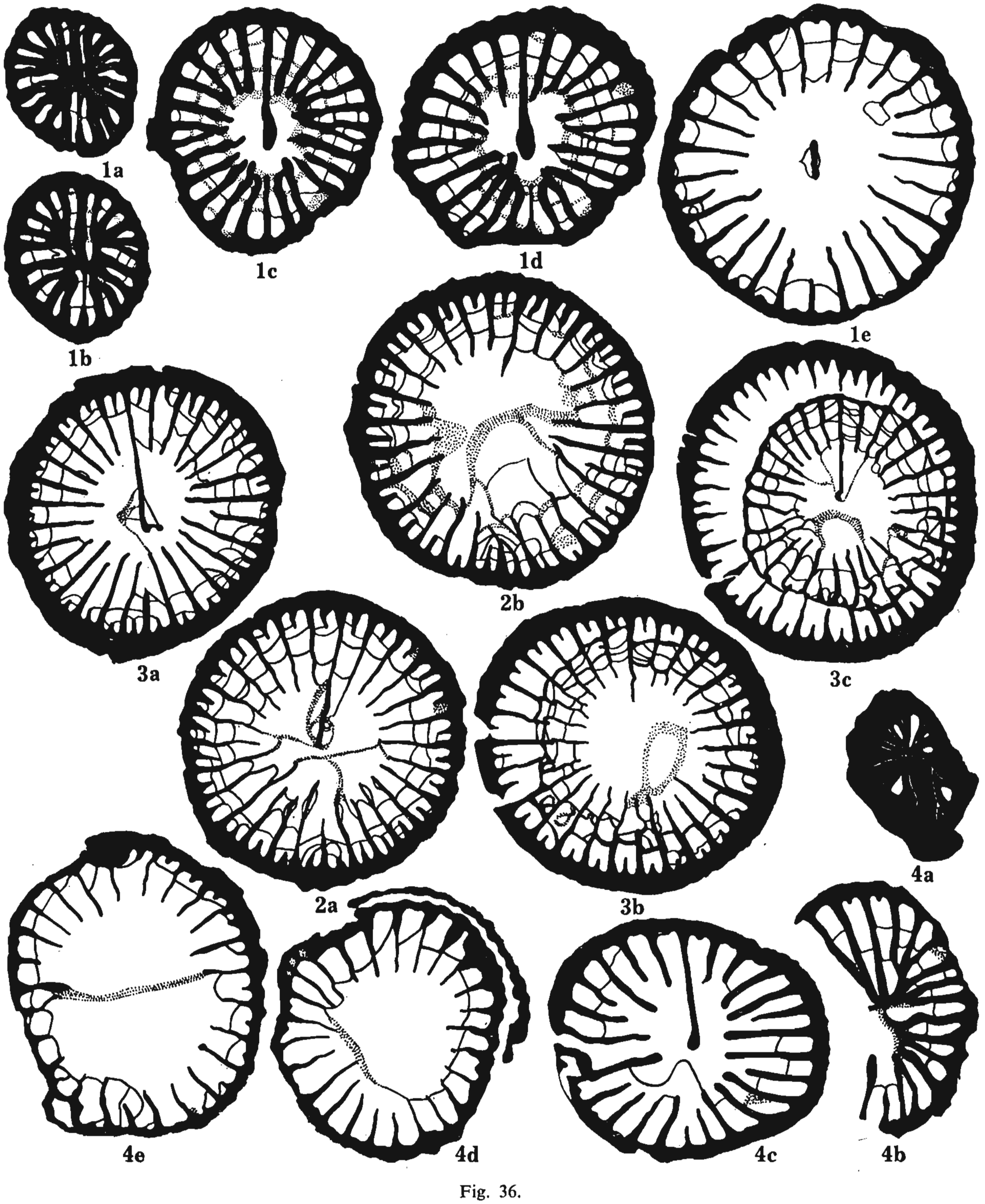

Fig. 36.

Lophophyllidium (*Lophophyllidium*) *westii* (Beede, 1898). Transverse sections. 1. Specimen USNM 196841. Locality USNM 700. Gaptank Formation, Upper (?) Missourian; a, b — early neanic stage; c, d — early ephebic stage; e — ephebic stage having columella separated from counter septum. All, ×4. 2. Specimen USNM 196831. Locality USNM 701e, Gaptank Formation, *Uddenites*-bearing member; a, b — ephebic stage, ×4. 3. Specimen USNM 196832. Locality and horizon as above. a — early (?) ephebic stage, b — beginning of rejuvenation, c — advanced rejuvenation. All, ×4. 4. Specimen USNM 196830. Locality USNM 700a, Gaptank Formation, Upper (?) Missourian; a — early neanic stage, ×8; b — late neanic stage, ×4; c — early ephebic stage, ×4; d, e — ephebic stage, ×4.

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below destruction shown on pl. 10:1, ×4. 8. Specimen USNM 196829. Locality USNM 701u, Gaptank Formation, *Uddenites*-bearing member; a — early ephebic stage; b — ephebic stage. Both, ×4.

of minor septa in corallite lumens, and thin external walls (pl. 9:5a—d; 10a), may in fact form a distinct taxon, not distinguished here for the reasons discussed in remarks on this species and genus.

Dimensions of the *Uddenites*-bearing shell member corallites fit exactly with the variety of this character exhibited by the group of larger corallites of older age. Development and variety of columella or, strictly speaking, the elongated counter septum, is the taxonomically most important character of both the geologically younger and geologically older large specimens. In more ot less advanced maturity of many of these specimens, the counter septum either does not differ in length from other major septa, except for the shortened cardinal septum, or is only slightly elongated (figs. 35:1c, d; 2b; 8b; 36:2b; 4d, e; pl. 9:1f; 8, 11b). In four specimens, the elongated counter septum lasts up to the distal end of their existing portions (fig. 35:4a, b; 5a—d; 36:3a—c; pl. 9:9a—d). None of them has a preserved calice floor however, and one may well consider these specimens immature. A single specimen of this small group (pl. 9:9a) shows temporary presence of a kind of septal lamella.

The elongated counter septum retained at a fairly advanced growth stage, as well as the arrangement of major septa in early maturity and variety in the development of minor septa (figs. 35, 36; pl. 9), may be of some taxonomic importance, discussed later in "Remarks".

Variety in morphology of the longitudinal section results in part from the presence or absence of the columella. There are also differences in arrangement of tabulae and in distance between them, when sections with (pl. 9:9d, 11a, lower part) and without (pl. 9:10b, 11a, upper part) the columella are separately compared. It is difficult to judge to what extent these differences are ecologically influenced and to what extent they are of real taxonomic value.

Remarks. — An analysis of the records of *Lophamplexus* existing so far permits the conclusion that each of the "species" represented by an adequate number of specimens shows a variation whose boundaries include a good deal or all of the characters considered typical for other "species". This is best illustrated by JEFFORDS (1947), who gave the most complete descriptions of several "species" of *Lophamplexus*. For instance, a short-septal mature portion of *L. phractus*, with hardly recognizable cardinal septum, can easily be compared with pl. 23:3, 6c—e, 8b, 9a, b (*L. brevifolius*), pl. 24:1b, 5a (*L. westii*), pl. 27:2d, 4a, 6a—c (*L. ulius*), 8b (*L. vagus*). It can also be compared to all mature portions of *L.*? *lutarius*, but the neanic morphology of the latter makes generic status of this species doubtful (see JEFFORDS 1947:79). Similar analysis, avoided in this paper, can be applied to: a) the columella, which may be separated from or united with the counter septum; b) variation in length of the cardinal septum; c) variation in length of the major septa, d) some differences in thickenings of the structural elements. However, particular characters are more common or dominating in some "species" and very rare in others. All species described by JEFFORDS (1947) and analysed in this paper possess short or very short minor septa and nonrhopaloid major septa, but the latter may in rare instances be differentiated in length (e. g. JEFFORDS 1947 pl. 24:6—8). JEFFORDS (1947, pl. 24:7), suggested that one or two septal lamellae are connected to the columella.

The morphology and trends of variation of the geologically oldest representatives of *Lophamplexus* described so far (MOORE and JEFFORDS 1945) are very similar to those of the geologically younger ones discussed above and do not bring any arguments for acknowledging *Lophamplexus* as an idependently developed phylogenetic line, i. e. a true genus.

The type species *Lophamplexus eliasi* MOORE and JEFFORDS, 1941 is represented only by two specimens, but even these two exhibit several differences in thickness of the external wall, length of minor septa, morphology of juvenile portions of growth, thickness of columellae in individual portions of corallites, and growth stage at which the columella disappears. Both these specimens seem to have a character not occurring in other groups of corallites of the lophamplexoid morphology, i. e. a complex columella. This is the only basis on which I excluded the species synonymized here from *L. eliasi*.

The single specimens identified as *Lophamplexus* sp. by COLSON, 1967 from the Alleghany of Ohio and *Lophamplexus* sp. by SCRUTTON, 1971 from the? Pennsylvanian of Venezuela can in my opinion be temporarily included in the synonymy proposed in this paper. Both of them show characters easily recognizable among those synonymized.

I am not convinced that we are really dealing with a single species. The synonymy proposed reflects a lack of good distinguishing criteria rather than the true relation of the groups of specimens discussed. Proposing this synonymy, I wanted to draw attention to the fact that from the two approaches that can be applied to this material both are possibly wrong. 1. One can easily establish sets of features characteristic for the specimens occurring in the time span from the Morrowan to Permian and call such specimens a species. Several "species" established this way will repeatedly co-exist in the same beds during a very long time not because they are real, but because of the subjective selection of this part of a natural variety of the real species, which were subjectively established characteristic for this artificial taxon. 2. All or most of the specimens derived from the given stratigraphic level are considered a species. Several features of such a "species" may be common with older and younger taxa established this way, but only a little attention is paid to this. The second approach, commonly applied by palaeontologists working mainly for the stratigraphy, mixes the whys and the wherefores: different bio- or lithostratigraphic level established on the basis of other fauna or on the lithology form in this approach an adequate excuse for introducing a new taxon. The genus *Lophophyllidium* and its synonyms are full of such examples.

The species of *Lophophyllidium* so far described and discussed and of its synonyms approve the meaning that this is one of morphologically most variable taxa among the Permo-Carboniferous rugosans and any strongly formalized approach to it must lead to the multiplication of mistakes. There probably are morphological repetitions and convergences considered as single species, as well as species artificially divided because of lack of fully established interspecific variation. To avoid multiplication of new specific names I accepted the first approach of the two mentioned in the previous paragraph, with as wide interspecific variation as I could have established. The situation among the "species" showing lophamplexoid morphology is especially complex because of a well known fact that the amplexoid morphology is reached in several phylogenetic lines (e. g. SCHINDEWOLF 1941; WEYER and ILINA 1979; WEYER 1981; FEDOROWSKI 1986). It thus can well be predicted that there were several species of *Lophophyllidium* that produced the "*Lophamplexus*" species by simple reduction of the columella at maturity. The latter character has been accepted as specific for the purpose of this paper. A careful analysis may prove its uselessness even on such a low taxonomic level, however.

The morphology and variation of the corallites derived from USNM locality 701e from the *Uddenites*-bearing member of the Gaptank Formation draw special attention in the context of the taxonomic value of amplexoid morphology. As shown above in the section "Individual variation", there exists a distinct variety in length of the counter septum. Other characters of the specimens discussed and especially the morphology and length of major and minor septa in mature portions are very similar to some specimens of the same age and locality assigned here to *L. dunbari* MOORE and JEFFORDS, 1941 and *L. absitum* (JEFFORDS, 1947). One can well accept a specific concept for these specimens quite different from that subjectively accepted in this paper. The specimens with thick, monoseptal columella (fig. 41:7), complex columella (fig. 39:1c, d), thin, elongated counter septum (fig. 35:4a, b) and without columella (fig. 35:8b) may, in accordance to that concept, be considered conspecific. This strictly stratigraphic approach to the material emphasises at the same time an artificial status for the genus *Lophamplexus* and its synonymy with *Lophophyllidium*. Without going so far as rejecting the taxonomic value of individual characters traditionally accepted as specific in this group of corals, I did not recognize the longlasting and early disappearing elongation of the counter septum as specific characters and placed bearers of all these features in the species discussed.

Occurrence. — Previous descriptions: Oklahoma, Hale Formation, Morrowan; Oklahoma, Marmaton Group, Desmoinesian; Missouri, Kansas City Group; Kansas, Lansing Group; Oklahoma, Skiatook Group; Ohio, Alleghany Group; Venezuela, ? Pennsylvanian. Here described: USNM 700:8, 700a:13, Gaptank Formation, Upper (?) Missourian; 701e:15, 701p:1, 701u:1, Gaptank Formation, *Uddenites*-bearing member, Lowermost Wolfcampian; 705j:1, undivided Gaptank Formation; 721:1, Lower Hueco Formation, 721g:1, 706x:1, Neal Ranch Formation, Lower Wolfcampian.

Lophophyllidium (*Lophophyllidium*) *distortum* (WORTHEN, 1875)

(figs. 37, 38; pls. 10:4—6; 11:2, 5, 6, 9)

1875. *Cyathaxonia distorta* WORTHEN; WORTHEN, A. H. and MEEK, F. B., p. 526, pl. 32:4.
e. p. 1915. *Lophophyllum distortum* WORTHEN; G. H. GIRTY, p. 318; fig. 37: 4, 8 in this paper.
1947. *Stereostylus lenis* JEFFORDS; R. M. JEFFORDS, p. 40, figs. 2—4, 7, 8; pls. 1:1; 14:1—15; 20:3, 4, 6.
e. p. 1947. *Stereostylus milichus* JEFFORDS; R. M. JEFFORDS, p. 52, fig. 7; pl. 17:1, 3, 5.
1947. *Stereostylus pandatus* JEFFORDS; R. M. JEFFORDS, p. 54, fig. 7; pls. 18:1—5; 26:3.
1966. *Stereostylus* sp. BEBOUT; D. G. BEBOUT, p. 4, pl. 2:4a—e.

Holotype. — The specimen illustrated by A. H. Worthen *in:* WORTHEN, A. H. and MEEK, F. B., 1875, pl. 32, fig. 4, housed in the Illinois State Museum, under the No. 10967, specimen 1.

Type locality: Greenup Limestone, Matoon Formation, McLeansboro Group, Cumberland County, Illinois.

Age: Middle Virgilian — base of upper third of the Stephanian of Europe (according to Dr. W. J. SANDO, written comm., 1983).

Diagnosis. — *Lophophyllidium* having n:d ratio 22:8.5—34:17.0; symmetry radial; major septa thin, equal in length except for shortened cardinal and elongated counter septum; minor septa very short; columella inconspicuous, may be free at maturity.

The type collection. — Three specimens are housed under the same number in the Illinois State Museum. Two of these corallites were illustrated originally by WORTHEN (1875, pl. 32:4, 4a). None of the originals was sectioned prior to this paper. The illustrated specimens are here considered conspecific, although the paratype is much smaller and has a much deeper calice than the one chosen herein as holotype. Only the single section through the calice was prepared from the former specimen (fig. 37:2), which is not discussed in detail. The third corallite originally not illustrated, differs from the former two at the family or higher level, being a dissepimentate coral belonging to a new genus (fig. 38:2a—c).

The holotype is filled in partly with matrix in its upper portion. This is interpreted herein as diagenetic, because of the presence of sections of tabulae in this infilled portion. The very early ontogeny of the corallite has not been investigated. The specimen was sectioned twice: in the supposidly neanic and in the ephebic portions. Peels, prepared from all four surfaces, are illustrated (fig. 37:1a—d) to show considerable variability of some structural elements, appearing at a distance of growth as short as approximately 1 mm. The ontogenetically youngest

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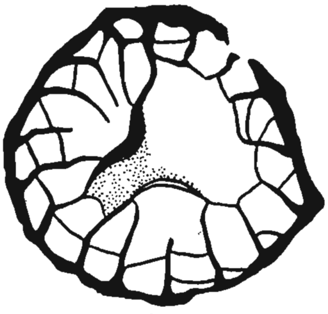
Fig. 37.

Lophophyllidium (*Lophophyllidium*) *distortum* (WORTHEN, 1875). Transverse sections. 1. Specimen 10967, corallite 1. Holotype. Greenup Limestone, Matoon Formation, McLeansboro Group, Middle Virgilian, Cumberland Co., Illinois. Housed in the Illinois State Museum; a, b — early ephebic (?) stage; c, d — ephebic stage; portions filled in with strange matrix are shaded. All, × 10. 2. Specimen 10967, corallite 2. Paratype. Depository, locality and horizon as above. Ephebic (?) stage, × 5. 3—8. Corallites described as *Lophophyllum distortum* by GIRTY (1915). Kansas City Group, Upper Missourian, Missouri. 3. Specimen USNM 121412; a — early ephebic stage; b — ephebic stage (= *L.* (*L.*) *westii* (BEEDE, 1898)). 4. Specimen USNM 121413; a, b — ephebic stage (= *L.* (*L.*) *distortum* (WORTHEN, 1875)). 5. Specimen USNM 121414—1, ephebic stage (= *L.* (*L.*) cf. *confertum* JEFFORDS, 1942). 6. Specimen USNM 121414—2, ephebic stage (= *L.* (*L.*) *dunbari* MOORE and JEFFORDS, 1941). 7. Specimen USNM 121414—3, ephebic stage (= *L.* (*L.*) *dunbari* MOORE and JEFFORDS, 1941). 8. Specimen USNM 121414—4, ephebic stage (= *L. distortum* (WORTHEN, 1875)). All, × 5. 9. Specimen USNM 196843. Locality USNM 701e, Gaptank Formation, *Uddenites* bearing member; a—d — early to late ephebic stage, × 5.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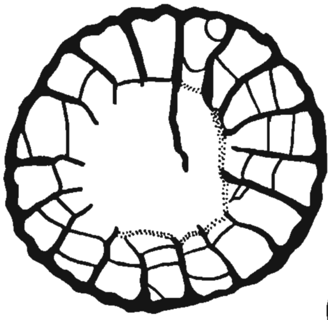
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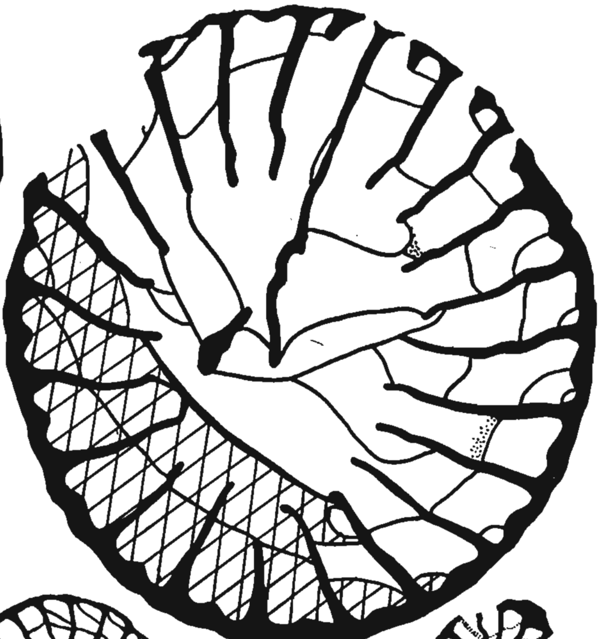
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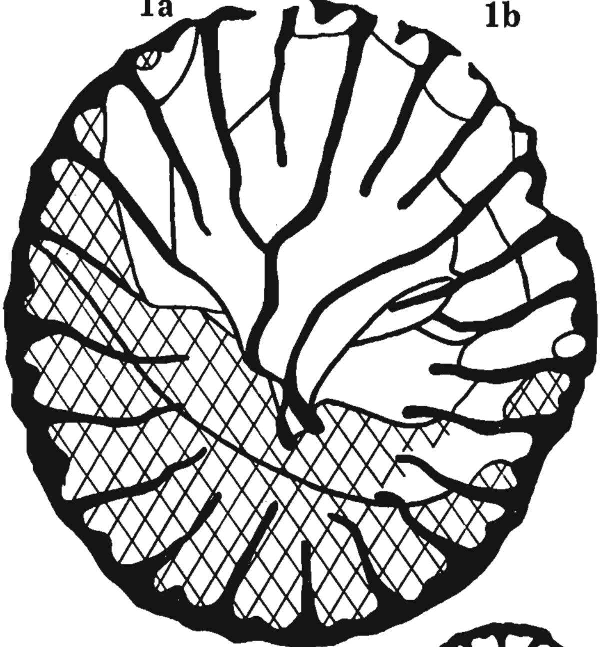
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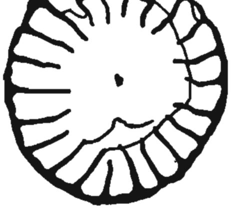
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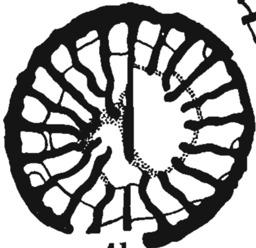
3b


5


3a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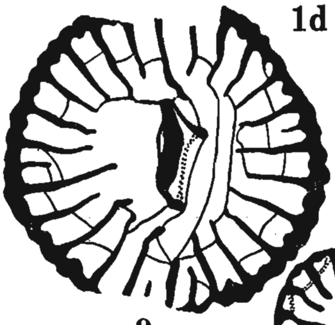
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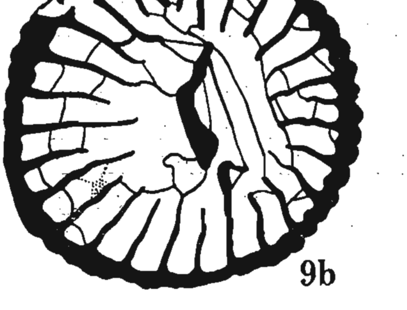
7


6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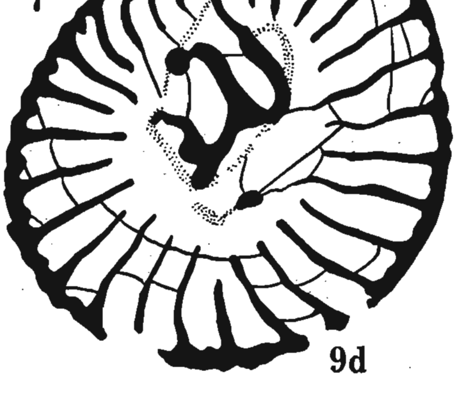
9d

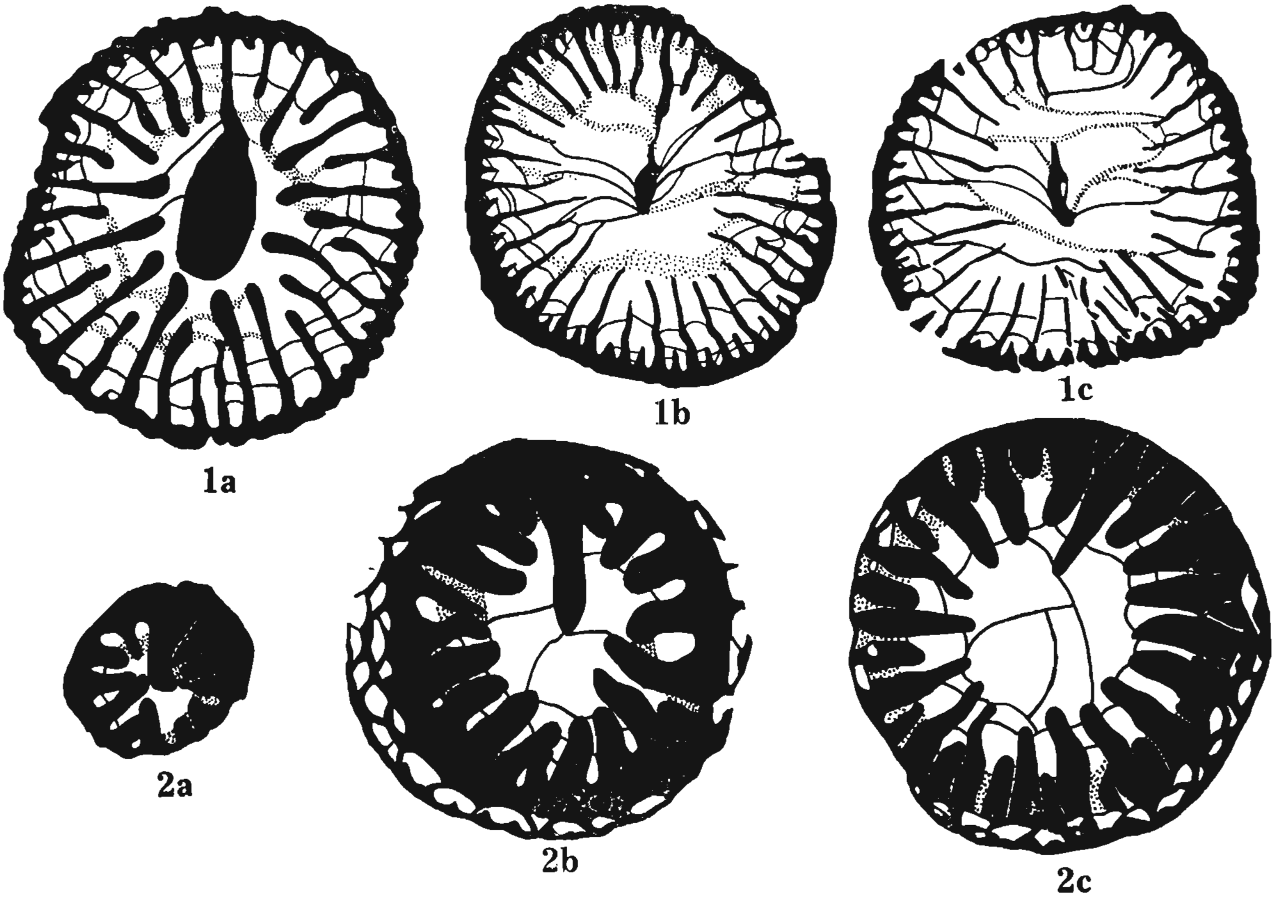

Fig. 38.
Lophophyllidium (*Lophophyllidium*) *distortum* (Worthen, 1875). Specimen USNM 196844. Locality USNM 701e, Gaptank Formation, *Uddenites*-bearing member. Transverse sections; a — early ephebic stage, × 5; b, c — late ephebic stage, × 3. 2. *Worthenophyllum vesiculatum* gen. n., sp. n. Specimen 10967, corallite 3. Holotype of the type species. Greenup Limestone, Matoon Formation, McLeansboro Group, Middle Virgilian, Cumberland Co., Illinois. Housed in the Illinois State Museum. Transverse sections; a — neanic stage; b, c — ephebic stage. All, × 10.

section (fig. 37:1a) shows the post-neanic morphology, despite its small dimensions (n:d ratio 17:4.0×4.3). The lower surface of the section runs through the tabula with the counter septum elongated so as to reach one of the metasepta of the cardinal quadrants. Also, axial ends of two septa of the latter quadrants are united to arch over the cardinal septum and two other major septa next to it. The other major septa are thin and shortened. The morphology of the opposite surface of the same section (fig. 37:1b) shows almost regularly radial arrangement of the major septa, with the cardinal septum hardly distinguishable by its slight shortening and with the counter septum thin, but elongated to the corallite axis. The minor septa are not yet developed in the corallite lumen, but their foundations are already present in a form of an undulation of the inner surface of the external wall.

The morphology of the upper section having n: d ratio 22:9×8 exhibits the same general characteristics as described above, except for the development of true minor septa, at least in some septal loculi, and except for the morphology of the columella. The latter may be simple but separated from the axial end of the long counter septum (fig. 37:1c) or may form the elongation of the counter septum, supplemented by a single axial lamella derived from other major septum (fig. 37:1d). The cardinal septum is shortened.

Discussion. — The specimens identified here as *L. distortum* (WORTHEN, 1875) are all larger than the holotype, and all are derived from geologically younger strata.

N:d ratio of representative specimens (in mm):

USNM cat. nos.	n: d ratio
196848	34:17.0
196844	32:16.7
196847	32:13.8
196843	28:12.7
196850	26:11.7

There are also morphological differences both between them and the holotype and between themselves. A single corallite (fig. 38:1a) possesses a strongly thickened columella and rhopaloid major septa in early maturity, but most of the corallites are, in this respect, rather similar to the holotype, although the underdevelopment of of the thickening of major septa is not so advanced as in the latter. The columella in the specimens here discussed is continuously connected with the counter septum (fig. 37:4a, b; 8; pl. 11:6a, b; 9) or it may lose this connection in late maturity (fig. 38:1c; pl. 11:2). This disconnection may be temporary in some instances. Also the morphology of the columella may vary considerably. In most of the corallites, the columella is a simple elongation of the counter septum (fig. 37:4a, b, 8; pl. 11:9) or was only derived from it, when separated (fig. 38:1b, c; pl. 11:2). Its morphology in some specimens is somewhat more complex owing to incorporation of some additional lamellae (fig. 37:9a—d; pl. 11:5a, b). In rare instances (pl. 11:6a, b), it varies greatly in morphology from section to section, being complex and compact in some and rather weak and almost simple in the neighbouring ones. In view of the variable morphology of this structure shown by the holotype and by the specimens here discussed, the columella has rather minor taxonomic value for *L. distortum*.

The major septa are short or very short, being hardly distinguishable in some specimens (e. g. fig. 37:4a, b, 8, 9a—d; pl. 11:2, 5a, b) and fairly well developed in the others (e. g. fig. 38:1a—c). This variability is not so large as to have any taxonomic implication, however.

The major septa are all more or less equal in length, except for the shortened cardinal septum and the elongated counter septum, but total lengths vary in comparison to the corallite diameter. There is no obvious trend in this variation. It is also not correlated to any other character and, as such, has rather restricted taxonomic value. Some long-septal specimens e. g. figs. 37:5, 38:1a—c may eventually be compared to other species, which is discussed in the next section.

Remarks. — The species concept of *L. distortum* (WORTHEN, 1875) is rather broad and may not be accepted by authors if the differences pointed out in the discussion are considered specific. Such an understanding of this species was mainly caused by the absence of topotypes available for study and by very restricted original material, whose individual corallites differ morphologically. There are also species which may not be approved because of their similarity to *L. distortum*. *L. dunbari* MOORE and JEFFORDS, 1941, with its possible synonym *Malonophyllum kansasense* MOORE and JEFFORDS, 1941, is one of these. Boundaries of the individual variation of *L. dunbari* and *M. kansasense* shown by MOORE and JEFFORDS (1941, pl. 1, figs. 1—8), broadened by the specimens included in that species in this paper, superimpose on some variants or characters attributes to *L. distortum* (e. g. fig. 39:5a—c). The opposite situation is observed in the single specimen identified herein as *L. distortum* (fig. 38:1a—c). It possesses an early ephebic stage similar to that of *L. dunbari*.

Some of the long-septal corallites identified here as *L. distortum* are fairly close to those specimens of *L. phainum* JEFFORDS, 1947, conditionally included here to *L. dunbari*, that show the major septa more or less equal in length. Differences in that case are slight and concern

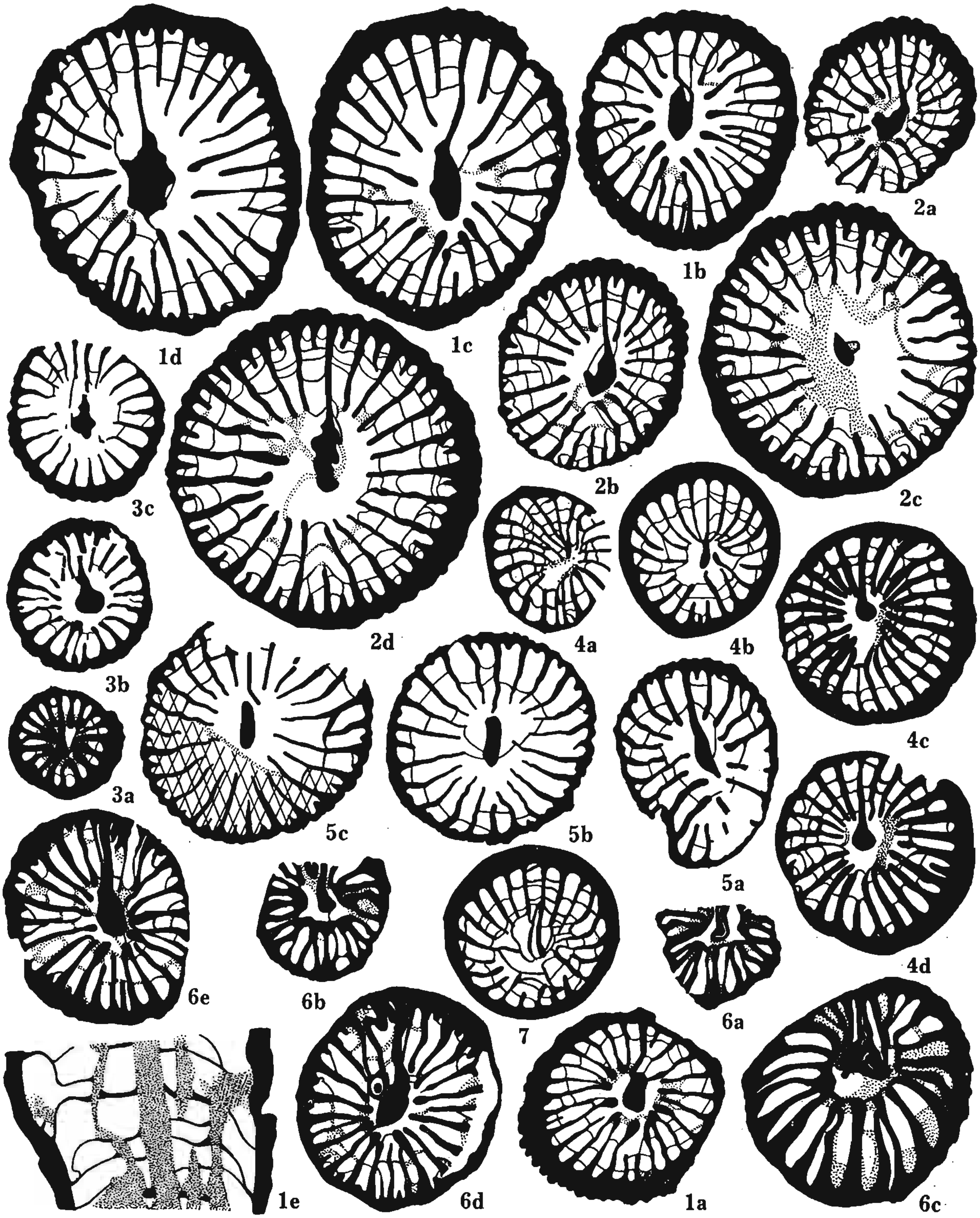

Fig. 39.

Lophophyllidium (*Lophophyllidium*) *dunbari* MOORE and JEFFORDS, 1941. 1. Specimen USNM 196851. Locality USMN 701e, Gaptank Formation, *Uddenites* bearing member; a—d — transverse sections, early to late ephebic stage; e — longitudinal section. All, × 5. 2. Specimen USNM 196852. Locality and horizon as above; a—d — transverse sections, early to late ephebic stage, × 5. 3. Specimen USNM 196853. Locality USNM 706x, Neal Ranch Formation. Transverse sections; a — late neanic stage; b, c — ephebic stage. All, × 5. 4. Specimen USNM 196854. Locality USNM 721, Lower Hueco Formation. Transverse sections; a, b — early ephebic stage; c, d — ephebic stage. All, × 5. 5. Specimen USNM 196855.

length of the minor septa, morphology of the columella, and slightly longer length of major septa — all characters that may be unacceptable to authors.

Occurrence. — The stratigraphic position of the holotype is indicated above. Previously described specimens: Kansas and Missouri, Kansas City Group and Lansing Group; Ohio, Conemaugh Group, Missourian; Kansas, Shawnee Group, Virgilian. Here described: USNM 700:3, 700A:5, Gaptank Formation, Upper (?) Missourian; 701e:5, 701v:1, Gaptank Formation, *Uddenites*-bearing member, Lowermost Wolfcampian.

Lophophyllidium (*Lophophyllidium*) *dunbari* Moore and Jeffords, 1941

(fig. 39; pls. 11:3, 7, 8, 12, 13, 15—17; 12:1—16)

e. p. 1915. *Lophophyllum distortum* Worthen; G. H. Girty, p. 318; fig. 37:6, 7 in this paper.
1941. *Lophophyllidium dunbari* Moore and Jeffords; R. C. Moore and R. M. Jeffords, p. 83, pl. 1:1—5.
1941. *Malonophyllum kansasense* Moore and Jeffords; R. C. Moore and R. M. Jeffords, p. 76, pl. 1:6—8.
? 1947. *Stereostylus phainus* Jeffords; R. M. Jeffords, p. 46, fig. 7, pls. 15:1—6; 20:5; 26:4.

Material. More than 60 specimens, many of which have calices and/or proximal ends preserved. Some corallites fragmentary or having internals partially etched out.

N: d ratio beneath calices (in mm):

USNM cat. nos.	n: d ratio
196853	20: 7.0
196866	22: 8.1
196864	25: 8.6
196852	25:13.4
196865	26:10.0
196860	28:13.0
196851	30:13.9
196859	31:12.2

Diagnosis. — *Lophophyllidium* having maximum diameter 14 mm at calice margin and up to 31 major septa; symmetry radial; major septa thin, shortened, slightly differentiated in length, occasionally a little rhopaloid; cardinal septum very short; counter septum commonly elongated to compound, often thick columella.

Individual variation. — The type and the other specimens described by Moore and Jefford (1941) vary in several morphological characters and, to a lesser degree, in n: d ratio. This variation is broadened by the specimens here described, especially as far as the n: d ratio is concerned (see table).

The internal structure of columellae vary (fig. 39:1—6; pl. 11:3, 7, 8, 12, 13, 15—17), but it is almost invariably compound in the mature corallites, incorporating a few coarse septal lamellae. The number of the latter is always smaller than half the number of major septa. Independently of its morphology, a columella may be sometimes very prominent, extending

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Locaity USNM 701k, Neal Ranch Formation. Transverse sections; a — early ephebic stage; b — ephebic stage having columlla separated from counter septum; c — calice; part below last tabula shaded. All, × 5. 6. Specimen USNM 197856. Locality USNM 706x, Neal Ranch Formation. Transverse sections; a—c — late neanic stage, × 10; d — ephebic stage; morphology disturbed by commensal organism, × 5. 7. Specimen USNM 196857. Locality USNM 727e, Neal Ranch Formation. Transverse section, early ephebic stage, × 5.

almost as high as to a calice margin (pl. 12:8a, b), or is medium in height (pl. 12:1b, 6b, 9a, 12a) or, in rare instances, it is restricted to the deeper portions of calices (pl. 12:7b, 15). In the type collection a similar variation is observed in that character.

The minor septa in almost all geologically younger specimens are well developed only in the upper portions of calices (pl. 12:1b, 2b, 9a, b, 15). Deeper in calices and beneath the last tabulae, the minor septa are often seen only in the external wall or are absent (pl. 11:3, 7, 16, 17).

Some specimens derived from the *Uddenites*-bearing shell member of the Gaptank Formation differ from the type specimen and from all younger representatives of the species discussed in having a comparatively thick external wall, fairly well developed minor septa, and more numerous major septa (fig. 39:1a—d, 2a—d; pl. 11:12a, b, 15). They may represent a distinct subspecies leading towards the ancestral form of *L. dunbari s. s.* Some morphological features of these corallites are similar to those shown by the specimens of the same age identified here as *L. distortum* (WORTHEN, 1875), which may be of some taxonomic value. There are also specimens of the Neal Ranch Formation, however, that exhibit several characters in common or identical with those of the geologically oldest specimens of *L. dunbari.*

Remarks. — *Malonophyllum kansasense* MOORE and JEFFORDS, 1941 is included here in the synonymy of *L. dunbari.* It has been stated (FEDOROWSKI 1974) that *Malonophyllum* is a junior synonym of *Lophophyllidium.* The characters of "*M.*" *kansasense* agree with the diagnosis of *L. dunbari.* A lack of tabulae in the former species, expressed by MOORE and JEFFORDS (1941), is most probably apparent and was caused either by the extreme depth of the calices or resulted from diagenesis. The fairly long minor septa of "*M*". *kansasense* are in fact the only difference when compared to the type specimen of *L. dunbari.*

"*Stereostylus*" *phainus* JEFFORDS, 1947 is conditionally included in synonymy with *L. dunbari.* It is geologically much older than the specimens here described and shows some morphological differences. Narrower understanding of *L. dunbari* may thus lead to considering "*S*". *phainus* distinct, but possibly ancestral for the former species. However, differences between the type collection of "*S.*" *phainus* and the geologically oldest specimens here included in *L. dunbari* are slight, forming the main basis for the concept of the last species here proposed. It may also be true, however, that the Gaptank Formation corallites, included in *L. dunbari* in this paper, may form a distinct species, common with the type of "*S.*" *phainus.*

Occurrence. — Former descriptions: ? Kansas, Drum Limestone of the Kansas City Group, Missourian; Kansas, Beattie Limestone of the Florena shell Member, Middle Wolfcampian. Here described: USNM 701e:6, 701p:1, 701v:1, Gaptank Formation, *Uddenites*-bearing member, Lowermost Wolfcampian; USNM 701:19, 701c:1, 701d:19, 701g:1, 701k:2, 701l:1, 701t:1, 702t:1, 706x:5, 721g:7, 721u:1, 727e:6, Neal Ranch Formation, Lower Wolfcampian. ? 702e:1, Hess Formation, Taylor Ranch Member; ? 707ha:1 Skinner Ranch Formation, Poplar Tank Member; ? 721:2, Lower Hueco Formation. Upper Wolfcampian.

Lophophyllidium (*Lophophyllidium*) *compressum* JEFFORDS, 1942

(fig. 40; pl. 8:18, 19; 13:1—8)

1942. *Lophophyllidium compressum* JEFFORDS; R. M. JEFFORDS, p. 224, Pls. 2:2; 8:1.
1942. *Lophophyllidium elongatum* JEFFORDS; R. M. JEFFORDS, p. 234, Pl. 4:1—3.
1947. *Stereostylus pelaeus* JEFFORDS; R. M. JEFFORDS, p. 48, Pls. 16:1—8; 20:1, 7.
? 1962. *Lophophyllidium solidum* ROSS and ROSS; C. A. ROSS and J. P. ROSS, p. 1182, e. p.
1966. *Stereostylus brushensis* BEBOUT; D. G. BEBOUT, p. 3, pl. 2:1—3.
? 1971. *Lophophyllidium pelaeum* (JEFFORDS); C. T. SCRUTTON, p. 202, pl. 1: 13—15.

Material. — 19 incomplete specimens having well preserved internal structure. The unillustrated specimen USNM 139738 identified by Ross and Ross, 1962 as *L. solidum* is here considered more similar to if not quite identical with *L. compressum.*

Some characteristics of representative corallites:

USNM cat. nos.	N: d ratio (in mm)	C septum side
196877	22: 7.7	lateral
196879	26: 9.8	? concave
196882	26:10.8	convex
196880	28: 8.7	lateral
196874	28:10.9	convex
196873	33:13.5	lateral

Diagnosis. — *Lophophyllidium* having n: d ratio beneath calice 22:7.7 to 33:13, 5; columella monoseptal; cardinal septum shortened; major septa slightly to distinctly rhopaloid, differentiated in length, semi-bilaterally arranged; minor septa short.

Individual variation. — Almost all the specimens studied are rather thick-walled corallites, having underdeveloped minor septa and a very short cardinal septum (fig. 40:2a, b, 3b, c, 4b, c, 5a, b). They vary in thickness of the major septa, differentiated development of the stereoplasmic infillings, and in the arrangement of major septa. The latter may be almost bilateral in mature portions of some corallites (e. g. fig. 40:1c, 3c; pl. 13:1c) and close to radial in the opposite extreme (fig. 40:2b, 4c; pl. 13:4a, 6b, c, 7a, b). Differentiation in length of major septa is rather slight in most of the corallites (pl. 13:2b, c, 6b, c, 7a, b), but it may be fairly well accentuated in some (fig. 40:1c, 3c, 5b; pl. 13:8a). Although length and thicknes of the columellae vary, their morphology is invariably monoseptal.

Two specimens included in this species have their mature morphology (fig. 40:1c, 3c) very similar to specimens included by JEFFORDS (1942) in *L. compressum* and *L. elongatum*, but the ontogenetically younger parts of them (fig. 40:1a, b, 3a, b) differ not only from each other but also from these two taxa.

Remarks. — Most of the specimens discussed in this paper are much smaller than the holotype and other specimens identified as belonging to the species synonymized here with *L. compressum* JEFFORDS, 1942. "*Stereostylus*" *brushensis* BEBOUT, 1966 from Ohio forms the only exception. Also, the morphology of several specimens discussed in this paper (e. g. fig. 40:2a, b; pl. 13:4a, b, 6a—c) resembles most closely "*S.*" *brushensis*. I agree with SCRUTTON (1971), however, that there is no specific difference between the Ohio "*S*". *brushensis* and Oklahoma "*S*". *pelaeus*. Moreover, the Desmoinesian *L. compressum* JEFFORDS, 1942 does not show any important morphological difference from the former two species and is here acknowledged as the senior synonym for all the specimens mentioned.

The specimen described by SCRUTTON (1971) from Venezuela differs in n: d ratio from all remaining specimens here identified as *L. compressum* and in having a much larger number of septa. Also, its morphology and especially the arrangement of major septa differs a little from JEFFORDS' (1942) type material.

The species discussed is morphologically most similar to *L. confertum* JEFFORDS, 1942 and to the group of specimens described here as *L.* cf. *confertum* JEFFORDS, 1942 in the structure of the columella and in the character of the major septa. If the strongly bilateral symmetry of the latter two is considered unimportant, there will not be any significant difference between these species.

L. compressum shows also a close similarity to the type of the Wolfcampian *L. skinneri* Ross and Ross, 1962, which differs mainly in having the cardinal septum only slightly shortened. If this character is considered unimportant or juvenile, *L. skinneri* may well be synonymized with *L. compressum*, in spite of its much higher stratigraphic position. As discussed with *L.* cf. *confertum*, *L. skinneri* is an ambiguous species and any comparison to it must be imprecise.

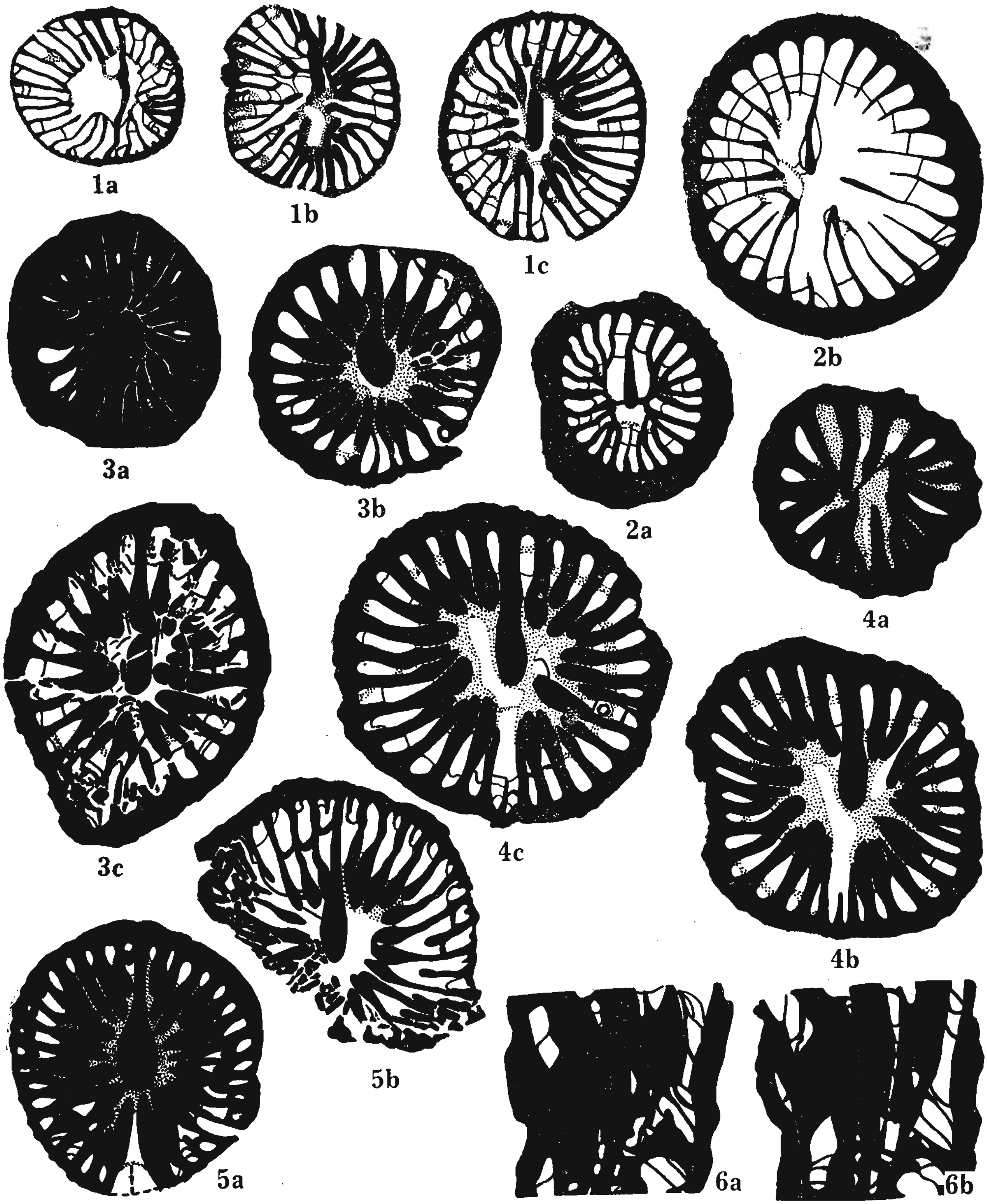

Fig. 40.

Lophophyllidium (*Lophophyllidium*) *compressum* Jeffords, 1942. Transverse sections. 1. Specimen USNM 196873. Locality USNM 701e, Gaptank Formation, *Uddenites* bearing member; a—c — early to late ephebic stage, × 3. 2. Specimen USNM 196874. Locality USNM 700a, Gaptank Formation, Upper (?) Missourian; a — early ephebic stage; b — ephebic stage. Both, × 5. 3. Specimen USNM 196875. Locality USNM 700, Gaptank Formation, Upper (?) Missourian; a — early neanic stage, × 10; b, c — early and late ephebic stage, × 5. 4. Specimen USNM 196876. Locality and horizon as above; a — neanic stage, × 10; b, c — ephebic stage, × 5. 5. Specimen USNM 139738 (= *L. solidum* Ross and Ross, 1962, e. p.). Locality USNM 704w, Gaptank Formation, Virgilian. 6. Specimen USNM 196885. Locality USNM 701e, Gaptank Formation, *Uddenites*-bearing member; a, b — successive longitudinal sections, × 3.

The species discussed shows also some similarity to *L. dunbari* MOORE and JEFFORDS, 1941 and *L. absitum* (JEFFORDS, 1947) in the arrangement and thickening of major septa. This may be considered as an indication for all these species being closely related.

Occurrence. — Former descriptions: Texas, Millsap Lake Group, Desmoinesian; Oklahoma, Kansas, Ohio, Middle Missourian; ? Venezuela, ? Pennsylvanian. Here described: USNM 700:10, Gaptank Formation, equivalent of Bed 10 of P. B. King, Upper Missourian; USNM 704D:1, undivided Gaptank Formation; ? 704w:1, Gaptank Formation with *Triticites joensis* THOMPSON, possibly Virgilian; ? USNM 701e:1, Gaptank Formation, *Uddenites* bearing member.

Lophophyllidium (*Lophophyllidium*) *absitum* (JEFFORDS, 1947)

(Fig. 41:1—7; pls. 10:7—12; 13:9—17)

1947. *Stereostylus absitus* JEFFORDS; R. M. JEFFORDS, p. 56; pl. 19:1—7.
? 1947. *Lophophyllidium spinosum* JEFFORDS; R. M. JEFFORDS, p. 34, pls. 5: 1, 2; 8:6, 8; 12:1—4; 13:1—4.
e. p. 1947. *Stereostylus perversus* JEFFORDS; R. M. JEFFORDS, p. 60, pl. 22:1, 4 only.
e. p. 1962. *Lophophyllidium solidum* ROSS and ROSS; C. A. ROSS and J. P. ROSS, p. 1182.
? e. p. 1971. *Lophophyllidium* sp. cf. *L. wewokanum* JEFFORDS, 1947; C. T. SCRUTTON, p. 203, pl. 1:18 only.

Material. — 18 corallites of well preserved internal morphology. Several specimens having calice floors and/or proximal ends preserved. Some silicified in part.

Diagnosis. — *Lophophyllidium* with n:d ratio 25:11—38:21; major septa arranged radially, rhopaloid, differentiated in length; minor septa commonly well developed; columella thick, solid, monoseptal or complex, tending to separate from counter septum; incipient biformity of tabularium may occur in some septal loculi.

Remarks. — The above synonymy is based on the reexamination of the sectioned specimens of JEFFORDS (1947) and on the original descriptions, but the morphology of the holotypes was decisive for the considerations. The species name *L. absitus* was accepted because the name *L. spinosum*, published on earlier pages is preoccupied by *Lophophyllidium spinosum* (MARTIN, 1881). Some paratypes of individual species may not belong to *L. absitum* in the meaning accepted here.

The specimens of the collection being investigated in this paper form two groups that differ in some morphological details and in stratigraphic position. The first group contains corals of small dimensions (n: d ratio 26:8.5—12.5 prevails, maximum stated 29:13.5), well developed minor septa, the major septa more or less rhopaloid and differentiated in length and the columella monoseptal in early growth, but composed of a few septal lamellae in the late ephebic stage (fig. 41:1a—d, 2a—c, 6a—f; pl. 13:9a—c, 10, 11, 12a, b, 14a—c). This group of corals is restricted to USNM Locality 720b (Western base of Franklin Mts, Hueco Formation). The morphology and radial arrangement of major septa, the very short cardinal septum, and the columella tending to separate from the counter septum are in common with the characters of the second group of specimens that is stratigraphically older, being restricted to the *Uddenites*-bearing member of Gaptank Formation. Larger dimensions (n: d ratio 30:10.5—36:15.5), underdevelopment of the minor septa that are better seen in a single corallite only (pl. 13:17), monoseptal columella, and more distinct rhopaloid thickenings on the major septa are the main distinguishing characters of specimens of this group when compared to the previous one (pl. 13:13, 15—17). Representatives of both groups exhibit characters in common with *L. absitum* and other species synonymized, but they differ from the latter in some other ones. It should be noted, however, that not the geologically older, i. e. closer to the type, but the geologically younger specimens are morphologically more similar to earlier described corals. I thus consider individual groups of corals discussed as the stratigraphically separated populations of the

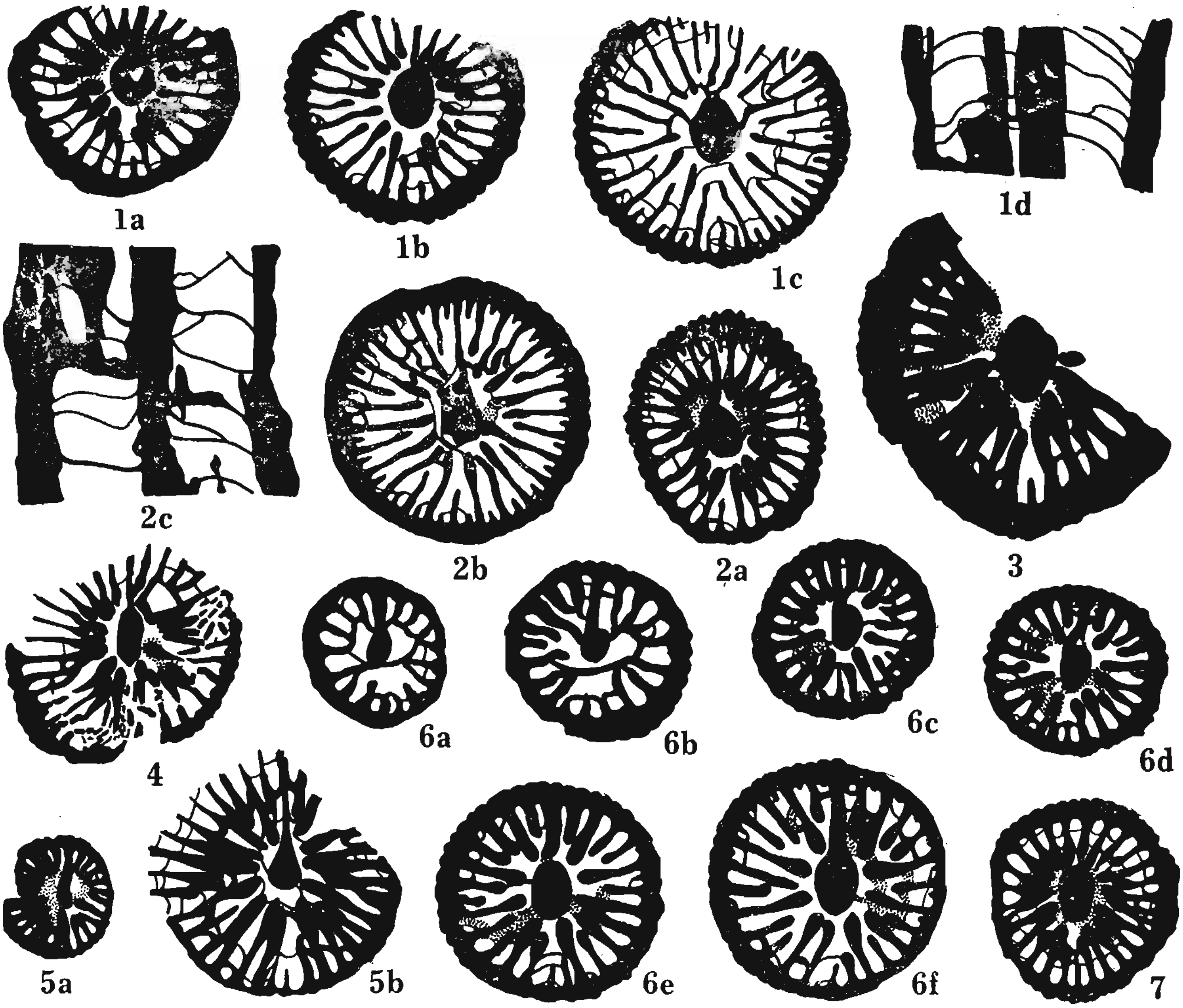

Fig. 41.
Lophophyllidium (*Lophophyllidium*) *absitum* (Jeffords, 1947). 1. Specimen USNM 196883. Locality USNM 720b, Hueco Formation; a—c — successive transverse sections, ephebic stage; d — longitudinal section. All, × 3. 2. Specimen USNM 196884. Locality and horizon as above. a, b — transverse sections, ephebic stage; c — longitudinal section. All, × 3. 3. Specimen USNM 139741 (= *L. solidum* Ross and Ross, 1962, e. p.). Locality USNM 705k, Lenox Hills Formation. Fragmentary transverse section, ephebic stage, × 3. 4. Specimen USNM 139736 (= *L. solidum* Ross and Ross, 1962, e. p.). Locality USNM 704w, Gaptank Formation, Virgilian. Transverse section, ephebic stage, × 3. 5. Specimen USNM 139737 (= *L. solidum* Ross and Ross, 1962, e. p.). Locality and horizon as above. Transverse sections; a — late neanic/early ephebic stage; b — ephebic stage. Both, × 3. 6. Specimen USNM 196886. Locality USNM 720b, Hueco Formation. Transverse sections; a, b — early ephebic stage, × 5, c—f — ephebic stage, × 3. 7. Specimen USNM 196887. Locality USNM 701e, Gaptank Formation, *Uddenites*-bearing member. Transverse section, ephebic stage, × 3.

same species although they may well be treated as separate taxa, if a narrow species concept is proved.

Several species (?) of similar, but not quite the same morphology have not been included in the synonymy of *L. absitum*. These are *L. sauridens* (White, 1875), possibly from Morrowan; *L. complexum*, *L. expansum*, *L. murale* from Des Moinesian, *L. radiatum* from Missourian, all of Jeffords (1947). Mutual differences in morphology between these species (?) as well as in comparison to *L. absitum* are small and may eventually be considered unimportant. *Pseudowannerophyllum solidum* (Ross and Ross, 1962) with its radial arrangement of the rhopaloid major septa and thick columella is seemingly close to the species discussed. It differs first of all in its distinct generic characteristics and in having comparatively long cardinal septum, inconspicuous, long, not triangular cardinal fossula, and thick septotheca.

Occurrence. — Previous works: Texas, Graham Group, Lower Virgilian; USNM 704w:2 Gaptank Formation, U. Virgilian (?); 705k:1 Lenox Hills Formation; Kansas, Shawnee Group and Wabaunsee Group, Lower to Upper Virgilian; Oklahoma, Wabaunsee Group, Upper Virgilian; ? Venezuela Merida Andes, Permo-Carboniferous. Here described: Loc. USNM 705f:1, undivided Gaptank Formation; 701e:2, 701v:1, 705j:1, Gaptank Formation, *Uddenites*-bearing member, Lower Wolfcampian; 720b:13, Hueco Formation, Upper Wolfcampian.

Lophophyllidium (*Lophophyllidium*) *plummeri* JEFFORDS, 1947

(fig. 42: 1—5; pl. 11:14)

1921. *Lophophyllum profundum* PLUMMER and MOORE *non* EDWARDS and HAIME; F. B. PLUMMER and R. C. MOORE, p. 147, pl. 20:1, 2, 4, 5.
1947. *Lophophyllidium plummeri* JEFFORDS; R. M. JEFFORDS, p. 33, figs. 1, 5, 6; pls. 5:4; 7:2, 6, 7; 9:3—7; 10:2, 3; 11:1, 2, 5, 6.
? 1962. *Lophophyllidium* cf. *vidriensis* ROSS and ROSS; C. A. ROSS and J. P. ROSS, p. 1184, pl. 163:6.
1963. *Lophophyllidium solidum* ROSS and ROSS; J. P. ROSS and C. A. ROSS, pl. 48:9; *non* ROSS and ROSS, 1962.
non 1982. *Lophophyllidium plummeri* JEFFORDS; WU, W. S. and ZHOU, K. J., p. 222, pl. 2:22, 23.

Material. — Three incomplete specimens having well preserved internal structures and two specimens of Ross and Ross (1962, 1963).

Some characteristics of representative corallites (in mm):

USNM cat. nos.	n: d ratio	Thickness of septotheca
139773	30:16.3 × 15.7	2.5
196897	28:16.5 × 16.5	2.5
196896	34:26.5 × 22.2	4.5

Diagnosis. — *Lophophyllidium* (*Lophophyllidium*) having maximum n: d ratio at calice floor 34:24.5; compact columella incorporating many short septal lamellae in growth layers; septotheca moderately to very thick; symmetry radial; major septa rhopaloid.

Description. — Although the original description is fairly complete (JEFFORDS 1947:33, 34), the following description of the well preserved specimen is included to emphasize some extreme characteristics of the species, which may eventually be considered adequate for a new specific identification of such corals.

In the ontogenetically youngest preserved part of the corallite (fig. 42:1a), the thick, elongated columella is already well developed and contains a few septal lamellae. The counter septum joins the columella slightly laterally, and the middle lines of these two structures are separated. The several major septa are thickened to the lateral contiguity, except for the periphery of the corallite, where open interseptal loculi occur. The cardinal septum is longer than two pairs of the neighbouring major septa, but it does not reach the columella. The presence of the minor septa is uncertain, because the external surface is dissolved.

In the early ephebic portion of growth (fig. 42:1b, c), the columella is very thick showing the "*Khmerophyllum*" — kind of morphology, i. e. containing many short septal lamellae arranged concentrically in accordance to the growth layers (not marked on the picture). The major septa are rhopaloid and differentiated in length and in thickness. The shortened cardinal

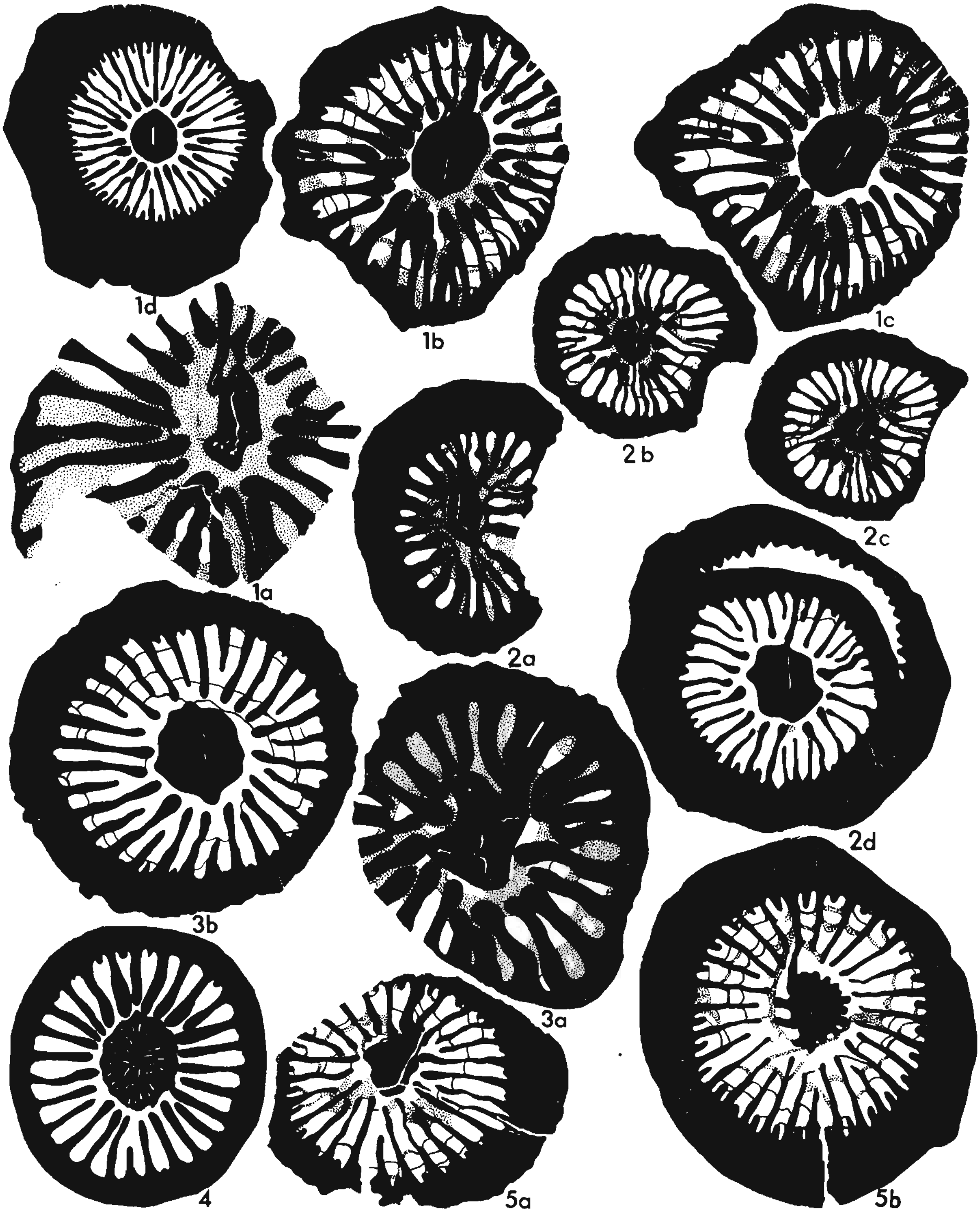

Fig. 42.

Lophophyllidium (*Lophophyllidium*) *plummeri* JEFFORDS, 1947. Transverse sections. 1. Specimen USNM 196896. Locality USNM 706x, Neal Ranch Formation; a — late neanic/early ephebic stage having dense stereoplasmic infillings, × 7; b, c — ephebic stage, × 3.5; d — lower part of calice, × 2.1. 2. Specimen USNM 196897. Locality and horizon as above. a — late neanic/early ephebic stage, × 7; b, c — ephebic stage, × 3.5; d — lower part of calice having shallow lateral rejuvenation, × 3.5. 3. Specimen USNM 139773 (= *L. solidum* Ross and Ross, 1963, pl. 48:9). Gaptank Formation, *Uddenites*-bearing member; a — early ephebic stage, × 7; b — ephebic stage × 3.5. 4. Specimen USNM 120853 (= *Lophophyllum profundum* M.-EDWARDS and HAIME, of GIRTY, 1915, pl. 2:1). Locality described as Station 2005, Oklahoma, Wewoka quadrangle, Wewoka Formation. Lower part of calice, × 3.5. 5. Specimen USNM 139742 (= *Lophophyllidium* cf. *L. vidriensis* Ross and Ross, 1962, pl. 163:6). Locality USNM 702h, Neal Ranch Formation; a, b — ephebic stage, × 3.5.

septum and the underdeveloped last pair of the major septa of the cardinal quadrants made the cardinal fossula crowded and inconspicuous. The counter septum remains in contact with the columella. The interrelation of these two elements and separation of their middle lines indicate the separate and independent growth of both these structures. The minor septa are already well developed, but the thick septotheca, characteristic of more advanced growth, is not yet present.

In the late maturity (fig. 42:1d; pl. 11:14), the major septa, distinctly rhopaloid and differentiated in length, come close to the columella, but only the counter septum joins its periphery. The slightly shortened cardinal septum is located in the hardly distinguishable, narrow, triangular cardinal fossula. The minor septa, reaching approximately one half the length of the major ones, are laterally contiguous with the latter to form a thick septotheca. They penetrate the corallite lumen only a little. The almost circular columella retains its "*Khmerophyllum*" — like morphology. The external, thickest layer of its growth is purely fibrous here (pl. 11:14).

In the middle of the calice, the columella remains circular in the outline, but the septal lamellae are elongated, extending almost the entire distance between the medial lamella and the periphery of the columella. The major septa are strongly differentiated in length and in thickness. The long ones remain rhopaloid, while the short ones are thin. The slightly reduced length and strongly reduced thickness of the counter septum, free from the columella, is notable. The axial ends of the minor septa are free.

Individual variation. — In spite of the small number of specimens discussed in this paper, they show variants similar to the type specimen on one hand (fig. 42:3a, b) and being different in several details from all other specimens of the species under consideration on the other. A single specimen from the same bed as that described above in detail (fig. 42:2a—d) differs from the latter and from all other specimens of this species in having the cardinal septum long up to the calice floor and only slightly shortened in the calice. The counter septum remains in contact with the columella up to the calice, which is in agreement with the morphology of the type material, but differs from other corallites of the collection here described. The latter have the counter septum tending to shorten a little just above the calice floor. The thickness of the septotheca increases in the geologically younger specimens, being the thickest in the corallite described above in detail (fig. 42:1d).

The corallite identified by Ross and Ross (1962) as *L.* cf. *vidriensis* (fig. 42:5a, b) was conditionally transferred here to *L. plummeri*. It differs from other corallites of this species in having the columella wavy in outline and composed of long, not numerous lamellae and in having the minor septa free in the corallite lumen. Sections of tabulae connected to one side of some of these septa indicate the unewen positions of peripheral parts of tabulae in these lumina.

Remarks. — JEFFORDS (1947:34) briefly discussed the difference between *L. plummeri* and his other new species *L. wewokanum* from the Desmoinesian of Oklahoma. The distinguishing characters he mentioned, i. e. the more elongated shape, fewer septa, and thicker cardinal septum in *L. plummeri*, will not make any substantial difference between these two groups of corals if the bilateral symmetry and different morphology of the columella in *L. wewokanum* were not considered. Even with the latter two distinguishing characters, the species discussed are morphologically very similar and hardly distinguishable from each other. Also, the Morrowan or Atokan *L. eastoni* MOORE and JEFFORDS, 1945 from Arkansas exhibits several similarities to *L. plummeri* in the morphology and thickness of the major septa, and the large columella. The main differences between these two species are in the morphology of the columella, built of superimposed layers of stereoplasm in *L. eastoni*, and in much shorter and nonrhopaloid major septa in that species.

Several characteristics of *L. plummeri*, and especially the radial arrangement of septa, the thick septotheca, and the very strong columella, are common to *L.* (*Lophbillidium*) *magnocolumnare* sp. n. The main distinguishing characters, in addition to the biform tabularium in the latter species, are: the long minor septa, the internal morphology of the columella, the long cardinal septum, and the concave axial tabularium.

Lophophyllidium plummeri of WU and ZHOU (1982) from the Asselian of China is here excluded from this species because of its short, nonrhopaloid major septa, thin external wall, and unknown morphology of the columella.

Occurrence. — Previous descriptions: Texas, Upper Graham Group, Middle Cisco (Virgilian) series; USNM 701p:1 Gaptank Formation, *Uddenites*-bearing member; ? USNM 702h:1, Neal Ranch Formation. Here described: USNM 706x:2, 712z:1, Neal Ranch Formation, Lower Wolfcampian.

Lophophyllidium (*Lophophyllidium*) *wewokanum* JEFFORDS, 1947

(fig. 43:1—4; pls. 12:17, 14:1, 2, 3, 6, 9)

e. p. 1915. *Lophophyllum profundum* Girty, *non* EDWARDS and HAIME, 1851; G. H. Girty, p. 19.
1947. *Lophophyllidium wewokanum* JEFFORDS; R. M. JEFFORDS, p. 24, figs. 5, 6; pls. 4:4—7; 7:5; 10:4, 5; 11:3.
1947. *Lophophyllidium coniforme* JEFFORDS; R. M. JEFFORDS, p. 28, figs. 1, 2, 4, 6; pls. 5:3, 5; 6:1—9; 7:1; 8:1; 11:4.
e. p. 1962. *Lophophyllidium solidum* Ross and Ross; C. A. Ross and J. P. Ross, p. 1182.

Material. — Six specimens having proximal ends and the internal morphology fairly well preserved, but without calices. A single corallite USNM 139784 included in *L. solidum* Ross and Ross, 1962 but not mentioned by those authors, was transferred here to the species discussed.

Diagnosis. — Bilateral *Lophophyllidium* having maximum n:d ratio at base of calice 32:16.5; cardinal septum very short in mature region; columella elongated, incorporates few lamellae; major septa thick, slightly rhopaloid; minor septa short.

Remarks. — JEFFORDS (1947:24—26) noted early shortening of the cardinal septum in ontogeny and separation of the columella from the counter septum in both his species synonymized in this paper. These characters, clearly shown in drawings on pl. 4:4—7, of that author (*L. wewokanum*), are much less obvious in *L. coniforme* (compare JEFFORDS 1947, pl. 6) and are not seen on the photographs of either of these species (JEFFORDS 1947, pls. 7:1,5; 11:3, 4), at least as far as the second of these characters is concerned. Also the specimens of the type collections of both species reexamined are rather variable in these characters. Such a variability prompted the synonymy above on one hand and identification of the specimens here discussed as *L. wewokanum* on the other. However, the cardinal septum is invariably long in early ontogeny of these corals (fig. 43:1a—c, 4a) and the counter septum meets the columella directly with the middle lines of these structures commonly united (pl. 14:1b, c, 2, 3, 6a). These extreme characters, together with larger dimensions, may result in future separation of such corallites as a new species. In addition to the characters mentioned, the specimens discussed in this paper differ from each other in the following minor characters: the columella may be monoseptal up to early maturity (pl. 14:2) only in the neanic stage (pl. 14:6a, b), or may incorporate some septal lamellae as early as this stage (pl. 14:1a); it is always elongated and most commonly solid, but a single specimen shows its perforation in some sections of the mature part of growth (pl. 14:1b), also the differentiation in length of the major septa and their rhopaloid character may be more or less clearly demonstrated (pl. 14; figs. 1b, c, 2, 6a).

From the GIRTY's (1915) collection, I was able to restudy only two specimens, illustrated by that author on pl 2:1, 6 and identified by him as *Lophophyllum profundum* EDWARDS and HAIME, 1851. Only one of them (fig. 43:2 in this paper) shows all characters attributed to *L. wewokanum* by JEFFORDS (1947) and resembles closely both the type collection and the specimens here described. The second one with radial symmetry and nonrhopaloid or very weakly rhopaloid major septa and free, rounded, complex columella composed of few radially arranged, long lamellae, is different. Both of GIRTY's specimens have comparatively thick septotheca. The

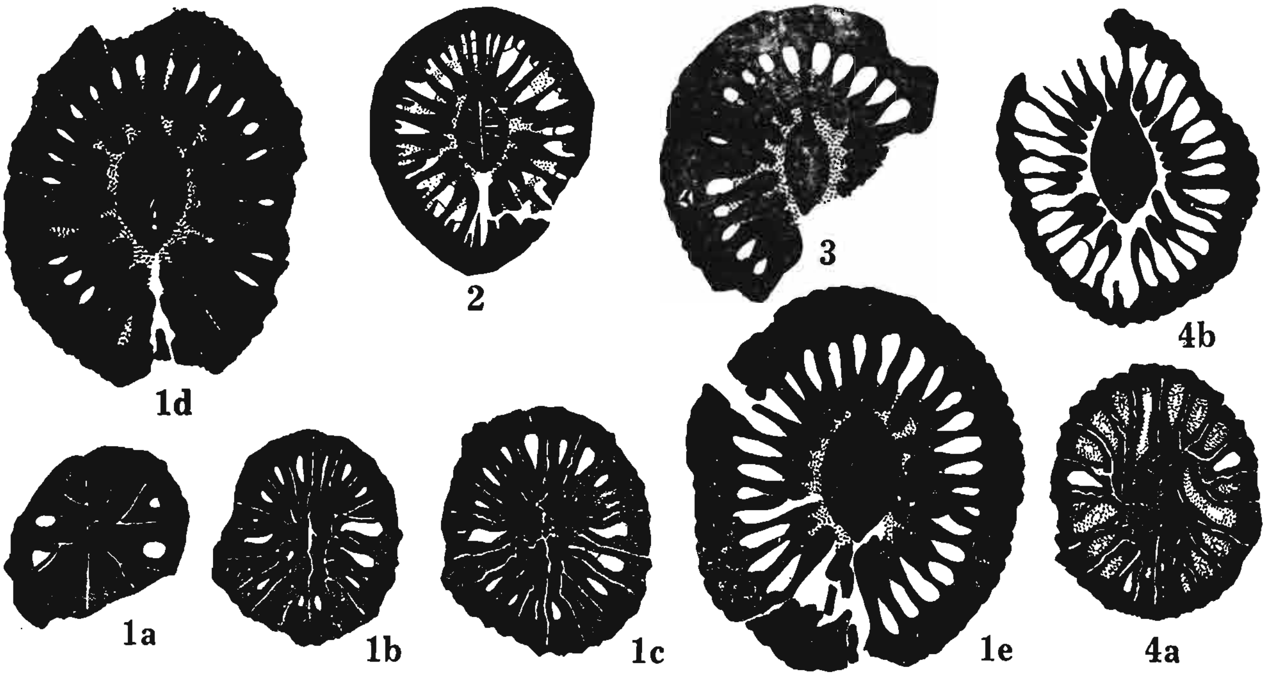

Fig. 43.
Lophophyllidium (*Lophophyllidium*) *wewokanum* JEFFORDS, 1947. Transverse sections. 1. Specimen USNM 196898. Locality USNM 701u, Gaptank Formation, *Uddenites* bearing member; a — early neanic stage, × 10; b — late neanic stage, × 5; c — late neanic/early ephebic stage, × 5; d, e — ephebic stage, × 3. 2. Specimen USNM 120858 (= *Lophophyllum profundum* M.-EDWARDS and HAIME of GIRTY, 1915, pl. 2:6). Locality described as Station 2006, Oklahoma, Wewoka quadrangle, Wewoka Formation. Ephebic stage, × 3. 3. Specimen USNM 196899. Locality USNM 701u, Gaptank Formation, *Uddenites* bearing member; a — late neanic/early ephebic stage, × 5; b — lower part of calice, × 3.

morphology of the second one is more similar to that of *L. plummeri* JEFFORDS, 1947, except for the morphology of the columella and the nonrhopaloid major septa.

The obvious similarity of *L. wewokanum* to *L. plummeri* JEFFORDS, 1947 is discussed together with the latter. *L. magnificum* JEFFORDS, 1942 from Desmoinesian of Oklahoma, similar to *L. wewokanum* in the bilateral arrangement of major septa and the morphology of the columella, differs from it in having the counter septum shortened in the calice, the external wall thin, the minor septa long in maturity, the major septa thin, and the stereocolumn disappearing early in ontogeny.

Occurrence. — Previous descriptions: Oklahoma, Wewoka Formation, Desmoinesian; Oklahoma, Kansas, Lansing and Pedee groups, Missourian; Texas, USNM 701p:1, Gaptank Formation, *Uddenites*-bearing member. Here described: USNM 701u:2 Gaptank Formation, *Uddenites*-bearing member; 705f:2 Gaptank Formation, with *Triticites joensis* Thompson, possibly Virgilian; ? 708n:1 Gaptank Formation with *Triticites burgessae* Burma, possibly Virgilian;? 706x:1, Neal Ranch Formation.

Lophophyllidium (*Lophophyllidium*) cf. *confertum* JEFFORDS, 1942

(fig. 44:5—7; pl. 14:5, 8)

e. p. 1915. *Lophophyllum distortum* WORTHEN; G. H. GIRTY, p. 318; fig. 37:5 in this paper.
e. p. 1962. *Lophophyllidium solidum* Ross and Ross; C. A. Ross and J. P. Ross, p. 1182.

Material. — Six slightly silicified specimens. Most of them have proximal ends and calice floors preserved. External surfaces often a little abraded. Internal structure well preserved.

A single nonillustrated specimen USNM 139740 identified by Ross and Ross (1962) as *L. solidum* is here transferred to group of specimens discussed.

N:d ratio at calice floor (in mm):

USNM cat. nos.	n:d ratio
196904	32:10.1 × 9.1
196905	31:11.0 × 10.2
139740	30:11.2 × 10.4
196906	29:10.7 × 7.7

Description. — The specimens are horn-shaped, with the cardinal septum located either strictly on their convex side or slightly laterally. The corallite surface, if well preserved, bears distinct septal furrows. In the single well preserved corallite the furrows adjacent to the cardinal septum are especially well developed. Small attachment flattenings are present at apical regions of some specimens. The arrangement of major septa is bilateral, but the outline of the corallites

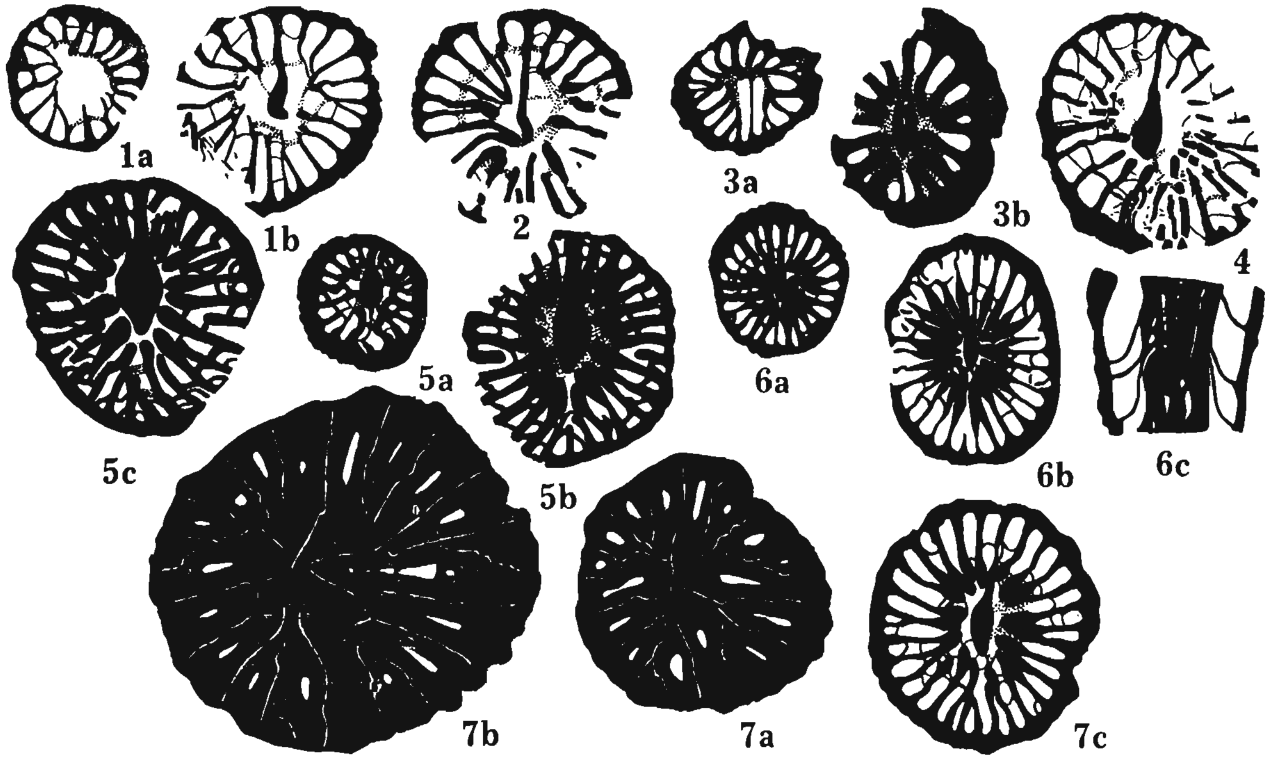

Fig. 44.
Lophophyllidium (*Lophophyllidium*) *skinneri* Ross and Ross, 1962. Transverse sections. 1. Specimen USNM 139744 (= Ross and Ross, 1962, pl. 162:18). Locality USNM 705ca, Lenox Hills Formation; a — late neanic (?) stage; b — early ephebic stage. Both, × 5. 2. Specimen USNM 139745 (= Ross and Ross, 1962, pl. 162:19). Locality and horizon as above. Early ephebic stage, × 5. 3. Specimen USNM 139746 (= Ross and Ross, 1962, pl. 162:17). Locality and horizon as above; a — late neanic stage; b — early ephebic stage. Both, × 5. 4. Specimen USNM 196903. Locality USNM 702t, Neal Ranch Formation, ephebic stage, × 5. *Lophophyllidium* (*Lophophyllidium*) cf. *confertum* Jeffords, 1942. 5. Specimen USNM 139740 (= *L. solidum* Ross and Ross, 1962, unillustrated). Locality USNM 705v, Gaptank Formation, uppermost shale of *Uddenites* bearing member; a—c — cross sections, early to late ephebic stage, × 3. 6. Specimen USNM 196906. Locality USNM 705f, Gaptank Formation, undivided; a, b — transverse sections, early and late ephebic stage, × 3; c — longitudinal section, × 3. 7. Specimen USNM 196905. Locality and horizon as above. Transverse sections; a, b, — neanic stage, × 10; c — ephebic stage, × 3.

is only slightly elongated in the cardinal-counter septa plan (pl. 14:5, 8c). The major septa in the transverse sections made just beneath a calice floor (fig. 44:6b, 7c; pl. 14:8c) are long, distinctly rhopaloid, and differentiated in length. Some of them reach or come very close to the elongated, monoseptal, more or less thickened columella, directly united with the elongated counter septum. Middle lines of these structures are mostly united. The thin cardinal septum crosses approximately one half or less of the narrow, triangular cardinal fossula bordered by two pairs of successively shorter major septa (fig. 44:5b, c, 7c). The minor septa are not seen even in the structure of the external wall, but their furrows are as distinct as those of the major septa. The early growth stage (fig. 44:7a, b; pl. 14:8a, b) is typical for the genus and will not be described in detail.

Remarks. — The group of corals discussed has not been described as an independent species for the reasons mentioned in the discussion of the genus and because of being represented by too few specimens, derived in majority from locality, whose exact stratigraphic position is a little doubtful. They differ from *L. confertum* JEFFORDS, 1942 first of all in n: d ratio, having a much larger number of septa at a given diameter of corallites. Less rhopaloid or nonrhopaloid major septa in maturity and much better developed minor septa are additional differences.

L. skinneri Ross and Ross, 1962, represented in the original collection by seven immature and badly preserved corallites differentiated in morphology, is a doubtful taxon, rather difficult to use. The existing thin section of the uppermost part of the holotype, schematically drawn by Ross and Ross (1962, fig. 10, right specimen) showing similar character and the arrangement of the major septa, to the specimens discussed, differs from them in having a long cardinal septum, distinct minor septa, and a different n: d ratio.

Occurrence. — USNM loc. 705j:1, Gaptank Formation, *Uddenites*-bearing member; 705F:5, Gaptank Formation, beds with *Triticites joensis* Thompson, possibly Virgilian.

Lophophyllidium (*Lophophyllidium*) *skinneri* Ross and Ross, 1962

(fig. 44:1—4; pl. 14:4, 7)

1962. *Lophophyllidium skinneri* Ross and Ross; C. A. Ross and J. P. Ross, p. 1184, fig. 10; pl. 162:17—20.

Remarks. — The specimens grouped by Ross and Ross (1962) under the common specific name are all rather poorly preserved and possibly immature specimens. I located all five paratypes in the collection but I did not found the holotype. The existing specimens differ in morphology from each other (fig. 44:1—3, pl. 14:4) and from the picture of the holotype (Ross and Ross, 1962, fig. 10). Two of them are partly destroyed and were not illustrated.

From the collection under study there was only a single specimen (fig. 44:4; pl. 14:7) that can be compared to the picture of the holotype. It was temporarily included in this species because it can not be located in any other taxonomic unit. With all this, the "species" discussed should be treated as a temporary, artificial taxon, not recommended for use until its true characteristics are established on well preserved and adequately studied topotype material.

Occurrence. — Previous description: Texas, USNM 705ca, Lenox Hills Formation. Here described: USNM 702t:1, Neal Ranch Formation, Lower Wolfcampian.

Lophophyllidium (*Lophophyllidium*) sp.

(pl. 14:13a—c)

Material. — A single, almost complete corallite having n:d ratio at the calice margin 24:7,6.

Description. — The corallite is ceratoid, nearly cylindrical in shape, with an almost smooth external surface. The calice margin bears equally developed foundations of major and minor septa. The minor septa are not distinct, but they appear in the corallite lumen fairly early in ontogeny (pl. 14:13a). The major septa in the upper portion of the calice are radially arranged,

TABLE 9

Morphologically-comparative table of species of the subgenus *Lophbillidium* FEDOROWSKI, 1986 described in this paper

Name of species	Shape of calice	Major septa	Minor septa	Cardinal septum	Counter septum	Columella	Tabularium	N: d ratio
Lophbillidum cyathaxoniaforme sp. n.	1/2—1/4 of corallite length, narrow, crawded	Straight, smooth, thick, equal in length; in calice free, beneath reach columella	In calice free, beneath reach inner ends of major septa; contratingent	As long as other major septa	Keep contact with columella up to lower part of calice; often thickened	May incorporate 1—2 lamellae, thick, wavy in outline, very high	In Position I tabulae densely spaced, downsloping; in II steeply uprising	16:5.5 to 19:7.1
Lophbillidium erugum sp. n.	As above, but minor septa absent	”	In calices absent; beneath may occasionally occur	”	”	Monoseptal, thick, rounded in outline	Biformity hardly recognizable; tabulae nearly horizontal in axial portions	15:7.2 to 17:5.2
Lophbillidium magnocolumnare sp. n.	1/2—1/3 of corallite length, fairly crawded	Straight, smooth, thick, slightly elongated on calice floor; beneath rhopaloid, almost reach columella	In calice free; in maturity often short; in neanic stage contratingent	Varies in length; may be slightly shortened	Often thicker than other septa; commonly reach columella laterally	Incorporates 1 to several lamellae, wavy in outline, very high	Biformity weakly developed; axial parts of tabulae concave	21:9.2 to 30:19.0
Lophbillidium sp. 1	?	Thin, radially arranged; some slightly rhopaloid; do not reach columella	Short, free	Slightly shortened	Either free or reaches only surface of columella	Wavy in outline, incorporates several coarse lamellae	In Position I tabulae horizontal; in II steeply uprising	24:10.5 to 30:13.5
Lophbillidium? sp. 2	1/2—1/4 ? of corallite length, fairly empty	In calice elongated only on floor; beneath differentiated in length; some slightly rhopaloid	”	Shortened; in triangular fossula	Thicker than other major septa; reach columella, often laterally	Incorporates many, mainly very short lamellae; almost circular in outline	Biformity indistinct (absent?) Tabular cardinal fossula occur	24:8.5 to 25:9.2

almost equal in length with the slightly elongated counter septum. This elongation is more distinct lower in the calice where the arrangement of the major septa is nearly pinnate. The cardinal septum is not shortened either in the calice or beneath it (pl. 14:13c), but the cardinal tabular fossula may be distinguished in the last portion of growth mentioned due to the arrangement of sections of tabulae. The arrangement of major septa is radial in this part of the specimen. A true columella is not formed, but the counter septum, slightly thickened axially, is elongated so as to almost reach the cardinal septum. In the early growth stage (pl. 14:13a, b), the cardinal, counter and, on the earliest growth stage, also the alar septa are united by their middle lines. The counter septum is slightly thicker than other major septa.

Remarks. — The arrangement of the major septa in early ontogeny and the long-lasting union of the cardinal and counter septa are not typical fo' *Lophophyllidium.* This is also true for the permanently long cardinal septum and the smooth external surface of the corallite.

Occurrence. — USNM 721:1, Lower Hueco Formation, Wolfcampian.

Subgenus *L.* (*Lophbillidium*) FEDOROWSKI, 1986

Type species: Lophophyllidium elongatum WANG, 1947

Diagnosis. — Like *Lophophyllidium* but with biform tabularium, after FEDOROWSKI, 1986.

Remarks. — The American species described in this paper from two extremities as compared to the Timor Island species. *L.* (*L.*) *cyathaxoniaforme* sp. n. developed extraordinarily long minor septa, while *L.* (*L.*) *erugum* sp. n. reduced them completely from the corallite lumen, resembling several species of the nominative subgenus.

Lophophyllidium (*Lophbillidium*) *cyathaxoniaforme* sp. n.

(figs. 45, 46; pls. 15:3, 4, 7—9, 11—18; 16:1, 2, 4—6)

Holotype: Specimen USNM 196912, fig. 45:1a—d; pl. 16:5a, b.
Type locality: USNM 7221.
Type horizon: Skinner Ranch Formation, Sullivan Peak member.
Derivation of the name: after superficial similarity to the genus *Cyathaxonia* MICHELIN, 1846.

Material. — Over 60 more or less deeply silicified corallites, many of them with calices and/or proximal ends preserved. Internal structures entirely or in part calcitic.

N:d ratio of representative corallites (in mm):

USNM cat. nos.	N:d ratio	Remarks
196917	16:5.5	calice margin
„	14:4.5	just beneath calice
196921	16:7.0	calice margin
„	16:6.0	„ floor
196926	16:8.8	„ „
196912	17:6.5	„ „
196919	17:6.5	„ margin
„	16:5.5	„ floor
196914	17:6.6	„ margin
„	17:6.0	„ floor
196930	17:6.7	„ margin
„	16:5.5	„ floor
196915	19:7.1	„ margin
„	18:6.3	„ floor
„	17:5.3	just beneath calice

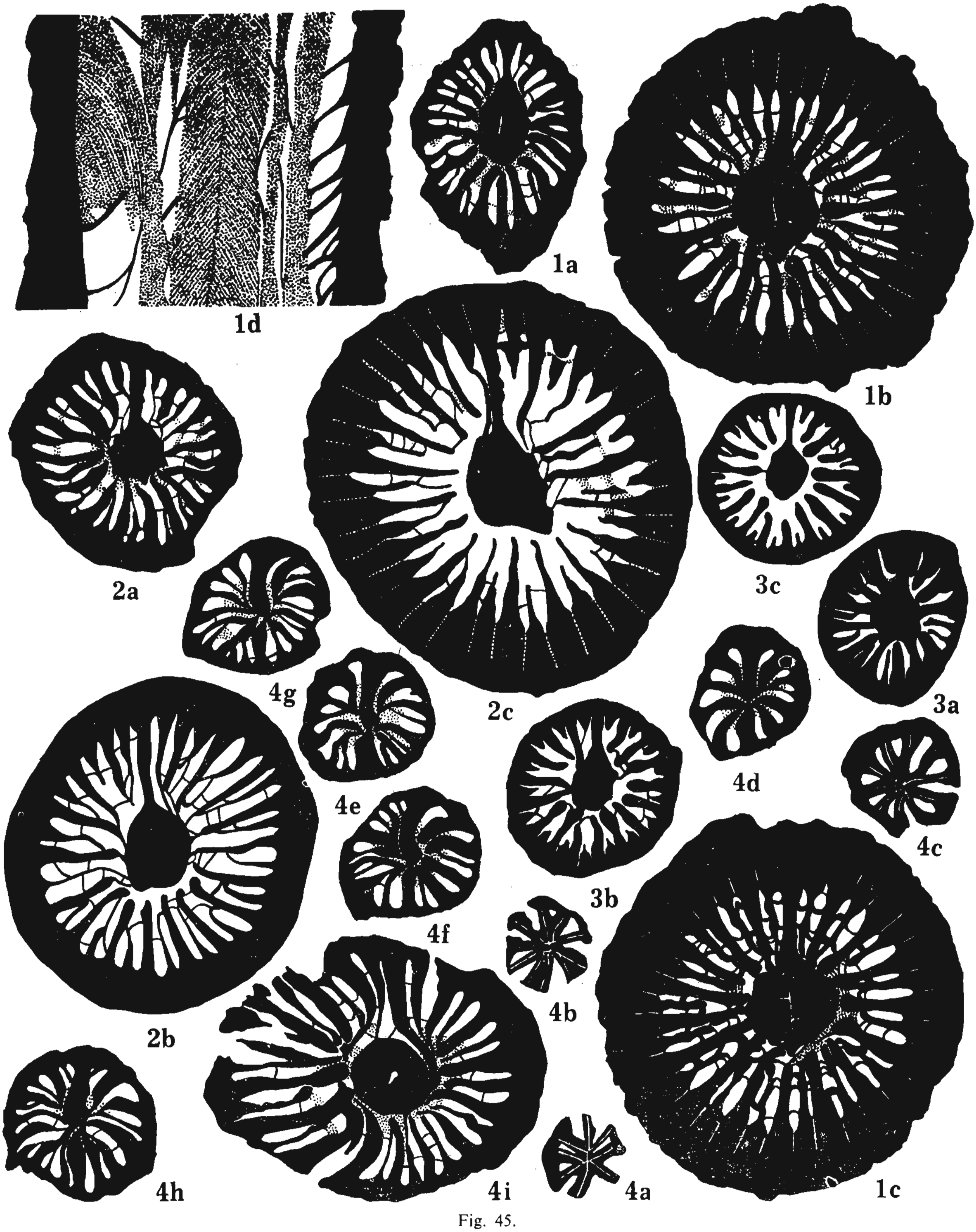

Fig. 45.

Lophophyllidium (*Lophbillidium*) *cyathaxoniaforme* sp. n. 1. Specimen USNM 196912. Holotype. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member; a — transverse section, early ephebic stage; b, c — transverse sections, ephebic stage, d — longitudinal section. All, ×10. 2. Specimen USNM 196913. Locality USNM 720f. Lower Skinner Ranch Formation; a—c — transverse sections, early to late ephebic stage, ×10. 3. Specimen USNM 196914. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Transverse sections; a, b — ephebic stage; c — just above calice floor. All ×5. 4. Specimen USNM 196915. Locality and horizon as above. Transverse sections; a—d — early to late neanic stage; e—h — late neanic/early ephebic stage; i — ephebic stage. All, ×10.

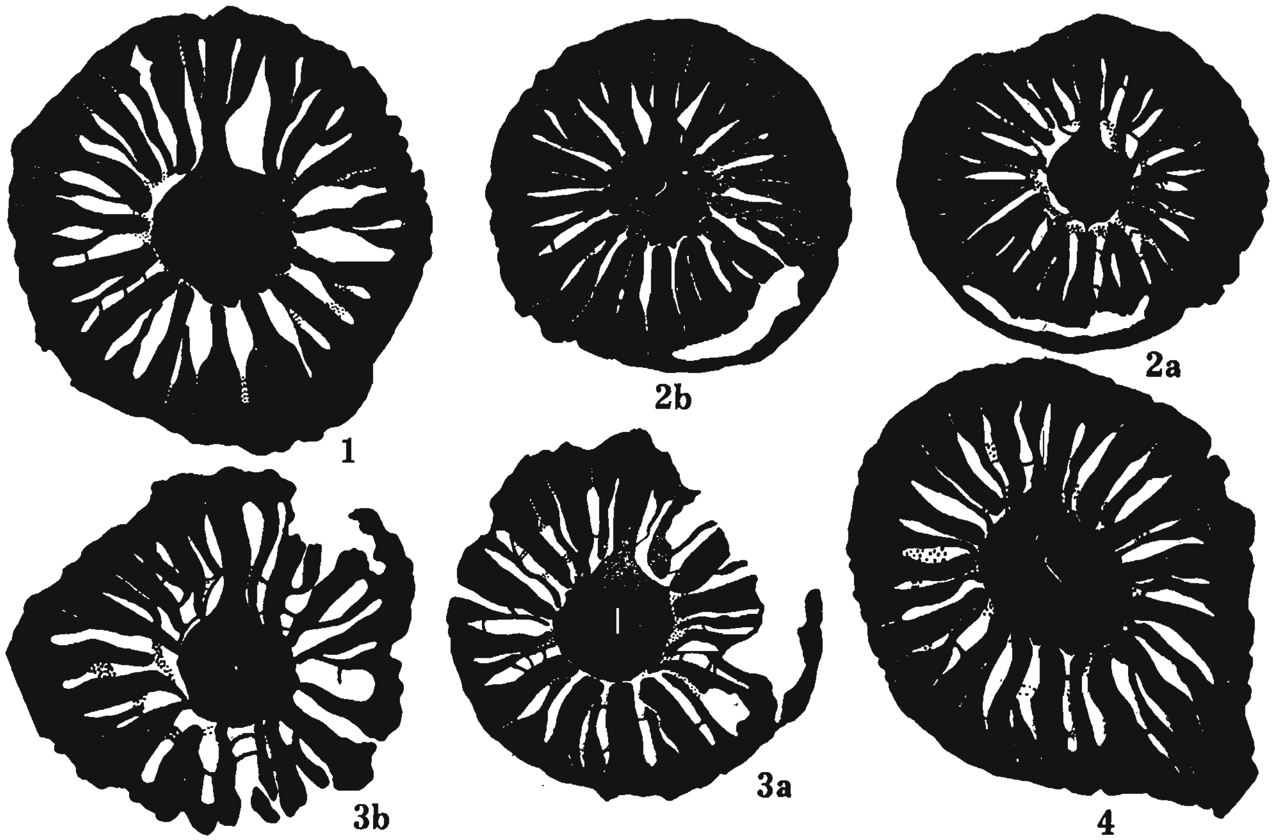

Fig. 46.

Lophophyllidium (*Lophbillidium*) *cyathaxoniaforme* sp. n. 1. Specimen USNM 196916. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Slightly schematized transverse section, ephebic stage, × 10. 2. Specimen USNM 196917. Locality and horizon as above; a, b — transverse sections, ephebic stage, × 10. 3. Specimen USNM 196918. Locality and horizon as above; a, b — transverse sections, ephebic stage, × 10. 4. Specimen USNM 196919. Locality and horizon as above. Transverse section, ephebic stage, × 10.

Diagnosis. — *Lophophyllidium* (*Lophbillidium*) having typical n:d ratio 16:5.5 to 17:6.6 at calice margin; major septa long, reaching large columella; cardinal septum not shortened; minor septa long, contratingent.

Description of the holotype — The calice of the specimen was broken away in its upper portion. The morphology of the almost cylindrical, mature part of the corallite does not change in any important detail (fig. 45:1b, c: pl. 16:5a). Major septa are all long and, except for the counter septum, are almost equal in thickness, possessing a peripheral septotheca forming widened portions. Most of them are in contact with the columella, but none penetrates its interior. The cardinal septum is distinguishable only by the arrangement of the minor septa. The latter are contratingent, very long, reaching the major septa near the ends of the latter. Some of them are so long as to reach the columella. The latter is very large, almost circular in the outline. Its microstructure is similar to that of the genus *Cyathaxonia* MICHELIN, 1846, i. e. it shows only a short middle line outlined by concentric growth lines (pl. 16:5a). In a single section of the corallite (pl. 16:5b), two short septal lamellae are seen in its innermost part. The microstructure described suggests the half-independent growth of the columella, and indeed, the middle line of the counter septum ends at the boundary of the columella (pl. 16:5b, lower). Observations in calices (see below) explained such a relation clearly.

In the ontogenetically youngest known portion of the corallite (fig. 45:1a), the simple columella is oval in shape. The major septa reach it directly as in the mature portion, but the minor septa are differentiated in length, with several being comparatively short.

The arrangement of tabulae in the longitudinal section is clearly biform. In Position I, all tabellae are fairly densely but regularly spaced and are directed obliquely downwards (fig, 45:1 d, right side). Tabulae in Position II are directed obliquely upwards, sometimes very steeply. The columella shows steeply domed, abaxial growth lines (fig. 45:1 d).

External characters of specimens. — Corallites are elongated, commonly slightly curved, sometimes horn-shaped or irregular. External surfaces of the well preserved corallites are almost smooth, with very delicate growth striae (pl. 15: 18a). Septal furrows are hardly seen or absent. Most of the corallites possess attachment processes developed on the concave side. They may last for as long as up to 2/3 of a corallite growth. Strong talons or larger attachment surfaces are not present except for the lowermost parts of some young specimens. Calices of the more completely developed corallites are 10—14 mm deep, occupying 1/2—1/4 of the corallite length. The calice margins are externally smooth. The inner marginal zone of them, 1.2—2.0 mm wide, is occupied by the regular, almost hemisphaerical, densely packed foundations of indistinguishable major and minor septa (pl. 15: 12a, 15a, 18b). Along the next 1—2 mm of depth of calices, i. e. in their intermediate zone, the foundations of septa became laterally flattened and differentiated in length into major and minor septa. The latter became successively but slightly, elongated and inclined towards the major septa near the calice floor, to become eventually contratingent (pl. 15:14b). The major septa possess their inner margin oblique in the intermediate zone of calices and almost vertical in their inner zone. All of them but the counter septum are equal in length, coming very close to or joining the columella without being incorporated in the latter. The counter septum keeps direct contact with the columella much longer than other major septa (pl. 15:12a), which is then reflected by a common outline of both these structural elements in the transverse section (pl. 16:1 a, b). Individual parts of a columella differ in shape. Those completely developed, i. e. located deeper in calices and met by counter septa, are thick, rod-like and sometimes wavy in outline (pls. 15:12a, 18b; 16:1a, 4a, 5b). Their upper parts may sometimes be flattened in the cardinal-counter septa plane. In most of the corallites observed, the columellae protruded up to the intermediate zones of calices, but in some they are restricted to their deeper parts. In the latter case they are also thinner and may be considered either underdeveloped (pl. 15:7a, b, 8, 9a, b) or rudimentary because they were thick in earlier growth stages (fig. 45:4a—i).

Ontogeny. — The ontogenetically youngest corallite present within the collection possesses the n:d ratio of 12:2.2 at the calice margin (pl. 15:3a). The calice occupies more than 1/3 of the corallite length. Its morphology is slightly deformed due to lateral curvature of the corallite and its attachment to another corallite (pl. 15:3b, upper small corallite). The elongated cardinal septum reaches the counter septum that already formed an incipient stage of columella. The counter-lateral major septa are slightly shorter than the other major septa in counter quadrants. In the cardinal quadrants, the pair of major septa adjacent to the cardinal septum is underdeveloped. The minor septa not yet fully developed, are seen only in some loculi. The morphology described corresponds with the stage of growth illustrated on fig. 45:4e, f, except for the thickness of the counter septum. The morphology of only a little larger specimen with: n: d ratio at the calice margin 11:2.6 (pl. 15:7a, b) is characterized by a well developed columella and minor septa seen in all septal loculi. Several of them are already contratingent at the calice floor. The development of the columella may vary, however (pl. 16:16a). Further ontogeny, different in small details, leads towards an increase of height and thickness of the columella and an elongation of the minor septa.

Deeply silicified tips restricted investigation of ontogeny in sections, but serial thin sections of the best preserved specimen (fig. 45:4a—i) confirms observations in calices. The zaphrentoid early ontogeny, with minor septa absent from the corallite lumen, is of the kind observed in the type species of *Lophbillidium* (FEDOROWSKI, 1986: 214). The columella is formed by the counter septum that began to dominate in thickness first (fig. 45:4d) and then became rhopaloid (fig. 45: 4e—h). The cardinal septum remains in touch with that rhopaloid end of the counter septum. The minor septa appeared in the corallite lumen fairly late in ontogeny and are at first present in some loculi only (fig. 45:4e). Their length increases in the course of growth of the corallite up to the length of major septa in some loculi (fig. 45:4f—i).

Individual variability. — The species described is rather constant in its diagnostic characters (figs. 45:2—4; 46:1—4). Only two corallites differ more distinctly from the average as far as either the diameter or the number of septa is concerned (see table). Most of specimens are in this respect very close to one another. Small differences in length of major septa, that may not reach the columella in some specimens (fig 45:2b; pl. 16:1b, 6c), is often only temporary (pl. 16:1a, b). Rare specimens have minor septa slightly shortened in the upper portions of growth (fig. 45: 3b, c). Shape of the columella is individualized, but it is only seldom and temporarily elongated (fig. 46:4; pl. 16:2, 6b, c). In rare cases, it may incorporate 1—2 short septal lamellae (pl. 16: 5b, 6b, c). Much more commonly, the individual calcitic fibres grew peripherally from the common centre of calcification or from short medial lamella (pl. 16:2, 4a, b, 5a, 7). The more or less distinct elevation of columellae in calices is the next small individual variant (pl. 15:4a, 8, 9b, 11b, 12a, 13, 15a, 16a, 18b).

Remarks. — The long, contratingent minor septa clearly separate the new species from all the described species of this genus and subgenus. Only the short-septal variant mentioned above exhibits some similarity to the Timor Island species. It may be at the same time indicative of the close relation of *L.* (*L.*) *cyathaxoniaforme* sp. n. and *L.* (*L.*) *erugum* sp. n. The rounded columella, exposed high in calices is one of the most spectacular characters in common for all species of *Lophbillidium* described so far. The striking similarity of the mature portions of specimens of the species described to the genus *Cyathaxonia* MICHELIN, 1846 suggests searching for the related species among the taxa described from the Upper Carboniferous and Permian under the latter name and not fully investigated.

Occurrence. — USNM 721:2, Hueco Formation, 707b:4, 707d:4, 7221:53, 727f:9, Skinner Ranch Formation, Sullivan Peak member, Upper Wolfcampian.

Lophophyllidium (*Lophbillidium*) *erugum* sp. n.

(fig. 47; pls. 15:5, 6, 10; 16:3; 17:1—4)

Holotype: Specimen USNM 196931, fig. 47:1a—c; pls. 16:3a, b; 17:1a, b.
Type locality: USNM 7221.
Type horizon: Skinner Ranch Formation, Sullivan Peak member, Upper Wolfcampian.
Derivation of name: lat. *erugo* — to smooth — after smooth septal loculi between major septa.

Material. — 13 silicified corallites, only 4 of which are mature. Majority of corallites are incomplete, but calices are often preserved at least in part.

N: d ratio of representative specimens (in mm):

USNM cat. nos.	n: d ratio	Remarks
196931	17:5.2	calice margin
196938	16:5.5	„ „
196937	15:7.2	„ „

Diagnosis. — *Lophbillidium* having typical n: d ratio 17:5.2 and minor septa absent in corallite lumen and calice margin.

Description of the holotype. — The specimen is horn-shaped, with the attachment surface developed approximately 3 mm above the apex (pl. 17:16). The epitheca is damaged, and only the deepest narrowings are seen on the corallite surface. The deep calice occupies over 1/3 of the corallite length. Its fragmentary preserved, narrow inner margin bears only wide and flat foundations of major septa (pl. 17:1a, left side). Minor septa are weakly developed in some loculi of the inner zone of the calice (pl. 17:1a, lower part). They are never prominent or contratingent. The columella protrudes to the marginal zone of the calice. The radially arranged blades of major septa that started close to the calice margin are oblique in the intermediate and vertical in the inner zone of the calice, having their inner ridges smooth and coming close to the columella.

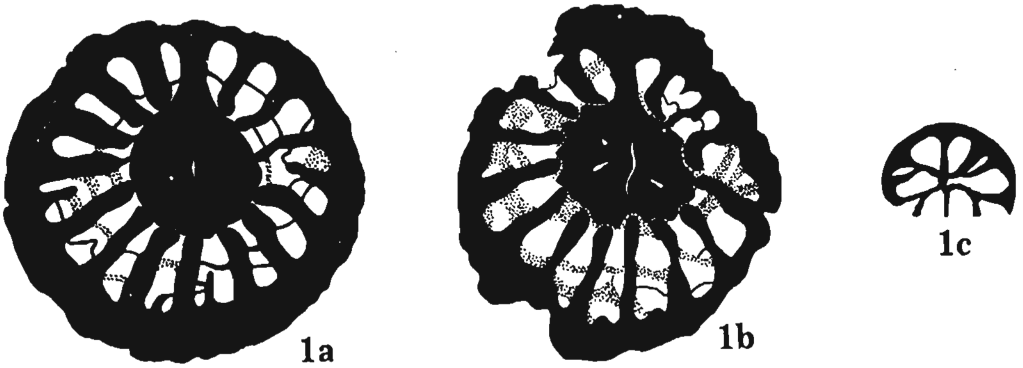

Fig. 47.
Lophophyllidium (*Lophbillidium*) *erugum* sp. n. Specimen USNM 196931. Holotype. Locality USNM 7221. Skinner Ranch Formation, Sullivan Peak member. Transverse sections; a, b — ephebic stage; columella incorporates a few septal lamellae in its younger portion; c — neanic stage. All, × 10.

In the transverse section made just beneath the calice (fig. 47:1a), almost all major septa are equally long, reaching the large, monoseptal columella, which is circular in the outline. The cardinal septum is indistinguishable by length, but its position is marked by the underdeveloped last pair of major septa of the cardinal quadrants. Also, the last pair of the major septa of the counter quadrants is underdeveloped. The counter septum is a little thicker than other major septa. Short, free minor septa are present in one or two septal loculi. The ontogenetically slightly younger section (fig. 47:1b; pl. 16:3a) shows a similar morphology, except for an absence of the underdeveloped minor septa that have not yet been inserted. The irregular columella may contain a few short septal lamellae (pl. 16:3b). The youngest part of the corallite preserved, 1.8 mm in the maximum diameter, shows 10 major septa. The arrangement of them is zaphrentoid, with six septa united in the periaxial part of the corallite (fig. 47:1c, schematized).

A longitudinal section was not prepared either from the holotype or from paratypes. The partly broken specimen (pl. 15:10) shows tabulae almost regularly spaced, rising obliquely upwards in their peripheral parts and nearly horizontal axially. A possible presence of the biform tabularium can be read from the arrangement of tabulae in the peripheral part of the cross section of the holotype (pl. 16:3a). A biform differentiation of them may be only slight, which is also the case observed in other genera of the short septal species (e. g. *P.* (*Vacoea*) *amplexoides* sp. n.). The biformity of the tabularium is best seen on the rejuvenated floor of the calice of another specimen (pl. 15:5).

Individual variation. — The species discussed is rather constant in morphology, although dimensions of individual mature corallites and their n:d ratios differ to some extent (see table). Larger or smaller columellae and their higher or lower protuberance in calices (pls. 15:5, 6; 17:3, 4); major septa slightly more or less elongated in calices; and the larger or smaller number of minor septa seen in the individual corallite lumens beneath calices are the main differences observed. None of them influenced strongly the general morphology of corallites. Also, calices of the mature corallites (e. g. pl. 17:4), and especially the morphology of their margins, do not differ from that in the holotype. The small calices (e. g. pls. 15:6; 17:3) are morphologically very similar to the larger ones, although their dimensions and number of septa indicate their immature stage of development.

Remarks. — Only a single character separates the species discussed from *L.* (*L.*) *cyathaxoniaforme* sp. n., i. e. the underdeveloped minor septa. This difference appears early in ontogeny, is constant, and concerns not only the floors of calices, but also their margins. Absence of foundations of minor septa in that part of a calice is very rare in the Rugosa in the collection under discussion and should thus be considered important. Also, the species from Timor Island although not so long-septal as *L.* (*L.*) *cyathaxoniaforme* sp. n., have minor septa always well developed. Much weaker accentuation of biformity of the tabularium is only a natural consequence of the underdevelopment of the minor septa.

Occurrence. — USNM 7221:12, Skinner Ranch Formation, Sullivan Peak member; 725c:1 Lower Bone Spring Formation, ? 721A:1 Hueco Formation, Upper Wolfcampian.

Lophophyllidium (*Lophbillidium*) *magnocolumnare* sp. n.

fig. 48; pls. 17:5—9, 11; 18:1—5

Holotype: Specimen USNM 196939, 48:1a—h; pls. 17:5a, b; 18:5a—e.
Type locality: USNM 705a.
Type horizon: *Scacchinella* Zone, Lower Skinner Ranch Formation.
Derivation of the name: after very large columella.

Material. — More than 50 silicified specimens. Calices are commonly preserved, although some septa are damaged in several of them. The proximal ends are always coarsly silicified when present.

N: d ratio of representative corallites in mm:

USNM cat. nos.	N:d ratio	Remarks
196944	21: 9.2× 9.2	calice margin juvenile
196940	22: 8.8× 8.0	calice margin juvenile
196941	23: 9.3× 9.0	calice margin juvenile
„	23: 8.8× 8.8	just beneath calice
196943	24:12.2×11.6	just beneath calice
„	23:10.4× 9.2	lower part of corallite
196945	25:14.2×12.4	calice margin
196939	28:20.0×15.2	near calice margin
„	28:15.8×14.9	just beneath calice
„	26:14.1×12.8	middle part of corallite
196942	29:17.3×16.1	calice margin
„	28:14.9×14.3	just beneath calice

Diagnosis. — *Lophbillidium* having n:d ratio up to 30:19; major septa rhopaloid, radially arranged; minor septa moderately long; columella thick, complex; external surface almost smooth; tabulae concave axially.

External characters. — (pl. 17:5b, 6b, 7b, 8b, 9b). Corallites increased their diameter slowly, becoming conico-cylindrical and almost cylindrical in shape. All better preserved specimens bear well developed attachment processes and/or attachment surfaces with flat talons, which may occupy over 2/3 of length of some of them. These parts of corallites are always curved, commonly in the cardinal-counter septa symmetry plane, with the cardinal septum

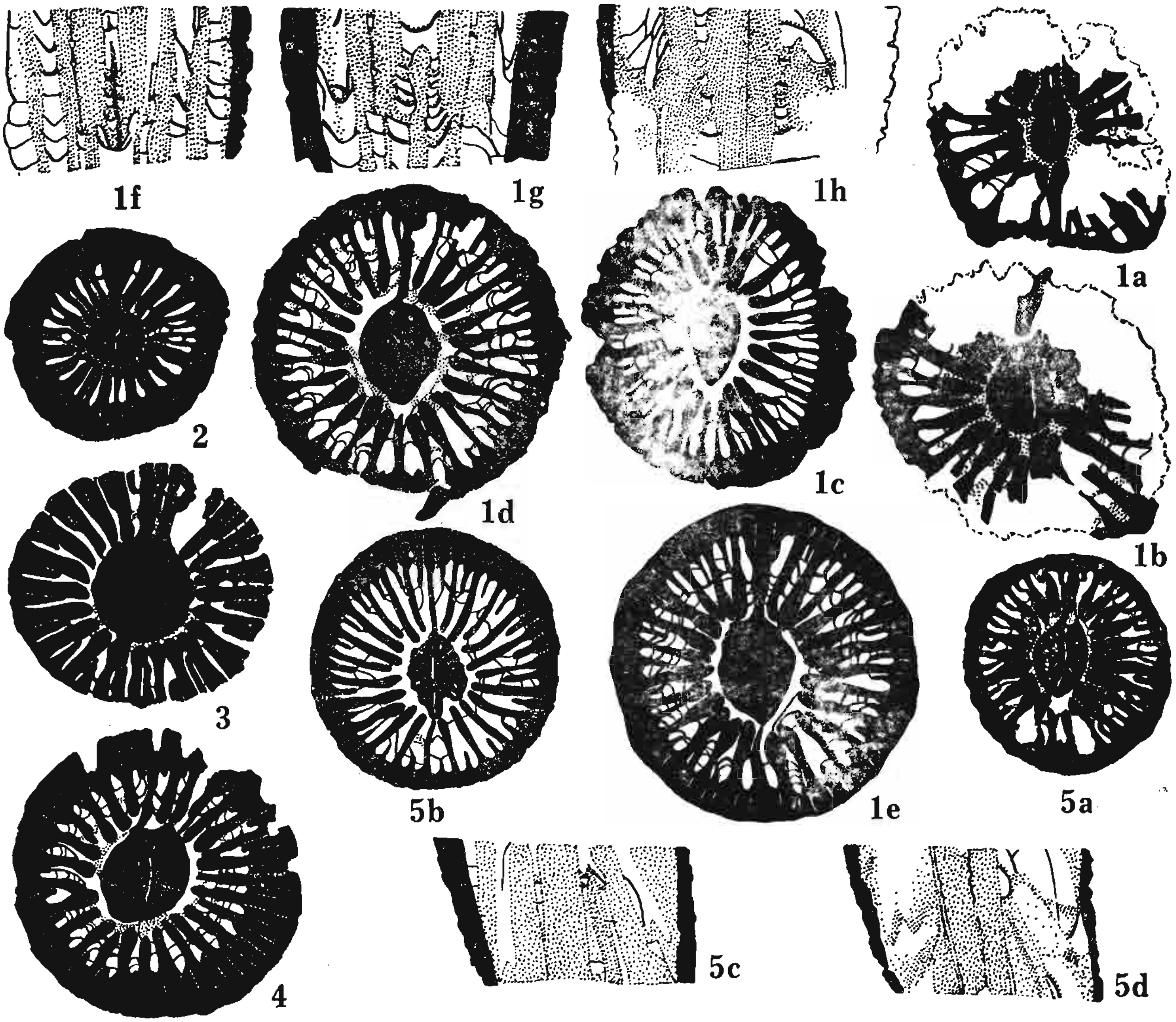

Fig. 48.
Lophophyllidium (*Lophbillidium*) *magnocolumnare* sp. n. 1. Specimen USNM 196939. Holotype. Locality USNM 705a, Lower Skinner Ranch Formation; a, b — transverse sections, early ephebic stage, × 5; c—e — transverse sections, ephebic stage, × 3; f—h — successive longitudinal sections, × 3. 2. Specimen USNM 196940. Locality USNM 707b, Skinner Ranch Formation, Sullivan Peak member. Transverse section, ephebic stage, × 5. 3. Specimen USNM 196941. Locality USNM 705a, Lower Skinner Ranch Formation. Transverse section, ephebic stage, × 5.4. Specimen USNM 196942. Locality and horizon as above. Transverse section, ephebic stage, × 3. 5. Specimen USNM 196943. Locality USNM 720e, Lower Skinner Ranch Formation; a — transverse section, early ephebic stage; b — transverse section, ephebic stage; c,d — successive longitudinal sections. All, × 3.

on the attachment-bearing side. Calices are deep (more than 15 mm in large specimens). The calice ridges are not preserved. The preserved marginal zone forms a ring of equally developed foundations of major and minor septa (pl. 17:6a, 7a, 8a, 9a). In the intermediate zone of calices, these foundations become differentiated in length to form fairly long blades of septa of both cycles. In the inner zone of calices, the length of the minor septa remains constant, but their portions inside calices are slightly reduced due to an increase in thickness of external walls, which incorporate their peripheral portions. The major septa are longest near calice floors, being often a little elongated on the upper surfaces of the last tabulae. In some specimens, the cardinal septum is slightly shortened, while in others it is indistinguishable in length from other major septa. The rod-like columellae vary in outline and are, in most cases, connected with the counter septa near the calice floors. They are free higher in calices, often protruding to the intermediate zone of the latter. In extreme specimens, the columella may reach the marginal zone of a calice. In the juvenile corallites, the length of a columella does not exceed 1/3 the depth of calices.

Description of the holotype. — (fig. 48:1a—h; pls. 17:5a, b; 18:5a—e). External characters of the type specimen (pl. 17:5a, b) fit well with the above discussion and do not need further description. The tip was not sectioned because the proximal end of the corallite is coarsely silicified. Its broken and slightly weathered lowermost portion shows a thick columella — a character typical for the subgenus. The arrangement of the major septa and presence of minor septa at this early stage of ontogeny (approximately 2.7 mm in diameter) have not been detected.

Approximately 10 mm higher up (fig. 48:1a; pl. 18:5a), the axial part of the corallite is preserved in calcite. The columella, monoseptal in the ontogenetically younger section (fig. 48:1a; pl. 18:5a) and with a single lamella incorporated in the slightly older one (fig. 48:1b; pl. 18:5b), is in contact with the counter septum. Middle lines of these structures are separated, however. The thick cardinal septum is slightly shortened, while the other major septa, rhopaloid in a character, reach or almost reach the columella. Their inner ends are laterally contiguous, and the remaining room is filled in with stereoplasm to form a solid ring around the columella. The minor septa seem to be differentiated in length. In some well preserved loculi, they are fairly long and contratingent (fig. 48:1b).

In contrast to earlier sections, the columella in the early ephebic stage (fig. 48:1c) is spindle-shaped and probably lacking septal lamellae. The counter septum reaches it slightly aside. Middle lines of these two structural elements remain disconnected up to the end of ontogeny. The major septa remain rhopaloid and equal in length, except for the slightly shortened cardinal septum. The axial stereozone is already reduced. In late maturity (fig. 48:1d, e; pl. 18:5c), the columella again becomes more circular and slightly wavy in outline, with several short septal lamellae incorporated. The presence of the latter is also manifested by the wavy outline of the columella in the calice (pl. 17:5a). The cardinal septum in the mature part of the corallite is as long as other major septa, but it is readily distinguishable by being slightly thinner and nonrhopaloid. It is slightly shortened on the calice wall.

Parallel longitudinal sections (fig. 48:1f—h; pl. 18:5d, e) document variability in shape and arrangement of tabulae, possibly resulted from their biformity. They seem to be more or less horizontal in both positions at the peripheral-most part of the corallite and sagging or concave near the columella (fig. 48:1f; pl. 18:5e). The major diversity in positions of the tabulae is noted somewhere around the inner ends of the minor septa. Tabulae in Position I dip down there (fig. 48:1g; pl. 18:1a, left), while these in Position II rise up (right on the same picture). The described changes in direction are well illustrated on the more axially made section, which runs through the end of a minor septum in one loculum (fig. 48:1g; pl. 18:5d, left). The axial longitudinal section (fig. 48:1h) documents the presence of quite numerous tabulae in this part of the specimen discussed. In the thick columella, a middle dark line and cone-shaped growth lines are seen. The rhythm of increase of the latter is much faster than that of the tabulae. This proves a semi-independent growth of the columella.

Individual variation. — Immature specimens form most of the collection, making the table of n:d ratio not representative for the species as far as the frequency of corallites in individual classes is concerned. They differ from one another mainly in the uneven development of individual characters at a given stage of growth. In some of them, the number of major septa, but not their thickness, increases quickly. The columella remains unthickened (pl. 17:6a). The other juvenile corallites are massive (pl. 17:11). Such variability could have been a function of ecological influences. It is in lesser degree observed among the mature corallites, however, where the thin septal corallites are rare (e. g. pl. 17:9a). The internal morphology of at least some small specimens (fig. 48:3) does not differ from that of large corallites, except perhaps for the comparatively long minor septa. Some of them (fig. 48:2; pl. 18:2) have these septa especially long, being similar to *L.* (*L.*) *cyathaxoniaforme* sp. n.

The specimens morphologically similar to the holotype form the main stock of the species. Variation in length of minor septa and morphology of the tabularium are most important within this group. Both these characters are often, but not always, correlated. A clearly biform tabularium commonly accompanies well elongated minor septa. In one of the specimens investigated, the tabulae are so widely spaced (diagenetically destroyed in part?) that their biformity can hardly be read from the transverse section (fig. 48: 5a, b; pl. 18:1a) and was not seen in the longitudinal sections (fig. 48:5c, d; pl. 18:1b). On the other hand, the biformity of the tabularium may be obvious from the transverse section (fig. 48:4; pl. 18:3) although the minor septa are rather short and often laterally contiguous with the neighbouring major septa.

Rare corallites (e. g. pl. 18:4). possessing some characters in common with other specimens of the species discussed, differ considerably from them in several other features. They have been temporarily included in this species because it is the morphologically closest taxon established so far.

Remarks. — The species discussed differs from all representatives of the subgenus *Lophbillidium* in having a concave axial part of the tabularium. The main differences as compared to the morphologically closest American species *L.* (*L.*) *cyathaxoniaforme* sp. n. are as follows: much larger dimensions, different n: d ratio, rhopaloid major septa, comparatively short minor septa, and horizontal, not dipping peripheral-most parts of tabulae in Position I.

The Timor Island *Lophophyllidium* (*Lophbillidium*) *elongatum* WANG, 1947 with its younger synonym *L.* (*L.*) *spinosum* SCHOUPPÉ and STACUL, 1955 *non* MARTIN, 1881 (see FEDOROWSKI 1986 for remarks) and *L.* (*Lophbillidium*) *martini* SCHOUPPÉ and STACUL, 1955, being similar to each other, also show a close similarity to *L.* (*L.*) *magnocolumnare* sp. n. in their dimensions and moderately long minor septa. The morphology of the tabularium in the latter species, as well as the rhopaloid major septa, the fairly long cardinal septum, and almost smooth surface of the external wall, are main distinguishing characters of the new species.

Occurrence. — USNM 720e:4, Lower Skinner Ranch Formation; 705a:44, *Scacchinella* Zone; 715v:2 Decie Ranch member; ? 707b:5, Sullivan Peak member; ? 707g:1, Poplar Tank member, all of Skinner Ranch Formation, Upper Wolfcampian.

Lophophyllidium (*Lophbillidium*) sp. 1

(fig. 49:3; pls. 16:8; 20:1)

Material. — Three fragmentary specimens without proximal ends. One with calice preserved.

N: d ratio (in mm):

USNM cat. nos.	n: d ratio	Remarks
196952	30:13.5	just beneath calice
„	29:12.7	ephebic stage
196951	24:10.5	? Ephebic stage
196953	26:10.2	calice margin

Description. — All specimens under the consideration (fig. 49: 3a, b; pls. 16:8; 20:1) have thin major septa almost equal in length and radially arranged. Some of these septa may be slightly rhopaloid. The cardinal fossula is inconspicuous, marked mainly by a slight shortening of the

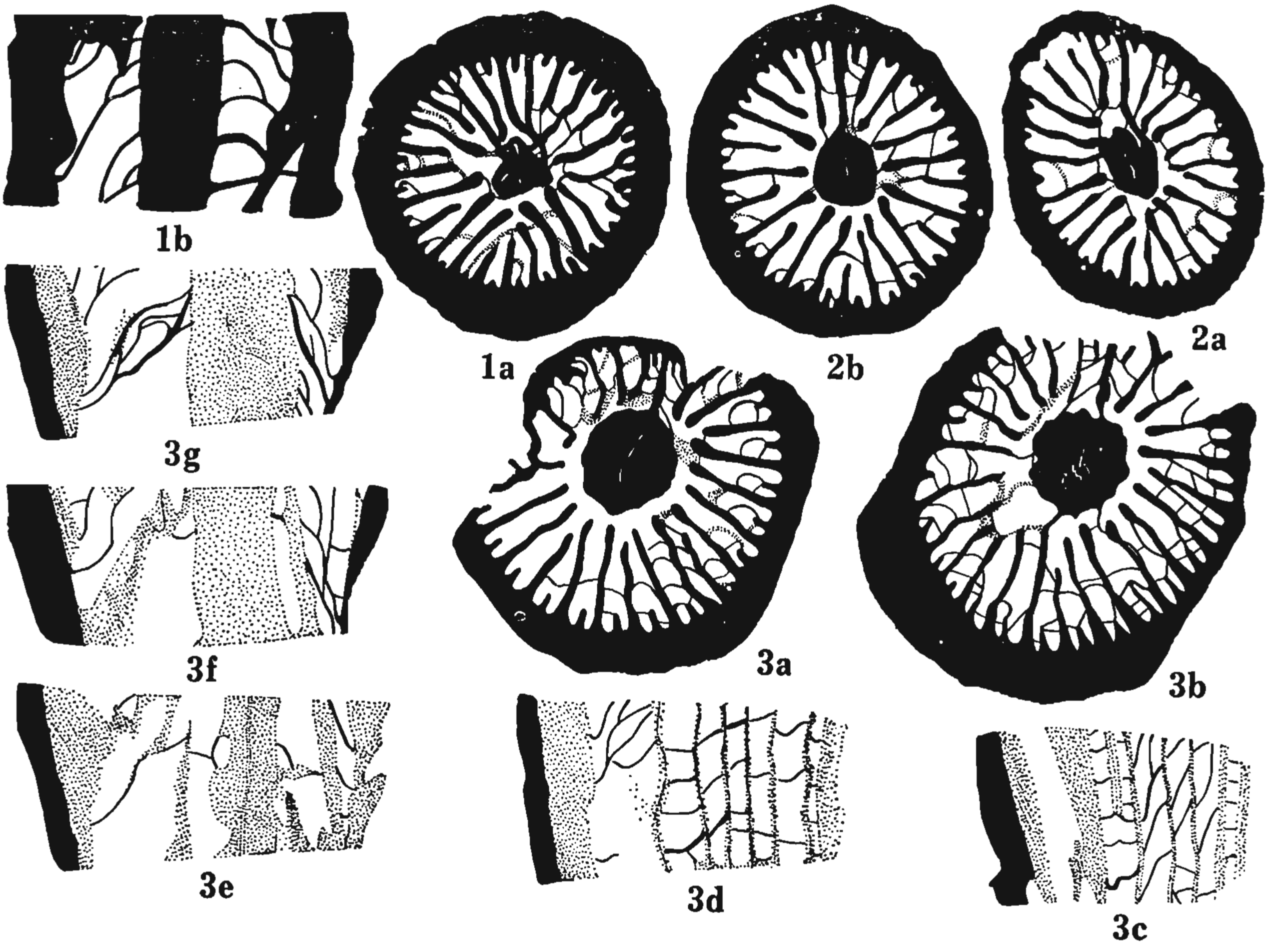

Fig. 49.

1. *Lophophyllidium* (*Lophbillidium* ?) sp. 2. Specimen USNM 196950. Locality USNM 705a, Lower Skinner Ranch Formation; a — transverse section, ephebic stage; b — longitudinal section. Both, × 5. 2. *Lophophyllidium* (*Lophbillidium* ?) sp. 2. Specimen USNM 196949. Locality and horizon as above; a, b — transverse sections, ephebic stage, × 5. 3. *Lophophyllidium* (*Lophbillidium*) sp. 1. Specimen USNM 196951. Locality USNM 716r, Upper Lenox Hills Formation; a,b — transverse sections, ephebic stage; c—g — successive longitudinal sections. All, × 5.

cardinal septum. The counter septum is either free or it reaches the surface of the columella without penetrating its interior. The columella is moderately thick, almost circular, with a slightly wavy outline corresponding to the coarse septal lamellae, and directed towards a short medial lamella. The minor septa are rather short, protruding 0.5—1.0 mm from the moderately thick septotheca. Transverse sections of tabulae indicate the fairly well developed biformity of the tabularium (fig. 49:3a, b). This is not fully confirmed by the longitudinal sections (fig. 49:3c—g), in which the tabulae in Position I of SUTHERLAND 1965 are only horizontal, not inclined, except for the peripheral-most section (fig. 49:3c). The tabulae in Position II rise obliquely upward toward the columella. The axial section shows hemisphaerical growth lines of the latter.

Remarks. — The morphology of the specimens discussed is similar to that of *L.* (*Lophbillidium* ?) sp. 2. Closer examination shows a different structure of the columella, a less shortened cardinal septum, a hardly distinguishable cardinal fossula, better developed minor septa, and well accentuated biformity of the tabularium in the specimens discussed. Differences between these corals and *L.* (*L.*) *magnocolumnare* sp. n. are much larger in almost all characters. Only a single specimen included in that species (pl. 18:4), having similar morphology of the columella and thin major septa, may be more closely compared to the specimens discussed. Its very long minor septa and a counter septum penetrating the columella form the main distinguishing characters.

Occurrence. — USNM 709f:1, 716r:1, Lenox Hills Formation, 705a:1, Lower Skinner Ranch Formation, Wolfcampian.

Lophophyllidium (*Lophbillidium*?) sp. 2

(fig. 49:1, 2; pls. 18:6, 7; 19:1, 2)

Material — Four silicified specimens having calices preserved, but with the proximal ends destroyed.

N: d ratio (in mm):

USNM cat. nos.	N: d ratio	Remarks
196949	24:8.7 × 8.3	calice margin
„	24:9.2 × 8.5	just beneath calice
„	23:8.6 × 7.1	lower part of corallite
196950	25:9.2 × 9.2	calice margin
„	25:9.2 × 8.1	just beneath calice
,	24:8.6 × 8.2	lower part of corallite

Description. — The specimens are ceratoid, almost cylindrical in shape, with the external surfaces bearing only very delicate septal furrows, often destroyed (pl. 19:2). The calices (pl. 19:1) are 7—11 mm deep and have inconspicuous peripheral zones that pass gently down into the inner zone, with blades of major septa only slightly better developed than those of the minor ones. Deeper in the calices, these proportions changed a little in favour of the major septa. The latter are short and almost vertically inclined along the whole length of the calice wall, being elongated only on the calice floor. Some septa may reach there the highly upstanding columella, which is rounded or slightly wavy in the outline (pl. 19:1). The morphology in transverse sections made just beneath the calice vary only a little. In some specimens (fig. 49:2; pl. 18:7b), the major septa are thin, slightly rhopaloid, and differentiated in length. The longest of them almost reach the columella, while the shortests are no longer than 2/3 of the former ones. Their arrangement is almost radial, but those adjacent to the shortened cardinal septum are slightly inclined towards it to form a triangular cardinal fossula. The counter septum, a little thicker than the adjacent major septa, joins the thick, almost circular columella, which is built of a short medial lamella and many disorderly arranged bodies that look like separate trabeculae. The middle lines of the columella and the counter septum are separated. The minor septa stick out from the moderately thick septotheca for approximately 1/2 milimeter, with those adjacent to the counter septum being slightly longer. The biformity of the tabularium may be noted only in some septal loculi. More commonly there are no traces of this a phenomenon.

The morphology of the youngest known section of the specimen discussed (fig. 49:2a; pl. 18:7a) differs from the afore-described one in showing only a slight differentiation in length of the major septa, which almost reach the elongated columella, built of rather long medial lamella surrounded by few trabeculae-like bodies at its cardinal septum side. The symmetry of this section is semi-radial.

Other specimen (fig. 49:1a; pl. 18:6a) has major septa more pinnately arranged and almost nonrhopaloid. The columella is irregular in outline and contains rather long medial lamella and three well developed septal lamellae in addition to the certain number of trabeculae-like bodies, The counter septum reaches it laterally. Other characteristics do not differ from those of the specimen described above in detail.

The longitudinal section (fig. 49:1b; pl. 18:6b) was made from a single specimen. The columella forms a thick, solid rod having delicate, conical growth lines. The complete tabulae, arranged much more steeply on one side of the corallite, show the position of the cardinal fossula. Rare tabellae occur only near the columella.

Remarks. — The specimens discussed are most similar to *L.* (*L.*) *magnocolumnare* sp. n., especially in the morphology of calices, the almost smooth surfaces of corallites, the internal structure of the columella, and its relation to the counter septum. Main differences are: dimensions and n:d ratio, the shortened cardinal septum in the specimens here discussed, their much shorter minor septa and the underdevelopment of biformity of the tabularium. The last character may result from the underdevelopment of the minor septa. In this respect, the specimens discussed show also some similarity to *L.* (*L.*) *erugum* sp. n., being only slightly larger than the latter and having the cardinal septum shortened and the major septa differentiated in length. The underdevelopment of biformity of the tabularium in some species or groups of specimens on one hand and the apperance of an incipient biformity in some other ones not considered as members of *Lophbillidium*, prevents acceptance of an independent generic status for this taxon and may be a reason for not acknowledging it even as a subgenus by some students. As in the case of *L.* (*L.*) *magnocolumnare* sp. n., the morphology of the calices with highly protruded columella is a character in common of the specimens here discussed with *L.* (*L.*) *erugum* sp. n. This character, invariably present in all specimens so far included in *Lophbillidium*, should possibly be treated as one of most important of this subgenus.

Occurrence. — USNM 705a:4, Lower Skinner Ranch Formation, Wolfcampian.

Genus *Pseudowannerophyllum* FLÜGEL, 1975

Type species: P. differens FLÜGEL, 1975

Species assigned: P. differens FLÜGEL, 1975, *Lophophyllidium solidum* ROSS and ROSS, 1962.
Geographic and stratigraphic distribution: Iran, Lower Bashkirian; USA, SW. Texas, Lower Wolfcampian.

Emended diagnosis. — Solitary corals without dissepimentarium; cardinal septum in maturity shortened; complex, loose columella starts its development from counter septum and primary lamellae; secondary lamellae appear by means of peripheral split; tabularium biform; microstructure of septa trabecular.

Remarks. — The genus *Pseudowannerophyllum* FLÜGEL, 1975 originally included in the family Verbeekiellidae SCHOUPPÉ and STACUL, 1955 was left in that family by HILL (1981). The last author remarked, however (p. F338), that "Dense packing of elements in axial structure may indicate relationship to Lophophyllidae" (= Lophophyllidiidae MOORE and JEFFORDS, 1945 in the meaning accepted here). FEDOROWSKI (1986) remarking briefly on that genus suggested its relationship with *Lophophyllidium* GRABAU, 1928.

There are two characteristics which may distinguish this genus: morphology of an axial structure and biform tabularium. In the first case there may be some controversies as to its taxonomic value, considered low by FEDOROWSKI (1974), WEBB (1984), and in the present paper (see remarks on the genus *Lophophyllidium*). This meaning, referring only to the simply perforated columella has not been changed and such species as "*Agarikophyllum*" *pavlovi* FOMICHEV, 1953 and *L. hadrum* JEFFORDS, 1947 have been left here in the genus *Lophophyllidium*. The perforated columella in some corallites of *L. wewokanum* JEFFORDS, 1947 (see above) has not even been considered adequate for the species distinction. There is one feature which seems to be developed in columellae of *P. differens* FLÜGEL, 1975, and which is clearly seen in the species included in *Pseudowannerophyllum* here, namely the increase of secondary lamellae in the columella by means of peripheral split. This feature, supplemented by the increasing separation of the structural elements of the inner morphology of the columella during ontogeny, forms a set of characteristics which is considered here as having a taxonomic value not lower than generic.

A similar increase of lamellae in columella was considered diagnostic for the family Verbeekiellidae (FEDOROWSKI, 1986). Such a high rank of this feature once applied may suggest a necessity of placing *Pseudowannerophyllum* in that family, as it was originally proposed by FLÜGEL (1975:49). However, differences in the ontogeny and especially in the foundation of the axial structure, as well as a distinct arrangement of trabeculae in septa and a specific organization of calices in that family (FEDOROWSKI, 1986) speak strongly in favour of considering the morphology of columella in *Pseudowannerophyllum* as being only homeomorphic to that in *Verbeekiella* PENECKE, 1908.

The second diagnostic feature of this genus, i. e. the biform tabularium, has already been evaluated as having a subgeneric rank in *Lophbillidium*, a subgenus introduced by FEDOROWSKI (in press). The rank of this feature lower than generic, may be also attributed to *Pseudowannerophyllum*, where it is developed late in the ontogeny and seems to vary also in the type species. Such development of biformity of the tabularium brings the genus discussed fairly close to *Lophbillidium*. The latter subgenus would thus have to be synonymized with *Pseudowannerophyllum* if the morphology of columella in these two taxa was considered taxonomically unimportant. *Pseudowannerophyllum* may in the latter case be considered a subgenus of *Lophophyllidium*.

Pseudowannerophyllum solidum (ROSS and ROSS, 1962)

(fig. 50; pls. 14:10—12; 15:1, 2)

e. p. 1962. *Lophophyllidium solidum* Ross and Ross; C. A. Ross and J. P. Ross, p. 1182, fig. 4J; pl. 161:10, 13, 16, 19.

Material. — Six incomplete specimens and the type collection of Ross and Ross (1962) were available for the study.

N:d ratio of representative specimens (in mm):

No of specimen	N:d ratio	Remarks
USNM 196909	31:13.5	just beneath calice
USNM 196907	26:11.0	just beneath calice
„ „	24: 9.9	early ephebic stage
USNM 196908	26:10.5	middle of calice
„ „	23: 9.0	just beneath calice
USNM 196910	25:10.2	calice floor
YPM 21802	24:10.1	just beneath calice

Diagnosis. — *Pseudowannerophyllum* having n: d ratio 24:10 — 31.13.5; major septa rhopaloid, radially arranged; cardinal septum only slightly shortened.

Discussion. — The specimens identified by Ross and Ross (1962) as *Lophophyllidium solidum* differ greatly in substantial diagnostic characters. They were sectioned for the purpose of this paper, and except for the holotype and one paratype (YPM 21802, Ross and Ross, 1962, pl. 161:10 = fig. 50:3a—c in this paper), were reidentified as belonging to different species of *Lophophyllidium*. The individual variation of the specimens included in *P. solidum* here is rather

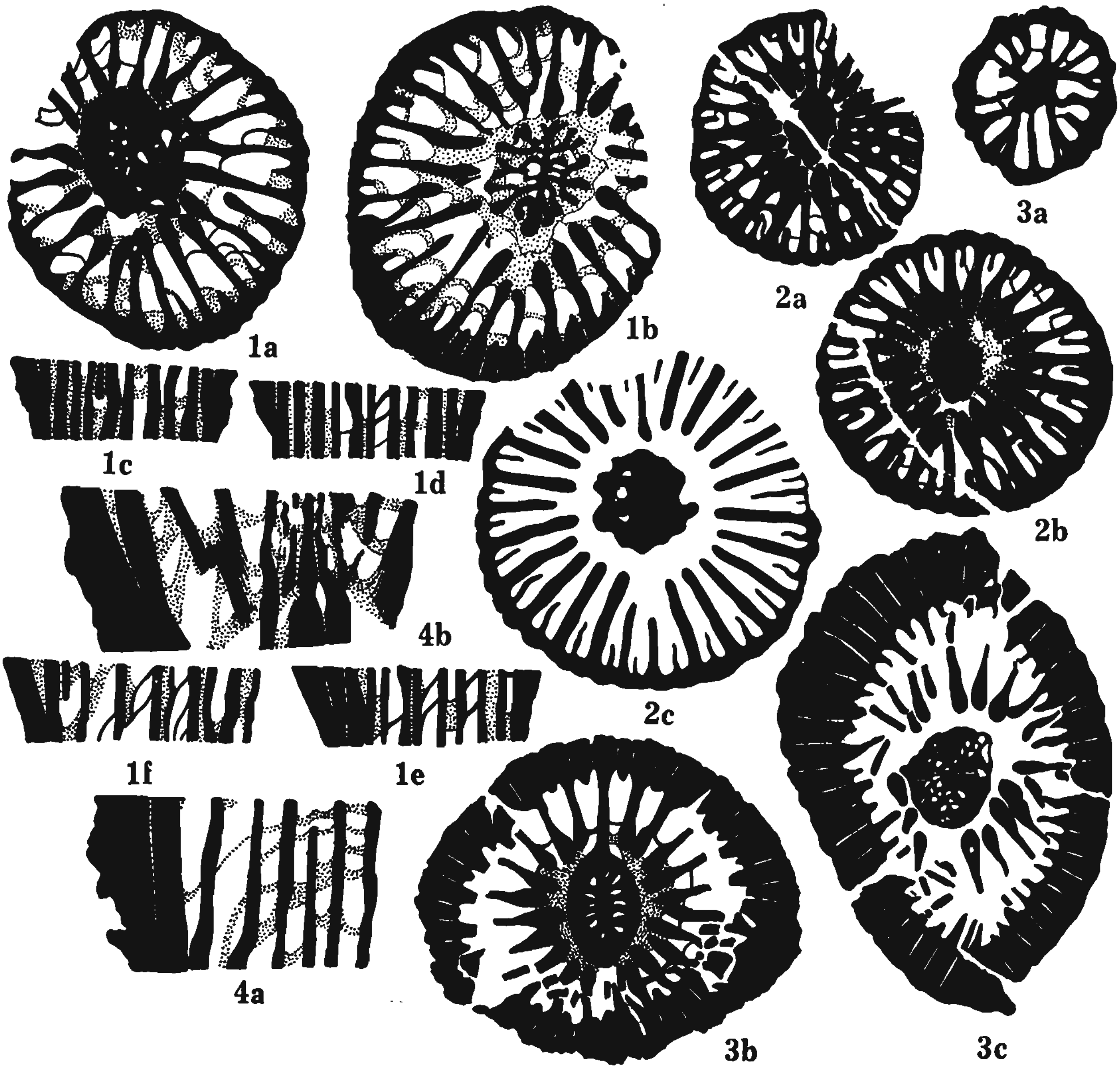

Fig. 50.

Pseudowannerophyllum solidum (Ross and Ross, 1962). 1. Specimen USNM 196907. Locality USNM 701p, Gaptank Formation, *Uddenites*-bearing member; a, b — transverse sections, ephebic stage; c—e — successive longitudinal sections of peripheral part of corallite. All × 5. 2. Specimen USNM 196908. Locality USNM 711g, Hess Formation. Transverse sections; a, b — ephebic stage; c — middle of calice. All × 5. 3. Specimen YPM 21802 (= Ross and Ross, 1962, pl. 161:10). Locality YPM 42, Gaptank Formation, *Uddenites*-bearing member; a — neanic stage, × 6; b — ephebic stage, × 5; c — lower part of calice, × 5. 4. Specimen USNM 196909. Locality USNM 701p, Gaptank Formation, *Uddenites*-bearing member; a, b — successive longitudinal sections, × 5.

large but random. The porosity of columellae is the only character showing a trend in development: columellae are generally more distinctly porous in the specimens derived from the stratigraphically older deposits. Such a relation is less well seen in the highly individualized morphology of the columellae. Most specimens, the holotype included, show fairly simple structure of the columella, which incorporates rather small number of septal lamellae. Also, an increase of lamellae by means of peripheral split is not always clear. Two corallites, both from the *Udde*-

nites-bearing member of the Gaptank Formation possess very complex columellae (fig. 50:1a, b; pl. 14:11a; 12b, c). In the single mature section of one of those specimens the columella is composed of a number of lamellae larger than the number of major septa (pl. 14:12c). Many of these lamellae exhibit characters that show them as produced by means of the peripheral split of earlier existing lamellae; the phenomenon recently described by FEDOROWSKI (1986) for *Verbeekiella* Penecke, 1908 and considered diagnostic for *Pseudowannerophyllum* in this paper. The morphology of the ontogenetically younger (fig. 50:1a) and the calicular sections of this columella does not show the number of lamellae so large as described above, retaining the characteristic relation of lamellae, however (pl. 14:12b).

Differences in length of minor septa are here considered rather important, because of their influence on the morphology of the tabularium. In the holotype and the other short-septal specimens (e. g. fig. 50:3b, c; pl. 14:11b), the tabularium is simple and apparently uniform, while in the long-septal ones (fig. 50:1a, b; 2a—c; pls. 14:12a; 15:2) the peripheral parts of the tabularium is biform. As seen on the polished transverse section (pl. 15:2), this biformity may in some specimens by quite distinct. The longitudinal sections of the peripheral part of this corallite (fig. 50:1c—f) shows the peripheral parts of the tabulae differentiated in elevation. Those located in the loculi equivalent to Position I of SUTHERLAND 1965 are higher than those on the opposite side of a given minor septum (Position II). The higher elevated parts of tabulae are more or less horizontal, while the less elevated ones rise adaxially. Lack of elongation of the minor septa in some corallites causes the almost complete unification of shape of peripheral parts of the tabulae (fig. 50:4a, b).

Some differences in the length and thickness of the major septa, as well as in the n:d ratio, are of lesser importance when compared to the previously discussed ones. Their taxonomical implications are rather minor.

Remarks. — *Pseudowannerophyllum solidum* (ROSS and ROSS, 1962) apparently resembles *Lophophyllidium* GRABAU, 1928 and was originally described by ROSS and ROSS (1962) under that generic name. Indeed, several specimens of ROSS and ROSS (1962, 1963) were reidentified here as belonging to different species of that genus. The holotype and one paratype of *L. solidum* were transferred to *Pseudowannerophyllum* in spite of bearing only incipient diagnostic features of that genus. They were supplemented by more typically pseudowannerophylloid specimens here to support a new concept of this species. It is the only one in *Pseudowannerophyllum* described so far except for the type species of the latter genus. Thus, it is briefly compared not only to *P. differens* FLÜGEL, 1975, but also to those species of *Lophophyllidium* which have a perforated columella.

P. solidum (ROSS and ROSS, 1962) differs from *P. differens* FLÜGEL, 1975 first of all in n:d ratio and in having the cardinal septum only slightly shortened. Major septa more distinctly rhopaloid, tabulae more widely spaced and less steeply dipping peripherally as well as later appearance of minor septa in ontogeny are the next distinguishing features of *P. solidum*.

The perforated columella, containing at least few secondary lamellae, only slightly shortened cardinal septum, and the major septa only slightly differentiated in length are the main distinguishing characters of the species discussed from *Lophophyllidium* (*Lophophyllidium*) *spinosum* JEFFORDS, 1947 *non* MARTIN, 1881. Both these species show close similarity in the variation in length of the minor septa and in the morphology of peripheral parts of tabularia, correlated to those septa. The latter feature, i.e. the development of incipient biformity of the tabularium brings *L.* (*L.*) *spinosum* JEFFORDS, 1947 close to either *Lophbillidium* or *Pseudowannerophyllum*.

From other American lophophyllidia sensu stricto, *L. hadrum* JEFFORDS, 1947 with its loose columella in advanced ontogeny may be close to the ancestral form of *L. spinosum*. Other American species of *Lophophyllidium* described so far are less similar and will not be discussed. Among the foreign ones, "*Agaricophyllum*" *pavlovi* FOMICHEV, 1953 from the Upper Carboniferous of the Donetz Basin differs from *P. solidum* in different morphogenesis of the columella, in having major septa thick and directly touching the slightly perforated columella and in not showing biformity of the tabularium.

Occurrence. — Previously described: SW Texas, Locality 42 of Ross and Ross (1962), Gaptank Formation, *Uddenites*-bearing member. Here described: USNM 701p:3, 701v:1, Gaptank Formation, *Uddenites* bearing member; 701c:1, Neal Ranch Formation; 711g:1, Hess Formation. Wolfcampian.

Family **Lophotichiidae** WEYER, 1972

Type genus: Lophotichium MOORE and JEFFORDS, 1945

Synonym: Epiphanophyllinae WEYER, 1972.

Genera assigned: Lophotichium MOORE and JEFFORDS, 1945; *Epiphanophyllum* ILINA, 1970; ? *Kabakovitchiella* WEYER, 1972; *Paraduplophyllum* WU and ZHOU, 1982; *Assimulia* gen. n.

Geographic and stratigraphic distribution: USA (Texas, Oklahoma), China (Xinjiang), Timor Island, USSR (Pamir), Austria, Jugoslavia, Spain. Morrowan to Upper Permian.

Diagnosis. — Small to medium size solitary corals without dissepimentarium; minor septa inserted as contrafused; columella built of axial end of counter septum may occur; tabularium distinctly biform; microstructure of septa trabecular.

Remarks. — The discussion of FEDOROWSKI (in preparation) of most of the genera included by HILL (1981) in the suborder Metriophyllina SPASSKY, 1965 permits limitation of the following discussion. The family discussed includes rugose coral taxa that do not submit to the rules of classical taxonomy, i. e. taxonomy dealing with taxa fully determined and constant on any level. In the family discussed, as in such "troublesome" taxa as the Devonian Phillipsastraeidae Hill, 1954 and related families, there are no constant criteria that can be used for individual taxonomic levels. The undisputable distinction between extreme taxa diminishes in the course of investigation of successively larger collections. HILL (1981:F181—F189) came to a point of dividing Phillipsastraeidae into four informal groups of genera. Such an extreme position is not accepted herein, but it has to be stressed that boundaries between genera and species are flexible. The problem of classification of such taxa that have hardly distinguishable boundaries is discussed in the general part of the following volumes of this monograph.

The most important, long-lasting characters of the family are: 1) The invariably present biform tabularium, 2) The fine trabecular microstructure of the septa, 3) The contrafused minor septa that are invariably inserted early in ontogeny. This new term is introduced for minor septa inserted at some angle to the adjacent major septa, but in contrast to contratingent minor septa, the middle lines of both cycles of septa are here directly united. All other characters vary. For instance: a) The columella developed from the elongated counter septum is present in some genera. In some others (*Paraduplophyllum*) this septum protrudes above the calice floor more than other major septa, although its elongation is not marked in sections; b) A tendency to shorten the cardinal septum beneath the calices is absent in *Paraduplophyllum* and *Assimulia* n. gen. In these genera the cardinal septum in the calices is less protruded along the cardinal fossula floor than other major septa apart from the fossula, but it is neither here nor in section shortened more than other major septa; c) Different kinds of carinae occur within the family and may be diagnostic of the specific and to a lesser degree of the generic level; their rank should not be higher, however.

The family status of earlier known genera here included in Lophotichiidae was interpreted differently by earlier authors. The nominative genus *Lophotichium* MOORE and JEFFORDS, 1945, originally included in the Lophophyllidiidae MOORE and JEFFORDS, 1945, was transferred by WEYER (1972*a*) to the family Cyathaxoniidae M.-EDWARDS and HAIME, 1850 and placed in the subfamily Lophotichiinae WEYER, 1972. HILL (1981) considered *Lophotichium* a member of

TABLE 10

Morphologically-comparative table of Lophotichiidae Weyer, 1972

Name of genus or subgenus	Cardinal septum	Cardinal fossula	Counter septum	Major septa	Minor septa	Carinae	Calice
Lophotichium Moore and Jeffords, 1945	More or less shortened in maturity	Present	Elongated to form columella	Smooth, straight, nonrhopaloid, sometimes differentiated in length	Smooth, contratingent or free; may be reduced	May rarely occur	Moderately deep, wide; septa short; columella sticking
Epiphanophyllum Ilina, 1970	Reach corallite axis	Inconspicuous or absent?	Elongated, thickened in axis	Strongly wavy but contiguous; come close to corallite axis	Longer than major septa; wavy up to disconnection	Similar to zig-zag	?
Kabakovitchiella Weyer, 1972	Equal to other major septa	Absent	Equal to other major septa	Smooth, straight, thin; leave wide free axial area	Smooth, straight, almost equal to major septa in length	Absent	?
Paraduplophyllum (*Paraduplophyllum*) Wu and Zhou, 1982	Reach corallite axis	”	Reach corallite axis, nonrhopaloid	Smooth, straight, meet axially in four systems (quadrants)	Long, contratingent or contrafused to opposite major septa	Long, peripheral may occur	Moderately deep, empty, wide; axial area flat
Paraduplophyllum (*Vacoea*) subgen. n.	Equal to other major septa	May occur	In calice may form columella; beneath inconspicuous	Smooth, straight, meet axially at least in neanic stage; may be shortened	From contrafused in some to absent in maturity in other species	Absent	Very deep, empty, wide; axial area often protruded
Assimulia (*Assimulia*) subgen. n.	Reach or almost reach corallite axis	Absent	Slightly elongated in calices; axially thickened beneath them	Come close or meet in calice axis; in sections wavy, commonly slightly rhopaloid	Long, strongly wavy, contratingent or contrajunct; rarely free	Zig-zag commonly present	Deep, funnel-shaped; septa elongated to axis; cardinal and counter may protrude
Assimulia (*Ericina*) subgen. n.	”	Well seen in calice	Equal to other major septa	Almost reach corallite axis, nonrhopaloid, strongly peripherally thickened.	”	Zig-zag mainly on minor septa	As above, but cardinal and counter equal to other major septa

Cyathaxoniidae and included Lophotichiinae in synonymy with the latter. My position is that the relation of *Lophotichium* and *Cyathaxonia* is not closer than on the family level. The relation of the genera grouped by WEYER (1972*a*) into Cyathaxoniidae, including *Lophotichium* and *Cyathaxonia*, was recently discussed by FEDOROWSKI (in preparation) with special emphasis being paid to the latter two genera.

Genus *Kabakovitchiella* WEYER, 1972, included originally in the Petraiinae de KONINCK, 1872, was conditionally transferred into Lophotichiidae WEYER, 1972 by FEDOROWSKI (1986). Unfortunately an investigation of this genus is inadequate. The holotype of the type species as well as of other species described as *Amplexocarinia* SOSHKINA, 1928 by SCHOUPPÉ and STACUL (1959) on bases of single corallites and included by WEYER (1972*a*) in *Kabakovitchiella*, does not have the proximal end preserved (FEDOROWSKI 1986). The existing ephebic stages of *Kabakovitchiella* are morphologically close to *Paraduplophyllum* (*Vacoea*) *amplexoides* sp. n., but lack of information about early ontogeny of the former makes any closer comparison impossible.

The systematic position and main morphological characteristics of *Epiphanophyllum* ILINA, 1970 was recently discussed by FEDOROWSKI (1986). The columella in this genus was thought to be developed from a counter and not from a cardinal septum, as originally described by ILINA (1970). This temporary concept resulted in placing Epiphanophyllinae WEYER, 1972 in synonymy with Lophotichiidae WEYER, 1972.

As mentioned, the family discussed shows flexible intrageneric boundaries. This prohibits distinguishing columellate and permanently acolumellate genera, even on a subfamily level. The similarity (relation?) of columellate taxa to such genera as *Lophophyllidium* GRABAU, 1928 or *Asserculinia* SCHOUPPÉ and STACUL, 1955 has recently been discussed (FEDOROWSKI 1986). *Paraduplophyllum* with no traces of columella in the transverse sections may be compared only with Duplocariniinae FEDOROWSKI, 1986 and with those taxa of "*Petraia*" MÜNSTER, 1839 that do not exhibit a tendency to form an aulos. The relation of these taxa to *Paraduplophyllum* is identical to these of other lophotichiids and was briefly discussed earlier (FEDOROWSKI 1986).

The similarity of *Paraduplophyllum* to *Duplocarinia* FEDOROWSKI, 1986 is at first glance, considerable. This concerns especially an arrangement of the major septa in four systems, the middle septa of which meet near the corallite axis. The main difference is a peculiar increase of the minor septa in the ontogeny of Duplocariniinae FEDOROWSKI, 1986 preceded by appearance of the minor septa-like peripheral carinae on the major septa. Similar carinae are not unknown in Lophotichiidae, but they never appeared in a sequence like that mentioned. The appearance of the peripheral carinae observed in some species of *Paraduplophyllum* occurs only when the minor septa are already present. A very close similarity in the ontogeny and in other important characteristics of *Paraduplophyllum* and *Lophotichium* permits considering the similarities above discussed between the former genus and Duplocariniinae as parallelism in development of two related but distinct families.

Phylogenetic relations of the family Lophotichiidae WEYER, 1972 like those of the nominative genus (see remarks on the latter), are not detectable on the recent level of knowledge of this group of corals. The incomplete specimen described by de GROOT (1963) as *Duplophyllum*? sp. from the Upper Namurian of Spain is the only one comparable to *Paraduplophyllum*. It may be slightly older geologically than the oldest known lophotichia, described by MOORE and JEFFORDS (1945) from the Upper Morrowan Hale Formation and differs from them by having the cardinal and the counter septa equal to other major septa. The recent study by RODRIGUEZ (1984) on similar corals from Spain, identified by him as *Duplophyllum* shows that the two septa mentioned do not differentiate in length both in the ontogenetically more advanced stage than that shown by de GROOT (1963) and in the geologically younger deposits. Present knowledge may indicate that *Lophotichium*, with the shortened cardinal septum and elongated counter septum, and *Paraduplophyllum* and/or *Kabakovitchiella* with these septa not differentiated, were already separated in the Upper Namurian. On the other hand, a comparison of some of the representatives of *Lophotichium* here described and *Paraduplophyllum* (see above) and *Assimulia* gen. n. suggests a close relation of them to one another rather than to the hypothetical, unknown ancestors of *Lophotichium vescum* MOORE and JEFFORDS, 1945 and *Duplophyllum*? sp. de GROOT, 1963. Three possibilities are suggested this way: 1) A linkeage by descent from a hypothetical common ancestor, bifurcated towards *Paraduplophyllum*-like and *Lophotichium*-like genera prior to Upper Namurian. These two lines are represented in the Upper Namurian and Morrowan by the species mentioned above. Such an early bifurcation and independent development of two forks may suggest a formal distinction of these two lines as subfamilies. This has not been accepted here because of inadequate data (see below). 2) All taxa here described developed from a common American ancestor and became differentiated as observed. The similarity of some of them to *Duplophyllum*? sp. de GROOT, 1963 has resulted from homeomorphism only. Descendents of the Spanish species never penetrated North American seas. Podolskian and Kasimovian *Duplophyllum* of RODRIGUEZ (1984) (= probably *Kabakovitchiella* WEYER, 1972) and the Lower Permian *Kabakovitchiella ruedemanni* (HERITSCH, 1936) may form a line leading from that ancestral taxon. 3) Both descendents of two forked lines of development (point 1) and homeomorphs to them (point 2) are mixed together. Any of these hypotheses must stay open until similar or comparable corals are found in the intermediate areas and strata.

Remote ancestors of the corals discussed might have been related to the Upper Silurian "*Petraia*" (MÜNSTER, 1839) with axially united septa. Discussion of this genus (WEYER 1978, 1980) documented that both this genus and the family Petraiidae de KONINCK 1872 are baseless for any comparison until selection of a neotype specimen for *Petraia decussata* MÜNSTER, 1839 is made. Even then, however, a very long time span with no evidence of taxa leading owards Lophotichiidae and no obvious tendency among the Silurian taxa of "*Petraia*" to elongtte the counter septum will in my opinion separate the discussed taxa on a family level.

Genus *Lophotichium* MOORE and JEFFORDS, 1945

Type species: L. vescum MOORE and JEFFORDS, 1945

Species assigned: L. vescum MOORE and JEFFORDS, 1945; ? *L. densum* MOORE and JEFFORDS, 1945; *L. dugoutense* sp. n.; *L. rotundiseptum* sp. n.; *L. simulatum* sp. n.

Diagnosis. — Lophotichiidae having cardinal septum typically shortened; major septa, in early ontogeny arranged in four systems, in maturity may be shortened; columella originated from counter septum may incorporate a few septal lamellae, reduced in mature parts of some species; minor septa may be reduced in maturity; tabulae highly domed in periaxial parts.

Remarks. — The genus *Lophotichium* MOORE and JEFFORDS, 1945 is known only from its original description and has been discussed in more detail only by WEYER (1972*a*) and recently by FEDOROWSKI (1986). Discussion of the former author was based not on the originals, but only on the MOORE and JEFFORDS' (1945) incomplete and not always correct description and illustrations. The earlier paper of FEDOROWSKI (1986) was restricted to more general remarks only. The following discussion contains descriptions and illustrations of the most important characters of the type collection.

According to MOORE and JEFFORDS (1945:111) "the seeming greater number of septa near the apex of corallite than in the upper part" is the most characteristic feature of the species and genus. This conclusion and application of such expressions as "septa-like structures" and "nonpersistent septa" clearly show of recognition of septal structure of these plates. MOORE and JEFFORDS (1945) correctly pointed out a nonpersistency of these structures and their often observed junction with major septa. Unfortunately, they interpreted these structures as "steeply

TABLE 11

Morphologically-comparative table of species of *Lophotichium* Moore and Jeffords, 1945 described in this paper

Name of species	Shape of calice	Major septa	Minor septa	Cardinal septum	Counter septum	Columella	N: d ratio
Lophotichium rotundiseptum sp. n.	Wide, empty; floor rise up axially toward columella	Radially arranged, slightly rhopaloid; leave wide free axial area	In calice absent; beneath short or absent; adjacent to counter septum may form triad	More or less shortened	Elongated; often thicker than other major septa	May incorporate 1—3 lamellae; in calices rounded, beneath pendulum-like	24:10.3 to 30:10.3
Lophotichium dugoutense sp. n.	Narrow, crawded; cardinal and counter septa may meet axially	Nonrhopaloid, wedge-shaped; arranged in systems; longest reach inner end of counter septum	Absent or very short in calice; beneath contratingent, sometimes free; thickened at periphery	In calices long; beneath may be slightly shortened	Reach corallite axis; slightly thickened in calices and beneath them	In calices absent; beneath elongation of counter septum, commonly thickened	16:5.3 20:8.0
Lophotichium simulatum sp. n.	Commonly wide; axial area flat; floor rise up at counter and dip at cardinal septum	Radially arranged, rarely slightly rhopaloid; may be differentiated in length	In calice absent or short; beneath vary from contratingent in some to absent in maturity of other taxa	Commonly slightly shortened; more distinctly beneath calices	In calices may be equal to other major septa; always long in early mature parts of growth	Not always present in calices; often only elongated counter septum	14:3.4 to 24:11.5
Lophotichium sp. 1	?	More or less rhopaloid; reach or almost reach columella	Free; reach up to 1/2 length of major septa	Equal to, but thinner from other major septa	Elongated to reach columella	Pendulum-like; may incorporate 1—2 lamellae in younger growth	28:18.0 × 14.3
Lophotichium sp. 2	?	Nonrhopaloid, wavy, almost reach inner end of counter septum	Long and contratingent up to lower part of calice	Long up to calice	Elongated; axial end thickened	Only thickened axial end of counter septum	26:11.7 × 7.0

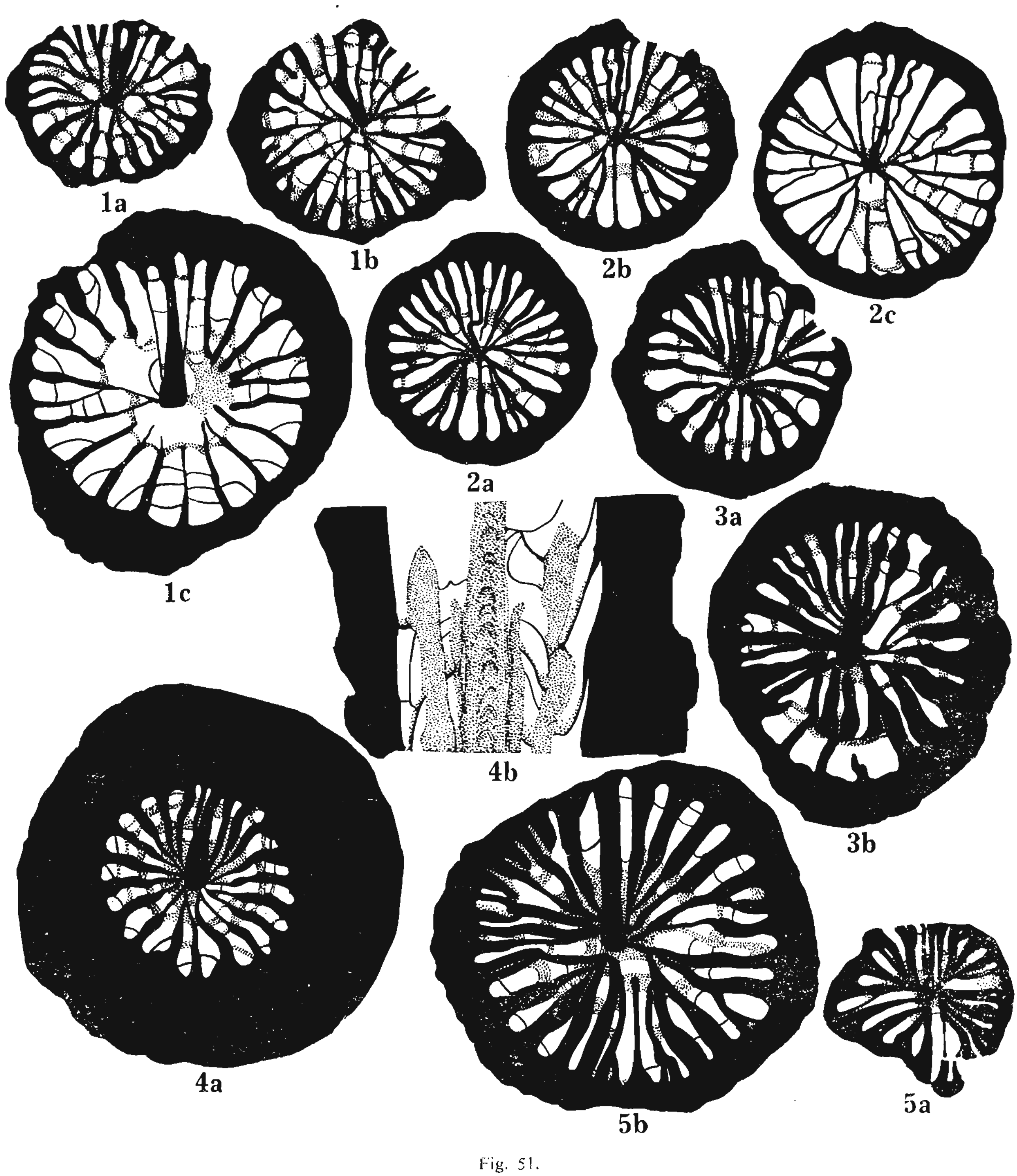

Fig. 51.

Lophotichium vescum Moore and Jeffords, 1945. Transverse sections. 1. Specimen KU 57322. Holotype (= Moore and Jeffords, 1945, fig. 62). Hale Formation, Morrowan, Greenleaf Lake, Oklahoma, Univ. Kansas locality 7385. Housed in Kansas Universum Museum; a -- late neanic/early ephebic stage; b — early ephebic stage; c — late ephebic stage. 2. Specimen KU 57325 (= Moore and Jeffords, 1945, fig. 63). Locality, formation and depository as above; a — late neanic/early ephebic stage; b — early ephebic stage. 3. Specimen KU 57333 (= Moore and Jeffords, 1945, fig. 73). Locality, formation and depository as above; a — late neanic/early ephebic stage; b — ephebic stage having shallow lateral rejuvenation. 4. *Lophotichium densum* Moore and Jeffords, 1945. Specimen KU 57359. Holotype. (= Moore and Jeffords 1945, fig. 77). Locality, formation and depository as above: a — transverse section, ephebic stage; b — longitudinal section. 5. *Lophotichium amoenum* Moore and Jeffords, 1945. Specimen KU 57360 (= Moore and Jeffords, 1945, fig. 81). Hale Formation, Morrowan, 2,5 miles north of Fort Gibson, Oklahoma. University Kansas Locality 77. Depository as above. Transverse sections, a — late neanic/early ephebic stage, b — ephebic stage. All, × 10.

inflected portions of tabulae". This obvious mistake led to their misinterpretation of the morphology of the type species of *Lophotichium*, expressed best on their Text-fig. 61.

WEYER (1972*a*) recognized the "steeply inflected portions of tabulae" of MOORE and JEFFORDS (1945) as minor septa, making the first important step in correction and proper interpretation of the morphology of this genus. The following observations of the present author, made on the type collection, may help in understanding it better.

As it has been observed in the holotype and some paratypes of the type species, as well as other Morrowan species of the genus, the minor septa, inserted invariably contrafused, are very differentiated in length during early ontogeny (see descriptions of species), being often short, not long as suggested by WEYER (1972*a*:457), and often losing their contrafusity. The pair adjacent to the counter septum are the only minor septa invariably present in a corallite lumen and mostly long. In some specimens, the minor septa are longest in the early ephebic stage, (fig. 51:2a) while in other ones, they are partly reduced at this level of growth (fig. 51:3a). The great variability in length has thus to be expressed as a general character of the minor septa. In the mature portions of the corallites, they are often reduced. This inconstancy reflects the morphology of Permian representatives of the genus, some of which are long- (*L. dugoutense* sp. n. and some short-septal (*L. simulatum* sp. n., *L. rotundiseptum* sp. n). The long-septal trend predictably leads also towards the genera *Paraduplophyllum* and *Assimulia* gen. n.

In addition to the inconstant contratingency and great variability in length, a kind of breaking or duplication of minor septa can also be observed (pl. 21:3a, b). This phenomenon might have led towards appearance of zig-zag carinae, frequently observed in the Permian genera *Paraduplophyllum* and *Assimulia* gen. n. The physiological importance and origin of these structures are discussed in more detail in the general part of one of volumes of this paper which follow. Metriophylloid carinae are very rare in *L. vescum* MOORE and JEFFORDS, 1945, but they have been noted in some instances (pl. 21:1b, c). Both of the structures discussed above have not, as yet, been found in Permian representatives of the genus *Lophotichium*, but they are characteristic for the two genera mentioned above.

WEYER (1972*a*) excluded several paratypes of MOORE and JEFFORDS (1945) from *L. vescum* and removed them from *Lophotichium*, together with *L. amoenum*, *L. densum*, *L. improcerum*, and *Lophotichium* sp. A, all species introduced by MOORE and JEFFORDS (1945). This opinion is not supported by the reinvestigated morphology and development of all the specimens and species questioned. On the contrary, these taxa are so similar to the type species of *Lophotichium*, and especially to the internal variability of *L. vescum*, as to make their independent taxonomic status rather than generic separation doubtful (e. g. fig. 51:4a, b; 5a, b). Each of these species, derived from the same Upper Morrowan Hale Formation as the holotype of *L. vescum* showing intermediate characteristics. In addition to the contrafused minor septa inserted at least near the counter septum and in early ontogeny, the biform tabularium is invariably present. The latter character is not always very obvious because of shortening of the minor septa in mature portions but this is similar to several of the otherwise typical corallites of *L. vescum*. Early ontogenetic stages are identical in both cases discussed: long septal, with the minor septa contrafused. Re-examination of the type material confirmed the broad individual variability of the corals in question, which was already established by MOORE and JEFFORDS (1945). Directions of changes, especially those concerning the minor septa (shortened or permanently long), length of the cardinal septum (shortened in calice and/or shortened well below its floor) in the young stage, presence of the cardinal tabular fossula, and distinction between two positions in the tabularium, permitted including in *Lophotichium* the highly variable Permian species described in this paper, although some of them differ distinctly from the type species by being simplified and similar to *Lophophyllidium* at maturity (*L. simulatum* sp. n.). The absence of records of *Lophotichium* from the long time span (Morrowan — Wolfcampian) may have resulted from a poor knowledge of the American Upper Pennsylvanian rugose corals.

WEYER (1972*a*:456—457) linked *Lophotichium* to an unnamed Lower Tournaisian representative of Petraiinae similar to *Petraiella* RÓŻKOWSKA, 1969 but with the major septa amplexoid and not split peripherally. This genus has not yet been described and WEYER's (1972*a*) concept was later changed (WEYER 1980). In my opinion, there are no genera known as yet leading directly toward *Lophotichium*. It may well be, however, that an ancestral form of the whole family descended from "Petraiinae" de KONINCK 1872, with peripherally continuous (not split) major septa, similar to the specimen illustrated by SCHINDEWOLF (1931, figs. 5—9) and reillustrated by WEYER (1980, pls. 2, 3). Unfortunately the present status of *Petraia* MÜNSTER, 1839 and Petraiidae de KONINCK, 1872 prevents any comparison. None of the genera known to occur in the time span between the Upper Silurian "*Orthoceras* Limestone" and the Upper Carboniferous Morrowan Series can be considered as leading towards *Lophotichium*. As indicated by the type species of the latter it must have possessed a biform tabularium, early inserted, long, contratingent minor septa, and a tendency to shorten the cardinal septum and to elongate the counter septum. None of the Devonian and Lower Carboniferous genera studied so far meets these conditions.

Lophotichium rotundiseptum sp. n.

(figs. 52:1a—f, 53:1—3; pls. 18:10, 11; 19:3—10)

Holotype: Specimen USNM 196959, fig. 52:1a—f, pl. 19:10a, b.
Type locality: USNM 701.
Type horizon: Neal Ranch Formation, Lower Wolfcampian.
Derivation of the name: lat. *rotundus*, a, um — circular, septum — septum; after radial arrangement of major septa

Material. — More than 100 corallites of variable state of preservation. All specimen silicified. Some retained only in a form of external silicified shells with internal structure completely etched out.

N: d ratio of representative corallites (in mm):

USNM cat. nos.	N: d ratio	Remarks
196968	30:10.2 × 10.4	calice margin
196959	30: 9.3 × 8.5	calice margin
„	27: 8.6 × 7.8	just beneath calice
196967	29:13.2 × 13.0	calice margin
196960	29:10.1 × 9.7	just beneath calice
„	24: 7.9 × 6.6	middle of growth
196963	28:12.5 × 12.5	calice margin
196966	26:11.3 × 11.2	calice margin
196962	24:10.4 × 10.2	just beneath calice
„	22: 8.7 × 7.2	early ephebic stage

Diagnosis. — *Lophotichium* having n: d ratio at calice margin up to 31:12.5; major septa short, thin, radially arranged; columella may incorporate 1—3 short septal lamellae; minor septa completely reduced at maturity.

Description of the holotype. — The specimen is more than 30 mm long, irregularly ceratoid, with an attachment flattening occupying almost half of its lower growth (pl. 19:10b). The

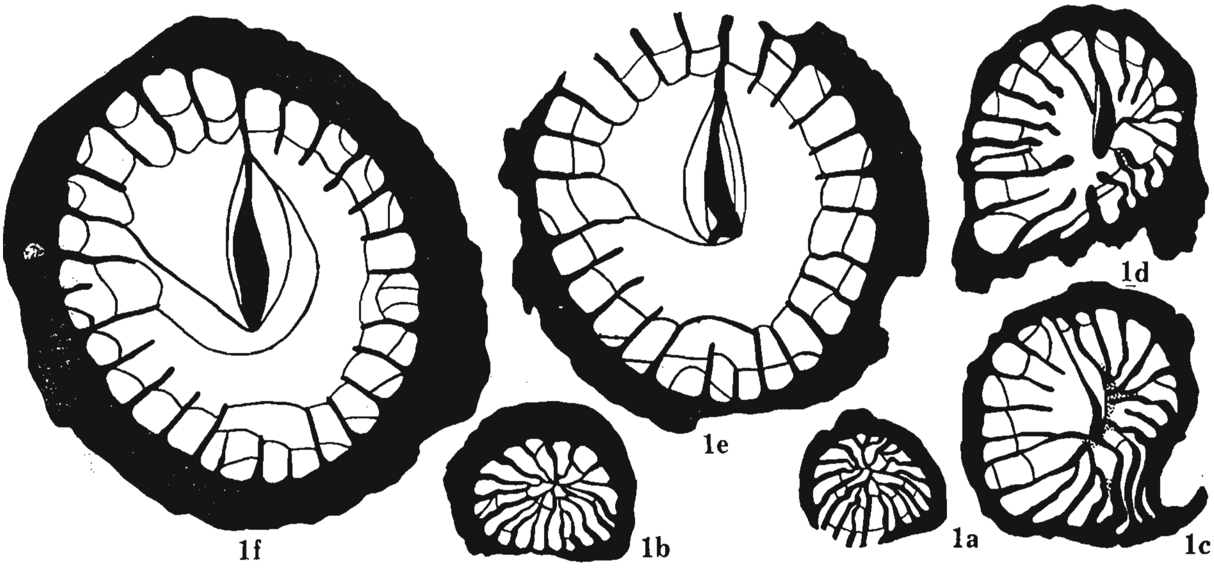

Fig. 52.
Lophotichium rotundiseptum sp. n. Specimen USNM 196959. Holotype. Locality USNM 701, Neal Ranch Formation. Transverse sections; a, b — neanic stage; c, d — early ephebic stage; e, f — ephebic stage. All, ×8.

cardinal septum is located on a convex, flattened side of the tip. The thick external wall bears very delicate septal furrows and growth striae; the former being absent on the tip.

The upper margin of the deeply rejuvenated calice is broken. The inner surface of the old calice shows only very low ribs of the major septa (pl. 19:10a). Major septa in the new calice, including the cardinal septum, are thin and almost equal in length. The alar septa are slightly elongated, but only the counter septum is long, penetrating the axial part of the calice where it forms a pendulum-like columella. The minor septa do not enter the calice, and the loculi between major septa are smooth. Only a single minor septum adjacent to the counter septum is elongated on the surface of the last tabula. This tabula has a shallow depression near the cardinal septum (the cardinal fossula) and rises most highly upwards near the counter septum. A biform structure of the peripheral part of the tabularium does not exist in any septal loculum observed in the calice. Septa are either not elongated on the surface of the last tabula or elongation is very slight.

The morphology of the mature part seen in the transverse sections (fig. 52:1e, f) is closely comparable to that described above in the calice. The moderately thickened columella is monoseptal. The cardinal septum is shorter in this part of growth than in the calice. The major septa, thin and short in the uppermost sections (fig. 52:1e, f), are elongated and may be rhopaloid in sections made just above a level of the shortening of the minor septa (fig. 52:1c, d). The counter septum is already long there.

Ontogeny. — This character was not studied and illustrated in detail, because of poor preservation and deep silicification of the tips of specimens studied. It has been checked in the holotype and in some paratypes that the early ontogeny is typical for the genus and the family. The late neanic stage shows some variability in morphology of the septa that may either be wavy or almost straight and thickened (figs. 52:1a, b; 53:1a, 3a). The arrangement of the septa, and the length and contrafusity of the minor septa are also typical for the genus and family. Rapid reduction of length of the minor septa takes place early in ontogeny (figs. 52:1c, d; 53:1b, 2a, 3b, c), which distinguishes this species from the other described. Up to the stage of shortening of the minor septa, the counter septum did not dominate in length, but at this level of growth it started to elongate, being not always protruded in height, however (pl. 19:9b).

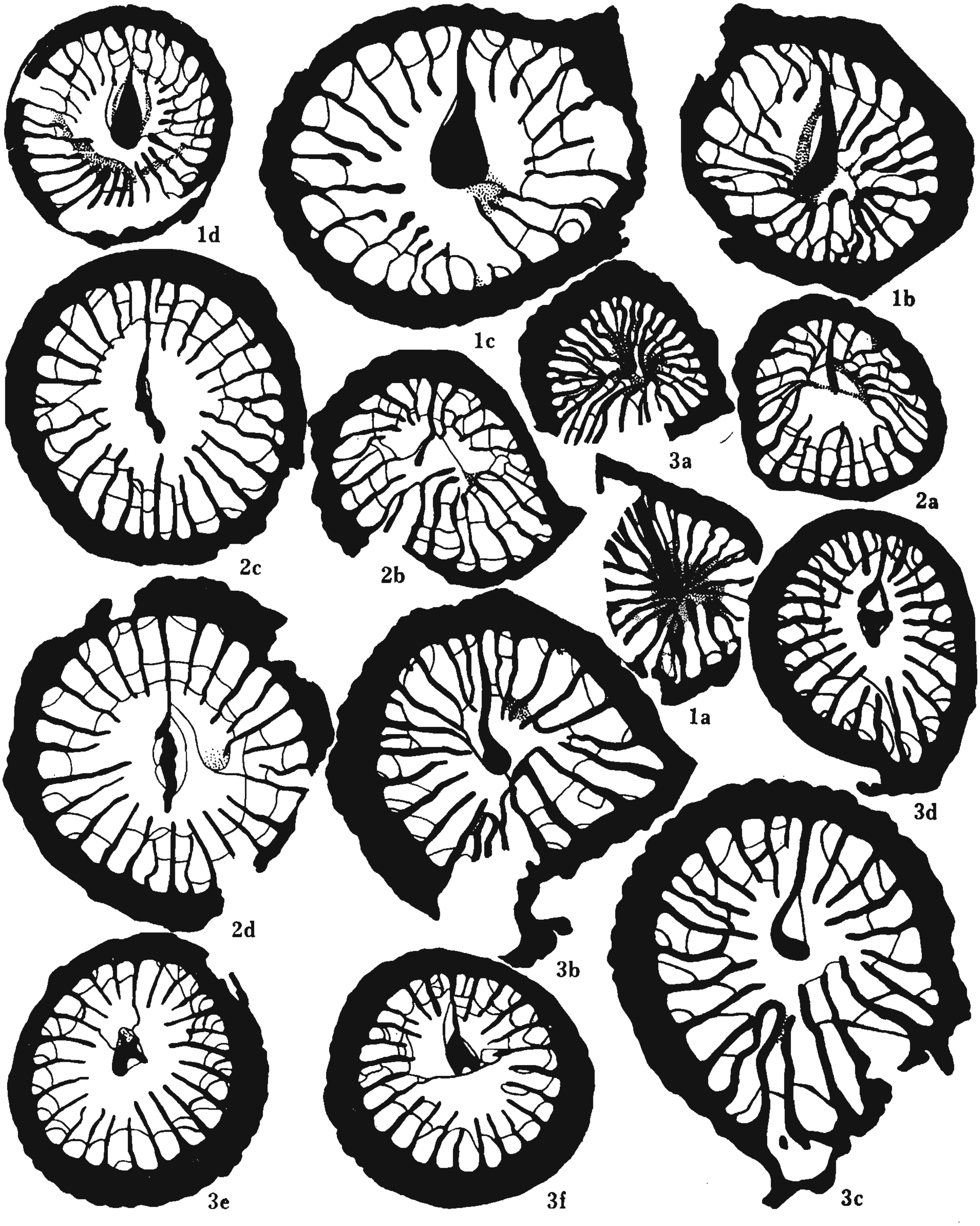

Fig. 53.

Lophotichium rotundiseptum sp. n. Transverse sections. 1. Specimen USNM 196960. Locality USNM 701; a — late neanic/early ephebic stage, × 8; b — early ephebic stage, × 8; c — ephebic stage, × 8; d — late ephebic stage, × 4. 2. Specimen USNM 196961. Locality USNM 701 k, Neal Ranch Formation; a, b — early ephebic stage; c, d — ephebic stage. All × 8. 3. Specimen USNM 196962. Locality USNM 701 a³, Neal Ranch Formation; a — late neanic stage, × 8; b, c — early ephebic stage, × 8; d—f — ephebic stage, × 4.

Longitudinal section. — The longitudinally broken specimen provides several data about the internal structure of the corallites, hardly attainable in ordinary longitudinal sections. The arrangement of the tabulae in the position perpendicular to the cardinal/counter septal plan is oblique because they are inclined downwards much more steeply toward one side of the corallite. This is observed both in the sections made through the columella and behind it towards the cardinal septum (pl. 19:4, in the upper and middle parts of the corallite successively). The tabulae are generally more steep and rise higher on the counter side. This arrangement is often confirmed by transverse sections made through such a tabula (e. g. pl. 18:10c). The cardinal fossula depression is constantly developed on tabulae and it is well seen both in the middle part of the longitudinally broken specimen (pl. 19:4) and on the lower surface of a tabula in the transversely broken specimen (pl. 19:15). As in the holotype, a biform tabularium was not clearly observed at this stage of growth, although the arrangement of the peripheral tabellae on the convex side of the corallite (pl. 19:4, left side) could be interpreted this way.

Individual variability — The structure of the columella may be permanently monoseptal (pl. 18:10a—c) or it may incorporate 1—3 short, thick septal lamellae, and in rare cases, may be temporarily separated from the counter septum (fig. 53:3d—f; pl. 18:11a, b). The thickness of the columella is individualized, varying from very thin to pendulum-like (fig. 53:2a—d, 1b—d). Rare specimens develop comparatively long minor septa adjacent to the counter septum (pl. 19:14a). In most corallites, this character is only weakly marked (pl. 19:5, 13) or not developed at all (pls. 18:10a—c, 11a, b; 19:6b, 7a, b). The minor septa, other than those neighbouring the counter septum, are always restricted to the structure of the external walls or are not seen at all. They are never marked on the internal surface of the inner parts of calices, except their margins.

Shortening of the cardinal septum differs greatly. Being weakly marked in the holotype, it is not shortened in some paratypes (e. g. fig. 53:2a—d; pl. 19:12a) and well shortened in the others (pl. 19:5, 7a, b, 15); some corallites (e. g. fig. 53:1a—d; pl. 18:10a—c) indicate that this character may vary from section to section. Such a large variability makes this character diagnostically unimportant. A cardinal tabular fossula is always present, but its depression may vary in depth from distinct (pl. 19:5, 15) through weak (pl. 19:7a, b, 8, 14) to almost none (pl. 19:12a, 13).

Remarks. — Several morphological characters of the species discussed, as well as trends of variability within it, are typical for the genus and can be observed starting from its Morrowan type species *L. vescum* MOORE and JEFFORDS, 1945 and other species of this age. It possesses larger dimensions and n:d ratio different from these early representatives of the genus. Wavy septa in early ontogeny, very early shortening of the minor septa, and lack of domination of a counter septum in early ontogeny are its main distinguishing characters from that group of species. This is true also for the Permian representatives of the genus here described. The major septa short and equal in length and an almost complete reduction of the minor septa form additional differences when compared to *L. simulatum* sp. n. *L. dugoutense* sp. n. differs distinctly by its long minor septa that are also much thinner than the major septa.

Occurrence. — USNM Loc. 701:23, 701a^3:3, 701d:22, 701k:44, 711l:1, 721g:4, 727e:7, Neal Ranch Formation, Lower Wolfcampian.

Lophotichium dugoutense sp. n.

(figs. 54, 55; pls. 20:12, 14—21; 22:1—6; 23:1—15)

Holotype: Specimen USNM 196975, fig. 54:1a—m, pl. 22:1.
Type locality: USNM 733j.
Type horizon: Skinner Ranch Formation, Sullivan Peak member.
Derivation of the name: dugoutense — after the type area.

Material. — More than 300 silicified specimens representing almost all stages of growth of corallites. Majority with calices and proximal ends preserved. Internal structure of several corallites was destroyed by etching.

N: d ratio of representative corallites (in mm):

USNM cat. nos.	N: d ratio	Remarks
196985	19:7.0	calice margin
196978	19:6.7	calice margin
„	16:5.4	ephebic stage
196981	18:6.0	calice margin
„	17:5.1	ephebic stage
196994	19:7.4	calice margin
196995a	18:7.8	calice margin
196996	16:5.4	calice margin
196999	18:5.8	calice margin
197000	16:5.3	calice margin
196976	20:6.4	middle of calice
196975	18:6 1	ephebic stage
196983	17:5.8	ephebic stage

Diagnosis. — *Lophotichium* having most common n:d ratio 16—18:5.5—7.0, maximum 20:8.0; cardinal septum only sporadically a little shortened; major septa thick at periphery, approaching monoseptal, weak columella; minor septa very thin axially, contrafused in juvenile portion, may in part be free, and shortened at maturity.

Description of the holotype. — Like many other corallites, the holotype was rejuvenated axially. Its parts prior (fig. 54:1 d, e) and after rejuvenation (fig. 54:1 f—h) differ a little in morphology. Its mature portion, investigated in the rejuvenated part (fig. 54:1 h; pl. 22:1) with n: d ratio 18:5.9 (average) has an external wall up to 1.5 mm thick, with the fine structure changed diagenetically to the zig-zag type. The individual sets of zig-zags correspond to the major and minor septa and document total reduction of the latter in some loculi. The minor septa, very differentiated in length, are always thick at the periphery and very thin in their peri-axial portions. Some of them, located in the rejuvenating part of the corallite (fig. 54:1 g), may be attached to the lateral sides of peripheral parts of the major septa. The long minor septa reach the counter septum to form a triad.

The major septa are thick, often wedge-shaped, and almost straight. Their axial ends in the cardinal quadrants incline slightly towards the long cardinal septum that reaches the corallite axis. Those of the counter quadrants are directed toward the axial end of the counter septum. The latter is rhopaloid, with an axial end bent aside. It dominates in length and thickness over all major septa.

The morphology of the early ephebic, rejuvenated part (fig. 54:1 f) differs from a comparable part of the holotype prior to rejuvenation (fig. 54:1 d, e) in having more regularly arranged, thicker and longer major septa, thicker counter septum, and total reduction of the minor septa in some loculi. The sections made just before the rejuvenation started (a stage comparable to fig. 54:1 h is absent in this part of the specimen) demonstrate irregular arrangement and length of the major septa, several of which are shortened. The counter septum is distinguishable mainly by being thickened along all its length, while other major septa thin axially. The minor septa are often free, short and slightly thickened. Only very few of them are elongated, thin-ended and contratingent or contraclined.

A series of longitudinal sections made from the peripheral to the axial part of the mature portion of the corallite (fig. 54:1 i—m) demonstrates the complex morphology of the tabellae

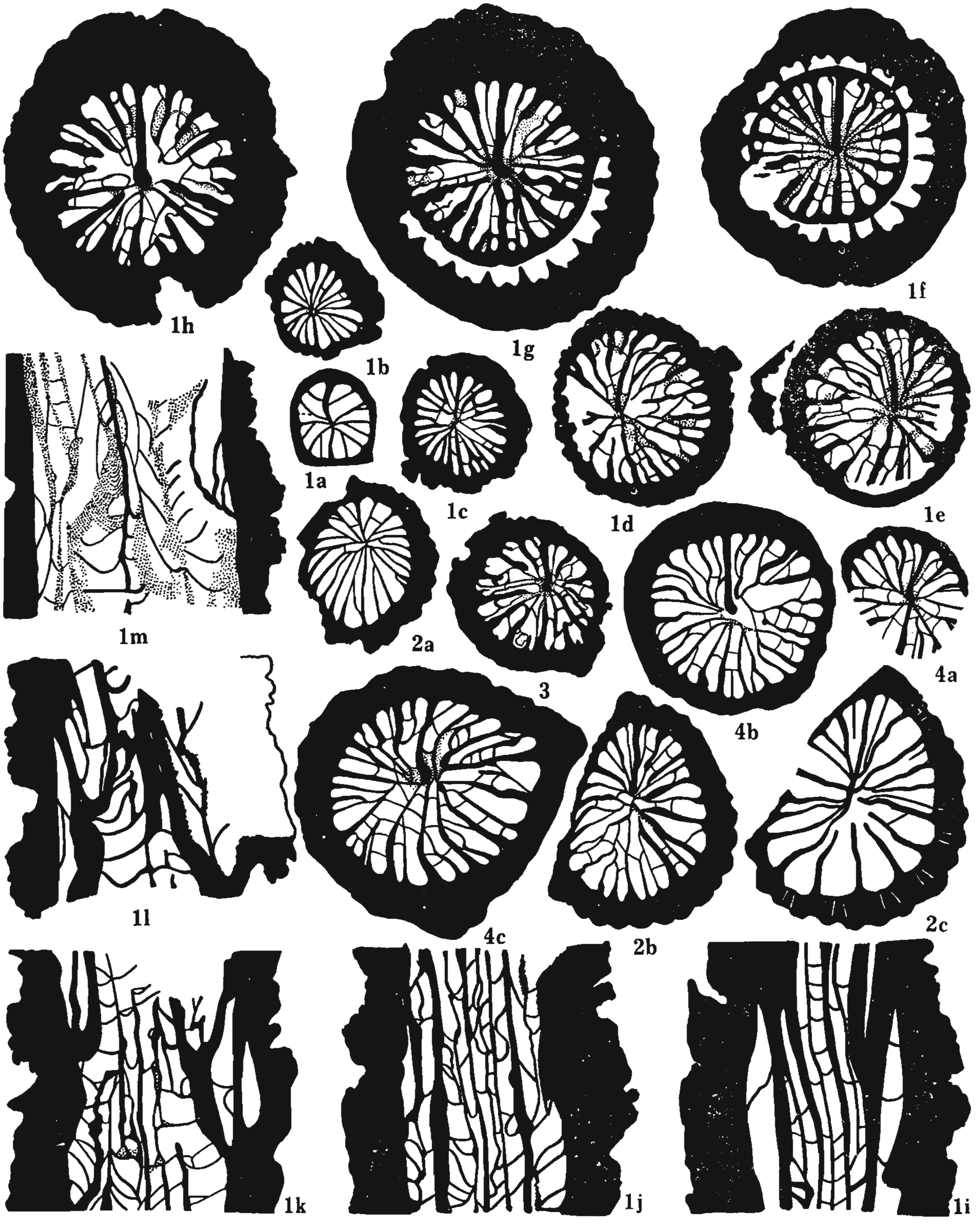

Fig. 54.

Lophotichium dugoutense sp. n. 1. Specimen USNM 196975. Holotype. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member; a — transverse section, early neanic stage, × 16; b, c — transverse sections, neanic stage; d, e — transverse sections, early ephebic stage; f, g — transverse sections, shallow axial rejuvenation; h — transverse section, ephebic stage; i—m — successive longitudinal sections. All, × 8. 2. Specimen USNM 196976. Locality USNM 728e, Lower Bone Spring Formation. Transverse sections; a — neanic stage; b — ephebic stage; c — just above calice floor. All, × 8. 3. Specimen USNM 196977. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Transverse section, early ephebic stage, × 8. 4. Specimen USNM 196978. Locality and horizon as above. Transverse sections; a — early ephebic stage; b, c — ephebic stage. All, × 8.

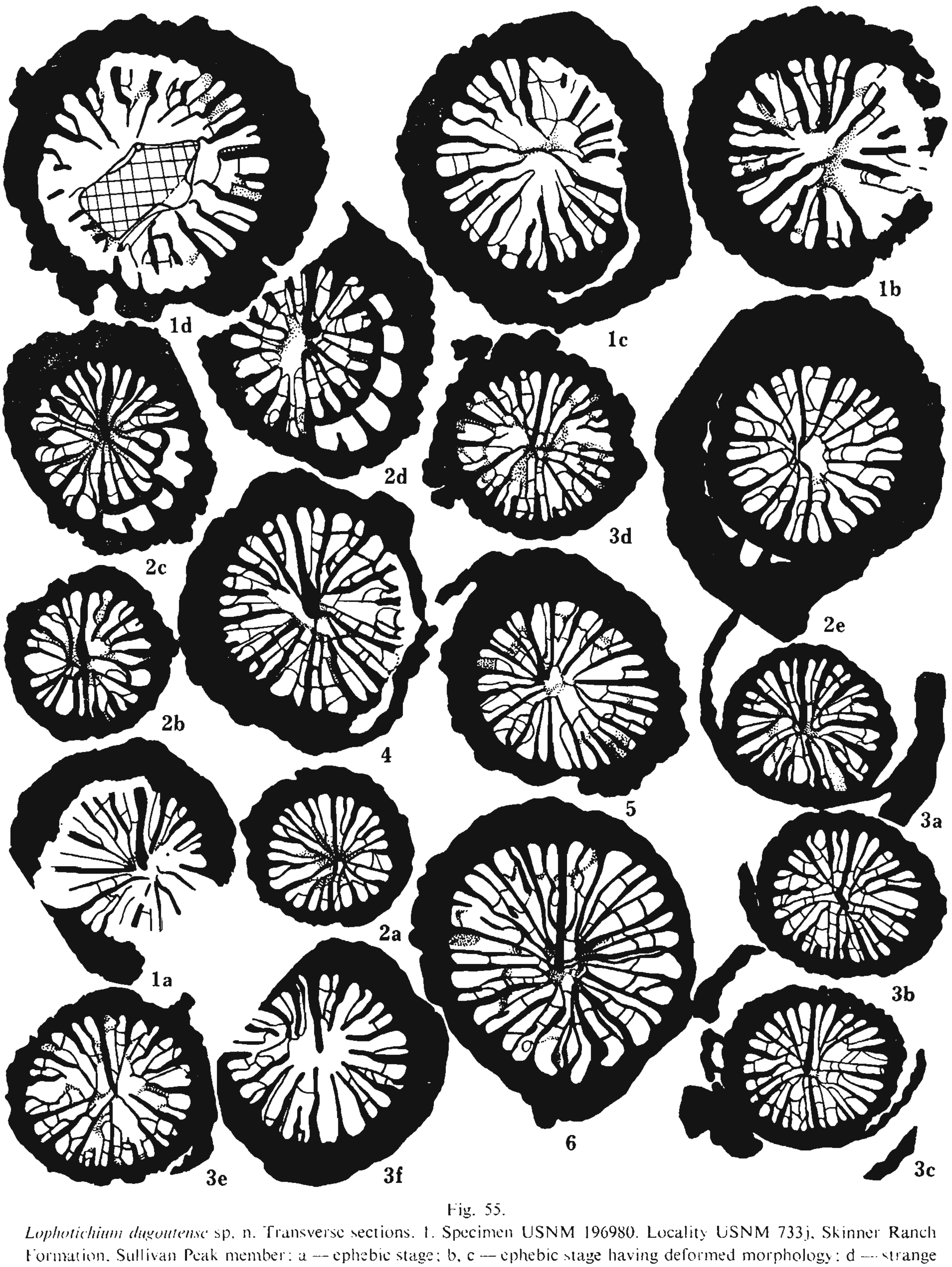

Fig. 55.

Lophotichium dugoutense sp. n. Transverse sections. 1. Specimen USNM 196980. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member: a — ephebic stage; b, c — ephebic stage having deformed morphology: d — strange body overgrown by coral skeleton. 2. Specimen USNM 196981. Locality and horizon as above; a — late neanic/early ephebic stage; b — early ephebic stage, c, d — shallow lateral rejuvenation. 3. Specimen USNM 196982. Locality and horizon as above; a—c — early ephebic stage of deep, laterally axial rejuvenation; deserted calices are completely (3b) or in part omitted from picture; d — ephebic stage. 4. Specimen USNM 196983. Locality and horizon as above. Ephebic stage. 5. Specimen 196979. Locality USNM 720e, Lower Skinner Ranch Formation. Ephebic stage having counter septum harldly recognizable. 6. Specimen USNM 196984. Locality and horizon as above. Ephebic stage. All, ×8.

and their relation to septa. The major septa are always strong and easily distinguishable, but the thin and wavy minor septa, especially in the periaxial part of the corallite (fig. 54:1j, k) are hardly distinguishable from the tabellae, especially in the case of a step or vertical arrangement of parts of the latter.

In the section made axially (fig. 54:1m), the complex pattern of the tabellae and tabulae is still visible. The axial tabulae and tabellae may either rise steeply upwards toward the columella, or are horizontal and partly sagging. Peripheral parts of the tabulae and peripheral tabellae show arrangement in the typical two positions of Sutherland 1965. Some sections of the tabellae (fig. 54:11, m, lower left) are dissepiment-like.

The ontogeny of the holotype has been investigated from the stage of 8 major septa and diameter 1.8 × 1.6 mm (fig. 54:1a). The counter septum dominates in thickness already as early as this stage. The long cardinal septum reaches the corallite axis, but its fusion with the counter septum is uncertain due to poor preservation of this part of the corallite. The long, contrafused minor septa are already present at the counter septum, the counter - lateral septa, the alar septa, and the first pair of metasepta in the cardinal quadrants. All minor septa stay long and contrafused during the first 2.2 mm of growth investigated (fig. 54:1b, c). They became irregularly shortened afterwards, often losing their contrafusity (fig. 54:1d, e), as described above.

Individual variation. — Ontogeny seen in the etched calices. — The ontogenetically youngest, horn-shaped specimen having its convex side 2.7 mm long and having a diameter of 1.1 mm at the calice margin, represents a most probably aseptate stage of development. Both its external surface and the inner surface of the calice show no traces of foundations of septa (pl. 20:15, b). The calice margin is partly broken and partly disfigured by silicification; it cannot provide any certain information about the occurrence of septal undulation at this stage of growth. The calice is 2.2 mm deep. The deeper part of the corallite is filled in with amorphous silica that probably replaced calcium carbonate deposits secreted at the floor of the postlarval calice.

The appearance of the first septa has not been traced in the collection studied. The ontogenetically youngest specimen in this respect is 3.4 mm long, with the calice 1.6 mm deep and 1.5 × 1.3 mm wide at the margin. Its external surface is almost smooth, showing only very delicate growth striae (pl. 23:1a). Septal furrows are not yet developed. The almost complete margin of its calice does not show the undulation characteristic for foundations of septa (pl. 23:1b). The latter are absent also in the upper part of the calice. Four (five?) septa may be distinguished at the calice floor, however. Two of these septa are elongated up on the calice wall. One of them (alar?) reached up to the middle of the calice depth, the second one (cardinal(?)counter(?)) almost reaches the calice margin (pl. 23:1b).

The next juvenile specimen illustrated (pl. 23:9) and several investigated but not illustrated ones invariably exhibit an absence of septal furrows on their external walls. This and the lack of septal furrows on all proximal ends of specimens of Lophotichiidae Weyer, 1972 investigated herein, suggests that this character is general (diagnostic?) for the whole family.

The collection studied does not contain well preserved specimens representing the stage of first appearance of metasepta and minor septa. All better preserved specimens (e. g. pl. 23:5) represent a slightly more advanced stage of development, with an arrangement of septa similar to zaphrentoid and with the cardinal and the counter septum dominating. They either form a continuous axial septum or come so close to each other as to meet at the corallite axis. Minor septa, most commonly underdeveloped, may in some calices be seen from a calice margin down to the middle part of it (pl. 23:9).

The increase of septa depends on corallite diameter. Specimens having narrow calices, although long, possess septa increasing slowly, while corallites with wide calices produced many foundations of septa at the calice margins. The number of septal blades in the inner parts of such calices remains restricted, however. In some young calices (pl. 20:14), the cardinal septum may slightly dominate over the counter septum.

There is some discrepancy in morphology (and morphogenesis?) between the youngest (pls. 20:15a, b; 23:1a, b) and the ontogenetically slightly more advanced specimens (pls. 20:14; 23:5, 9) as to the sequence of appearance of foundations of septa: first at a calice floor or at its margin. This problem will be more widely discussed in one of volumes of this paper which follow.

External characters (pls. 20:12, 14—21; 23:1—15). — Corallites are elongated, having an average diameter to length ratio = 1:3—1.5, irregular in shape, often horn-shaped, with the cardinal septum located on their convex side. Short attachment processes are commonly present; attachment flattenings occur only in the juvenile portions, and talons have not been observed. Several specimens are cemented to calcareous algae (now silicified), bryozoan colonies, brachiopod shells or form groups attached to each other (pl. 23:15). Rejuvenescence, almost exclusively axial and often very deep, is commonly observed (pls. 20:12b, 17a, b; 23:2—4, 7, 10a, 11). External surfaces of corallites bear delicate growth striae and distinct but shallow septal furrows (pl. 20a, 20:12a, 16b, 19a, 21b). Calices (pls. 20:12b, 14, 16a, 17b, 18, 19, 20a, 20b, 21a; 23:1—15) are up to 12 mm deep, with approximately 2 mm wide marginal zones undulated into small, shallow, equally developed foundations of the major and minor septa. The narrow intermediate zone of the calices is characterized by elongation of blades of the major septa and disappearance of the minor septa, which became incorporated into the external wall (pls. 20:12b, 17b, 21a; 23:3a, 4, 6, 9). Traces of the minor septa in the internal zone of calices may sometimes be distinguished as low elevations in the middle parts of septal loculi; well developed blades of the minor septa are not seen in these parts of the calices, however. The counter septum is the most prominent septum in calices, but it did not produce a prominent columellae. The cardinal septum is most commonly the second in length, and alar septa are often the third. Shortening of the septa in quadrants is regular, but the bilateral symmetry may be camouflaged by irregular curvature of the corallites, causing some irregularity in the arrangement of septa. All differences in the morphology between the calices and the thin sections e. g. figs. 54:2a—c, 4a—c; 55:2a—d; pls. 20:18, 19b; 23:10a took place just above the calice floors and on their level.

The calice. — General morphology of the calices was described above within the paragraph "External characters". The following discussion is restricted to the variability of some more important structures. The general morphology of calices is mentioned only when necessary.

A variant most common for the species, including well over half the specimens, shows the cardinal and the counter septum dominating and meeting but not uniting at the corallite axis; other major septa fairly long, coming very close to the former two; and individual quadrants well defined due to shortening of the last pairs of major septa (pls. 20:16a, 21a; 23:3b, 6, 8). All juvenile specimens pass through this morphology, increasing the total number of representatives of this variant. Being most common among small and medium sized corallites, it may also include the largest within the collection. In several large calices the major septa withdraw a little from the corallite axis, but the cardinal and the counter septum remain elongated. A columella never occurs, but the counter septum dominates a little over the cardinal septum (pl. 23:3a, 6, 8) or, less commonly, these two septa are equal in length and height (pl. 20:21a). They remain elongated also in the case of shallow rejuvenation (pls. 20:12b; 23:7, 11).

A group of the short septal specimens (pl. 23:2, 13) may either be considered a separate variant or extreme representatives of the main variant described above. They are always large specimens and may possibly be considered intermediate between the main variant and the rare variant of corallites with the major septa in the calice not differentiated in length (pl. 20:19b). This morphology follows the stages of growth with the counter septum weakly elongated. The short septal group of specimens (pl. 23:2, 13) may also be considered as leading towards a group of specimens with only a counter septum dominating and with all other major septa more or less withdrawn from the corallite axis. The cardinal septum in this group of specimens may either be equal to other major septa (pl. 20:18) or may be slightly shortened (pl. 23:3a, 12). The last variant invariably includes the largest corallites. Juvenile corallites do not show this morphology.

Transverse sections. — The morphology of calices looks at first glance fairly different from that of the transverse sections made just beneath them. This oconcerns the thickness of major septa and especially the rhopaloid, long, counter septum and the length of the minor septa that are almost or entirely absent in calices. These differences resulted from changes in development of the structures in question just above or on the surface of the last tabula. They are hardly, if at all, seen in the calices having long major septa. In the case of the short-septal calices (pl. 20:18, 19b), the arrangement and length of septa beneath the calices may depend on the stage of development (fig. 55:2a—d; pl. 22:6), although individual differences are also noticeable (e. g. pl. 20:18 versus fig. 54:4c, the section made just beneath the calice floor and showing the major and minor septa long). Particular transverse sections of given corallites are morphologically inconstant in several details (figs. 54:2b, c, 4b, c; 55:1a—d, 2b—e, 3a—e). In this context, comparison of the parallel growth stages of separate corallites shows comparatively small individual variation. It can also be stated that variants in the sections and in the calices are parallel and are observed in length and in the mutual relation of the cardinal and the counter septa, in the slight shortening of the cardinal septum in some corallites, thickness and length of the counter septum, and other major septa. Unfortunately, these obsrvations have been made mostly on different specimens, because those with well etched calices often have the internal structure partly destroyed.

One of the corallites investigated in detail (fig. 55:1a—d) differs in the morphology beneath the calice floor from all other specimens in having long, thin-ended cardinal and counter septa, slightly elongated alar septa, and other major septa distinctly withdrawn from the corallite axis. The morphology of the younger part of this specimen (fig. 55:1a), although incomplete shows all the main characteristics typical for the species. The uppermost section of the same specimen (fig. 55:1d) exhibits a strange body (a sharply contoured grain of limestone) closely surrounded by the tabulae. This grain was probably present in the gastrovascular cavity of the polyp, causing changes of the corallite morphology described. Some specimens (e. g. figs. 54:3; 55:6) have several long septal carinae imitating the longitudinal splits of major septa. Individual carinae of this kind are observed in most of the sectioned specimens of the species discussed.

Minor septa are very differentiated in length, not only in separate corallites, but also in individual sections of the same corallites and even within a single section (figs. 54:2b 4c; 55:2e, 3—5; pl. 22:2, 4, 5). In some loculi they may be as long as the major septa, while in some others they may disappear totally. They are fairly often "bipartite". Their peripheral, thickened parts are connected, often with some angle (fig. 55:3e, 6) to very thin, periaxial parts. The latter look like sections of tabulae, but their microstructure is trabecular.

Remarks. — *L. dugoutense* sp. n. is more similar to *L. vescum* Moore and Jeffords, 1945 from the Morrowan of Oklahoma than to most of the species of this genus here described. Better developed contrafused minor septa in the juvenile stage, a thinner columella that never incorporates septal lamellae, much less accentuated tendency to short major septa, smaller dimensions, and slightly different n:d ratio form a set of characters distinguishing it from the type species of the genus.

All of these distinguishing characters are either simplifications of some structures typical for the genus (e. g. columella as a simple elongation of a counter septum) or continuation of juvenile image of other ones into mature portions of corallites (long minor septa, long or weakly shortened cardinal septum, lack of distinct columella). All these characters, as well as absence or advanced underdevelopment of minor septa in calices, bring the species discussed close to *Paraduplophyllum* (*Vacoea*) subgen. n. Some specimens of *P.* (*V.*) *tubaeformis* sp. n. and *P.* (*V.*) *vermiculare* sp. n. have a columella developed in the calices, although this structure is never seen in sections. Some other species *P.* (*V.*) *amplexoides* sp. n. have shortened minor septa in sections. The mentioned similarities, very close indeed, may either be interpreted as advocating against distinction of *P.* (*Vacoea*) subgen. n. as a separate taxon or as an indication that the latter is closely related to *Lophotichium*. The second possibility is accepted herein, although *L. dugoutense* sp. n. is not considered a species intermediate between the genera mentioned. Acceptance of the first attitude to the material must ignore several small but constant qualitative characters. With a number of species described already and present on the higher stratigraphic levels within the collection studied, the genus *Lophotichium* will soon be a "waste-basket" similar to that of *Cyathophyllum* Goldfuss, 1826 some years ago.

Occurrence. — USNM 707d:2, 7221:1, 733j: over 300, Skinner Ranch Formation, Sullivan Peak member; 720e:2, Lower Skinner Ranch Formation; 728e:2, 732e:1, Lower Bone Spring Formation; 738r:1 Cibolo Formation, Breccia Zone. Upper Wolfcampian.

Lophotichium simulatum sp. n.

(figs. 56, 57; pls. 22:7—18; 23:13, 16—20; 24:1—15)

Holotype: Specimen USNM 197007, fig. 56:1a—g, pl. 24:11a, b.
Type locality: USNM 7221.
Type horizon: Skinner Ranch Formation, Sullivan Peak member.
Derivation of the name: lat. *simulatus, a, um,* — seeming — after its similarity to the genus *Lophophyllidium* Grabau, 1928.

Material. — More than one hundred and fourty silicified specimens. Several of them are almost complete, having calices and proximal ends preserved.

N: d ratio of representative corallites (in mm):

USNM cat. nos.	N: d ratio	Remarks
197007	24:11.7 × 11.4	calice margin
„	22: 7.8 × 7.5	just beneath calice
„	22: 6.0 × 6.0	early mature stage
197015	22:10.0 × 8.2	calice margin
„	22: 9.1 × 7.4	mature stage
197011	20: 6.7 × 6.4	calice margin
„	19: 6.5 × 6.0	mature stage
197033	24:10.2 × 9.3	calice margin
197032	24: 9.3 × 8.5	„ „
197034	22: 7.8 × 7.3	„ „
197031	20: 8.5 × 8.0	„ „
197030	21: 7.7 × 7.3	„ „
197029	19: 7.1 × 6.6	„ „
197036	18: 5.3 × 4.7	„ „
197028	17: 5.3 × 5.1	„ „
197027	14: 3.5 × 3.3	„ „

Diagnosis. — *Lophotichium* with n:d ratio at calice margin up to 24:12.0; mature morphology lophophylloid with thin, elongated counter septum; major septa thin; minor septa in mature stage free, shortened.

Description of the holotype. — **External characters** (pl. 24:11a, b). The specimen is elongated, almost conical, only slightly curved, with the cardinal septum located perpendicularly to the curvature. The well preserved external wall bears distinct septal furrows and delicate growth

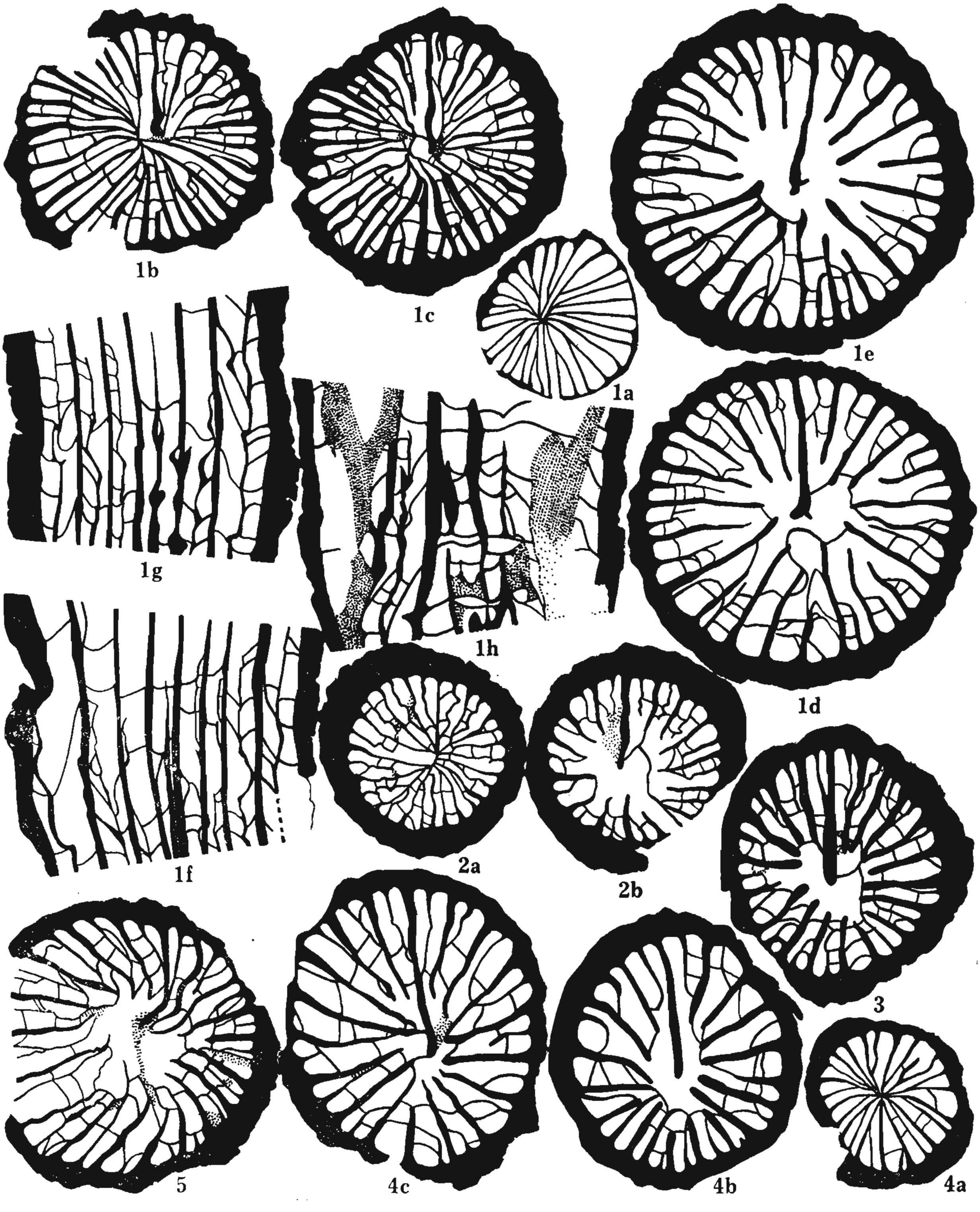

Fig. 56.

Lophotichium simulatum sp. n. 1. Specimen USNM 197007. Holotype. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member; a — transverse section, neanic stage, b, c — transverse sections, early ephebic stage, d, e — transverse sections, ephebic stage; f—h — successive longitudinal sections. 2. Specimen USNM 197008. Locality USNM 738r, Cibolo Formation, Breccia Zone. Transverse sections. a — late neanic/early ephebic stage; b — ephebic stage. 3. Specimen USNM 197009. Locality USNM 720e, Lower Skinner Ranch Formation. Transverse section, ephebic stage. 4. Specimen USNM 197010. Locality and horizon as above. Transverse sections; a — neanic stage; b, c — ephebic stage. 5. Specimen USNM 197011. Locality and horizon as above. Transverse section, ephebic stage. All, ×8.

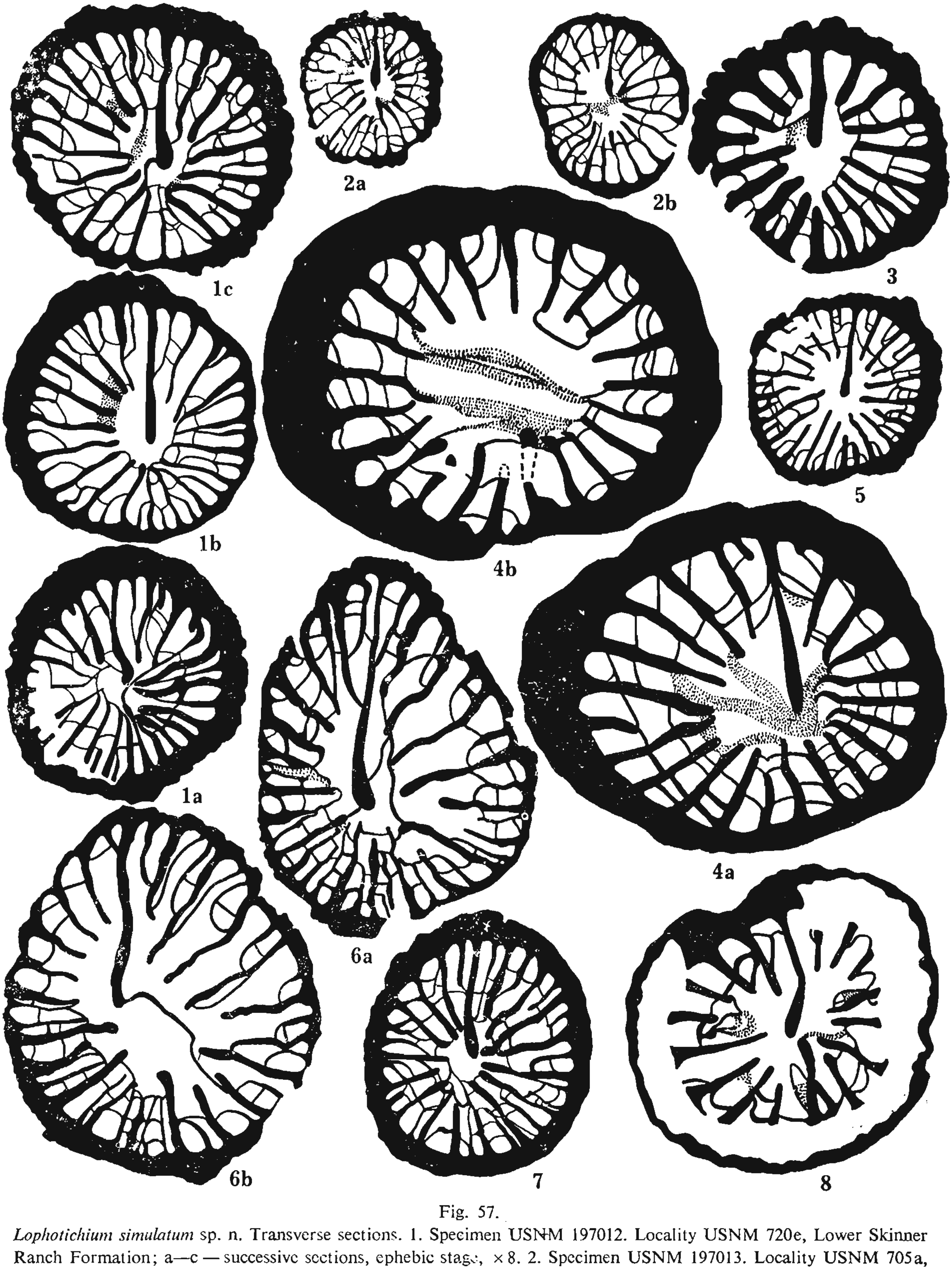

Fig. 57.

Lophotichium simulatum sp. n. Transverse sections. 1. Specimen USNM 197012. Locality USNM 720e, Lower Skinner Ranch Formation; a—c — successive sections, ephebic stage, ×8. 2. Specimen USNM 197013. Locality USNM 705a, Lower Skinner Ranch Formation; a, b — ephebic stage, ×4. 3. Specimen USNM 197014. Locality USNM 720e, Lower Skinner Ranch Formation. Ephebic stage, ×8. 4. Specimen USNM 197015. Locality USNM 728e, Lower Bone Spring Formation; a, b — ephebic stage, ×8. 5. Specimen USNM 197016. Locality USNM 702d, Hess Formation, Taylor Ranch member. Ephebic stage, ×4. 6. Specimen USNM 197017. Locality and horizon as above. Ephebic stage, ×8. 7. Specimen USNM 197019. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Ephebic stage, ×8. 8. Specimen USNM 197018. Locality USNM 720e, Lower Skinner Ranch Formation. Ephebic stage, ×8.

striae. The calice is 14 mm deep, occupying almost a third of the corallite length. The upper margin of the calice, approximately 4 mm wide, bears very delicate, shallow foundations of equally developed major and minor septa. They undergone rapid development in the intermediate zone of the calice and rather slow development in its inner part, becoming almost "h" shaped in the outline (pl. 24:11 b) and leaving a comparatively large axial area of the calice free. The alar septa are slightly and the counter septum distinctly elongated. The axial end of the latter forms a narrow, slightly curved columella, protruded 3 mm above the calice floor. The young corallite developed in the discussed calice *postmortem*, shadows the cardinal septum area.

Internal characters. — In the younger preserved part of the holotype (fig. 56:1a) having n:d ratio 15:3.5×3.1, major and minor septa are almost equally developed, thin, grouped in systems, with many of the minor septa remaining contrafused. The cardinal septum almost meets the counter septum at the corallite axis, being distinguishable only by the arrangement of other major septa. A cardinal septal fossula is not developed, but there is a true tabular fossula present.

The next sections, made 6.5 mm and 7.5 mm above the first one, show a morphology different from both the youngest and the fully mature parts of the specimen (fig. 56:b). It is considered as being at the late neanic stage, because of closer similarity to the former. From all protosepta, only the counter septum is slightly thicker and more prominent than other major septa. It is located in a kind of pseudofossula formed by the arrangement of the minor septa adjacent to it. Either one or both of these septa join not the counter but the counter-lateral septa. The cardinal septum is distinguishable by its slight shortening and by lack of the adjoining minor septa. Other major septa are slightly thicker than the minor septa, but they are only a little longer than them. All septa together form four indistinct systems by having their axial ends joined near the corallite axis.

The morphology of the mature portion of the specimen (fig. 56:1 c, d) resembles that of the genus *Lophophyllidium* GRABAU, 1928. The major septa are slightly rhopaloid or thin, differentiated in length. The well elongated counter septum is slightly thickened axially, where a single septal lamella is additionally incorporated in it. The slightly shortened cardinal septum is located in an inconspicuous fossula. The minor septa do not reach more than half the length of the shortest major septa, being much shorter in most septal loculi. They are almost invariably free. The contratingent-like arrangement of some of them is apparent and was caused by sections of tabulae, connected to their inner ends (contrajunct).

In the longitudinal section of the peripheral parts of the specimen (fig. 56:1 e, g), some septa show lateral protuberations similar to incipient carination. This are also the sections that best show the biform type of tabularium. In the axial section (fig. 56:1 f), the tabulae are irregularly spaced, inclined more or less steeply upwards at the periphery and horizontal or even slightly sagging in the axial area, where they reach the columella. The amplexoid character of the major septa and the relation of septa and tabulae is well illustrated by the broken specimen (pl. 24:13).

Individual variation. — Two main trends of development can be observed. One of them (fig, 57:1 a—c, 7; pl. 22:7, 8) tends towards *L. dugoutense* sp. n. in possessing fairly long major septa, almost equal in length and a comparatively long cardinal septum. The second trend leads towards reduction of the minor septa in mature portions of specimens. Extreme specimens (fig. 57:3, 4, 8; pl. 22:11, 12a, b, 17) reduced their minor septa completely. Some intermediate ones (figs. 56:4b; 57:2a, b; pl. 22:9, 15, 16, 18) have the minor septa very variable in length, up to total reduction in some loculi. Differentiation of length of the major septa and shortening of the cardinal septum are more advanced in the second trend. Length of the counter septum varies in individual specimens independently of other characters, e. g. it may be elongated just beneath the calice and indistinguishable on the calice floor (fig. 56:5; pl. 23:13). Variants in dimensions, although fairly large, are proportional (table).

In calices, the counter septum varies from not elongated (pl. 23:13, 17, 20), through slightly elongated (pl. 24:3, 8b, 9, 14) to distinctly elongated, but only slightly protruded above the last tabula (pls. 23:18a, 19; 24:5b, 7b, 15). The calice floors are always flat in the axial part and distinctly differentiated at the periphery owing to the arrangement of tabulae in two positions. This is well developed also in the case of a total reduction of the minor septa within a corallite lumen (pl. 24:10, 13). The cardinal septum is marked by being located in a deep depression, while a high protuberation of the tabula joins the lateral sides of the counter septum.

Remarks. — The species described is most similar to *L. dugoutense* sp. n., especially in the ontogeny up to the late neanic stage. Up to this level these two species are indistinguishable. The mature morphology of most of the specimens differs distinctly from this and the other so far described lophotiichids in its strongly lophophylloid character.

Occurrence. — USNM Locality 724p:1 Skinner Ranch Formation; 705a:22, 715v:1, 716t:1, 720e:56, Lower Skinner Ranch Formation; 707w:4, Skinner Ranch Formation, Decie Ranch member; 707ha:3, Skinner Ranch Formation, Poplar Tank member; 7221:15, 733j:13 Skinner Ranch Formation, Sullivan Peak member; 7231:1, Skinner Ranch Formation (top); 702d:6, Hess Formation, Taylor Ranch member; 725c:3, 728e:9, 728f:4, 728h:1 Bone Spring Formation; 7281:1, 738r:1, Cibolo Formation, Breccia Zone. Upper Wolfcampian.

Lophotichium sp. 1

(fig. 58:1)

Material. — Single, incomplete specimen having slightly damaged internal structure was available for study. The young corallite existing in its calice was interpreted as having been developed due to a deep lateral rejuvenation or offsetting. Unfortunately the part of that small corallite most important for making that supposition certain was destroyed by sectioning of the old calice.

Description. — The existing part of the widely ceratoid or trochoid corallite is 10 mm long and slightly diagenetically flattened in the cardinal-counter septa plan. The external surface bears narrow, distinct septal furrows. The calice was approximately 5 mm deep, with major and minor septa well developed up to its upper part (fig. 58:1d).

The ontogenetically youngest morphology (fig. 58:1e) is interpreted as resulting from rejuvenation (offsetting?). This is indicated by the structure of two elongated septa of the old calice margin. They form a basis for the attachment of part of the new external wall with some new septa developed on it (fig. 58:1e, lower left). Disconnection of this wall from the rest of the wall that surrounds the young corallite and a seeming duplication of some parts of the wall (fig. 58:1e, lower left) was most possibly caused by curvature of the young specimen and skewness of the section. The lower, marginal part, separated on the picture from the young specimen but connected to the old one, is ontogenetically youngest.

In morphology of the young specimen (fig. 58:1e), the large, trilobate columella dominates. Poor preservation did not permit establishing the complexity of its morphology suggested by the outline. Major septa are long, with several of them connected to the columella. Their arrangement is irregularly pinnate, with the cardinal septum indicated mainly by this arrangement. It does not meet the columella, but it is not distinctly shortened either. The minor septa do not extend more than half the length of the major septa. They are most commonly free or only contrajunct, and rarely contratingent.

The ontogenetically youngest and two subsequent sections of the larger corallite (fig. 58:1a—c) show a morphology slightly different from the described above. The columella is monoseptal, pendulum-like in the youngest section and step by step thinner upperwards. The major septa are long, but they do not meet the columella. Many of them are more or less rhopaloid. The cardinal septum is not shortened, but it may be slightly thinner than the other major septa.

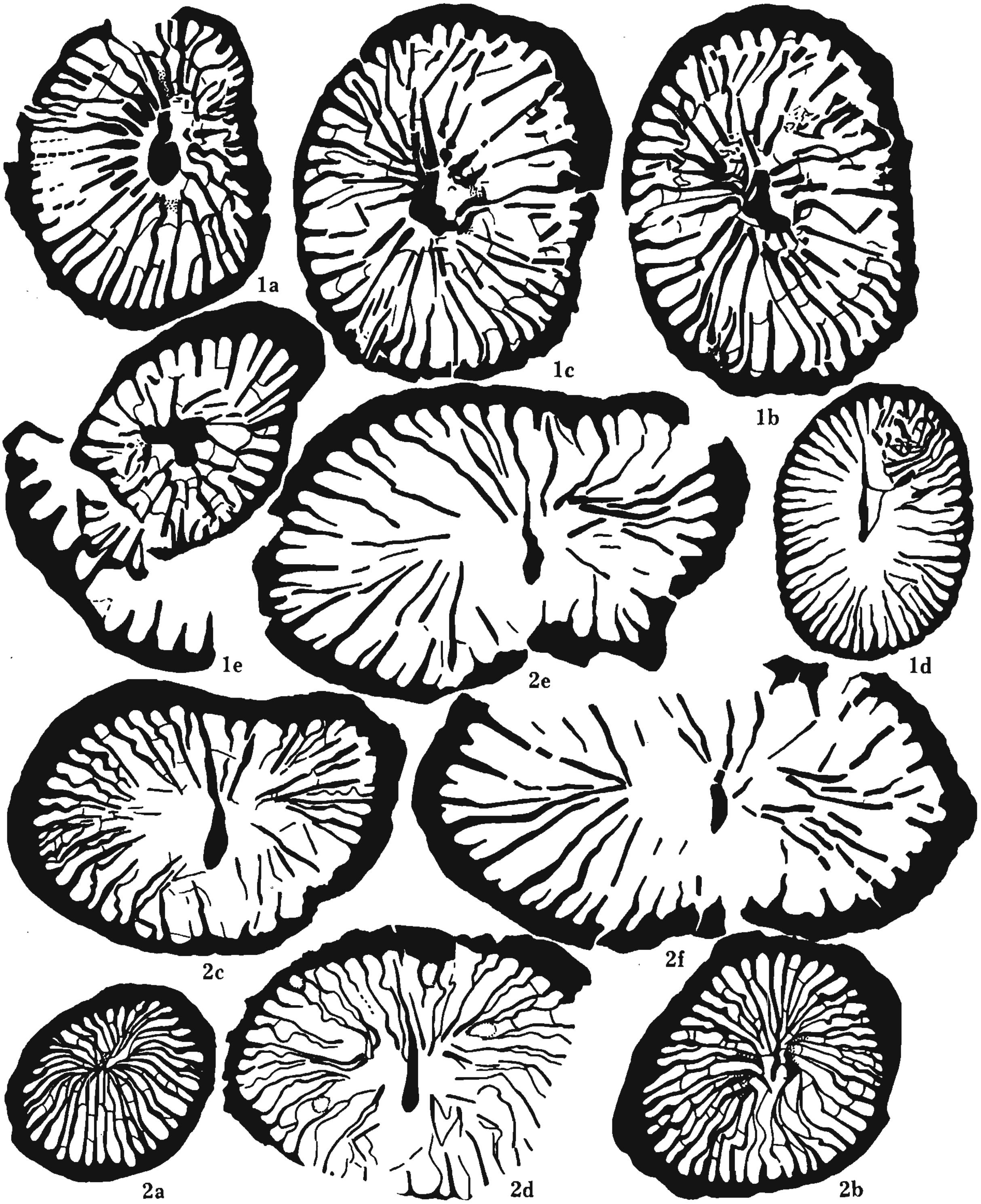

Fig. 58.

1. *Lophotichium* sp. 1. Specimen USNM 197043. Locality USNM 713e, Gaptank Formation, lower bioherm. Transverse sections; a—c — early to late ephebic stage, ×8; d — just above calice floor; foundation of offset (?) upper right, ×4; e — early ephebic stage of offset (?), ×8. 2. *Lophotichium* sp. 2. Specimen USNM 197044. Locality USNM 706x, Neal Ranch Formation. Transverse sections; a — neanic stage; b — early ephebic stage; c, d — ephebic stage; e, f — middle part of calice. All, ×8.

Its shortening is more clearly noticeable in the middle part of the calice (fig. 58:1d). The minor septa beneath the calice reach less than half the length of the major septa, being almost invariably free. Their length in the calice is relatively greater due to shortening of the major septa.

The lower right side of the middle part of the calice (fig. 58:1d) was most possibly an area of a very early stage of lateral rejuvenation (offsetting?). There are some septal bodies not belonging to any old septa, but obviously hanging on them. This small area is filled in with calcite, like all septal loculi beneath the calices, while in the other parts of the calice a sandy matrix occurs. Unfortunately, this small remaining part is inadequate for any detailed description.

Remarks. — The species discussed is geologically oldest of all the species of *Lophotichium* described in this paper. Its precise stratigraphic position within the Gaptank Formation is unknown. COOPER and GRANT (1972—1977) described from this locality the following new species: *Echinauris subquadrata, Limbella costellata, Composita* sp., *Kozlowskia* sp., and *Reticulatia* sp.

The main morphological characters of *Lophotichium* sp. 1, i. e. the only moderately long, mainly free minor septa in the late neanic/early ephebic stage (fig. 58:1e) and the ontogenetically late shortening of the cardinal septum, form a combination of features that distinguish it from the geologically younger *Lophotichium* sp. 2 and from the Morrowan species of *Lophotichium*. From these two characters, the late shortening of the cardinal septum seems phylogenetically important. It is observed also in *Lophotichium* sp. 2, indicating a growth tendency that resulted in appearance of *Assimulia* gen. n. *A. uddenitense* sp. n., the so far oldest representative of the latter genus shows this character well developed.

Shortening of the minor septa, considered here a specific specialization, prevents considering *Lophotichium* sp. 1 as a direct ancestor of *Assimulia* gen. n. The mosaic of characters of *Lophotichium* and *Assimulia* gen. n. observed in the Late Carboniferous — Early Permian indicates that branching off of *Assimulia* gen. n. might have taken place somewhere at the Carboniferous — Permian boundary.

Occurrence. — USNM loc. 713e:1, Gaptank Formation.

Lophotichium sp. 2

(fig. 58:2)

Material. — Single specimen, 25 mm in incomplete length, with the late neanic portion of growth preserved. The approximately 17 mm deep calice, 14.7×9.5 mm in the widest preserved part, is filled in with fabric and is diagenetically flattened. The internal structure is fairly well preserved in calcite.

Description. — The corallite is widely ceratoid, having delicate but distinct septal furrows on its surface. The ontogenetically youngest transverse section preserved, with n:d ratio 19: 4.8×3.8 (fig. 58:2a), shows the morphology typical for the family and genus and similar to *L. rotundiseptum* sp. n. due to a waviness of septa and irregularity of their arrangement. The cardinal septum is located on the convex side of the corallite.

The waviness of septa is a constant character for the specimen discussed, lasting up to the middle part of the calice (fig. 58:2c, d). The highest subcalicular transverse section, with n:d ratio 23:6.5×5.4 (fig. 58:2b), shows the major septa very long, coming close to the counter septum. The latter is elongated to the corallite axis and slightly thickened to form a weak columella. Thickness of the latter increases, becoming the greatest in the middle part of the calice with n:d ratio 24:8.5×6.0 (fig. 58:2c). The cardinal septum remains long up to the calice. Its varying length (fig. 58:2c—f) may be apparent and caused by diagenesis or mechanical destruction. The minor septa remain long and contratingent in the lower part of the calice, but their blades are developed also in the upper part of the latter with n:d ratio 25:10.5×7.0 and 25:11.7×7.0 (fig. 58:2e, f).

Remarks. — The specimen described, in its ontogenetically youngest known part is most similar to *L. rotundiseptum* sp. n., but its further growth differs completely in the long lasting minor septa. This a character may be compared to *L. dugoutense* sp. n. and to some specimens of *L. simulatum* sp. n. Septa in both these species are straight, with the majoı and minor septa distinctly differentiated in thickness, columellae are thinner, dimensions much smaller, and n:d ratios different. It resembles most closely *Lophotichium* sp. 1, also represented by a single specimen. Slightly rhopaloid major septa of the latter, its contrajunct or free minor septa in the subcalicular region, and shallower calice form major distinctive characters from *Lophotichium* sp. 2. Both these specimens were described because of their possible value for phylogeny of Lophotichiidae, although their preservation is poor.

The early ephebic stage of the specimen discussed (fig. 58:2b) can be closely compared to the ephebic stage of *Assimulia uddenitense* n. sp. from the *Uddenites*-bearing member of the Gaptank Formation. Development of such a morphology in the geologically younger representative of *Lophotichium* here described, i. e. of the genus considered here as possibly ancestral for *Assimulia* gen. n., is one more indication of close relation of these two taxa.

Occurrence. — USNM loc. 706x:1, Neal Ranch Formation.

Genus *Assimulia* gen. n.

Type species: *Duplophyllum septarugosum* Moore and Jeffords, 1945

Synonyms: Duplophyllum Moore and Jeffords, 1945, *non* Koker, 1924, *Stereostylus* Ross and Ross, 1962, *non* Jeffords, 1947.

Derivation of the name: lat. *assimulo* — to imitate — after its similarity to *Lophotichium* Moore and Jeffords, 1945 and *Epiphanophyllum* Ilina, 1970.

Subgenera assigned: Assimulia subgen. n., *Ericina* subgen. n.

Diagnosis. — Lophotichiidae having major and minor septa long in funnel-shaped calices; columella not developed in calices, but counter septum may be well elongated in sections; cardinal septum not shortened; septa, especially minor, strongly wavy and/or disintegrated into zig-zag carinae.

Remarks. — The family status and possible inter-relations of genera here included in Lophotichiidae Weyer, 1972 were discussed in several aspects in remarks on the family, on the genera *Lophotichium* Moore and Jeffords, 1945 and *Paraduplophyllum* (*Vacoea*) subgen. n. The following remarks are restricted to a simple morphological comparison of *Assimulia* gen. n. to the related or similar genera and to pointing but distinctions and similarities between the subgenera distinguished.

Assimulia gen. n. differs from *Lophotichium* Moore and Jeffords, 1945 first of all in possessing funnel-shaped calices having both cycles of septa well developed and in having the cardinal septum never shortened more than other major septa. In some instances it is longer than neighbouring major septa. In calices of the nominative subgenus, the cardinal septum may be one of the highest protruded major septa, sometimes equalling the counter septum. Such a development of the cardinal septum is never observed either in the Morrowan type species or in the Permian representatives of *Lophotichium*. It should be mentioned, however, that the cardinal septum in *L. dugoutense* sp. n. shows several similarities to those mentioned above. The cardinal septum in calices of *A*. (*Ericina*) subgen. n., located in the inconspicuous but clearly seen cardinal fossula, may protrude slightly less than other major septa. Even there it is not shortened, however.

The rhopaloid characteı of major septa, the disintegration of septa into zig-zag carinae, especially well developed on the minor septa, the development of the elongated counter septum rather than a columella, and the lack of tendency to shorten the minor septa, are additional characters developed in all or in some representatives of *Assimulia* gen. n., but not present or only sporadic and underdeveloped in *Lophotichium* Moore and Jeffords, 1945.

Genus *Epiphanophyllum* ILINA, 1970, very distinct from *Assimulia* gen. n. if oriented as originally proposed by ILINA 1970, comes close to it when reoriented and its columella forming septum considered as the counter septum. This problem has been discussed in more detail by FEDOROWSKI (1986 *a*). Supposing this reorientation correct, there will still remain the following differences between *Assimulia* gen. n. and *Epiphanophyllum* ILINA, 1970:1. Extremely long minor septa that not only are longer than the major septa but often join each other above the latter, including the reinterpreted cardinal septum. 2. Several bends of most of the minor septa are so distinct as to form plates joining the neighbouring major septa in the manner of transverse sections of tabulae in Position II of SUTHERLAND 1965. 3. Axial parts of tabulae are concave not convex or flat like those in *Assimulia* gen. n.

The listed differences are, in my opinion, substantial enough to distinguish the discussed genera, even if the cardinal septum is positioned as reoriented and if the not yet known early ontogeny of *Epiphanophyllum* appears to be similar to that of *Assimulia* gen. n., which is predicted here. *Epiphanophyllum*, a highly Upper Permian genus may well be considered descendent of *Assimulia* gen. n., however.

Distinction between *Paraduplophyllum* (*Vacoea*) subgen. n. and *Assimulia* gen. n. may in some instances be difficult. This concerns mainly *A.* (*Ericina*) subgen. n., the more primitive taxa of *P.* (*Vacoea*) subgen. n. and *P.* (*Paraduplophyllum*) *multiplicatum* sp. n. In sections all these taxa exhibit a similar grouping of the major septa and absence of the columella. The zig-zag carinae in *A.* (*Ericina*) subgen. n. *versus* smooth septa in primitive *P.* (*Vacoea*) subgen. n. form the main differences. This would be considered inadequate if there were not substantial differences in depth and structure of calices. The latter character, considered here as physiologically important and genetically well determined, was the main basis for distinction of the taxa discussed and for placing *A.* (*Ericina*) subgen. n. in close relation to *A.* (*Assimulia*) subgen. n.

The two subgenera mentioned differ most clearly in their transverse sections. The commonly continuous septa of both cycles, the rhopaloid majorsepta, and the elongated counter septum in *Assimulia* (*Assimulia*) subgen. n. are replaced by the disintegrated, sharply ended major septa and the unelongated counter septum in *A.* (*Ericina*) subgen. n. As stated above, calices of both subgenera discussed are very similar, but the cardinal septum in *A.* (*Ericina*) subgen. n. is slightly less protruded and located in a more easily distinguishable cardinal tabular fossula than that of *A.* (*Assimulia*) subgen. n.

The differences listed above are not always clear in *A.* (*A.*) *flexibilis* sp. n. A very broad internal variability of this species (see description), with several trends of development, places it as morphologically intermediate between the subgenera discussed. Closer agreement of most of the specimens of this species with *A.* (*Assimulia*) subgen. n. reflects placement this taxon.

Genus *Asserculinia* SCHOUPPÉ and STACUL, 1959, emended and discussed by FEDOROWSKI (1986), can formally be compared with *Assimulia* gen. n. as having the columella built from a counter septum. Its different ontogeny, comparable only to that of *Duplocarinia* FEDOROWSKI, 1986, the short minor septa that became free in early ontogeny, and the metriophylloid carinae facilitated its distinction from *Assimulia* gen. n.

Subgenus *A.* (*Assimulia*) subgen. n.

Type species: as for genus

Synonyms: as for genus.

Species assigned: Duplophyllum septarugosum MOORE and JEFFORDS, 1945, *Stereostylus tergidus* ROSS and ROSS, 1962, *A.* (*A.*) *abscessa* sp. n., *A.* (*A.*) *arta* sp. n., *A.* (*A.*) *compacta* sp. n., *A.* (*A.*) *flexibilis* sp. n., *A.* (*A.*) *frequentis* sp. n., *A.* (*A.*) *uddenitense* sp. n., *A.* (*A.*) sp. 1.

Diagnosis. — As for genus, but septa only sporadically disintegrated; major septa slightly rhopaloid; counter septum permanently elongated in mature sections.

Remarks. — As for genus.

TABLE 12

Morphologically-comparative table of species of *Assimulia* gen. n.

Name of species	CALICE											BENEATH CALICE								
	Shape	Major septa		Minor septa		Cardinal septum		Counter septum		Cardinal fossula	Columella	Arrangement of major septa	Axial area	Morphology of major septa	Thickness of major/minor septa	Minor septa	Counter septum	Cardinal septum	N: d ratio	
		Wall	Floor	Wall	Floor	Wall	Floor	Wall	Floor										from — to	commonest
Assimulia (*Assimulia*) *uddenitense* sp. n.	Lack of observations											Radial to semi-pinnate	Small, free	Slightly wavy and rhopaloid	Almost equal	Very long, contratingent, contraclined	Slightly elongated	Tend to shorten	25:6.7	?
Assimulia (*Assimulia*) *tergida* (Ross and Ross, 1962)	Funnel-shaped; 1/4—1/8 of corallite length	Elongated downwards	Meet or almost meet at axis	Shorter and thinner than majors	Contratingent, long	May be a little protruded in some	Often protruded	May be slightly protruded lowermost	Slightly or well protruded	Very narrow and shallow	Counter septum highly protruded	Radial	Small, free, sporadically wide	Strongly wavy, noncarinated, rhopaloid	”	Long, contratingent, contraclined or free	Elongated; often to form columella	May be a little elongated in some	18—26:4.5—10.0	21—22:5.7—7.0
Assimulia (*Assimulia*) *arta* sp. n.	Lack of observations											Radial to semi-pinnate	Stereoplasmic infilling or septa meet axially	Wavy; in external wall often split	Slightly differentiated	Long, contratingent or contraclined	Elongated, axially thickened	Vary in length in individual sections	25—27:9.8—14.5	?
Assimulia (*Assimulia*) *abscessa* sp. n.	Funnel-shaped; 1/3—1/5 of corallite length	”	Almost meet at corallite axis	”	”	Equal to other major septa	Rarely slightly protruded	Equal to other major septa	Often slightly protruded	? absent of very shallow	Absent	Radial	Major septa almost in touch axially	Rhopaloid; zig-zag carinae may occur at periphery	Differentiated	As above; zig-zag carinae common at periphery	May be elongated in some sections	May be elongated in some sections	18—24:4.5—8.5	20—22:5.5—7.0
Assimulia (*Assimulia*) *flexibilis* sp. n.	Funnel-shaped; 1/3—1/4 of corallite length	”	As above; bent towards cardinal s.	”	”	May be a little protruded downwards	”	Often slightly protruded	In most strongly protruded	”	Rarely present	Semi-pinnate; in counter quadrants slightly shorter	Rarely free; often septa meet axially	Wavy, bent towards cardinal septum; zig-zag carinae occur	Slightly differentiated	As above; rarely free	Commonly longer than adjacent septa	”	11—21:2.5—6.0	13—16:3.0—4.5
Assimulia (*Assimulia*) *frequentis* sp. n.	Funnel-shaped; 1/2—1/4 of corallite length	”	Meet at corallite axis	Disappear between major septa	”	Slightly protruded downwards	May protrude more than counter septum	Slightly protruded	Slightly or well protruded	Absent	Absent	Almost radial; juvenile arrangement long-lasting	Septa meet in or come close to axis	Rhopaloid, slightly wavy, thickened at periphery	”	Some may be free and rhopaloid; contratingent	Commonly elongated; may form columella	”	20—27:5.7—7.1	22—24:5.2—6.1
Assimulia (*Assimulia*) *compacta* sp. n.	Wide, fairly empty, deep	Slightly elongated downwards	Almost meet at corallite axis	Shorter and thinner than majors	Contraclined or free	Equal to other major septa	May be slightly shortened	Equal to other major septa	Equal to other major septa	Very narrow and shallow	”	Semi-pinnate, in irregular systems	Stereoplasmic infilling; septa almost meet	Slightly wavy, laterally smooth, smooth	”	Vary in lenght; contratingent and contraclined	Longer; may be thicker than major septa	Equal to other major septa	26:12.0—14.0	?
Assimulia (*Assimulia*) sp. 1	Septa broken; calice 13.5 mm deep	Elongated downwards; radially arranged	Pinnately-bilateral	Free; moderately long	”	”	Reach corallite axis	”	Slightly elongated and thickened	Narrow, distinct	Weak present	Pinnately-bilateral; middle septa of quadrants are longest	”	Thick, straight, rhopaloid	”	Free; laterally contiguous with major septa	Reach cardinal septum axially	Reach counter septum axially	27:13.7	?
Assimulia (*Ericina*) *fracta* sp. n.	Funnel-shaped; 1/2—1/4 of corallite length	Elongated downwards	Meet at corallite axis	Shorter and thinner than majors	Long, contraclined	”	May be slightly less protruded	”	Slightly to distinctly protruded	Very narrow and shallow	Absent	Semi-pinnate in irregular systems	Rarely free; commonly major septa in touch	Nonrhopaloid; strong to moderate zig-zag carinae	Differentiated	Very long, contratingent; zig-zag carinae at periph.	May be slightly elongated	Equal to other major septa	18—24:4.9—10.8	20—22:7.5—9.0
Assimulia (*Ericina*) *recrea* sp. n.	Funnel-shaped; 1/3 of corallite length	”	Stop around axis	Often short	Long, contratingent or contraclined	”	”	”	May be slightly protruded	Very shallow	”	In four systems	Rarely free or stereocolumn	Slightly rhopaloid and wavy; thickened at periphery	”	”	Reach cardinal septum axially	Reach counter septum axially	15—24:3.5—10.5	20—22:7.0—9.0

Assimulia (*Assimulia*) *uddenitense* sp. n.

(fig. 59)

Holotype: Specimen USNM 197045, fig. 59:1 a—j.
Type locality: USNM 701 p.
Type horizon: Gaptank Formation, *Uddenites*-bearing member.
Derivation of the name: uddenitense — after the type horizon of occurrence.

Material. — Only the holotype. The specimen is slightly abraded, with no calice and proximal end. Internal structure well preserved.

Diagnosis. — *Assimulia* with n:d ratio beneath calice 25:6.7; slightly wavy nonrhopaloid major septa arranged in systems in early ontogeny, pinnately radial in mature portion; cardinal septum tends to shorten; counter septum elongated.

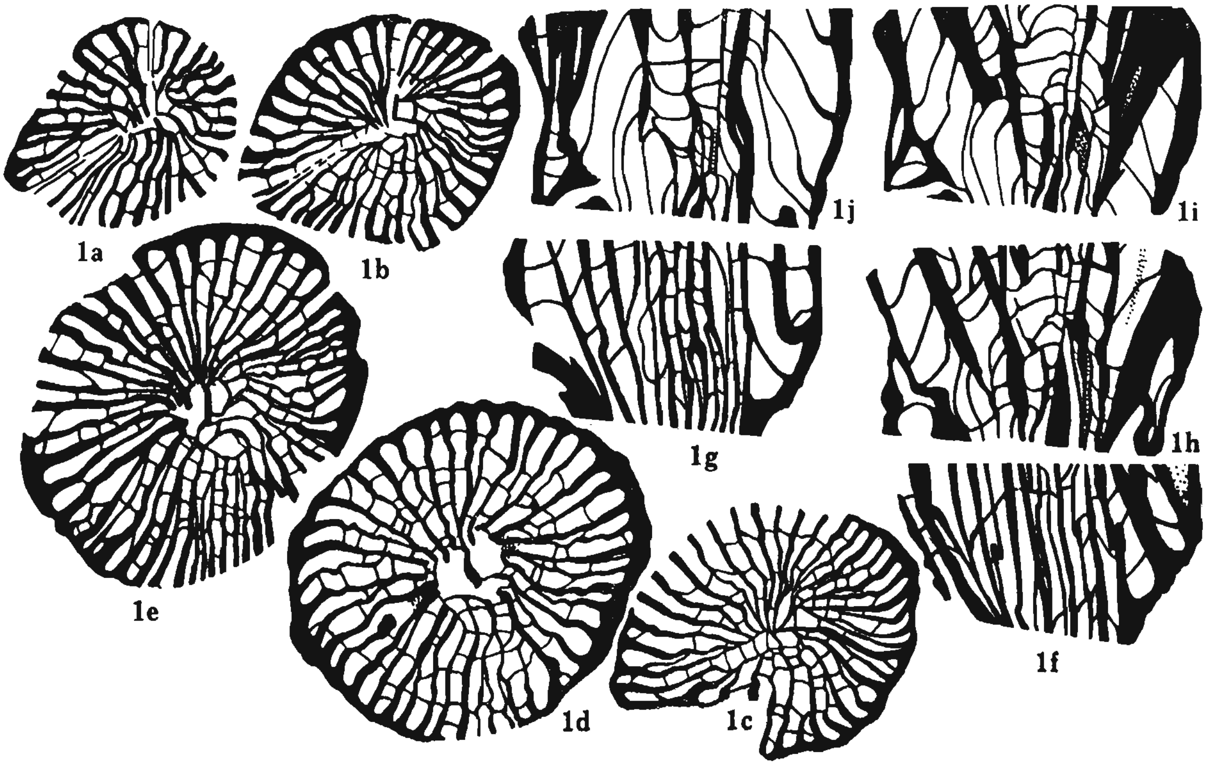

Fig. 59.
Assimulia (*Assimulia*) *uddenitense* sp. n. Specimen USNM 197045. Holotype. Locality USNM 701 p, Gaptank Formation, *Uddenites*-bearing member; a—c — transverse sections, neanic stage; d, e — transverse sections, ephebic stage; f—j — successive longitudinal sections made from corallite periphery to its axis. All, × 8.

Description. — The morphology of the youngest known part of the corallite, corresponding already with the late neanic stage (fig. 59:1 a—c) is characterized by long, slightly wavy major septa, grouped in systems. The cardinal and the counter septum may be temporarily disconnected. Minor septa increase their length in the course of growth. On the youngest known stage of growth, (fig. 59:1 a, b) several of them may be free. Higher up, almost all or all of them are contratingent and very long.

Arrangement of septa in the mature portion (fig. 59:1 d, e) is pinnate rather than radial, but the axial area is free of septa. The distinctly elongated counter septum forms a kind of a simple columella. The cardinal septum, although not shortened, tends to decrease its length and thickness. Some major septa may be slightly rhopaloid, especially when sectioned just on their junction with tabulae. This is not the rule, however.

In the serial longitudinal section, made between the transverse sections (fig. 59:1c, d) the minor septa are often so sharply curved at the periphery as to give the impression of being broken (fig. 59:1f). The tabularium is biform, with tabellae in Position I better distinguished in the very peripheral section (fig. 59:1f), but seen also on the other sections (fig. 59:1g—j). The tabulae in Position II are inclined steeply upwards in their periaxial parts, being horizontal or almost horizontal at the periphery. Their axial parts are horizontal, sagging, or even directed slightly downwards (fig. 59:1i, j).

Remarks. — The new specific name has been given for the single specimen for three reasons: 1. It is the geologically oldest representative of one of the largest group of species of the fauna described. It may also be close to the ancestral taxon of this group. 2. It represents a mixture of characters, developed separately in the geologically younger taxa. 3. Being similar to some other species, it stays in each case beyond the limit of their internal variability.

Two species: *A.* (*A.*) *tergida* (Ross and Ross, 1962), with its similar n:d ratio, and *A.* (*A.*) *compacta* sp. n., with its arrangement of septa, seem to be especially close to the species discussed. The former differs from *A.* (*A.*) *uddenitense* sp. n. in its almost regular radial arrangement of rhopaloid major septa, slight elongation of a cardinal septum, that never tends to shorten and in more wavy and often free minor septa. The main differences of *A.* (*A.*) *compacta* sp. n. are: different n:d ratio, much larger size, a counter septum often not elongated in the mature part, and the cardinal septum not tending to shorten.

Occurrence. — USNM 701p, Gaptank Formation, *Uddenites*-bearing member.

Assimulia (*Assimulia*) *tergida* (Ross and Ross, 1962)

(figs. 60, 61; pls. 22:19—26; 25:1—13)

1962. *Stereostylus tergidus* Ross and Ross; C. L. Ross and J. P. Ross, p. 1186, figs. 40, P, 11; pl. 161:12, 21, 22.

Material. — More than 600 specimens; many with calices and/or proximal ends preserved. Morphology of the ontogenetically earliest parts often destroyed by silicification.

N:d ratio of representative corallites (in mm):

USNM cat. nos.	N:d ratio	Remarks
197052	26:7.0	calice margin
,,	26:6.7	just beneath calice
197051	25:9.1	calice margin
,,	25:8.4	just beneath calice
,,	25:7.5	early ephebic stage
197055	24:7.7	calice margin
,,	24:7.2	just beneath calice
197056	24:6.5	calice margin
,,	24:7.2	ephebic stage
197060	22:6.6	calice margin
197048	20:4.3	calice margin
,,	20:5.5	beneath calice
197054	19:5.2	calice margin
,,	18:4.8	just beneath calice

Diagnosis. — *A.* (*Assimulia*) having most common n:d ratio 21—22:5.7—7.0; maximum n:d ratio 26:10.0; major septa wavy, slightly rhopaloid, almost reaching corallite axis; cardinal septum equal to other major septa; counter septum elongated; minor septa wavy, often contratingent.

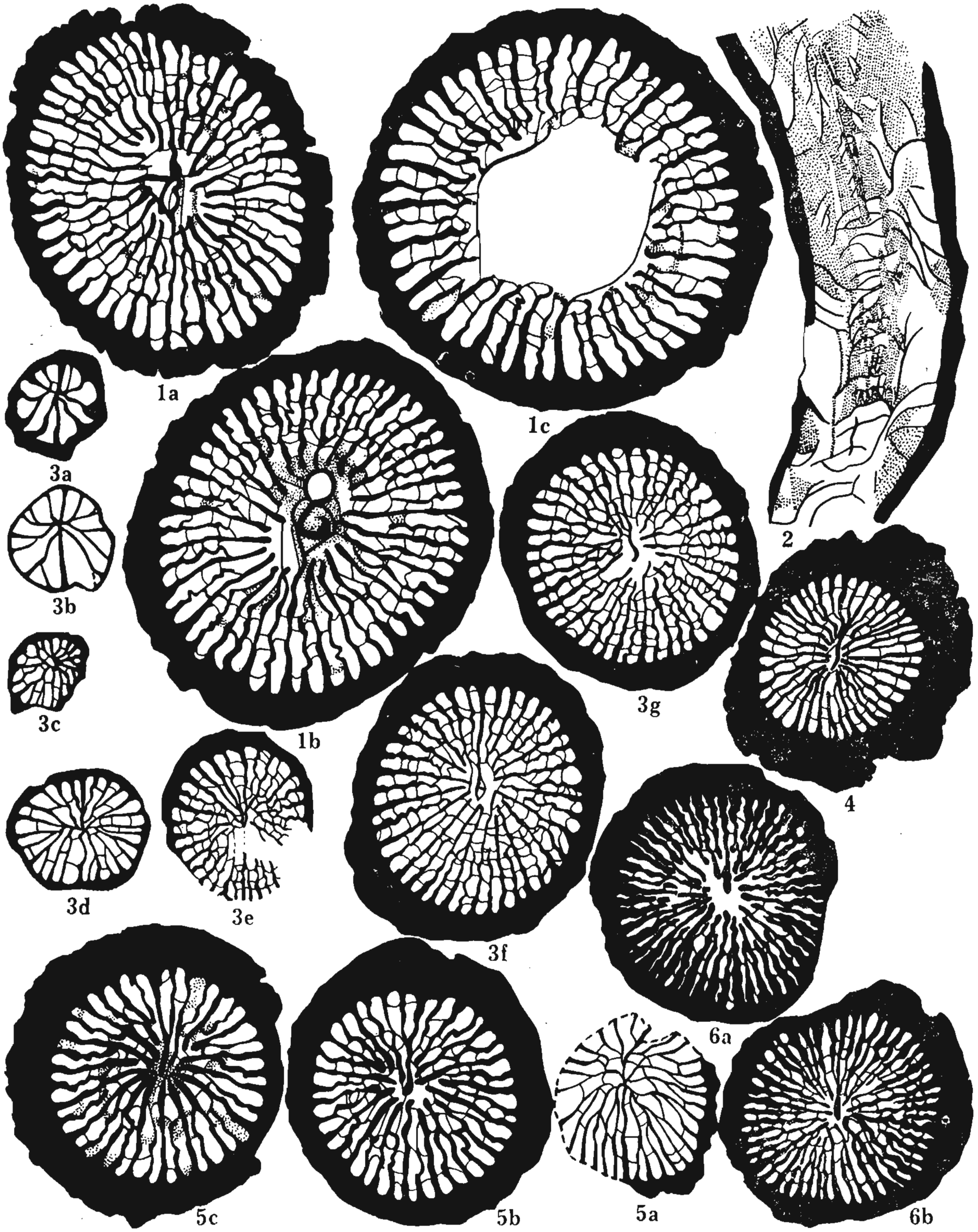

Fig. 60.

Assimulia (*Assimulia*) *tergida* (Ross and Ross, 1962). 1. Specimen USNM 197051. Locality USNM 705a, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse sections, ephebic stage; a, b — showing morphology of axial area disturbed by commensal organism; c — just beneath calice; coarsely recrystallized axial area of corallite is bordered by sections of tabulae (compare pl. 22:21a). All, × 8. 2. Specimen USNM 197049. Locality and horizon as above. Longitudinal section, × 4. 3. Specimen USNM 197048. Locality USNM 727f, Upper Skinner Ranch Formation. Transverse sections; a, b — early neanic stage (b — slightly schematized Camera lucida drawing), × 24; c—e neanic stage, × 8; f, g — ephebic stage having cardinal septum elongated, × 8. 4. Specimen USNM 197047. Locality USNM 702d, Hess Formation, Taylor Ranch member. Transverse section, ephebic stage, × 8. 5. Specimen USNM 197050. Locality USNM 705a, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse sections; a — neanic stage; b, c — ephebic stage. All, × 8. 6. Specimen YPM 21815. Holotype. Locality 68. Lenox Hills Formation; a, b — transverse sections, late ephebic stage, × 8.

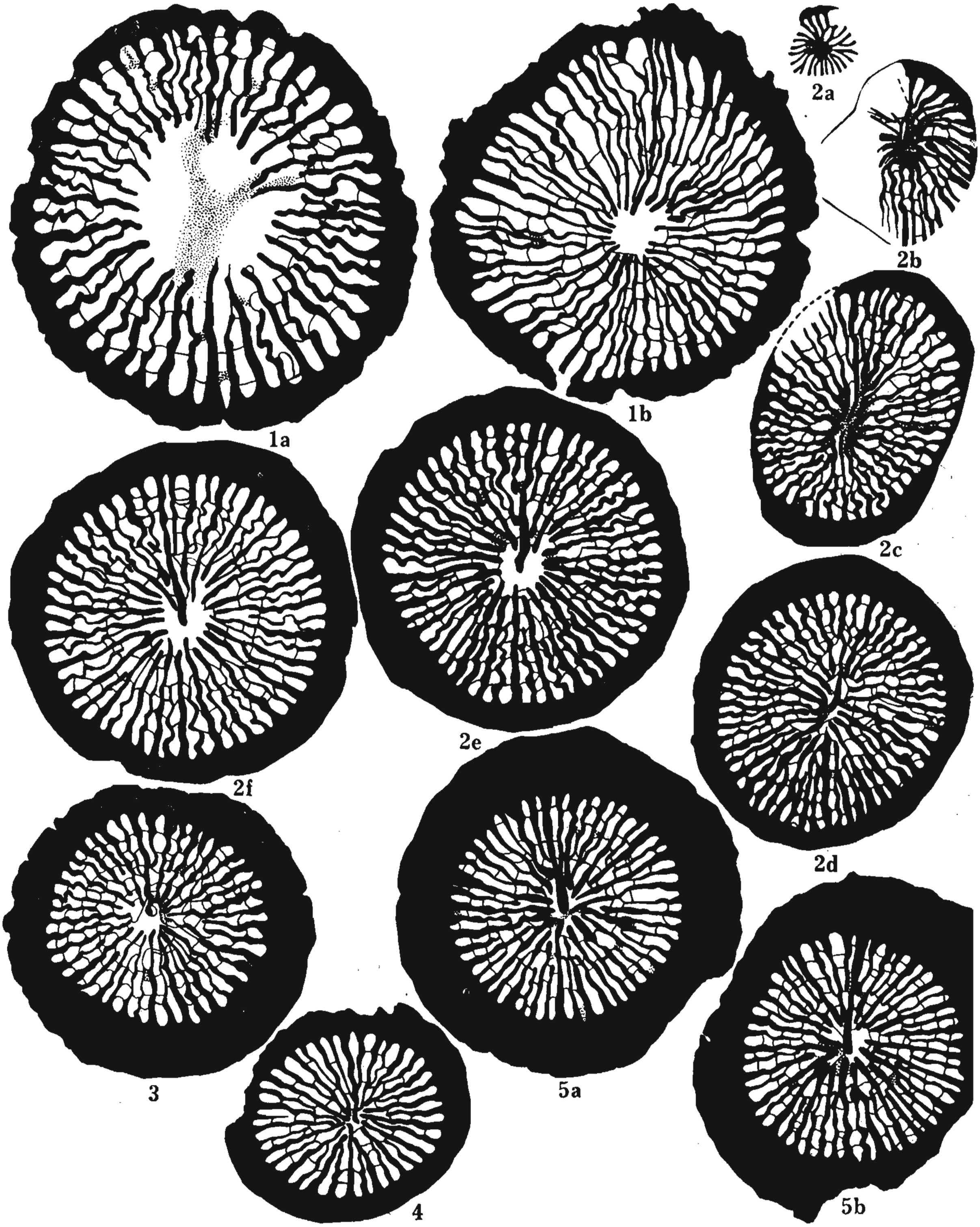

Fig. 61.

Assimulia (*Assimulia*) *tergida* (Ross and Ross, 1962). Transverse sections. 1. Specimen USNM 197046. Locality USNM 705a, Skinner Ranch Formation, base of *Scacchinella* beds; a, b — successive sections of ephebic stage 2. Specimen USNM 197052. Locality USNM 728e, Lower Bone Spring Formation; a, b — neanic stage; c — early ephebic stage; d—f — ephebic stage. 3. Specimen USNM 197053. Locality USNM 705a, Skinner Ranch Formation, base of *Scacchinella* beds. Ephebic stage. 4. Specimen USNM 197054 Locality USNM 732e, Skinner Ranch Formation, Dugout Mountain member. Ephebic stage. 5. Specimen USNM 197055. Locality USNM 705a, Skinner Ranch Formation, base of *Scacchinella* beds; a,b — ephebic stage. All, ×8.

Description. — External characters (pl. 25:1—9, 11—13). The corallites are horn-shaped in their juvenile parts, often with talons or attachment processes present (e. g. pl. 25:4a, 5a). In the mature portions, they are irregularly cylindrical or vermiform in shape, reaching up to 7—8 cm in length (e. g pl 25:1a, 11b, 13b). Better preserved external walls have shallow septal furrows and delicate growth striae. Rejuvenation, which is exclusively axial, deep or shallow, is fairly common. The calices are 5—7 mm deep, regular, funnel-shaped with the undulated margins (pl 25:1b, 2, 3, 4b, 5b, 6, 7, 11a). The peripheral zone of the calices bears distinct, equally developed foundations of the major and minor septa. In the intermediate zone of the calices the latter become thin and almost disappear in the narrow loculi between the more prominent and thicker major septa. All septa are directed centripetally. In many calices, the counter septum, and to a lesser degree also the cardinal septum, are distinctly (the former) or slightly (the latter) better developed than the average major septa (pl. 25:2, 7, 9, 11a, 13a). All better preserved major septa have smooth upper ridges (pl. 25:1b, 2, 3, 5b, 6, 11a, 13a). Modifications of these parts of them (pl. 25:4b, 8b) were all caused by chemical preparation or weathering. Directions of individual septa changed a little in the course of their growth, causing the undulation, seen in the transverse sections and in the calices when broken (pls. 22:19—22, 24—26; 25:4b).

Ontogeny. — The earliest stage of growth investigated, 0.7 mm in the diameter, shows the acceleration of septa in the counter quadrants (fig. 60:3a). Metasepta of the cardinal quadrants are not yet present. The alar protosepta join the axial septum close to the corallite axis, but separately from the axial junction of septa of the counter quadrants, which already form systems. The clearly separated systems of septa of individual quadrants are absent in the most completely studied specimen (fig. 60:3c—e) but they may exist in some other corallites (e. g. fig. 60:5a).

The first septa inserted next to the counter septum are the first minor septa. Early neanic portions of growth of the corallites are similar to each other (figs. 60:3c, d, 5a; 61:2a), but the further growth of individual corallites show considerable differences in their morphology (figs. 60:3e; 61:2b, c). These differences decrease again in the mature stage (figs. 60:3f, g, 5b, c; 61:2e. f).

Variability in transverse sections. — Like the rather constant morphology of the calices, the transverse sections show only moderate modifications. The most common morphotype is that with long, slightly rhopaloid, but free major septa; the elongated counter septum that forms a simple columella and the cardinal septum as long as other major septa or slightly longer from them on some sections of individual specimens. In this basic group of specimens, the minor septa often reach the periaxial thickenings of the major septa and are mostly free and contraclined or indistinctly contratingent, being contrafused only early in ontogeny. Minor modifications within this group appear in: a) the length and thickness of the columella; this variation can also be seen in the type material of Ross and Ross (1962, fig. 11 B; pl. 161:21, and fig. 60:5a, b illustrating other sections of the holotype), b) the length of the cardinal septum, which is a little longer and sometimes slightly thicker than the adjacent major septa (figs. 60:3f, g; 61:1a, 4, 5a, b; pl. 22:25), but may sometimes be equal to them (figs. 60:4, 5b, c; 61:3; pl. 22:19a, 22), or fairly long in some ontogenetically younger sections of a given corallite (fig. 61:2c), c) the length, thickness, advancement of undulation and contratingency of the minor septa; only rare specimens have all minor septa contratingent. Most commonly a part of them are free.

Some specimens show modifications extending beyond the limit of changes accepted for the basic group of specimens discussed above. Some of them may develop an extremely long counter septum, producing bilateral symmetry in the corallite (fig. 60:4), or an extremely long cardinal septum (fig. 60:3f, g). In the latter specimen, there is also a septal lamella connected to the axial end of the long counter septum. Such a phenomenon was observed only in this single section.

A small group of specimens (only 12 observed) differ from the holotype in such characteristics as reduction of the counter septum to the length of other major septa; formation of a wide ree axial area; and, in some cases, also in larger dimensions (maximum n: d ratio 26:9.5 and 26:10·1). The correlation between the mentioned characters is not always present. For instance a reduction in length of the counter septum may have (figs. 60:1c; 61:1a; pl. 22:21a, 24) or have not caused an increase in width of the axial area. The latter may have been in some specimens (fig. 60:1c; pl. 22:21a) diagenetically caused, while in some other ones (fig. 61:1a, b; pl. 22:24) it is more constant. Calices of the specimens discussed might have developed rather wide, flat floors (pl. 25:4b), which forms next difference when compared to the main group. Like the others discussed, this character is individualized. This, together with a small number of representatives prevents distinguishing these corals as a separate taxon.

Longitudinal section (fig. 60:2; pls. 22:23; 25:10). — The tabularium is distinctly biform, but the arrangement of the tabellae is often shadowed by densely packed sections of the septa. The peripheral tabellae in Position I are either directed slightly downwards adaxially (fig. 60:2, middle left side) or are dessepiment-like (fig. 60:2, lower right side). In Position II they always rise steeply upwards adaxially, being less steep or even horizontal only at the external wall. The axial parts of the tabulae are always more or less horizontal. Width of this part of the tabularium depends on the diameter of the free axial area as seen in the cross section.

Remarks. — The species was originally described by Ross and Ross, (1962) on two specimens only, which made any discussion of its real variability impossible. The conico-cylindrical shape of these specimens (Ross and Ross 1962, fig. 40,P) permits considering them mature. Several misunderstandings of Ross and Ross (1962) should be pointed out.

1. The cardinal septum is not shortened, and the septum described by these authors as the cardinal septum is one of the minor septa. 2. The minor septa are not only present, but are very well developed and often contratingent. The number of septa 44—46 calculated by Ross and Ross (1962) is the total number of major and minor septa. 3. The "monacanthine" structure mentioned by Ross and Ross (1962: 1186, pl. 161:22) is nothing but the undulation of septa discussed above in the description. Judging from the transverse sections investigated in this paper the microstructure of septa is possibly fine-trabecular, but no trabeculae have so far been found in the longitudinal sections. There are no large monacanths present, however.

The species discussed seems to occupy a central position among other species of this genus and is close to its geologically oldest representative known so far, i. e. *A.* (*A.*) *uddenitense* sp. n. which comes from the *Uddenites*-bearing member of the Gaptank Formation. Better accentuated radial arrangement and the rhopaloid character of the major septa in *A.* (*A.*) *tergida* form the main difference between these two taxa. *A.* (*A.*) *septarugosa* (MOORE and JEFFORDS, 1941) differs from *A.* (*A.*) *tergida* in n: d ratio, in the much weaker development of the columella, and in the distinct difference in thickness between the major and the minor septa. Differences between *A.* (*A.*) *tergida* and other species described in this paper are discussed with the latter.

Occurrence. — 701:1, Neal Ranch Formation; 702d:3, Hess Formation, Taylor Ranch member; 705a:590, 720e:18, Skinner Ranch Formation, base of *Scacchinella* beds; 720f:6, 720g:8, Lower Skinner Ranch Formation; 707a:3, 715v, Skinner Ranch Formation, Decie Ranch member; 732e:1, Skinner Ranch Formation, Dugout Mountain member; 722h:1, 722l:1, Skinner Ranch Formation, Sullivan Peak member; 727f:36, Upper Skinner Ranch Formation; 723l:7, top of Skinner Ranch Formation; 728e:1, Lower Bone Spring Formation, Wolfcampian.

Assimulia (*Assimulia*) *arta* sp. n.

(fig. 62; pls. 25: 14, 15; 26:1)

Holotype: Specimen USNM 197067, fig. 62:1a—c; pls. 25:15; 26:1.
Type locality: USNM 706x.
Type horizon: Neal Ranch Formation.
Derivation of the name: lat. *artus, a, um* — cramped, packed; after dense arrangement of septa.

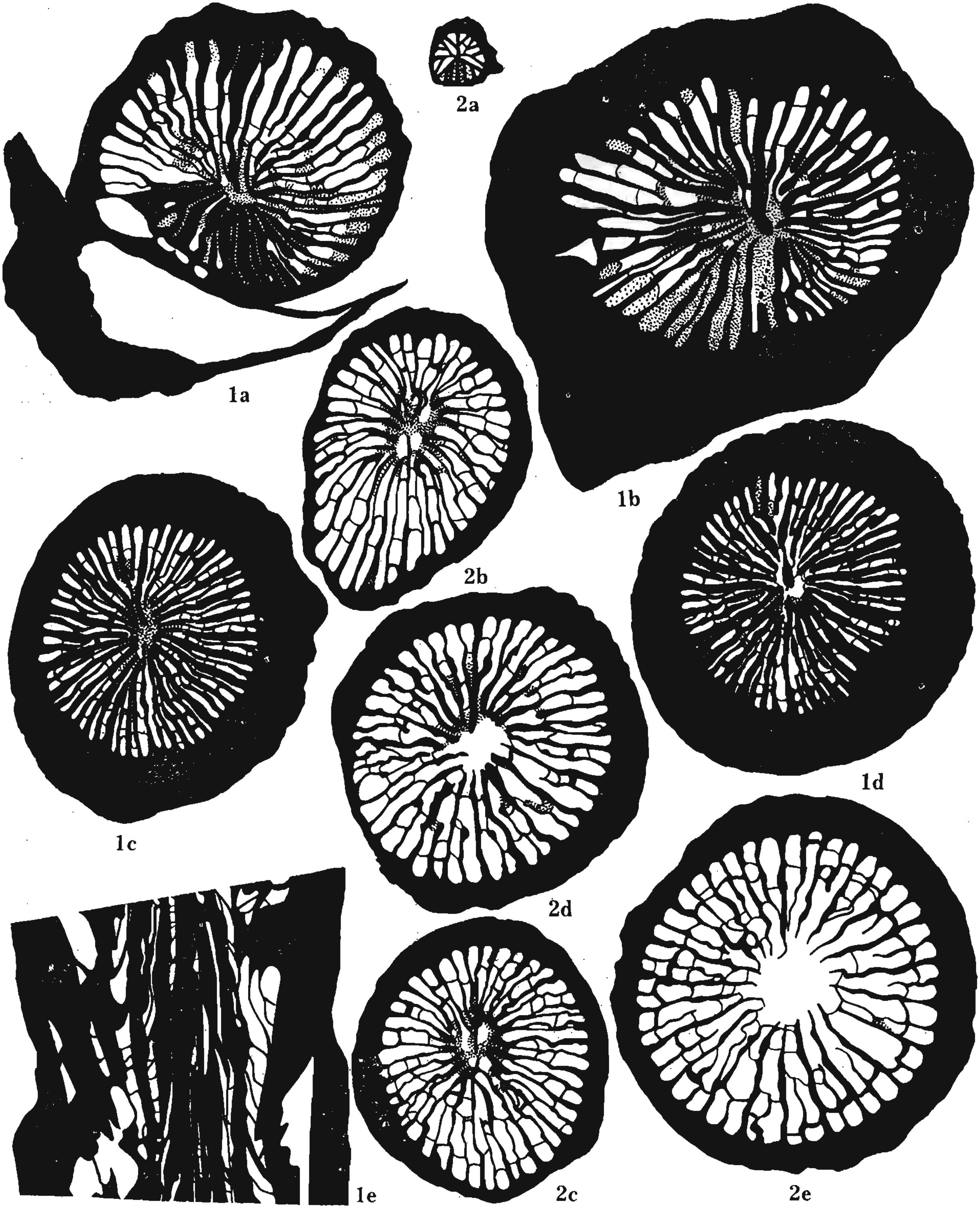

Fig. 62.

Assimulia (*Assimulia*) *arta* sp. n. 1. Specimen USNM 197067. Holotype. Locality USNM 706x, Neal Ranch Formation; a, b — transverse sections, early ephebic stage, ×8; c, d — transverse sections ephebic stage, ×4; e — longitudinal section, ×4. 2. Specimen USNM 197068. Locality and horizon as above; a — transverse section, early neanic stage; b—e — transverse sections, early to late ephebic stage. All, ×8.

Material. — Three specimens of well preserved internal structure but without calices and proximal ends.

Diagnosis. — *Assimulia* (*Assimulia*) having n: d ratio 27:14.5; septa long, thickened; major septa almost reach elongated end of counter septum; septotheca thick; some septa in it split.

Description of the holotype. — The specimen lacking a calice and a proximal end is 46 mm long. A cardinal septum is located on its convex side. The major septa are arranged slightly differently in different sections (fig. 62:1 a—d; pl. 26:1). Most commonly, a fan-shaped, close to radial arrangement occurs with the elongated counter septum in the fan axis. The axial ends of the septa may be attached to a columella by stereoplasm (fig. 62:1 a—c) or they may form a very narrow axial area free of septa (fig. 62:1 d; pl. 26:1). The counter-lateral septa are often shortened. The cardinal septum is generally as long as the adjacent pair of the major septa, but it may be slightly shortened in some sections or elongated in the other (fig. 62:1 c, d). The minor septa reaching 1/2 to 3/4 of length of the major ones, are almost straight, commonly contratingent, and only slightly thinner than the major septa. Those adjacent to the counter septum may form a triad or are free. Their length in relation to length of the counter septum is reduced towards the calice.

In the longitudinal section (fig. 62:1 e) the tabularium is biform, but its structure remains unclear due to the density of sections of the septa. Peripheral parts of the tabulae in Position II are slightly concave, while their axial parts are inclined steeply upwards. Tabulae in Position I are S-shaped and horizontal (fig. 62:1 e, upper right). The microstructure of peripheral parts of the septa within the septotheca (pl. 25:15) differs from that of their inner parts. It consists of several hemisphaeres, each of which is built of thin calcite fibres arranged obliquely but generally perpendicular to the hemisphaere surface. Although the fibres themselves may be recrystallized, their positions agree with directions of growth of the hemisphaeres, which most probably were produced by wide folds of ectoderm at the marginal part of the calice (foundations of septa).

The described peripheral structures i. e. the foundations of septa, transfer either gently or sharply into septal blades. In some septa at the very beginning of the development of the septal blades, there is only one row of trabeculae. Much more commonly, however, the trabeculae are arranged there in two parallel rows, which form two dark lines (pl. 25:15). In further growth of septal blades (i. e. towards the corallite axis), the trabeculae either became scattered to form a diffuso-trabecular microstructure or are arranged in a single row (pl. 25:15), The diffuso-trabecular microstructure is replaced by trabecular microstructure in the periaxial and axial ends of septa. In some septa two rows of trabeculae may be distinguished not only in the most peripheral but also in the middle parts of septal blades. These parallel dark lines are always very short, however. The primary growth of many septa was irregular, as indicated by trabeculae and growth lines in sections. This irregularity and waviness is afterwards smoothed by the basal, stereoplasmic sheets of septa. The structure as described above is considered secondary by OEKENTORP (1980). For broader discussion of this respect see SORAUF (1984) and FEDOROWSKI (1986).

Individual variation. — The investigated paratype differs from the holotype in having smaller dimensions, thinner and shorter major septa, that leave a comparatively wide free axial area in maturity, and in developing the minor septa mostly free at that stage of growth. It has been identified as belonging to *A.* (*A.*) *arta* sp. n. mainly on a basis of morphology in early maturity (fig. 62:2b, c), similar to that of the comparable growth stage of the holotype.

Remarks. — The species discussed, although described on a few specimens only, may be easily distinguished from all the species of *Assimulia* gen. n. by its thickened major septa, different n: d ratio, and first of all, by the microstructure of septa described above.

Occurrence. — USNM Loc. 706x:3, Neal Ranch Formation, Lower Wolfcampian.

Assimulia (*Assimulia*) *abscessa* sp. n.

(figs. 63, 64; pls. 25:16, 17; 26:2—8)

Holotype: Specimen USNM 197069, fig. 63:1a—i; pl. 26:2a—c.
Type locality: USNM 707b.
Type horizon: Skinner Ranch Formation, Sullivan Peak member.
Derivation of the name: lat. *abscessus, us:* withdrawn, absence — after absence of elongated counter septum in maturity.

Material. — More than 80 silicified specimens, most of which are poorly preserved externally but often with internal structures preserved in calcite.

N:d ratio of representative corallites (in mm):

USNM cat. nos.	N:d ratio	Remarks
197073	27:7.1	just beneath calice
,,	25:6.2	ephebic stage
197070	23:6.7	ephebic stage
197069	22:6.6	just beneath calice
197072	21:5.5	just beneath calice
197078	21:5.1	calice margin
,,	21:5.1	just beneath calice
197071	20:7.3	just beneath calice
197077	20:6.1	calice margin
,,	20:5.3	just beneath calice
196076	18:4.9	just beneath calice

Diagnosis. — *Assimulia* (*Assimulia*) having n: d ratio 18—24:4.5—8.5, most commonly 20—22:5.5—7.0; major septa arranged radially, come very close to corallite axis without being united; minor septa long contratingent or contraclined; counter septum not elongated; carination of septa typically present at periphery, sometimes weak.

Description of the holotype. — The specimen is conico-cylindrical in shape, with a calice approximately 5 mm deep, and has almost smooth external surface with only delicate septal furrows. This may partly be due to diagenesis. The ontogenetically youngest part of the corallite is not preserved.

Four transverse sections, prepared along approximately 7 mm of length of the mature portion of the specimen, do not show any substantial differences (fig. 63:1a—d). All septa are much thicker at the periphery, but the minor septa thin faster, making differences between them and the major septa distinct. Their axial ends are thin and either contratingent or contraclined. The axial ends of the major septa, slightly rhopaloid, come very close to the corallite axis, without being in contact there. Their length is differentiated. Some septa including the alars, are slightly longer, and several other ones are clearly shorter than the other septa. The cardinal and the counter septa belong to the longest, but they never dominate. The carination(?) of the septa changes a little from one section to the other, but in none of them are all septa carinated.

The biform nature of the tabularium is rather weakly accentuated in longitudinal serial sections, where only some peripheral tabellae exhibit opposite positions in the neighbouring septal loculi (fig. 63:1e—i; pl. 26:2b, c). In contrast to this, the carination (?) of septa is well seen in both, the peripheral and the axial longitudinal sections. Some of these septal bodies are directly united with the medial lines of septa, some are attached to the peripheral thickenings of septa. The present picture of the latter presumably resulted from the sectioning of the bodies

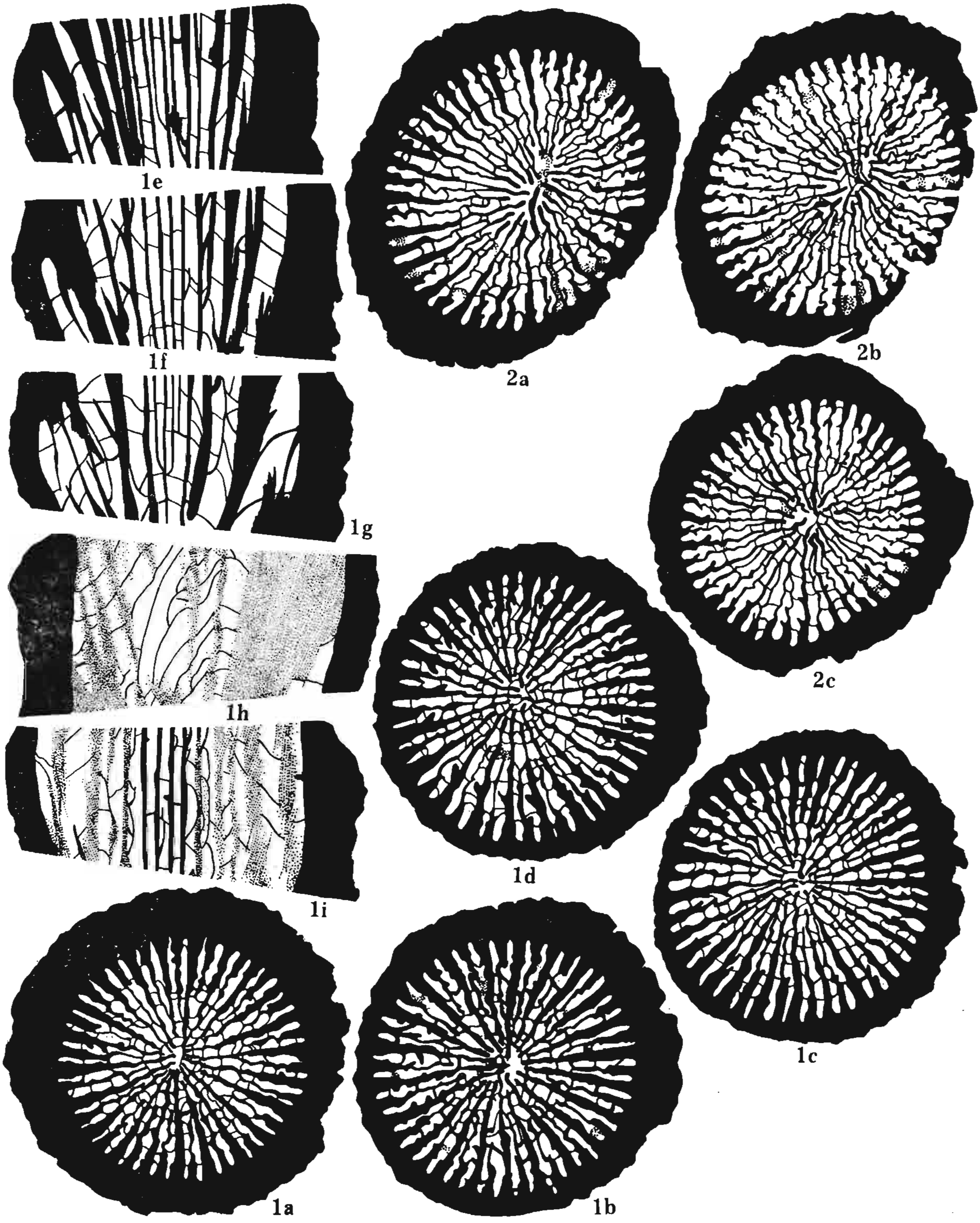

Fig. 63.

Assimulia (*Assimulia*) *abscessa* sp. n. 1. Specimen USNM 197069. Holotype. Locality USNM 707b, Skinner Ranch Formation, Sullivan Peak member; a—d — transverse sections, ephebic stage; e—h — successive longitudinal sections made from corallite periphery to its axis; i — longitudinal section of periaxial part of corallite, opposite to fig. 1g. All × 8. 2. Specimen USNM 197070. Locality and horizon as above; a—c — transverse sections, ephebic stage, × 8.

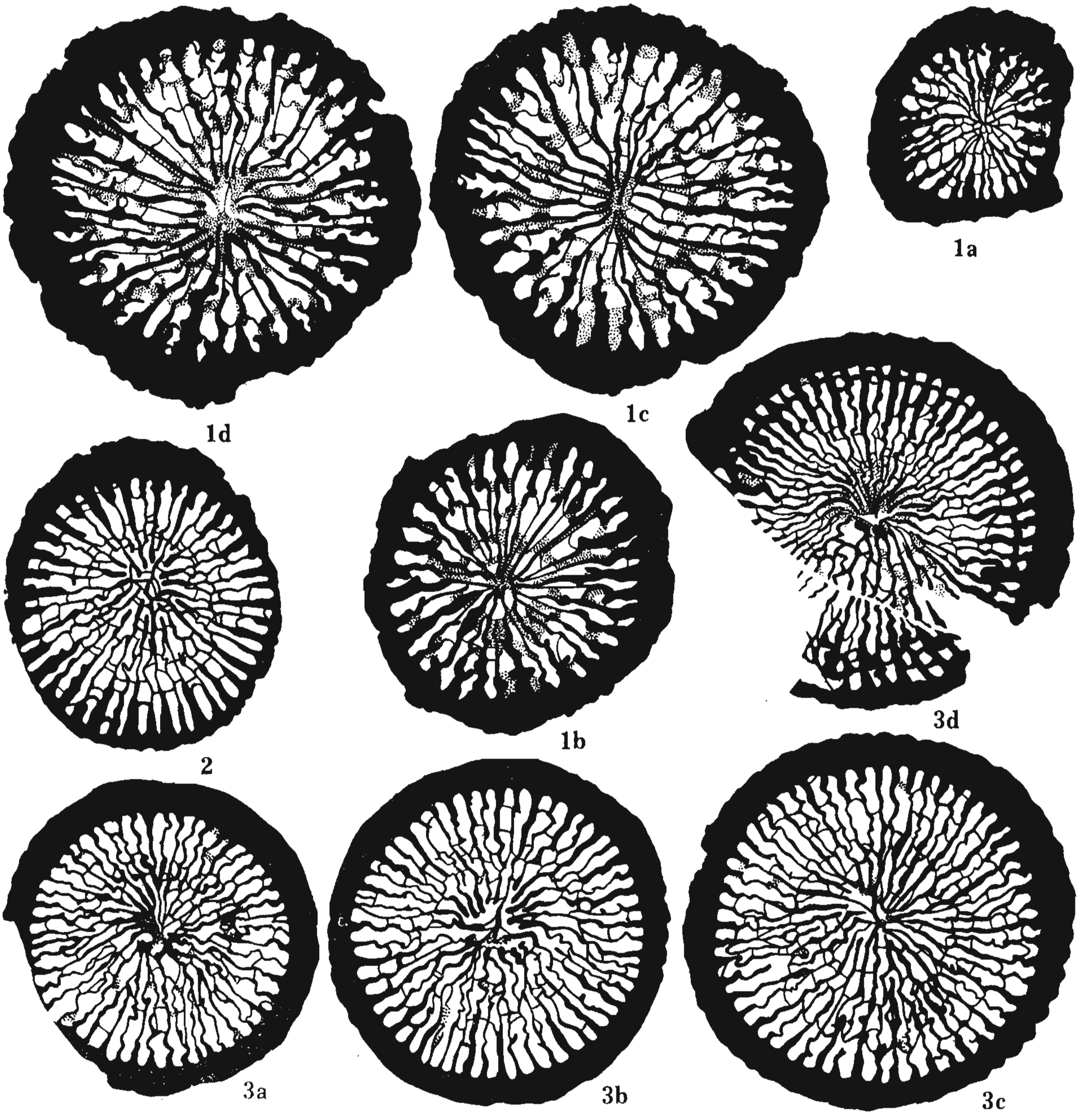

Fig. 64.
Assimulia (Assimulia) abscessa sp. n. 1. Specimen USNM 197071. Locality USNM 707b, Skinner Ranch Formation, Sullivan Peak member; a—d — transverse sections, early to late ephebic stage. 2. Specimen USNM 197072. Locality and horizon as above. Transverse section, ephebic stage. 3. Specimen USNM 197073. Locality USNM 728e, Lower Bone Spring Formation; a—d — successive transverse sections, ephebic stage. All, ×8.

outside the regions of their origin. This is confirmed by observations in transverse sections, where no carinae or other bodies, septal in structure, are attached to the lateral sides of septa. The longitudinal section of peripheral part of one of the paratypes (pl. 26:8d) illustrates best the inter-relations of individual septal bodies discussed.

Individual variation. — The arrangement of the tabulae in longitudinal sections of the paratypes is similar to that of the holotype (e. g. pl. 26:3b, 8c, d). Variability in the transverse sections is larger. However, this is also true for individual sections of given specimens (e. g. figs. 63:2a—c, 64:1b—d, 3a—d; pl. 26:4a—c, 8a, b). Two variants are especially noteworthy: the corals with weak or only sporadic carination (?) of septa (pl. 26:3a, 5, 6) and the corals with the counter septum elongated in some sections (e. g. figs. 63:2c; 64:2, 3b, c; pl. 26:4b, c, 7). Some specimens of the latter variant (fig. 64:3a—d; pl. 26:4a—c) are so variable in their ontogeny and so distinct from the holotype that they have been included in this species conditionally. Some other specimens, typically built in some sections, exhibit distinct carination (?) and/or elongation of the cardinal septum on the others (fig. 63:2a—c; pl. 26:8a, b). All these variants, as well as a tendency of some specimens to have the major septa slightly withdrawn from the axis (pl. 26:6) or heavily carinated (fig. 64:1a—d), make the species discussed comparatively variable.

Remarks. — The new species discussed is at first glance, almost identical with *A.* (*A.*) *tergida* (Ross and Ross, 1962). This is first of all impressed by a radial arrangement of the slightly rhopaloid major septa, by a very similar n: d ratio, and by the appearance of an elongated counter septum on individual sections of some specimens. The following differences speak in favour of its taxonomical separation: 1. The carination (?) of septa, although not always distinct, is invariably present in *A.* (*A.*) *abscessa* sp. n. and never seen in *A.* (*A.*) *tergida*, which in turn has the counter septum permanently elongated. This is not so in *A.* (*A.*) *abscessa* sp. n., in which most specimens have this septum permanently equal to other long major septa. 2. The axial parts of the tabulae in *A.* (*A.*) *tergida* are horizontal, which is possibly correlated with development of the free axial area. In *A.* (*A.*) *abscessa* sp. n. the tabulae are inclined upwards there and practically no free axial area is present. 3. The tendency of the cardinal septum to elongate although rare in *A.* (*A.*) *abscessa* sp. n., may serve as an additional distinctive character.

A. (*E.*) *fracta* sp. n., and to some extend also *A.* (*E.*) *recrea* sp. n., show some similarity to the species discussed. The carination (?) of septa and their distinct peripheral thickenings are present in both species. The fairly long minor septa in the calices bring the new species closer to *A.* (*E.*) *fracta* sp. n. The main differences are: 1. The radial arrangement, the slightly rhopaloid character and the slight differentiation in length of the major septa which, coming close to the corallite axis, are never in contact and never form systems in the maturity of *A.* (*A.*) *abscessa* sp. n. 2. Different n: d ratio, 3. Different arrangement of the tabulae in the longitudinal sections. Shallower calices from an additional difference from *A* (*E.*) *fracta* sp. n., and the fairly long minor septa in calices are not observed in *A.* (*E.*) *recrea* sp. n. Other species described so far are less similar and will not be discussed. It should only be mentioned, what is clear from the above discussion, that *A.* (*A.*) *abscessa* sp. n. is one of these species, that connects the subgenera *Assimulia* subgen. n. and *Ericina* subgen. n.

Occurrence. — USNM Loc. 714p:9, 720f:9, Lower Skinner Ranch Formation; 705a:10, Skinner Ranch Formation, base of *Scacchinella* beds; 715v:18, Skinner Ranch Formation, Decie Ranch member; 707h:4, Skinner Ranch Formation, Poplar Tank member; 707b:40, 707c:1, 722b:1, Skinner Ranch Formation, Sullivan Peak member; 727f:5, Upper Skinner Ranch Formation; 725c:4, 728e:1, 732e:1, Lower Bone Spring Formation; 728l:1, Cibolo Formation, Breccia Zone. Upper Wolfcampian.

Assimulia (*Assimulia*) *flexibilis* sp. n.

(figs. 65—67; pls. 26:9—12; 27:1—28)

Holotype: Specimen USNM 197083, fig. 65:5a—c; pl. 27:2a, b.
Type locality: USNM 728f.
Type horizon: Lower Bone Spring Formation, Upper Wolfcampian.
Derivation of the name: lat. *flexibilis, e* — variable — after variability in morphology.

Material. — More than 160 silicified specimens having calices often well preserved and almost complete proximal ends in several specimens. Internal structure, especially at the tips, often destroyed by coarse silicification. N:d ratio (in mm) shown on fig. 67 and in the following table.

N:d ratio of representative corallites (in mm):

USNM cat. nos.	N:d ratio	Remarks
197079	21:6.0	calice margin
,,	21:5.0	just beneath calice
,,	20:4.5	early ephebic stage
197087	20:5.8	calice margin
,,	18:3.2	ephebic stage
197080	18:5.2	calice margin
,,	16:4.1	just beneath calice
,,	16:3.4	ephebic stage
,,	16:3.8	early ephebic stage
197083	16:4.8	calice margin
,,	14:3.0	just beneath calice
,,	12:2.4	early ephebic stage
197089	14:3.2	calice margin
,,	14:3.0	just beneath calice
,,	13:2.9	early ephebic stage
1970	14:2.8	calice margin
,,	14:3.6	just beneath calice
,,	14:2.8	early ephebic stage

Diagnosis. — *Assimulia* (*Assimulia*) having n:d ratio 11:2.5 to 21:6.0, most commonly 13—16:3.0—4.5; in calices, counter and often also cardinal septum dominate; in sections, axial ends of almost equally long major septa bent towards long cardinal septum; carination (?) of septa weak.

Description of the holotype. — The specimen is narrow, elongated. The ratio of its upper margin to its length = 4.8:19.0 The delicate septal furrows seen along most of its surface are absent from the tip. The approximately 7.5 mm deep calice is funnel-shaped, with a delicately wavy upper margin. The marginal zone of the calice bears foundations of the major and minor septa equally developed, transmitting gently downwards into the septal blades of the inner zone of the calice (pl. 27:2b). Septa of both cycles in this zone are only a little differentiated in length and thickness, with the major ones only slightly thicker and extending to the calice axis. Septal ridges are all smooth. In the lower part of the calice, the cardinal and the counter septum are the longest septa.

In cross sections of the ontogenetically older part of the corallite (fig. 65:5c), all septa are wavy up to the calice floor. Those of the cardinal quadrants have their thin axial ends bent towards the axial end of the cardinal septum. The latter is slightly longer than the counter septum, which is also well exposed owing to a smaller length of the major septa in the counter quadrants. The minor septa, long and contratingent, are more wavy and slightly thinner than the major septa. Only those forming a triad with the counter septum are comparatively short.

Arrangement of septa in the ontogenetically younger part of the corallite (fig. 65:5b) is irregular, with the cardinal septum dominating and the minor septa comparatively long at the counter septum. In the ontogenetically youngest preserved part of the corallite, 0.8 × 1.3 mm in diameter (fig. 65:5a), the cardinal and the counter septa are united to form the axial septum. The major septa join this septum near the corallite axis. The minor septa are contrafused. The ontogeny observed also on several paratypes is typical for the family. Small differences in the increase of septa are considered individual variation.

The holotype has not been longitudinally sectioned. In longitudinal sections of the paratypes, the tabulae are sparsely distributed, biformly arranged, with their axial parts horizontal or slightly declined abaxially and their peripheral parts almost horizontal in Position I and gently or steeply inclined adaxially in Position II (fig. 65: 1e, f, 3d—f).

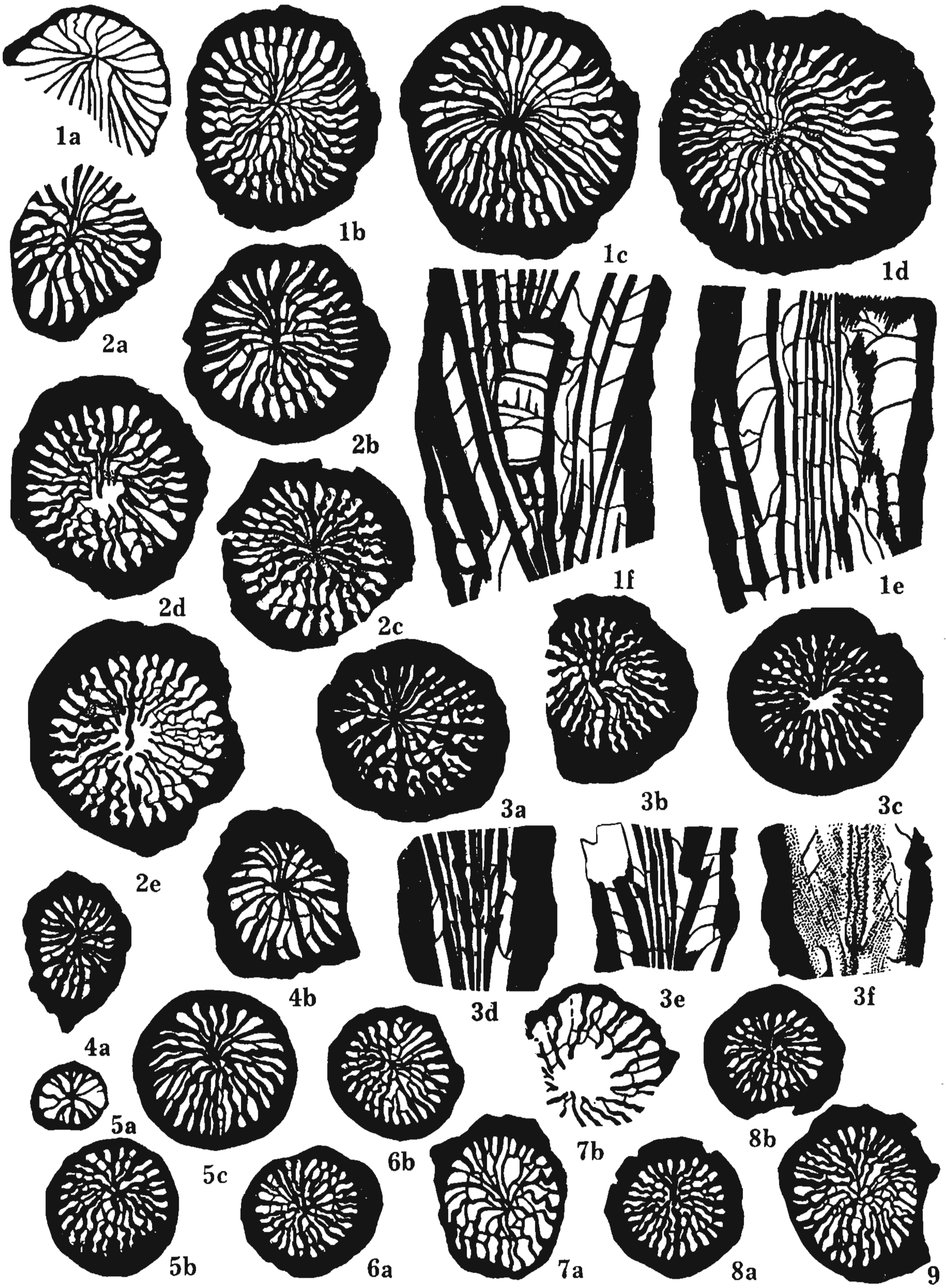

Fig. 65.

Assimulia (*Assimulia*) *flexibilis* sp. n. Specimen USNM 197079. Locality USNM 728f, Lower Bone Spring Formation; a — transverse section, neanic stage; b—d — transverse sections, early to late ephebic stage; e, f — periaxial and axial longitudinal sections. 2. Specimen USNM 197080. Locality and horizon as above; a — transverse section, late neanic

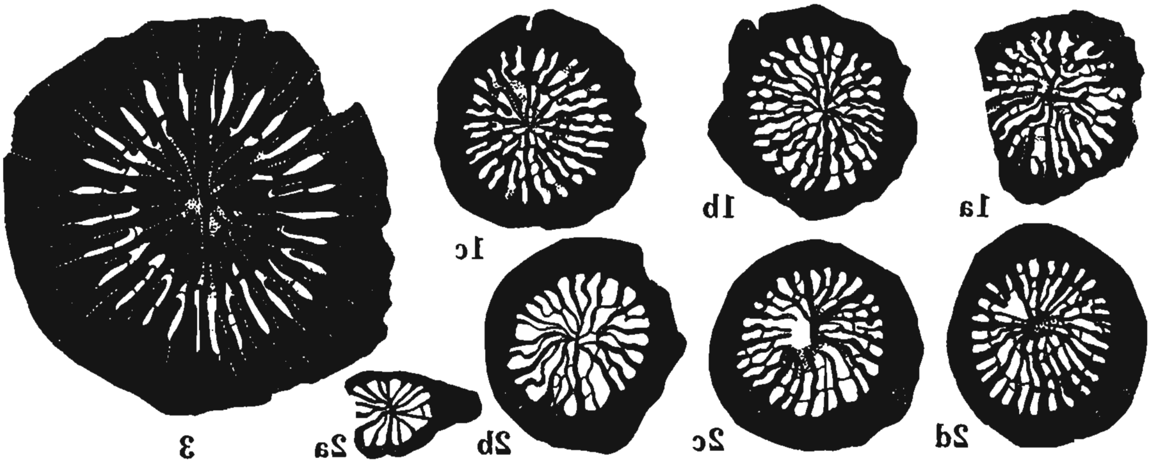

Fig. 66.

1. *Assimulia* (*Assimulia*) *flexibilis* sp. n. Specimen USNM 197088. Locality USNM 7281, Lower Bone Spring Formation; a—c — transverse sections, ephebic stage, × 10. 2. *Assimulia* (*Assimulia*) *flexibilis* sp. n. Specimen USNM 197089. Locality and horizon as above. Transverse sections; a — neanic stage; b—d — ephebic stage. All, × 10. 3. *Assimulia* (*Assimulia*) sp. 1. Specimen USNM 197131. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Transverse section, ephebic stage, × 4.

Individual variation. — The morphology of calices varies in several directions. The most common trend leads towards a slight domination of the counter septum. The cardinal septum becomes eventually equal to other major septa (pl. 27:4, 14b, 19, 21, 22, 23, 24). The arrangement of septa is either like that in the holotype, i. e. they are straight, dipping steeply towards the calice axis (pl. 27:5, 7a, 8a, 18b, 21, 24), very slightly curved (pl. 27:4, 9, 14b, 17b, 20b), or more or less distinctly curved axially toward the end of the cardinal septum (pl. 27:3a, 6, 15, 19, 23, 26, 28). The last trend is accompanied by a better development of the counter septum in some specimens. It starts from a slight domination of the latter at a calice floor (pl. 27:3a, 4, 8a, 15, 21, 22, 24) through formation of a kind of a columella (pl. 27:9, 14b, 16a, 27, 28) to formation of a fairly distinct columella protruding into the inner zone of a calice (pl. 27:5). In the latter case, the cardinal septum also may be slightly protruded. Only a single specimen of this kind was found within the collection.

A trend opposite to the described one, i. e. towards the equality of length of all major septa, is less common within the collection (pl. 27:19, 23). It is independent of the shape and arrangement of septa: curved versus straight.

Many intermediate specimens, leading towards all extremities and similar n : d ratio of corallites (fig. 67), speaks in favour of considering the variants discussed as conspecific. Very rare specimens (pl. 27:22, 24) show axial parts of the calice floor flat. They have been evaluated as extreme morphological variants connected with the main group by intermediate forms (pl. 27:6, 9).

The morphology in sections (figs. 65, 66; pl. 26:9—12) is as variable as that of the calices. Septa are always wavy and more or less curved towards the end of the cardinal septum at least

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stage; b—e — transverse sections, early to late ephebic stage. 3. Specimen USNM 197081. Locality and horizon as above; a—c — transverse sections, ephebic stage; d—f — longitudinal sections made from corallite periphery to its axis. 4. Specimen USNM 197082. Locality and horizon as above; a, b — transverse sections, late neanic/early ephebic stage. 5. Specimen USNM 197083. Holotype. Locality and horizon as above. Transverse sections; a — neanic stage; b, c — ephebic stage. 6. Specimen USNM 197084. Locality and horizon as above; a, b — transverse sections, ephebic stage. 7. Specimen USNM 197085. Locality USNM 728h, Lower Bone Spring Formation; a, b — transverse sections, ephebic stage; short septal variant. 8. Specimen USNM 197086. Locality USNM 7281, Lower Bone Spring Formation; a, b — transverse sections, ephebic stage. 9. Specimen USNM 197087. Locality and horizon as above. Transverse sections, ephebic stage. All, × 10.

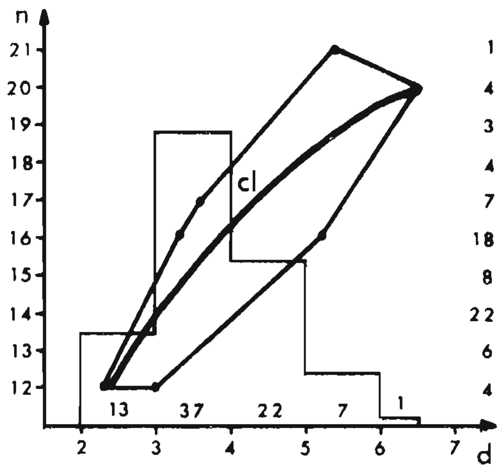


Fig. 67.
Assimulia (*Assimulia*) *flexibilis* sp. n. Septal index n:d (in mm). Points corresponding to extreme specimens are united by lines. Correlation line of n:d ratio (cl) is a mean line for individual classes. Frequency diagram is suppl emented by numbert corresponding to amount of corallites measured in given classes. Numbers on right side of the picture show amouns of specimens possessing given number of major septa.

in some portions of particular corallites. This is so even in the case of the specimens having the major septa straight in calices (e. g. the holotype). The curvature may be distinct (pl. 26:10), variable (figs. 65:1b—d, 2b—e; 66:2b—d) or slight (figs. 65:3a—c, 6a, b, 8a, b; 66:1a—c; pl. 26:12a, b). In some specimens, a shortening of the axial parts of septa is noted (fig. 65: 7a, b; pl. 26:10). This shortening may be very distinct beneath a calice (fig. 65:7b), although septa are long at the calice floor (pl. 27:3a). A few specimens have an elongated counter septum in some sections (figs. 65:2d, e, 8a, b; 66:2c; pl. 26:9a). More or less accentuated thickness and waviness of the septa is also noted. Some specimens with very thick septa may have free individual minor septa (fig. 65:3a).

Remarks. — Corallites of the species discussed belong to the smallest described. Forming incipient systems of septa, several of them are morphologically similar to *A.* (*Ericina*) *fracta* sp. n. They can easily be distinguished from that species by their much smaller dimensions and by the different arrangement, shape, and morphology of septa either in individual specimens or in particular sections. Some specimens with slightly elongated counter septum show similarity to *A.* (*A.*) *tergida* (Ross and Ross, 1962). The curvature of the major septa beneath calices serves in this case as an additional distinctive character of the species discussed, in addition to its smaller dimensions and different morphology and arrangement of septa.

Occurrence. — 707a:6, 714p:1, Lower Skinner Ranch Formation; 705a:4, Skinner Ranch Formation, base of Scacchinella beds; 707h:1 Skinner Ranch Formation, Poplar Tank member; 707b:2, 722h:4, 7221:2, Skinner Ranch Formation, Sullivan Peak member; 702e:16, Hess Formation, Taylor Ranch member; 728e:4, 728f:102, Lower Bone Spring Formation; 738r:1, Cibolo Formation, Breccia Zone. Upper Wolfcampian.

Assimulia (*Assimulia*) *frequentis* sp. n.

(fig. 68; pls. 28:1—5; 29:1—9)

Holotype: Specimen USNM 197113, fig. 68:1a—f; pl. 28:4a, b.
Type locality: USNM 728e.
Type horizon: Lower Bone Spring Formation, Upper Wolfcampian.
Derivation of the name: Lat. *frequentis, tis* — frequent, crowded — after crowded septa on a calice wall.

Material. — 31 silicified specimens, many with calices and/or proximal ends preserved. Inner structure at least partly calcitic.

N: d ratio of representative specimens (in mm):

USNM cat. nos.	N:d ratio	Remarks
197116	27:7.1	calice margin
„	20:5.5	ephebic stage
197117	24:5.4	calice margin
„	24:4.7	lower part of calice
„	22:4.0	just beneath calice
197127	23:6.1	calice margin
197123	22:6.1	calice margin
197118	22:5.4	calice margin
„	22:4.5	lower part of calice
197120	22:5.2	calice margin
„	19:4.0	ephebic stage
197124	20:5.7	calice margin

Diagnosis. — *Assimulia* (*Assimulia*) with deep, funnel-shaped calices; major septa in calice successively elongated downwards to meeting at its floor; in transverse sections major septa frequently bent towards cardinal septum; those of counter quadrants supressed in length, with counter septum elongated.

Description of the holotype. — The corallite is horn-shaped, 14 mm long when measured along the convex side. A strong attachment to a fenestrellid bryozoan colony occupies more than 1/3 of its length (pl. 29:5b). Wide but low interseptal ridges are separated by shallow septal furrows. Growth striae are distinct.

The funnel-shaped calice (pl. 29:5a) occupies almost one half of the length of the corallite. Its margin is wavy, with the internally located foundations of the septa more prominent than the external interseptal ridges. Deeper in the calice the foundations are gently transferred into septal blades of a thickness almost equal to the former. There is no intermediate zone of the calice and all septa increase their length regularly step by step down to the eventual meeting on the calice floor. The cardinal septum, located on the convex side of the corallite, dominates a little in hight. There is no kind of columella developed in the calice (pl. 29:5a). The minor septa differ from the major septa only by being shorter in the inner part of the calice, where they disappear between the major septa. Inner ridges of all the septa are smooth.

In the transverse section made just beneath the calice floor (fig. 68:1f; pl. 28:4b) inner ends of the major septa and also some free minor septa are slightly rhopaloid, while other portions of them are thin and wavy without being fragmented. The inner ends of the former bend towards the inner end of the cardinal septum. All septa are much shorter in the counter quadrants (fig. 68:1f; pl. 28:4b). This is a natural shortening, because the section follows a growth line. Also, a depth of the calice is naturally larger in the counter quadrants. The section there is located just above the last tabula in the centre of the corallite. Some of the minor septa are free, some are contratingent or contraclined. The parts next to the wall of all septa are thickened.

The morphology, in the ontogenetically younger transverse sections approximately 0.5 mm apart from each other (fig. 68:1d, e), shows a mixture of juvenile and mature characters. The minor septa are clearly contratingent and the rhopaloid character of the major septa is not marked. The counter septum is well developed and its axial end is already thickened a little (fig. 68:1e). The length of the major septa is almost equal in all quadrants, although the counter-lateral septa are some of the shortest. Also, the minor septa adjacent to the counter septum are shorter than several other minor septa, especially those in the cardinal quadrants.

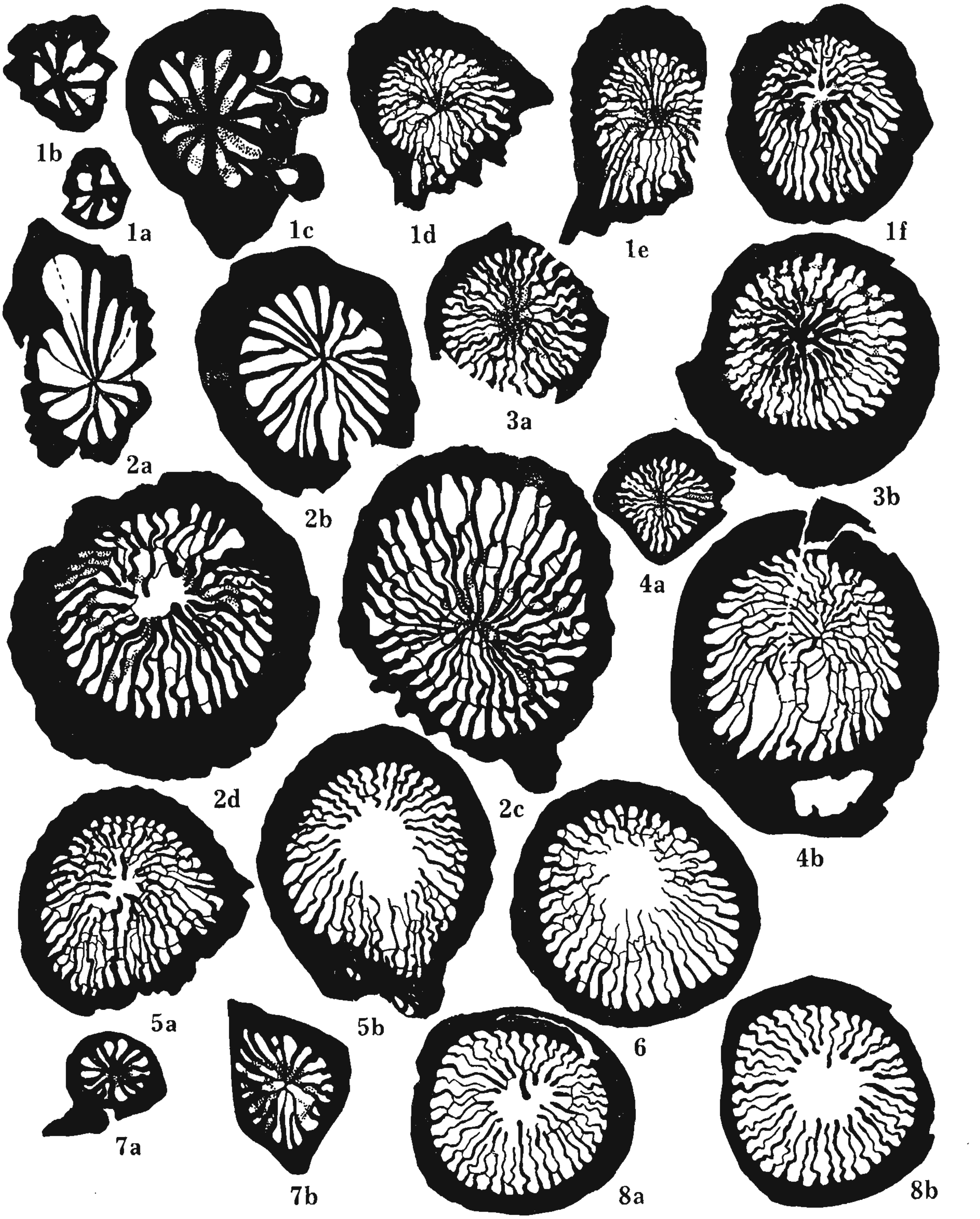


Fig. 68.

Assimulia (*Assimulia*) *frequentis* sp. n. 1. Specimen USNM 197113. Holotype. Locality USNM 728e, Lower Bone Spring Formation. Transverse sections; a—c — early neanic stage ×25; d—f — early to late ephebic stage, ×10. 2. Specimen USNM 197114. Locality USNM 714p, Lower Skinner Ranch Formation. Transverse sections; a, b — neanic stage, ×20; c, d — early and late ephebic stage, ×10. 3. Specimen USNM 197115. Locality USNM 728e, Lower Bone Spring Formation. Transverse sections. a — early ephebic stage, b — ephebic stage. Both. ×10. 4. Specimen USNM 197116. Locality and horizon as above. Transverse sections; a — late neanic/early ephebic stage; b — ephebic stage. Both. ×10. 5. Specimen USNM 197117. Locality and horizon as above. Transverse sections: a — late ephebic stage; b — partly above calice floor. Both, ×10. 6. Specimen USNM 197118. Locality and horizon as above. Transverse section. late ephebic stage, ×10. 7. Specimen USNM 197119. Locality and horizon as above; a, b — transverse sections, neanic stage, ×15. 8. Specimen USNM 197120. Locality and horizon as above. Transverse sections; a — late ephebic stage; b — lower part of calice. Both, ×10.

The ontogeny has been investigated from a section 0.6×0.4 mm in diameter and a clearly seen axial septum (fig. 68:1a). There are also some other septa present already, but their identification is uncertain. Two pairs of them, meeting each other and the axial septum eccentrically (closer to the cardinal septum side) are interpreted as the counter-lateral and the alar septa. Small septa, contrafused to the axial septum at its counter septum side would have thus been the first minor septa. Such an interpretation is partly confirmed by the following thin section, made approximately 0.4 mm apart from the former one (fig. 68:1b), where the short septal bodies mentioned continue to occur at the counter septum. The mode of insertion of a third pair of septa and their status are unclear, however. The septum contratingent to the left counter-lateral septum is possibly the minor septum. The left part of the corallite would thus contain the counter-lateral septum with its minor septum and the alar septum. The right part of the corallite contains probably the counter-lateral septum and the alar septum with either the contratingent minor septum or with the first metaseptum already inserted. A postponed increase of the minor septum at the counter-lateral septum in this part of the corallite is confirmed by the next thin section, made approximately 0.8 mm apart (fig. 68:1c), where the minor septum in question just comes into being. Also, this section shows some characters different from the comparable growth stages of regularly built representatives of the family. This concerns first of all the irregularity in the increase of the minor septa (e. g. a postponed increase of the minor septum at the left alar septum) and the irregular shape of a weak counter septum, accompanied by differently developed minor septa.

Individual variation. — The shape of corallites varies depending on extrinsic factors, attachment abilities, rejuvenation, etc., but they are always elongated, ceratoid or horn-shaped and almost invariably armed with a strong attachment surfaces (pl. 29:3a, b, 5b, 6a, 7b). Septal furrows, never prominent, are hardly distinguishable on some corallites. In all better preserved corallites the cardinal septum is located on the convex side. In the specimens changing the direction of their growth (pl. 29:3a, b) the cardinal septum may be located on the concave side in the upper portion but it was founded on the convex side of the specimen at an early ontogenetic stage (pl. 29:3b). The latter specimen serves also as an example of a corallite with indistinct septal foundations on the calice margin and thin septal blades inside the calice (pl. 29:3c). A strong attachment to its own lower portion of growth (pl. 29:3a, b) draws attention as an indicator of a possible strengthening of water turbidity and lack of any stable substrate in the vicinity of the specimen to attach to.

The cardinal septum in the calice is commonly a little better developed than other major septa, the counter septum included (pl. 29:4, 5a). There are calices, however, where it is hardly distinguishable (pl. 29:1a, 3c, 8). This character should be treated only as an individual phenomenon, because it is independent from ontogeny. A prominent cardinal septum can be present already in ontogenetically young corallites (e. g. pl. 29:7a).

Individual variation seen in the transverse sections seems rather large, although the diagnostic characters are easily distinguishable in all corallites (fig. 68:2c, d, 3a, b, 4b, 5a, b, 6, 8a, b). It depends at least in part on the stage of ontogeny represented by a given corallite and on a modification of its shape. There are also differences independent from these factors, however, e. g. the long lasting juvenile character in the arrangement and shape of septa (fig. 68:2c, 4b; pl. 28:1, 2), fairly strong elongation of the counter septum (fig. 68:2d, 8a) or an almost radial arrangement of straight major septa (fig. 68:3b pl. 28:5). It should be pointed out, however, that the morphology of all corallites sectioned becomes similar to each other near or just above a calice floor (fig. 68:5b, 6, 8b). The early ontogeny investigated in some specimens (e. g. fig. 68:2a, b, 7a, b) is typical for the family with some individual variations.

Rejuvenation. — This phenomenon is quite common in the species in question, but a typical course of this process (e g. pl. 29:2) does not require detailed description. A single corallite (pl. 29:6b) produced a very deep axial rejuvenation by secreting an aseptal wall around an axial portion of the calice, where the old septa continued to develop.

Remarks. — The species discussed shows the closest similarity to *A.* (*A.*) *flexibilis* sp. n., the holotype and many paratypes of which from the same formation, and also some specimens from the same localities are derived. Larger dimensions, slightly different n: d ratio, deeper calices, better accentuated asymmetry in length of septa in the cardinal and counter quadrants, a better accentuated rhopaloid character of major septa in maturity, commonly more distinct elongation of the counter septum in this stage with a lack of that elongation in calices, where rather the cardinal septum dominates, are differences which, put together, seem adequate for a taxonomic distinction. It must be pointed out, however, that all these differences are slight and an opposite conclusion, i. e. a consideration of *A.* (*A.*) *frequentis* sp. n. as only an extreme variant of *A.* (*A.*) *flexibilis* sp. n. should not be excluded. Both these species but *A.* (*A.*) *flexibilis* sp. n. in particular, form a kind of intermediate leading towards the subgenus *Ericina* subgen. n.

Differences between *A.* (*A.*) *frequentis* and *A.* (*A.*) *septarugosum* (MOORE and JEFFORDS, 1941) are fairly large and concern dimensions, n: d ratio, different proportions in the thickness of major and minor septa and a large, free axial area in the premature portions of the latter. *A.* (*A.*) *tergida* (ROSS and ROSS, 1962), another species similar to the one discussed, differs first of all in the radial arrangement of septa, equally long in all quadrants and in clear domination of the counter septum both in calices and in the transverse sections of mature portions of corallites.

Occurrence — USNM 728c:29, Lower Bone Spring Formation; 733j:1, Skinner Ranch Formation, Sullivan Peak member; ? 720e:1, Skinner Ranch Formation, base of *Scacchinella* beds. Upper Wolfcampian.

Assimulia (*Assimulia*) *compacta* sp. n.

(fig. 69; pls. 28:10, 11; 31:1a—c)

Holotype: Specimen USNM 197128, fig. 69:1a—e; pl. 31:1a—c.
Type locality: USNM 728f.
Type horizon: Lower Bone Spring Formation.
Derivation of the name: lat. *compactus, a, um* — stocky; after shape of corallites.

Material. — Ten silicified specimens, most with calices and/or proximal ends preserved. Some with internal structures etched out in part.

Diagnosis — *Assimulia* (*Assimulia*) having n: d ratio 26:12—14; septa only slightly wavy, almost equal in thickness; major septa nonrhopaloid, meet or almost meet at corallite axis; counter septum as long as other major septa or slightly longer; minor septa often comparatively short, sometimes free.

Description of the holotype. — The specimen widens rapidly in its younger portion and is almost cylindrical above (pl. 31:1c). The 6.5 mm deep calice (pl. 31:1a) shows a quasi-bilateral symmetry, a slight shortening of the cardinal septum, and formation of a kind of flattened shelf at a part of its periphery. All these changes were caused by rejuvenation, best marked on the lower right part of the picture.

That shallow rejuvenation started comparatively early in ontogeny, causing first changes in morphology just above the diameter of 9.0 × 7.0 mm (fig. 69:1c). The slightly wavy, equally thickened major septa of that diameter come close to or meet in the stereoplasmic infilling of the corallite axis. The cardinal septum is broken, but it is not shortened. The counter septum does not differ in length from the other major septa. The minor septa, vary from less than 1/2 to over 3/4 of length of the major septa; short septa are most common; several of them are free.

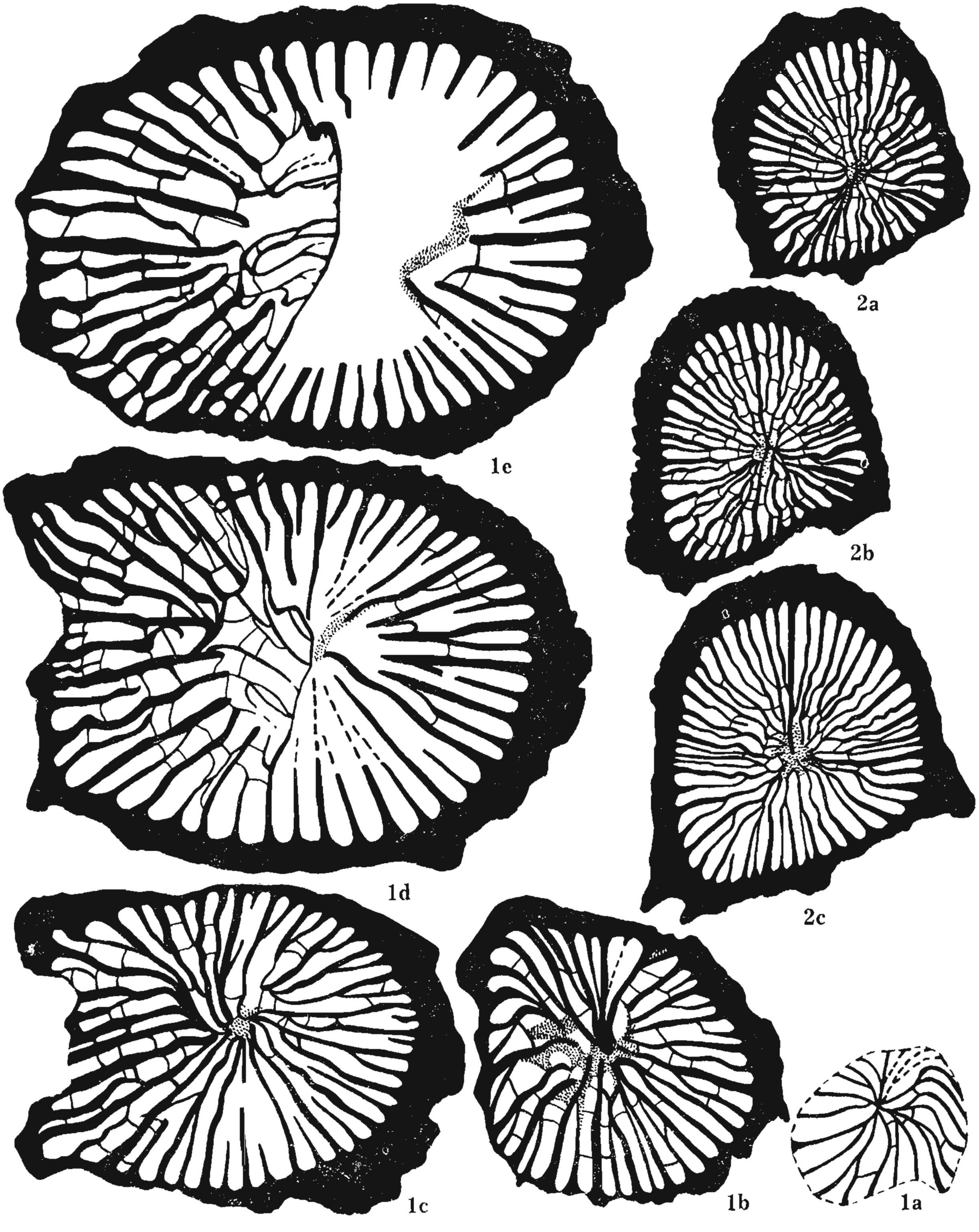


Fig. 69.

Assimulia (*Assimulia*) *compacta* sp. n. 1. Specimen USNM 197128. Holotype. Locality USNM 728f, Lower Bone Spring Formation. Transverse sections; a — neanic stage; b, c — ephebic stage; d, e — late ephebic stage having offset-like, deep lateral rejuvenation. 2. Specimen USNM 197129. Locality and horizon as above. Transverse sections; a, b — early ephebic stage; c — ephebic stage. All, ×8.

The morphology of the slightly younger part (fig. 69:1b) shows elongation of the counter septum, the axial end of which forms a simple columella that is almost met by the cardinal septum. Most of the other major septa, thin and slightly wavy, come close to the corallite axis and end in its stereoplasmic infilling without forming systems. The minor septa are generally longer than in the section described above and mostly contratingent. In early ontogeny (fig. 69:1a), all irregularly curved major septa form four systems that meet together and with the cardinal and the counter septum. All preserved minor septa are contrafused and mostly long.

Rejuvenation. — The holotype shows an unique mode of rejuvenation. Only very small part of the old calice became separated in the course of this process (pl. 31:1a, lower right). The other parts of the calice are characterized by completeness of all major and minor septa. A wide flat shelf neighbouring the disconnected parts is the only difference as compared with the rest of the normally developed calice. This shelf corresponds with a wide empty area in the sections (e. g. fig. 69:1e, right). The empty area is bounded by the left over old septa on one side and by the laterally rejuvenated corallite on the other. The new septa, i. e. the major and the contratingent and contrafused minor ones were inserted on the new wall that originated from two septa of the former calice, united by a piece of an additional basal structural element built between them (fig. 69:1d, e). They meet the normally developed septa of the old part of the corallite, forming a bilateral symmetry of the rejuvenated calice. Their uppermost ridges are to be seen in the deepest part of the calice (pl. 31:1a). A picture made in the transmitted light (pl. 31:1b) shows that the newly inserted and the old septa unite just at the peripheral border of the shelf of the calice mentioned above.

Offsetting. — Only morphological description is given herein. The morphogenetic interpretation is left to the general part of this monograph. The incipient stage of the process started with the formation of the basal plate, located between the major septa and on their flattened and smoothed uppermost margins (pl. 28:10c, upper). Secretion of this plate forms the main difference between the offsetting of this and the dissepimentate corals. Offsets of the latter are based on the uppermost surfaces of dissepiments. The mentioned plate is very uneven, but it is impossible to correlate any of its protuberations or curves with future septal structures. In the case discussed, the uprised margins of the plate indicates that the just started offset was going to build its septal apparatus independently of the parent's septa. This is very uncommon elsewhere and unique in the specimen discussed. In another very young offset for sure (pl. 28: 10a, c, right) and in the older two specimens most probably, a part of the septal apparatus of the parent corallite is fully adopted by the offset at least at its very early stage of development. In the last case, the basal plate was located between the septa. It had grown upwards independently of the septal apparatus of the parent and formed an external wall of the offset. Increase of new septa was asymmetrical and took place on one side of the new corallite, i. e. at the new wall. This was also a side of formation of a new calice (pl. 28:10a, c, right). The arrangement of septa and their increase on the new wall suggest that one of the inherited septa is the cardinal septum. The counter septum has been newly inserted. The proposed interpretation, although most possible, is uncertain. Positions of the cardinal septa in both the older offsets, located at the parent's wall may serve as an indirect proof of such an interpretation. Deep silicification of the specimen precluded investigation of the older offsets in serial sections with peel replicas.

Individual variation. — The inadequate number of specimens prevents any extensive discussion about the problem. The calices vary in two aspects: a) depth and shape, b) relation of depth to length of the corallites. Both these aspects are often random, showing no connection to the stage of ontogenetic development of the specimens. The calices are generally deep, occupying from less than half to slightly more than a third of the corallite length. Sclerenchymal columns in corallite axes have been produced by almost all specimens investigated in sections. In contrast to the holotype, the cardinal and the counter septum of most of the paratypes sectioned remain connected for a long period of their ontogeny (fig. 69:2a, b). Minor septa, contratingent, or contraclined vary greatly in length within a given section of a single specimen. The counter septum may be slightly elongated (fig. 69:2c).

Remarks. — The species discussed has one of the largest ratios of depth of calices to length of corallites and one of the largest dimensions at calice margins. It resembles *Paraduplophyllum* Wu and Zhou, 1982 in having the septa smooth and the calices deep. The morphology of calices, and especially long blades of the minor septa forms the most important character distinguishing *A.* (*A.*) *compacta* sp. n. from that genus. There is no species of *Assimulia* (*Assimulia*) subgen. n. described so far to compare *A.* (*A.*) *compacta* sp. n. more closely.

Occurrence. — USNM 728E:5, 728f:2, Lower Bone Spring Formation; 720e:1, Lower Skinner Ranch Formation; 715v:2, Skinner Ranch Formation, Decie Ranch member. Upper Wolfcampian.

Assimulia (*Assimulia*) sp. 1

(fig. 66:3; pls. 30:14; 33:3)

Material. — The incomplete, silicified specimen having the calice preserved.

Description. — An almost complete calice with 27×2 septa has a depth of 13.5 mm and a diameter of 13.7 mm. The major septa were slightly broken apart, and their original shape remains unknown. Their arrangement, radial at the external wall, becomes pinnately bilateral at the calice floor. The major septa near the cardinal and the counter septa are slightly shortened. The cardinal septum penetrates the narrow but distinct cardinal fossula, reaching the corallite axis. The counter septum, longer than all major septa in the counter quadrants, is slightly thickened axially to form a kind of columella. The moderately long minor septa are free and mostly contraclined.

In the transverse section made in the cylindrical part of the corallite approximately 0.5 cm beneath the calice, the major septa are arranged similar to the arrangement in the calice. There are no systems present, but the middle septa of the quadrants belong to the longest. Their axial ends are thickened so as to meet laterally. All empty spaces between these thickened ends, as well as the axial part of the corallite, is filled in with stereoplasm. The cardinal and counter septa are in contact at the corallite axis but are not united by their middle lines. The cardinal septum is thinner than all other major septa and slightly rhopaloid axially. The counter septum is almost equally thick along its length. The minor septa, including those adjacent to the counter septum, are non-contratingent, but are in lateral contact with the neighbouring major septa along their whole length. They are 1/2 to 2/3 the length of the major septa, only sporadically reaching the axial thickenings of the latter. The cardinal fossula is not marked. The 2 mm thick septotheca consists of equally thickened peripheral parts of the major and minor septa.

Remarks. — The specimen described differs distinctly from all the species of this genus so far described. Its generic position is confirmed mainly by the morphology of the calice. *A.* (*A.*) *arta* sp. n. from the Lower Wolfcampian is the only species exhibiting some similarity in individual sections more enriched with stereoplasm.

Occurrence. — Locality USNM 7221:1, Skinner Ranch Formation, Sullivan Peak member. Upper Wolfcampian.

Subgenus *A.* (*Ericina*) subgen. n.

(*Type species: A.* (*E.*) *fracta* sp. n.

Species assigned: ? *Lopholasma ilitschense* Felser, 1937 *non* Soshkina, 1928, ? *Metriophyllum quganqulutense* Guo, 1980, ? *Paraduplophyllum arcuatum* Wu and Zhou, 1982, *A.* (*E.*) *fracta* sp. n., *A.* (*E.*) *recrea* sp. n.

Diagnosis. — *Assimulia* having cardinal fossula fairly well seen in calices; in sections major septa semi-pinnately or radially arranged, nonrhopaloid, meet at or come close to corallite axis; septa, especially minor, commonly disintegrated into zig-zag carinae-like bodies.
Remarks. — As for the genus.

Assimulia (Ericina) fracta sp. n.

(figs. 70, 71; pls. 29:6—10; 30:1—4; 31:2—11)

Holotype: Specimen USNM 197140, fig. 71:2a—d; pls. 30:1a, b, 31:4a, b.
Type locality: USNM 7221.
Type horizon: Skinner Ranch Formation, Sullivan Peak member.
Derivation of the name: lat. *fractus, a, um* — broken — after carinae-like fragmented septa.

Material. — More than 100 silicified specimens, several having almost complete calices and/or proximal ends preserved. Most of the calices are partly filled in with matrix. The proximal ends are commonly coarsely silicified, although the rest of the internal structure is often preserved in calcite.

Some features of representative corallites (in mm):

USNM cat. nos.	N:d ratio	Depth of calice	Remarks
197140	24:10.7	14·0	calice margin
„	24:10.6		just beneath calice
197144	21: 9.5	incompl.	calice floor
„	20: 7.8		just beneath calice
197136	20: 8.4	8·5	calice margin
„	20: 8.0		just beneath calice
„	19: 6.9		middle of growth
197146	20: 7.3	7·8	calice margin
„	19: 6.2		just beneath calice
197133	20: 5.5	8·2	calice margin
„	16: 4.6		middle of growth
197143	19: 6.4	10·0	calice margin
„	18: 5.5		just beneath calice
197150	18: 6.4	8·3	calice margin
197149	18: 4.9	8·2	calice margin

Diagnosis. — *A.* (*Ericina*) having maximum septal index at calice margin 24:11; calices deep, funnel-shaped, with slightly dominating counter septum; in transverse sections septa much thicker at periphery, commonly divided into zig-zag carinae-like bodies, minor septa more so.

Description of the holotype. — The external characters of the specimen do not differ from those of the paratypes, described below in detail. The axial end of the cardinal septum is broken (an apparent shortening on pl. 31:4a). In the transverse section made just beneath the calice (fig. 71:2a; pl. 30:1a) the major septa reach or almost reach the corallite axis. Their peripheral portions, several times thicker than the very thin axial ends, form the 1 mm thick septotheca. The counter septum is hardly distinguishable. The cardinal septum does not differ from other major septa. The septal cardinal fossula is not developed. All minor septa are almost as long as the major ones, and are mostly contratingent. Those adjacent to the counter septum are free. Almost all septa appear carinated. This morphology results from their division into zig-zag carinae-like fragments. The peripheral part of any such fragment follows the main direction of

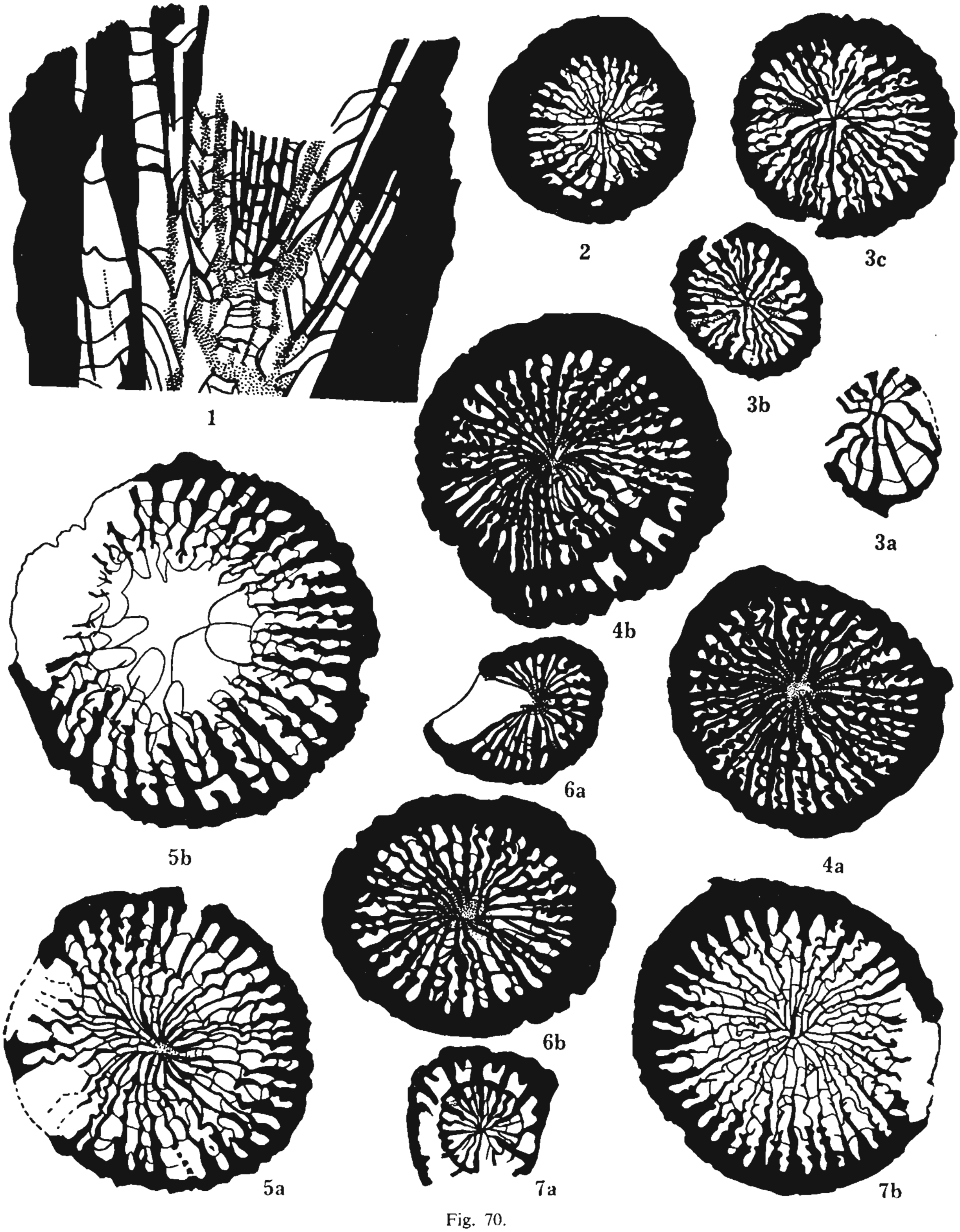


Fig. 70.

Assimulia (*Ericina*) *fracta* sp. n. 1. Specimen USNM 197132. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Longitudinal section, × 8. 2. Specimen USNM 197133. Locality USNM 721. Lower Hueco Formation. Transverse section, ephebic stage having incipient rejuvenation, × 8. 3. Specimen USNM 197134. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Transverse sections; a — early neanic stage, × 16; b — early ephebic stage, × 8; c — ephebic stage, × 8. 4. Specimen USNM 197135. Locality and horizon as above; a, b — transverse sections, ephebic stage, × 8. 5. Specimen USNM 197136. Locality USNM 7230. Skinner Ranch Formation. Transverse sections; a — ephebic stage; b — section made just beneath calice floor; short-septal variant having very deep axial rejuvenation. Both, × 8. 6. Specimen USNM 197137. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Transverse sections; a — early ephebic stage; b — ephebic stage. Both, × 8. 7. Specimen USNM 197138. Locality and horizon as above. Transverse sections; a — deep axial rejuvenation having late neanic morphology; b — ephebic stage. Both, × 8.

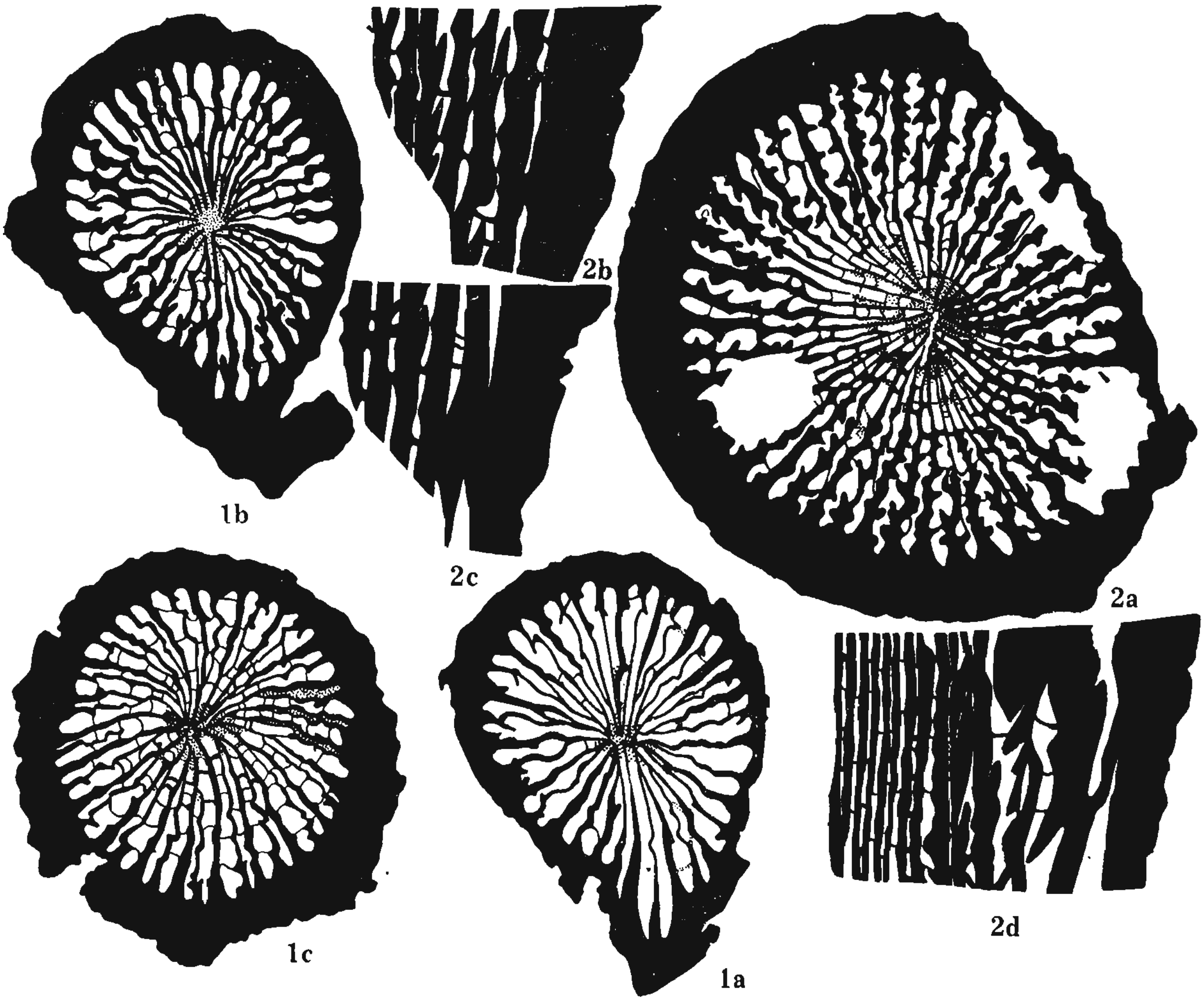


Fig. 71.
Assimulia (*Ericina*) *fracta* sp. n. 1. Specimen USNM 197139. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Transverse sections; a — late neanic stage, b, c — ephebic stage. 2. Specimen USNM 197140. Holotype. Locality and horizon as above; a — transverse section, ephebic stage, b—d — successive longitudinal sections showing carination (?) of septa. All, ×8.

a septum, while its axial part bent laterally, forming a carina-like structure on the lateral surface of a septum (fig. 71:2b, c; pl. 30:1b; see also pl. 31:6b). These structures are better seen on the minor septa, which are mostly thin and consist of a single row of trabeculae. The structure of the major septa, although generally similar, is often camouflaged and complicated by their diffuso-trabecular microstructure. Some septa bear additional plates, which can well be compared to metriophylloid carinae. Sections of the periaxial parts of the holotype show no carinae or carinae-like structures (fig. 71:2a, d). Morphogenesis of the described type of septa will be discussed in more detail in the general volume of this monograph.

The best longitudinal section was prepared from one of the paratypes (fig. 70:1). The tabularium is composed of a narrow axial area, occupied by the horizontal axial parts of tabulae, and a wide peripheral area showing a strongly biform arrangement of tabulae. The tabulae in both positions are almost horizontal near the external wall, but they soon change their directions. Those of Position I are steeply declined adaxially, while those of Position II are steeply inclined adaxially, while those of Position II are steeply inclined upward. The relation mentioned is best seen near the inner margins of minor septa (fig. 70:1, left). No traces of carinae *sensu* *stricto* were found either in the serial longitudinal sections of the holotype or in the paratype described above. Some parts of septa in the longitudinal section bear thickenings corresponding to the carinae-like portions, looking sometimes like being longitudinally duplicated (fig. 71: 2b—d; pl. 30:1b). This is in full agreement with the observations in the transverse sections described above.

External characters of specimens. — Corallites are subcylindrical, elongated, often slightly curved (pl. 31:2b, 3a, b, 4b, 10a, 11b). The ontogenetically young specimens are horn-shaped, supplied with attachment processes. External surfaces of corallites bear delicate septal furrows and growth striae. The calices are deep, funnel-shaped, with the marginal zone occupied by the equally developed foundations of the major and minor septa (pl. 31:2a, 4a). In the inner zone of the calices, the smooth upper ridges of the major septa dominate (pl. 31:2a, 3c, 4a, 5, 8, 11a). The minor septa, long but thin, are hardly seen between the former. The counter septum in most of the corallites is onger than lother major septa, almost all of which meet at the corallite axis. The dominative role of the counter septum is marked by its slightly higher elevation of the axial end and by an arrangement of the major septa in the counter quadrants: one or two pairs of them adjacent to the counter septum are shortened. The cardinal septum is slightly less elevated than other major septa, but it is not shorter, being elongated to the corallite axis along the narrow cardinal fossula. The latter is bordered by 1—3 pairs of the slightly shortened major septa adjacent to the cardinal septum. The arrangement described made the symmetry semi-radial, although all major septa tend to meet at the corallite axis.

Ontogeny.— All observations on the broken tips of specimens and in the transverse sections (e. g. fig. 70:3a) show agreement of the early ontogeny of this species with the main characteristics of the family.

Individual variation. — Some differences in the dimensions of corallites depend on the stage of ontogenetic development rather than reflecting real interspecific variability. Differences in morphology of septa seem most interesting. The holotype and quite a few paratypes belong to a group having most fragmented septa (figs. 70:4a, b, 5a, b, 7b; 71:2a; pls. 29:7b, c, 10; 30:4; 31:6a, b, 9) while in some other specimens (e. g. figs. 70:2, 3b, c, 6a, b; 71:1a—c; pls. 29:8a, b, 9a—c; 30:3), only some septa show that characteristic development. In other corallites, carinae-like structures are common (pl. 30:2a, b). Some of them are so long as to almost reach the neighbouring septum.

Among other morphological structures, differences in length of the counter septum draw attention. In some calices this septum is almost indistinguishable from other major septa (figs. 70:2, 3b, c, 5a, b, 6a, b; 71:1a—c; pls. 29:6a, b, 8a, b, 10; 30:2a, b; 31:9), while in the opposite extreme, it is quite distinct (fig. 70:4a, b, 7b; pls. 29:7b, c, 9a; 30:4). Better development of the diffuso-trabecular microstructure of septa is, to some extent, dependent on the growth stage, being more common in the mature specimens. Differences in length of the minor septa and in the number of the contratingent versus free minor septa vary slightly both in ontogeny of a single specimen and between specimens.

Some specimens (e. g. pl. 30:3) have weakly fragmented septa arranged in pairs, with especially well accentuated two positions of the tabulae. This character is best seen directly on the specimens, where the infillings of the septal loculi occupied by the tabulae in Position I differ clearly from these in Position II.

Remarks.— The species described is type for the subgenus; remarks are thus restricted to its similarity and distinction to earlier described species and to species of the nominative subgenus. It differs from the latter first of all in the subgeneric characters. *A.* (*A.*) *tergida* (Ross and Ross, 1962) has also smaller dimensions and different n: d ratio and so does *A.* (*A.*) *flexibilis* sp. n. *A.* (*A.*) *septarugosa* (MOORE and JEFFORDS, 1941) differs additionally in having the major and minor septa much more differentiated in thickness.

Two specimens (fig. 70:5a, b; pl. 29:9a—c) have wide free axial areas showing some similarity to "*Lopholasma*" *ilitschense* FELSER, 1937 *non* SOSHKINA, 1928 from the Lower Permian Trogkofel Limestone of the Carnic Alps. Different n:d ratio and stronger waviness and fragmentation of septa distinguish these two corals from the Carnic Alps species.

The Chinese species, included with some restriction in this subgenus, may well appear members of *Paraduplophyllum* (*Vacoea*) subgen. n. This has to be checked against the morphology of their calices and against the occurrence of fragmentation of the septa. This was impossible to establish for certain on the illustrations published by the Chinese authors.

Occurrence — USNM 721:14, Lower Hueco Formation; 723o:2, Skinner Ranch Formation, undivided; 707c:2, 707d:5, 7221:93, Skinner Ranch Formation, Sullivan Peak member. Upper Wolfcampian.

Assimulia (*Ericina*) *recrea* sp. n.

(figs. 72—74; pls. 30:5—13; 32:1—12; 33:1, 2)

Holotype: Specimen USNM 197151, fig. 72:1a—p; pls. 30:7a—e; 32:7a, b.
Type locality: USNM 728c.
Type horizon: Lower Bone Spring Formation.
Derivation of the name: lat. *recreo* — to enlive, to revive — after very common rejuvenation.

Material. — More than 80 specimens, often complete. Several calices free of matrix. Internal structure often preserved in calcite, except for the proximal ends, commonly silicified

N:d ratio of representative corallites (in mm):

USNM cat. nos.	N:d ratio	Remarks
197167	24:10.2×10.2	calice margin
197170	24: 9.2× 9.2	calice margin
197175	22:10.0× 8.8	calice margin
197151	22: 9.2× 8.7	calice margin
197151	22: 9.0× 8.2	near calice floor
„	22: 7.8× 7.8	2 mm below
197159	22: 8.7× 8.5	calice margin
„	22: 7.7× 6.7	near calice floor
„	22: 7.0× 5.8	2.5 mm below
197164	21: 8.1× 7.8	calice margin
197166	21: 6.2× 6.2	calice margin
197162	20: 9.2× 8.7	calice margin
„	20: 7.0× 6.8	just beneath calice
197169	19: 7.5× 6.7	calice margin
197172	18: 7.1× 6.8	middle of calice
197157	16: 5.5× 4.3	calice margin
197171	15: 4.0× 3.4	calice margin

Diagnosis. — *Assimulia* (*Ericina*) having maximum n:d ratio at calice margin 24:10.5, most commonly 20—22:7.0—8.5; septa wavy, peripherally thickened; majors meet in corallite axis in indistinct systems; minor septa long, contratingent, much thinner than majors, peripherally carinae-like fragmented, underdeveloped in calices.

Description of the holotype. — External characters (pl. 32:7a, b). The specimen is 27 mm long, irregularly conico-cylindrical, having numerous rejuvenations at different levels of its growth. The attachment flattening, bounded by a number of small attachment protuberations, occurs along half the length of the corallite, starting from its tip. Distinct interseptal ribbings occur along most of its length, except for the tip, where only growth striae can be distinguished.

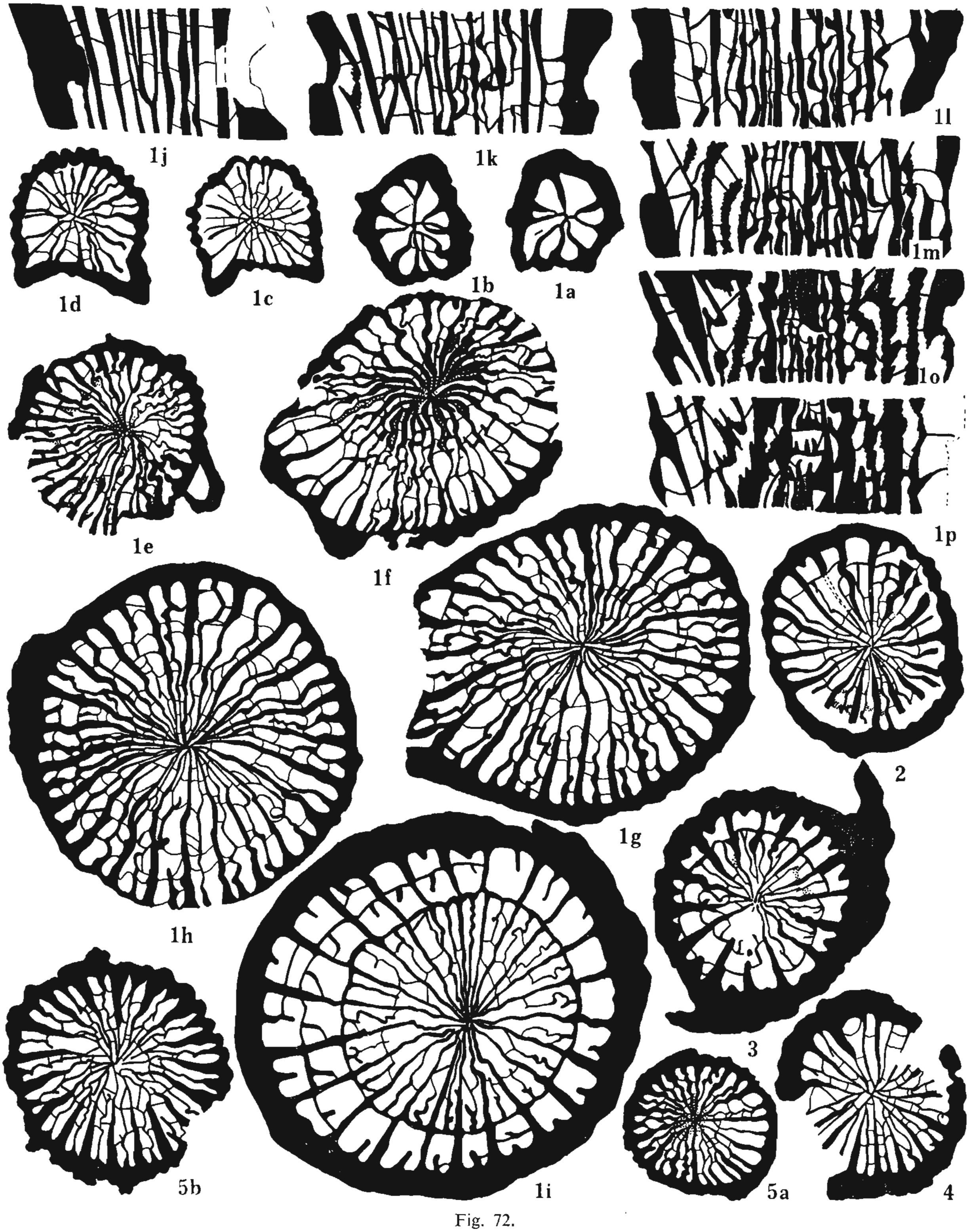


Fig. 72.

Assimulia (Ericina) recrea sp. n. 1. Specimen USNM 197151. Holotype. Locality USNM 728e, Lower Bone Spring Formation; a, b — transverse sections, early neanic stage, × 16; c, d — transverse sections, neanic stage, × 8; e—h — transverse sections, early to late neanic stage, × 8; i — transverse section made above floor of oldest calice, and three successive rejuvenations, × 8; j—p — successive longitudinal sections made from corallite periphery to its axis, × 8. 2. Specimen USNM 197152. Locality USNM 7231, top of Skinner Ranch Formation. Transverse section, early ephebic stage, × 8. 3. Specimen USNM 197153. Locality and horizon as above. Transverse section of rejuvenated corallite, × 8. 4. Specimen USNM 197154. Locality and horizon as above. Transverse section, late neanic/early ephebic stage having weak carination (?) of septa, × 8. 5. Specimen USNM 197155. Locality USNM 7221. Skinner Ranch Formation, Sullivan Peak member. Transverse sections; a — late neanic/early ephebic stage; b — ephebic stage. Both, × 8.

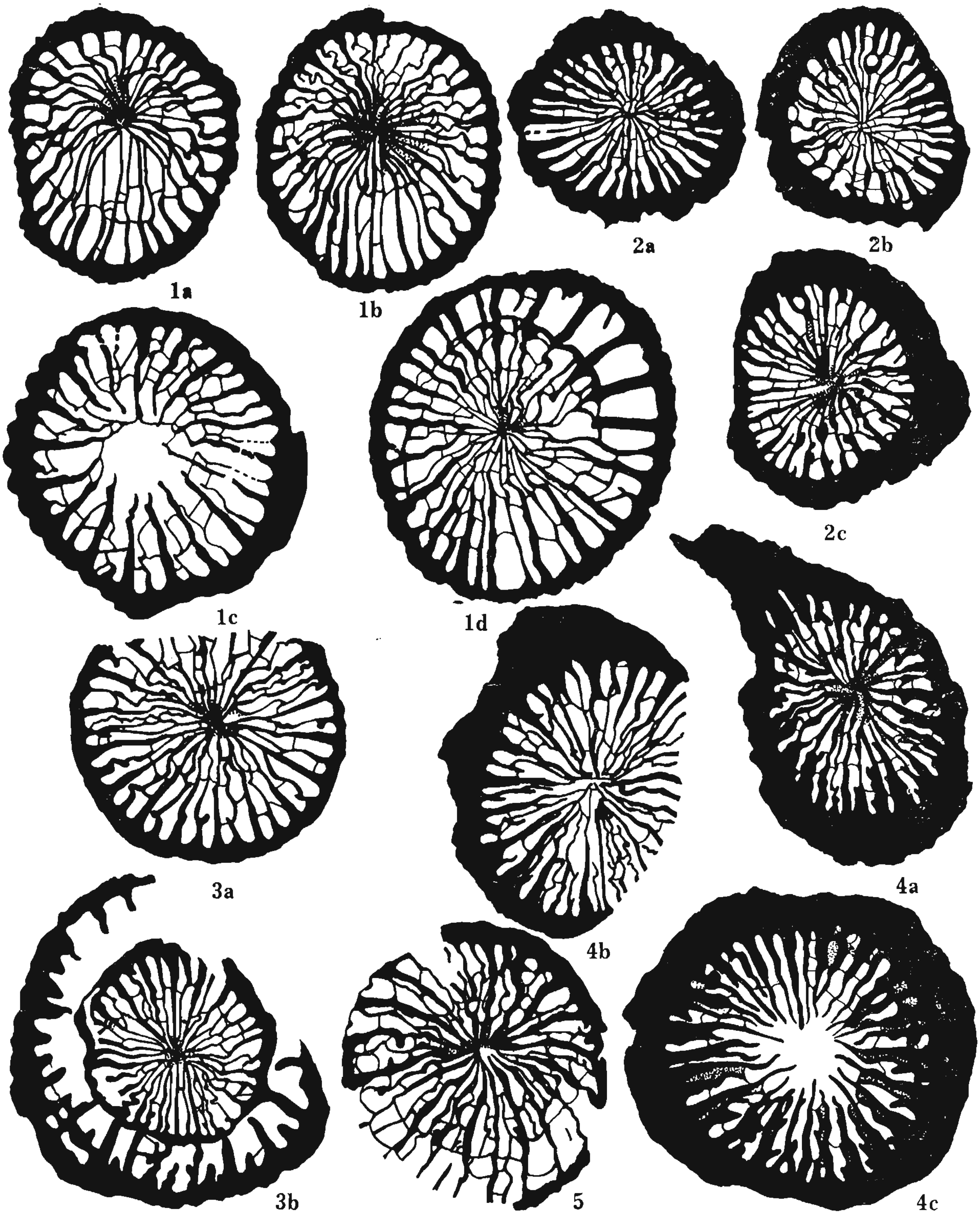


Fig. 73

Assimulia (*Ericina*) *recrea* sp. n. 1. Specimen USNM 197156. Locality USNM 728e. Lower Bone Spring Formation. Transverse sections; a — juvenile morphology retained long in ontogeny, b — ephebic morphology; c — major septa withdrawn from corallite axis; d — lateral rejuvenation occurring in uppermost part of corallite. 2. Specimen USNM 197157. Locality USNM 707b, Skinner Ranch Formation, Sullivan Peak member; a—c — successive transverse sections; b and c having commensal worm tube incorporated. 3. Specimen USNM 197158. Locality USNM 728e, Lower Bone Spring Formation. Transverse sections; a — ephebic stage; b — deep axial rejuvenation. 4. Specimen USNM 197159. Locality and horizon as above. Transverse sections; a — early ephebic stage, b — ephebic stage; c — just above calice floor except for most loculi in Position J. 5. Specimen USNM 197160. Locality and horizon as above. Transverse section, ephebic stage of laterally rejuvenated corallite. All, ×8.

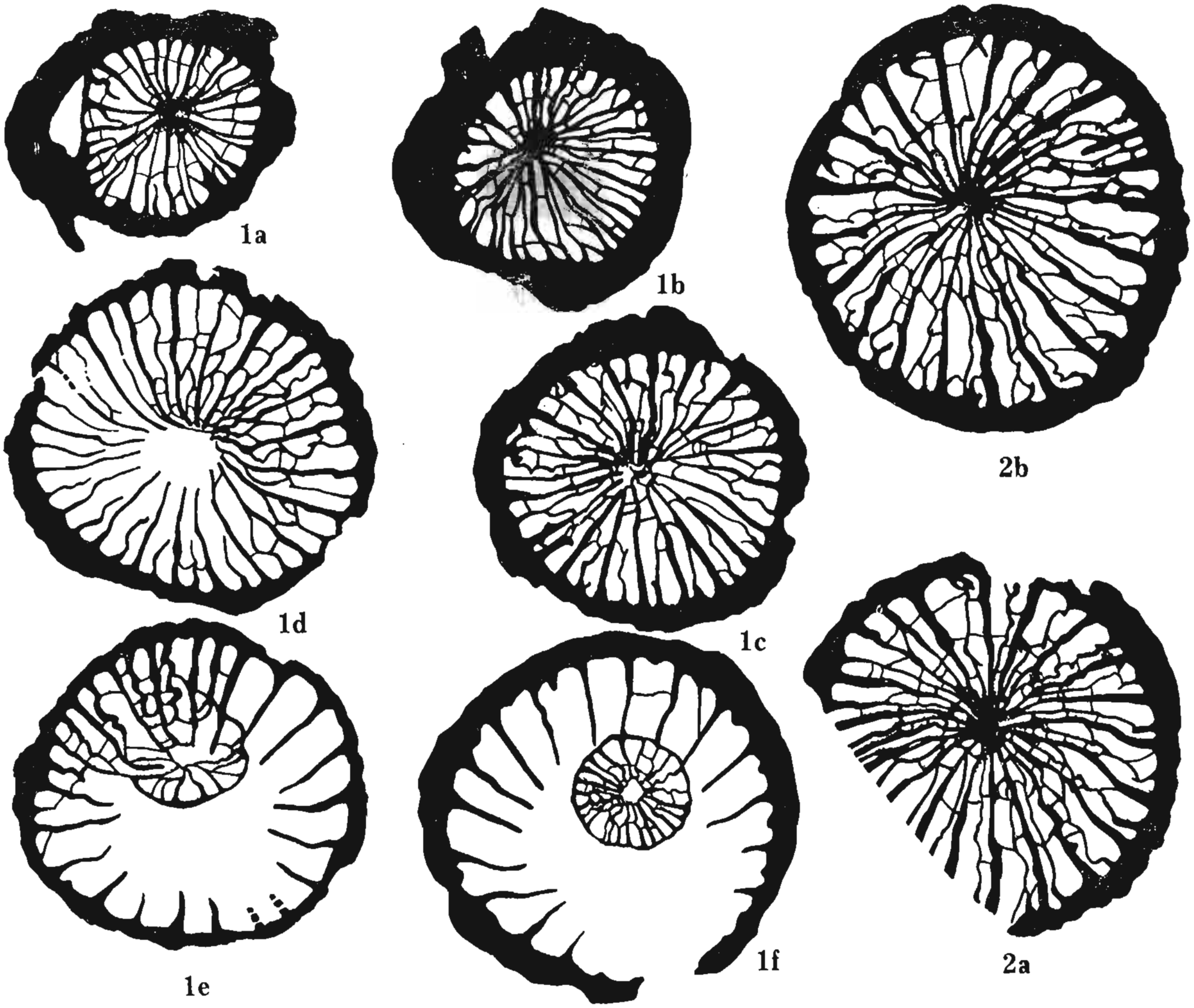


Fig. 74.
Assimulia (*Ericina*) *recrea* sp. n. 1. Specimen USNM 197161. Locality USNM 728e, Lower Bone Spring Formation. Transverse sections; a — late neanic/early ephebic stage; b, c — ephebic stage having counter septum slightly dominating in thickness; d — calice (left) and continued to grow part of corallite (upper right), e — early stage of lateral rejuvenation based on counter septum and adjacent major septa; f — rejuvenated corallite starting new axial rejuvenation just before its final mortification. 2. Specimen USNM 197162. Locality and horizon as above; a, b — transverse sections, ephebic stage. All, × 8.

The calice is approximately 7 mm deep from its upper margin to the bottom of the youngest rejuvenation. Its strongly wavy margin marks the peripheral zone of the calice, where foundations of the major and minor septa are equally developed. The calice margin of the youngest rejuvenation is almost straight and the peripheral zone is smooth. The beginning of the inner zone of the old calice is fairly well marked by an almost complete disappearance of the minor septa. Blades of the major septa, smooth and rounded in their upper margins, slope down without marking any intermediate zone of the calice.

The corallite rejuvenated five times, with all rejuvenations taking place within the frame of the old calice and diping successively into it. The lateral kind of rejuvenation, with a permanent portion of the old calice being left alive, provided this side of the youngest calice with the same, old major septa (pl. 32:7a). It inherited also the lowermost part of the old septa that became elongated along the new wall as soon as it is developed.

Morphology in the transverse sections. — Three sections (fig. 72:1g—i) can be considered as mature, but only the middle one (fig. 71:1h; pl. 30:7d) exhibits the most advanced morphology.

The major septa are wavy, but not so much as to become fragmented; very thin in their inner parts, peripherally thickened, and bent slightly towards the cardinal septum, they meet in the corallite axis forming hardly distinguishable systems. The minor septa, contratingent and almost as long as the major septa, are thinner and more strongly bent than the latter; some of them bend so much as to form carinae-like fragmentations at their periphery. The hardly distinguishable cardinal and counter septa do not differ from the other major septa. They meet at the corallite axis.

The morphology in the ontogenetically younger section (fig. 72: 1g) differs from that described above only by slightly more accentuated differences in thickness of major and minor septa and by an increase of waviness of the latter. The same is true for the uppermost section that was cut through the rejuvenation (fig. 72:1i). The carinae-like structures are fairly common on the very thin and distinctly wavy minor septa of this stage of growth.

Serial longitudinal sections made through the cardinal quadrants of the early mature part of the corallite (fig. 72:1j—p; pl. 32:7e) show clearly biform tabularium of the peripheral part, absence of metriophylloid carinae, and presence of carinae similar to the xyloid type. Axial parts of the tabulae are horizontal and spaced 0.3—0.5 mm.

Early ontogeny of the holotype (fig. 72:1a, b; pl. 32:7a, b) has been investigated on the apical part of the corallite with only the growth striae present. The youngest part preserved, 1.0×0.8 mm in diameter, exhibits a septal apparatus composed of 8 septa, bilaterally arranged, with the axial septum as the symmetry axis (fig. 72:1a; pl. 32:7a). The bifurcated lateral septa are interpreted as the counter-lateral septa and the contrafused minor septa corresponding to them. Absence of the minor septa at the counter septum is notable. The corallite retains the same number of septa during at least 0.4 mm of further growth.

In the next thin section, made approximately 0.5 mm apart (fig. 72:1b; pl. 32:7b), a single minor septum at the counter septum and another one in a cardinal quadrant are being inserted. Increase of septa remains irregular during further growth of approximately 0.7—1.0 mm i. e. until the appearance of the first septal furrows (pl. 32:7b). The arrangement, positions, and sequence of appearance of septa indicate that an increase of the major and minor septa alternate both in the apex and in the higher, ribbed part of the corallite. The second minor septum at the counter septum appeared almost at the level of that ribbed portion. The appearance of the latter does not change the model of increase of further septa (fig. 72:1c, d), making mysterious the reason for the septal furrows not having been developed on the tip.

Individual variation. — The shape of the corallites varies from conical and almost trochoid (pls. 32:8a; 33:1a) through horn-shaped or conico-cylindrical (pl. 32:2, 5b, 6b, 7b, 12b) to scolecoid (pls. 32:3a, b; 33:2a). All better preserved specimens show flattenings or imprints of attachment and are supplied with attachment protuberations or processes. Development of these bodies is to a large extent correlated with the shape of specimens. The scolecoid corallites are almost lacking attachments, while those of the two other groups have them well and very well developed. No talons are present, but attachment processes of some specimens are so strong as to destroy the symmetry of the calice.

There are hardly any calices within the collection of this species that do not show traces of rejuvenation. In some specimens (e. g. pl. 32:1, 12a, c), the process of rejuvenation has been repeated so many times as to result in reduction of the diameter to a twelfth of the starting calice and to aseptal morphology. Almost as large reduction of the diameter might have taken place almost immediately, however (pl. 32:9a, b). Apart from changes in morphology caused by rejuvenation, the calices differ slightly in n:d ratio and in development of the minor septa in their inner zone. Their lengths vary there from short but well distinguishable blades (pl. 32: 8a, b, 9a, 12a) to almost smooth external wall in the loculi between the major septa (pl. 33:1b). The first and intermediate variants constitute most of the collection, whilst the calices belonging to the latter variant are very rare. There are no specimens with long minor septa in calices present, however.

Differences in sections of the mature parts of corallites depend to some extent on positions of the sections compared (early to late stage). There are also some more substantial variations in morphology, however. The holotype and several paratypes (figs. 73:1a—d, 3a, b; 74:2a, b; pl. 30:5a, b, 6a, b, 11) may well be considered as the central, most frequent morphotype. Differences between these paratypes and in comparison to the holotype are slight and concern mainly the thickness of the major and minor septa and the relation of the uncarinated (fractioned?) to carinated minor septa, with the latter never being in large majority. Thickenings of axial ends of the major septa in the late neanic/early ephebic stage, exposed well in the holotype, can be seen, but never so advanced, in the paratypes (e. g. fig. 73:1a, b, 5). The cardinal septa are permanently long, also in calices. This is equally true for all the variants discussed below (e. g. figs. 73:4c; 74:1d, e).

The next variant, composed mainly of corallites with small dimensions, can eventually be treated as ontogenetically determined. The radial arrangement of septa, typical for the mature portions of specimens of the central group, speaks in favour of distinction of this group of corals as a morphological variant. Large differences in thickness of the major and minor septa and the almost complete absence of the carine-like structures on the latter are the main characteristics of its representatives (fig. 72:2, 4, 5a, b; pl. 30:12). Individual sections of rare specimens of this group expose more strong carination (fragmentation?) of septa (fig. 73:2c; pl. 30:9). Sections of the same specimen, immediately below the afore mentioned one (fig. 73:2b) show these structures much less distinctly developed.

From the other two variants, each represented by a single specimen studied, the one having the counter septum slightly dominating (fig. 74:1a—c) is otherwise similar to the holotype, especially in its mature portion (figs. 74:1c). The ontogenetically younger section (fig. 74:1a) differs from the comparable section of the holotype in having the major septa much more straight and thin axially.

The second specimen discussed (fig. 73: 4a—c) differs from all other specimens of this species in having the minor septa located so close to the major ones as to give the impression as being laterally united in some loculi. Positions I and II of the tabulae are additionally stressed by different matrix infillings in the given septal loculi. The specimen has been included in the species discussed mainly because of the typical morphology of its calice.

Rejuvenation. — In spite of an apparent variety, the process of the rejuvenation can be reduced to only a few generalized steps or phases. Separätion of a given part of an old calice from the rest of it forms the first step (pl. 33:1b), either in axial (upper circular wall on the picture) or in lateral rejuvenation (a wall structure at the calice floor that unites two major septa). The more advanced stage of the latter is shown in fig. 74:1e. Presence of a part of an old septal apparatus is almost invariably a character of this stage. It has probably been present even in an almost aseptal tube of the very early rejuvenated young corallite (pl. 33:2b). Only the very extreme axial rejuvenation of the calices strongly reduced in dimensions leads to the appearance of a completely structure-less short ring of an external wall, i. e. the aseptal morphology (pl. 32:12c). Previous rejuvenations of the same specimen were normally septal, however (pl. 32:12a).

Reduction of the minor septa in an early stage of rejuvenated calice is the second general character in common. Septal furrows corresponding to those septa are present on a corallite surface, however (pl. 32:5c), except for the beginning of this stage, which shows only growth striae and is directly comparable to early ontogeny of corallites of this species.

Reduction of dimensions may sometimes lead to creation of a calice showing regular, zaphrentoid arrangement of septa at its floor (pl. 32:6c). The illustrated calice, 1.8×1.7 mm in diameter has most possibly 8 to 10 septa at its floor and a similar number of them on its wall. A slightly more advanced stage with better developed septal blades, but similar in the arrangement of septa, is more common (pl. 32:5c, 11). A young calice, fully developed in the course of rejuvenescence (pl. 32:5a, c) may well be compared with those developed in normal ontogeny (pl. 32: 4, 10). In all these calices the minor septa are not present in their lumens. Their foundations appear in calices slightly more advanced in ontogeny (e. g. external part of the young calice of the specimen USNM 197167, pl. 32:5c; third rejuvenation of the specimen USNM 197169 and USNM 197173, pl. 32:8b, 12a, c respectively, etc.). Reduction in the number and length of the major septa during the advanced process of rejuvenation may also lead to the formation of the irregular arrangement of partly new and partly old major septa (pl. 32:9b). The latter phenomenon was observed only during lateral rejuvenation.

Remarks. — The species discussed shows the closest similarity to *A.* (*E.*) *fracta* sp. n. and also to *A.* (*A.*) *abscessa* sp. n. both from the Upper Wolfcampian. The rather shallow calice, with underdeveloped or rarely absent minor septa, distinguish it from both these species. Although it has an n:d ratio similar to *A.* (*E.*) *fracta* sp. n., *A.* (*E.*) *recrea* sp. n. differs from the latter in having much less advanced development of the carinae-like structures, larger differences in thickness of the major and minor septa, shallower calices when compared to the length of the corallites and larger diameters achieved by extreme specimens. From *A.* (*A.*) *abscessa* sp. n., the species discussed differs in n:d ratio, larger diameters of corallites, an absence of thickenings of axial ends of major septa, except for some ontogenetically young sections, much better accentuated arrangement of major septa in systems, and in their almost invariable junction at the corallite axis.

Occurrence. — USNM locality 728e:68, 728f:1, Lower Bone Spring Formation; 707b:2, 722h:1, 7231:4, 733j:1, Skinner Ranch Formation, Sullivan Peak member; 727f:2, Upper Skinner Ranch Formation; 707a:2, Skinner Ranch Formation, Decie Ranch member. Upper Wolfcampian.

Genus *Paraduplophyllum* WU and ZHOU, 1982

Type species: P. delicatum WU and ZHOU, 1982

Synonym: Duplophyllum GUO, 1980 *non* KOKER, 1924.
Subgenera assigned: Paraduplophyllum WU and ZHOU, 1982; *Vacoea* subgen. n.

Diagnosis. — Lophotichiidae having smooth major septa weakly developed in wide, deep calices where minor septa are hardly seen or absent; septa of both cycles elongate on calice floor and beneath it, major septa often to axial connection; amplexoid species may occur; cardinal septum equal to other major septa; counter septum may form weak, simple columella in calice but not in sections; peripheral and/or split-like carinae may occur.

Remarks. — The present paper was almost ready for publication and the family Lophotichiidae WEYER, 1972 was completely elaborated when I received a copy of WU and ZHOU (1982) with the genus *Paraduplophyllum* newly established by these authors. It was thus necessary to change some parts of the manuscript, but not the previous concept of the taxon.

First of all I do not agree with the family placement of *Paraduplophyllum* by WU and ZHOU (1982) and I transferred that genus from the family Metriophyllidae HILL, 1939 to Lophotichiidae WEYER, 1972. This has been done in spite of the fact that the early growth stages of the type species of *Paraduplophyllum* were not illustrated and described by WU and ZHOU (1982). The mature morphology of all specimens illustrated by those authors left almost no doubts that it does not differ from specimens described here in detail. The strongly biform tabularium present in *Paraduplophyllum* and lacking in *Metriophyllum* M.-EDWARDS and HAIME, 1850 speaks adequately against its original placement, even without a knowledge of the early ontogeny of its type species.

The calices of the Chinese specimens remain unknown, while their morphology was established herein as one of the most important diagnostic characters for the American taxa. Because of this, the placement of the two Chinese species in different genera, proposed in this paper, must be considered temporary. This has been done because of the close similarity of the Chinese to the American species of given subgenera.

The original generic diagnosis was emended because of its incompletness. This concerns, first of all, the occurrence of the biformity of the tabularium and the early ontogeny, both typical for Lophotichiidae. It was also broadened because of the presence of amplexoid species in American collection.

In the remarks on their new genus, Wu and Zhou (1982) pointed out the similarity of that genus to *Duplophyllum* Koker, 1924 and to *Asserculinia* Schouppé and Stacul, 1959. In the latter case, they indicated an absence of the fossula in *Paraduplophyllum*, which in fact may not be a case. It is true, however, that the cardinal fossula is inconspicuous, often very much so, because of the arrangement of the major and minor septa, especially in the nominative subgenus. The similarity of *Paraduplophyllum* to *Duplophyllum* is rather superficial, although one of two missing specimens originally illustrated by Koker (1924, pl. 8, fig. 2) might well belong to *P.* (*Vacoea*) subgen. n. The present status of *Duplophyllum* was recently discussed by Fedorowski (1986).

The stratigraphic position of the type species of the genus was originally established as Upper Carboniferous. However, the Kangkelin Formation, from which it came, is regarded by Wu and Zhou (1982) as the same age as the Sakmarian of the USSR and Lower Wolfcampian of the USA, both considered Lower Permian in accordance with the generally accepted time scale. Such an occurrence makes this genus, as well as the closely related *Assimulia* gen. n., a good guide to the Lower Permian and, maybe also one of the guide fossils for the lower boundary of the Permian System, at least in some parts of North America and China. These subgenera appear to be of interest for international correlation.

Guo Shengzhe (1980:107, pl. 62, figs. 10a, b) described a new species *Duplophyllum subdendroideum* as colonial. Three specimens located next to each other on the section do not prove colonial growth form (Fedorowski 1981), and the species may well be solitary. The early ontogeny and morphology of the calices are unknown. The morphology of the mature portion in both longitudinal and transverse section fits well with the diagnosis of *Paraduplophyllum* and especially with the carinated forms of the nominative subgenus. The specimens discussed seem to be close to the American species discussed here, but the incompletness of their description and illustration as well as the uncertain growth form, prevent establishment of their precise relation.

Subgenus *P.* (*Paraduplophyllum*) Wu and Zhou, 1982

Type species: as for the genus

Species assigned: Duplophyllum subdendroideum Guo, 1980, *P.* (*P.*) *delicatum* Wu and Zhou, 1982, *P.* (*P.*) *multiplicatum* sp. n., *P.* (*P.*) *oppositum* sp. n.

Diagnosis. — *Paraduplophyllum* having at least some minor septa arranged in ditoecholasmid manner; cardinal and counter septa equal to other major septa in length and in height in calice; long, split-like and peripheral carinae may occur.

Remarks. — Two subgenera can be recognized in the corals described in this paper: the rare nominative subgenus and the much more abundant subgenus *Vacoea* subgen. n. The latter differs from the former in the relation of the major and minor septa, the arrangement of tabulae, which slope steeply in both positions, and, in the lack of peripheral and/or split-like carinae. The latter character may not occur in some specimens or species of the nominative subgenus, but it is well developed in *P.* (*P.*) *multiplicatum* sp. n. and seems to be present also in some specimens of the type species (e. g. Wu and Zhou, 1982, pl. 3, fig. 1) and in the ontogenetically most advanced specimen of Guo (1980, pl. 62, fig. 10a). The differences listed are adequate for subgeneric distinction in spite of the fact that they appear in combination with characters common for both subgenera.

Paraduplophyllum (*Paraduplophyllum*) *oppositum* sp. n.

(fig. 75; pls. 30:15—18; 33:4—11)

Holotype: Specimen USNM 197176, fig. 75:3a—5; pl. 30:17.
Type locality: USNM 702d.
Type horizon: Hess Formation, Taylor Ranch member, Upper Wolfcampian.
Derivation of the name: lat. *oppono, posui, positum* — opposed — after positions of major and minor septa.

Material. — More than 40 silicified specimens; several with calices and/or proximal ends preserved but mostly deeply silicified.

N: d ratio of representative specimens (in mm):

USNM cat. nos.	N: d ratio	Remarks
197183	20:7.8	middle of calice
197178	19:7.1	calice margin
„	18:6.2	just beneath calice
„	18:5.5	earther beneath calice
197187	18:6.4	calice floor
197181	17:6.0	beneath calice
197176	16:5.8	calice floor
„	16:4.8	just beneath calice
„	14:3.8	early ephebic stage
197179	16:5.7	just beneath calice
197185	16:3.7	calice floor

Diagnosis. — *P.* (*Paraduplophyllum*) having n: d ratio near calice floor 16:5.7—18:6.2; septa thin, noncarinated.

Description of the holotype. — The narrow ceratoid corallite bears delicate growth striae and shallow septal furrows on its epitheca. The calice, preserved only in its lower part and slightly filled in with matrix, exhibits a shallow axial rejuvenation. Minor septa are not seen. Major septa, short at the wall, become elongated along the calice floor. In the section made 2 mm below the calice floor (fig. 75:31), the arrangement of major septa is centripetal, with almost all of them, including the cardinal and counter septa, connected at the corallite axis. The latter two form a symmetry axis for all other septa. Judging from the densely packed sections of tabulae in Position II, directly comparable with other loculi, the cardinal tabular fossula may not be developed.

Minor septa are almost as long as the major septa. Each of them starts close to a counter side base of one septum and meets the periaxial, cardinal side part of an adjacent major septum. Because of this arrangement, there are two minor septa starting at the base of a cardinal septum and none at the base of a counter septum. A wide triad is always present at the latter instead.

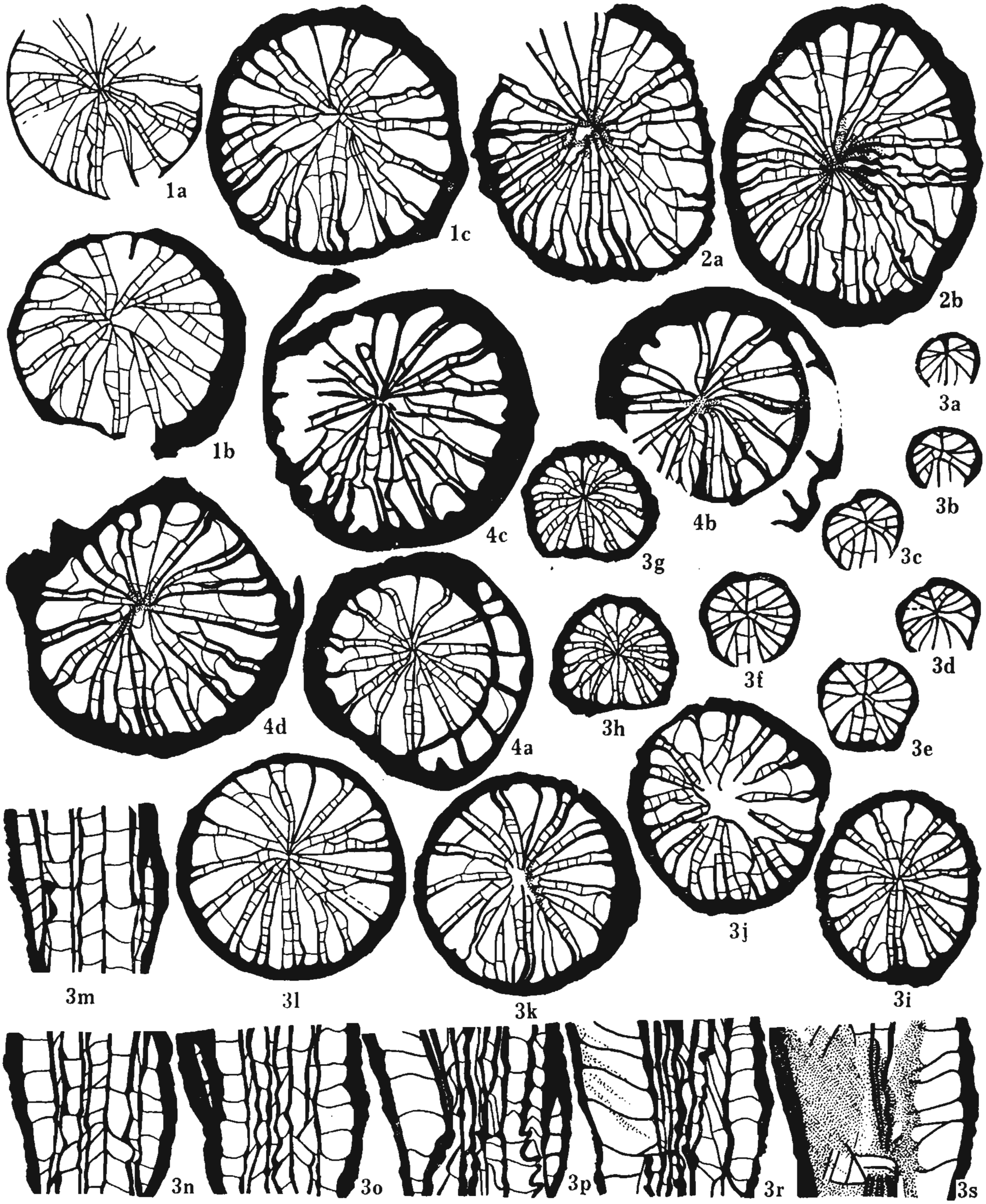


Fig. 75.

Paraduplophyllum (*Paraduplophyllum*) *oppositum* sp. n. 1. Specimen USNM 197177. Locality USNM 727u, Skinner Ranch Formation, Decie Ranch member; a—c — transverse sections, early to late ephebic stage. 2. Specimen USNM 197178. Locality USNM 722l, Skinner Ranch Formation, Sullivan Peak member; a, b — transverse sections, ephebic stage. 3. Specimen USNM 197176. Holotype. Locality USNM 702d, Hess Formation, Taylor Ranch member; a—f — transverse sections, early to late neanic stage; g—l — transverse sections, early to late ephebic stage; m—s — successive longitudinal sections made from corallite periphery to its axis. 4. Specimen USNM 197179. Locality and horizon as above. Transverse sections; a, b — rejuvenated part of corallite having early ephebic morphology; c, d — ephebic stage. All, ×8.

The arrangement described is very constant. It is not developed only at an early ontogeny (see below) and is slightly broken for only 2—3 mm of the mature growth of the corallite (fig. 75:3j, k; pl. 30:17). The axial area free of septa seen there must be treated as incidental (pathological? mechanically or diagenetically caused?), because the sections made both below and above the mentioned portion of growth show typical morphology.

The longitudinal serial section was made in counter quadrants between the transverse sections shown on fig. 75:3i and 3j. Tabulae in Position I (wide septal loculi) are almost regularly, widely spaced 4—6 for 4 mm, and are horizontal or sloping slightly downwards abaxially. Only peripheral parts of these tabulae near the counter septum rise slightly upwards, being broadly tent-shaped (fig. 75:3m—o). Tabulae in Position II (very narrow septal loculi) are directed obliquely, but not steeply, upward at the periphery, with some of them being horizontal. Their periaxial parts (fig. 75:3p—s) slope very steeply upwards abaxially. Axial parts of tabulae are horizontal (fig. 75:3s, lower part).

Ontogeny has been investigated from the youngest preserved stage, 1.2×1.4 mm in diameter and 12 septa. Due to silicification of the tip, the peel technique could not be used and fig. 75:3a—f are camera lucida drawings from polished surfaces.

The cardinal and the counter septum of the youngest stage observed (fig. 75:3a) are directly united by their middle lines. The latter are thicker than all other major septa. The metasepta and the lateral protosepta form an introductory stage of four systems. Their middle lines are directly united. Of six septa present in the counter quadrants, two are minor septa contrafused to the counter-lateral septa. The minor septa adjacent to the counter septum are not yet seen in the corallite lumen, although they may be already present in the thick external wall. Septal loculi between the counter septum and the counter-lateral septa are the largest present.

The minor septa adjacent to the counter septum appeared in the corallite lumen within a distance of less than 0.3 mm above the formerly described level of growth (fig. 75:3b). Their appearance at the base of the counter septum, as well as their arrangement, may suggest an increase by splitting of the latter. This has not been confirmed by any direct observations because the septal furrows were destroyed by silicification. The minor septa mentioned elongate successively, and the loculi between them and the counter septum widen, becoming eventually the largest present.

The next minor septa appeared first and clearly in sequence in the counter quadrants (fig. 75:3c, d). Those of the cardinal quadrants were inserted only after 1.2 and 1.6 mm of further growth of the corallite, respectively (fig. 75:3e, f). The increase in septa described differs from that of the other lophotihiids in the irregular appearance of the minor septa. In other representatives of Lophotichiidae they are inserted in regular sequence alternately with major septa. Approximately 1.5—2.0 mm above the section illustrated on fig. 75:3f the morphology of the corallite changes quickly from common for the whole family to characteristic for the genus and species discussed (fig. 75:3g, h).

Individual variation. — External characters. Corallites are ceratoid, sometimes so narrow as to be almost cylindrical, uppermost (pl. 33:7a, 11b), with their lower parts often more or less curved (pl. 33:5, 7a, 10a, b, 11b). Attachment flattenings and processes are common, but talons are not developed. Calices, 7—12 mm deep, occupy from 1/2 to 1/4 the length of the corallites. Their marginal zones, formed of equally developed foundations of major and minor septa (pl. 33:11a), pass gently downwards into the inner zone, and only the major septa are seen in the calice lumen. The minor septa disappeared in this zone and reappeared only at the calice floor, where their arrangement is identical with that in sections (pl. 33:4, 6, 7b, 8, 9). Axial parts of the major septa may be slightly protruded above the calice floor (pl. 33:11a). There is a large difference in depth of the calices between the loculi occupied by tabulae in Positions I and II. On pl. 33:4, 6, 7b, 9, they are illustrated as wide and shallow versus very narrow and deep (dark in the picture) parts of the calice floor, respectively.

In very young calices, corresponding to the neanic stage with more equally spaced major and minor septa (see description of the ontogeny of the holotype), the calice floor may also be fairly differentiated in depth (pl. 33:10b, c), although this character is not always distinct (pl. 33:8). Axial parts of both the young calices mentioned are slightly camouflaged by silica infillings, and their primary morphology is not quite certain.

The n:d ratio, although dependent mainly on growth stage, differs also a little in the comparable sections (see table above). The morphology and especially the arrangement of septa, is differentiated both in individual sections of a given corallite and between corallites (fig. 75:1a—c, 2a, b, 3i—l, 4a—d; pl. 30:15a, b, 16, 17, 18a, b). These irregularities are, in several cases, caused by rejuvenation (e. g. fig. 75: 4a—d; pl. 30:15a, b, 18a, b) or by mechanical (? epibiontic? or diagenetic?) disturbances (fig. 75:2a, b) causing strong curvature of a corallite, its rejuvenation, rearrangement of septa, and/or axial thickenings of the latter.

On a single section of one specimen (fig. 75:1b), the counter septum is distinctly shortened. This inconstant a character might have been diagenetically caused. Both septal loculi in question are filled in with coarse grained druzy calcite on this separate section.

Remarks. — The species discussed resembles most closely the type species of the subgenus, at least as far as the transverse sections of the mature portions of the corallites are concerned. Of these, the sections illustrated on pl. 1: 9—11 of WU and ZHOU (1982) are especially close morphologically to the specimens here described. The main differences may be found in less frequent sections of tabulae in Position II and in the closer connection of the minor septa with bases of the oppositely situated major septa. The latter may in *P.* (*P.*) *delicatum* WU and ZHOU, 1982 give the impression of being inserted from the major septa well above their bases (e. g. WU and ZHOU, 1982, pl. 1:9, 10 the cardinal septa and some major septa adjacent to the latter). Also, the longitudinal section of *P.* (*P.*) *delicatum* WU and ZHOU, 1982 (pl. 1:14) differs seemingly very much from that of *P.* (*P.*) *oppositum* sp. n. This is caused by the position of the section running in its major part slightly peripherally and through the loculi in Position I. The upper portion of the same section shows several tabulae in Position II, as well as their horizontal axial portions. The greatly sagging tabulae in Position I of the type species differ from the almost horizontal ones in *P.* (*P.*) *oppositum* sp. n.

The specimens illustrated by WU and ZHOU (1982) on pl. 3:1, and those of GUO (1980, pl. 62:10a), with their long carinae, are more similar to *P.* (*P.*) *multiplicatum* sp. n.

Occurrence. — USNM 702d: 27, Hess Formation, Taylor Ranch member; 727u:1, Skinner Ranch Formation, Decie Ranch member; 722h:2, 722l:12, Skinner Ranch Formation, Sullivan Peak member, Upper Wolfcampian.

Paraduplophyllum (*Paraduplophyllum*) *multiplicatum* sp. n.

(fig. 76; pls. 33:12, 40:1—3)

Holotype: Specimen USNM 197190, fig. 76:1a—m; pl. 40:2a—c.
Type locality: USNM 727u.
Type horizon: Skinner Ranch Formation, Decie Ranch member.
Derivation of the name: lat. *multiplico* — to multiply — after seeming multiplication of septa.

Material. — Six silicified specimens without proximal ends and with very incomplete calices. The preserved part of the calice of the holotype is filled in with matrix. Maximum n:d ratio of the holotype 24:9.7×7.8.

N: d ratio of representative corallites (in mm):

USNM cat. nos.	N: d ratio	Remarks
197190	24:9.7 × 7.8	middle of calice
„	23:8.6 × 7.9	lowermost part of calice
„	20:6.7 × 6.2	just beneath calice
„	17:5.6 × 4.6	early ephebic stage
197192	20:7.1 × 6.2	calice floor
197191	16:5.0 × 5.0	near calice floor
„	? 16:4.9 × 4.5	just beneath calice

Diagnosis. — *P.* (*Paraduplophyllum*) having n: d ratio at calice floor up to 24:8.8; major septa often form peripheral carinae that imitate minor septa; the latter long, contrafused or contratingent.

Description of the holotype. — The specimen is ceratoid, having distinct septal furrows on the thick external wall. All the transverse sections made below the calice exhibit characters of maturity and only a little morphological variation (fig. 76:1 a—c; pl. 40:2a, b). Slightly wavy major septa, often thicker than minor septa, especially in their peripheral parts, come very close to or meet metriophylloidally at the corallite axis without forming clear systems. Minor septa are very long, contrafused and arranged in the manner typical for the subgenus. Differences in width of septal loculi corresponding with positions I and II of tabulae are not always large, however. Major septa often form additional septa-like carinae, which commonly start at the external wall, being contratingent to major septa. In some cases they are attached only to lateral surfaces of the major septa. Both these structures are most frequent in the lowermost preserved part of the corallite (fig. 76:1 a) and absent in the calice (fig. 76:1 f). The section made at the calice floor is situated almost entirely above the last tabula. Only some peripheral-most parts of the cardinal quadrants are subtabular (fig. 76:1 f, lower). All major septa are radially arranged and distinctly peripherally thickened. The cardinal septum is shortened. The couter septum does not differ from other major septa. Its position is indicated by better developed minor septa. Other minor septa in this section through the calice form only small knobs on the internal surface of the external wall.

The longitudinal serial section was made from a very short part of the corallite (fig. 76: 1 g—m; pl. 40:2c), but it shows a clearly biform tabularium as well as the long carinae described above. Metriophylloid carinae are absent.

Individual variation. — The sectioned paratypes (fig. 76:2a—c; pl. 40:1 a, b, 3a, b) vary in the individual portions of their growth and between themselves. In the first case, there is often a sequence of the morphotypes similar to those described for the holotype. The rejuvenating specimen (pl. 40:3a, b) illustrates this best, having also the early ephebic stage (pl. 40:3a) most similar to the type species of the subgenus and to *P.* (*P.*) *oppositum* sp. n. The arrangement of septa in the mature portion of this specimen (pl. 40:3 g) is camouflaged by numerous carinae. A single paratype (fig. 76:2a—c; pl. 40:1 a, b) differs from all other specimens in having a much smaller number of septal carinae, an arrangement of septa closely resembling that of *P.* (*Vacoea*) subgen. n. and the counter septum elongated near the calice floor (fig. 76:2c). Minor septa in that region are shortened in several loculi and may disappear.

Remarks. — The species discussed, having similar n: d ratio differs from *P.* (*P.*) *oppositum* sp. n. and from most of the specimens of the type species in developing peripheral and elongated carinae of major septa and in the less well differentiated width of septal loculi corresponding to Positions I and II of tabulae. As a consequence of the latter, the loculi adjacent to the counter septum are not distinctly wider than the other ones. The latter characters make it closer to *P.*

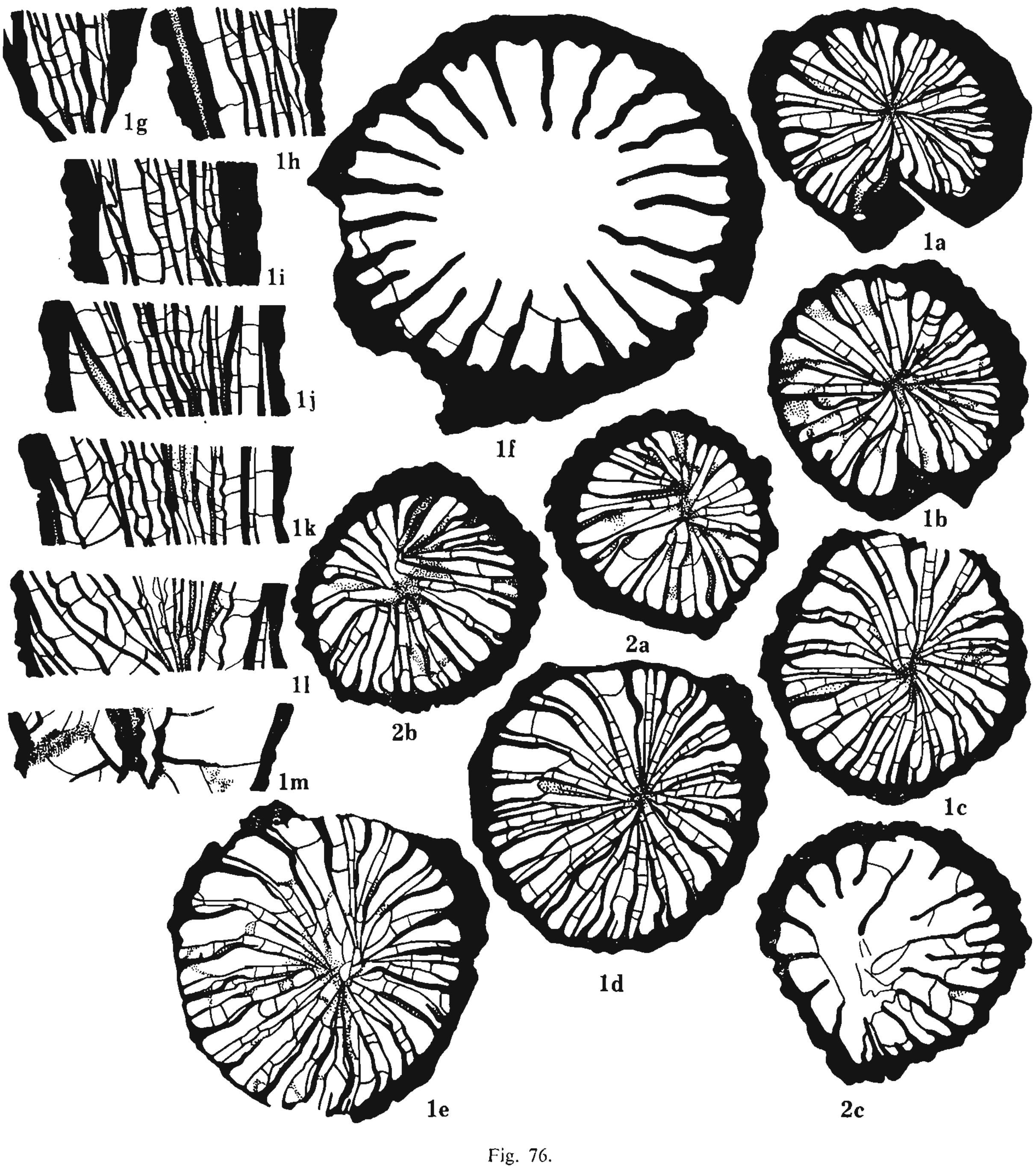


Fig. 76.
Paraduplophyllum (*Paraduplophyllum*) *multiplicatum* sp. n. 1. Specimen USNM 197190. Holotype. Locality USNM 727u, Skinner Ranch Formation, Decie Ranch member; a—e — transverse sections, early to late ephebic stage; f — calice; g—m — successive longitudinal sections, made from corallite periphery to its axis. 2. Specimen USNM 197191. Locality USNM 720e, Lower Skinner Ranch Formation. Transverse sections; a, b — ephebic stage; c — near and above (middle and upper left) calice floor. All, ×8.

(*P.*) *subdendroideum* (Guo, 1982). The much larger number of peripheral carinae and a tendency of some specimens to shorten the major septa a little are main differences that could have been established so far except for the doubtful colonial growth form of the Chinese specimens. More complete study on the latter may prove their priority over *P.* (*P.*) *multiplicatum* sp. n. as a senior synonym.

Occurrence. — USNM 720e:1, Skinner Ranch Formation, base of *Scacchinella* beds; 707a:3, 727u:1 Skinner Ranch Formation, Decie Ranch member; 7221:1, Skinner Ranch Formation, Sullivan Peak member. Upper Wolfcampian.

Subgenus *P.* (*Vacoea*) subgen. n.

Type species: P. (*V.*) *tubaeformis* sp. n.

Derivation of the name: lat. *vaco* — to be empty — after morphology of calices.
Species assigned: P. (*V.*) *amplexoides* sp. n., *P.* (*V.*) *tubaeformis* sp. n., *P.* (*V.*) *verniculare* sp. n.

Diagnosis. — *Paraduplophyllum* having minor septa contratingent and reduced at maturity in amplexoid species; cardinal septum equal to other major septa; counter septum may form weak, simple columella in calices, not seen in sections; carinae absent.

Remarks. — Differences between the subgenus discussed and the nominative subgenus are mentioned in remarks on the latter. The most important characteristics of the genera and subgenera, of Lophotichiidae Weyer, 1972 are shown on Table II. The following discussion is thus focussed mainly on the intrageneric relationships of the genera and subgenera described in this paper. The whole discussion is based on the fact, well documented in this paper, that early ontogeny of all these taxa is indistinguishable up to the late neanic stage inclusively. *Vacoea* subgen. n. is the only taxon in which this basic morphology may be retained up to the mature portions of corallites. Thus, the subgenus may in theory be ancestral for the whole family. Such a consideration is not supported by data actually existing (see remarks on the family). On the contrary, its stratigraphic position and close morphological similarity to some species of *Lophotichium* Moore and Jeffords, 1945 and to *Assimulia* gen. n. indicate its closer relation to these two genera rather than to the other ancient genera. There are several possibilities of the occurrence of species within this genus and of their inter- and intra-generic relations. Some of them are as follows:

a) *Vacoea* subgen. n. derived from an unknown representative of *Lophotichium* in the neanic stage of the latter. Such a concept of paedomorphosis is supported by two facts: 1) *Lophotichium* is the stratigraphically oldest known genus, 2) All modifications of the septal apparatus of *Vacoea* subgen. n. are based on the neanic morphology, with the cardinal septum not shortened and the counter septum not yet elongated. Trends of the development within *Vacoea* subgen. n., i. e. the tendency to form a columella — like counter septum in some species and to achieve amplexoid morphology in the other ones may be interpreted as repetition or reminiscent of the same tendencies observed within *Lophotichium*.

b) Although the occurrence of such a closely comparable pair of species as *L. dugoutense* sp. n. and *P.* (*V.*) *vermiculare* sp. n. speaks strongly in favour of the concept discussed above it is also theoretically possible to reach the vacoeoid morphology from taxa related to *Duplophyllum* (?) sp. de Groot, 1963. In this case, there will not be paedomorphosis, but a slow evolution leading towards development of a columella in some and an amplexoid morphology in other species. First of those two ways of evolution has not been proven as yet, but the recent study by Rodriquez (1984) shows that the second one may be considered. Apart from the incomplete knowledge of the Spanish taxa, the long time gap in the occurrence, and the uncertain ways of communication between Spain and North America (Fedorowski 1981), at least one North American species described so far, i. e. *P.* (*V.*) *amplexoides* sp. n. may represent this way of evolution i. e. may belong to *Kabakovitchiella* Weyer, 1972.

c) *Vacoea* subgen. n. derived from a primitive representative of *Assimulia* gen. n., which in turn was a paedomorphic descendent of *Lophotichium*. In the latter case, derivation took place prior to achievement of the ability to shorten a cardinal septum but after the development of elongation of the counter septum. *A. uddenitense* sp. n. from the Gaptank Formation, *Uddenites*-bearing member, the stratigraphically oldest species described herein, with its laterally smooth septa and well developed columella, may to some extent prove the possibility of this way of evolution. *Vacoea* subgen. n. would have developed from a taxon similar to *A. uddenitense* sp. n. by reduction of the columella. The slightly elongated counter septum observed in some specimens and the weak columella present in *P.* (*V.*) *tubaeformis lophotichioides* subsp. n. have to be considered as rudiments in this case. The morphology of the calice in *A. uddenitense* sp. n. is unknown.

d) *Vacoea* subgen. n. is not a real genus, but a polyphyletic composition of species that achieved a given morphological level by means of development or reduction of some structural elements. Such species might have been derived from either of the three afore mentioned genera (*Duplophyllum* (?) sp. de GROOT, 1963 = gen. n., *Lophotichium* MOORE and JEFFORDS, 1945 or *Assimulia* gen. n.). Moreover, *Vacoea* subgen. n. can be considered ancestral for some species of *Lophotichium* (e. g. *L.dugoutense* sp. n.) and of *Assimulia* (*Ericina*) (*A.* (*E.*) *recrea* sp. n. and *A.* (*E.*) *fracta* sp. n.).

Only a part of the possibilities listed above can be accepted as probable, i. e. those based on similar morphology of the calices. The taxonomic value of this character may be treated as either important if the genetic interpretation is employed, or secondary if this interpretation is purely ecological and somatic. Of these two, the first one is accepted in this paper. Such an interpretation is based on two facts: 1) Specimens with funnel-shaped as well as wide and empty calices were mixed together and thus were possibly influenced by similar extrinsic factors, 2) Boundaries between them are fairly sharp, which would not have been the case if a step by step ecological change are accepted.

Considering the morphology of calices taxonomically important, a close relation of species of *Vacoea* subgen. n. to *A.* (*E.*) *fracta* sp. n. is rather doubtful, while a relation to *A.* (*E.*) *recrea* sp. n. seems slightly more possible. The same is true for such a pair of species as *P.* (*V.*) *verniculare* sp. n., which might have been derived from *L. dugoutense* sp. n. or vice versa.

The above discussion does not solve the problem of the relation of genera and species within Lophotichiidae WEYER, 1972. The main reason for presenting it is to show at least some ways of evolution leading towards individual taxa and the uncertainty of classification of such extraordinarily plastic taxa. The systematic scheme applied is subjective, but the objective relations within such a group are possible to reconstruct only when a study of the genetic mechanism is applicable.

Paraduplophyllum (*Vacoea*) *tubaeformis* sp. n.

Holotype: Specimen USNM, fig. 77:9a—c; pl. 34: 22a, b

Type locality: USNM 728f.

Type horizon: Lower Bone Spring Formation.

Derivation of the name: lat. *tuba, ae* — trumpet — after shape of deep calices and curved corallites.

Subspecies assigned: P. (*V.*) *tubaeformis lophotichioides* subsp. n.; *P.* (*V.*) *tubaeformis reductum* subsp. n.; *P.* (*V.*) *tubaeformis tubaeformis* subsp. n.

Diagnosis. — *P.* (*Vacoea*) having n:d ratio at calice margins up to 24:12.0 and 26.10·0; wide calices occupy approximately half the corallite length; minor septa may slightly penetrate inner zone of calice; major septa in calices arranged zaphrentoidally, or centripetally, beneath calices grouped in systems.

Remarks. — The species described has been divided into three subspecies, with the nominative subspecies dominating greatly in number of specimens. The other two subspecies form small accessory offshoots, showing differences larger than can subjectively be accepted by the present author as interspecific. All subspecies are from the same localities and, judging from the very well preserved skeletons, were not transported long distances. The problem of such satellite subspecies, observed also within other genera and species, will be more widely discussed in the general considerations of this monograph.

The morphology and trends of variation of the species discussed are most similar to those observed in *P.* (*V.*) *vermiculare* sp. n. It differs from the latter in deeper calices and in the relation of this depth to the corallite length, in n: d ratio at the calice margins, well marked septal furrows, and in higher elevation of the axial area of calices in some subspecies.

Paraduplophyllum (*Vacoea*) *tubaeformis tubaeformis* subsp. n.

(figs. 77, 78; pls. 34:4—22; 35; 36; 37:1, 2)

Holotype: Specimen USNM 197202, fig. 77:9a—c; pls. 34:22a, b.
Type locality: USNM 728f.
Type horizon: Lower Bone Spring Formation.
Derivation of the name: lat. *tuba, ae* — trumpet — after shape of corallites.

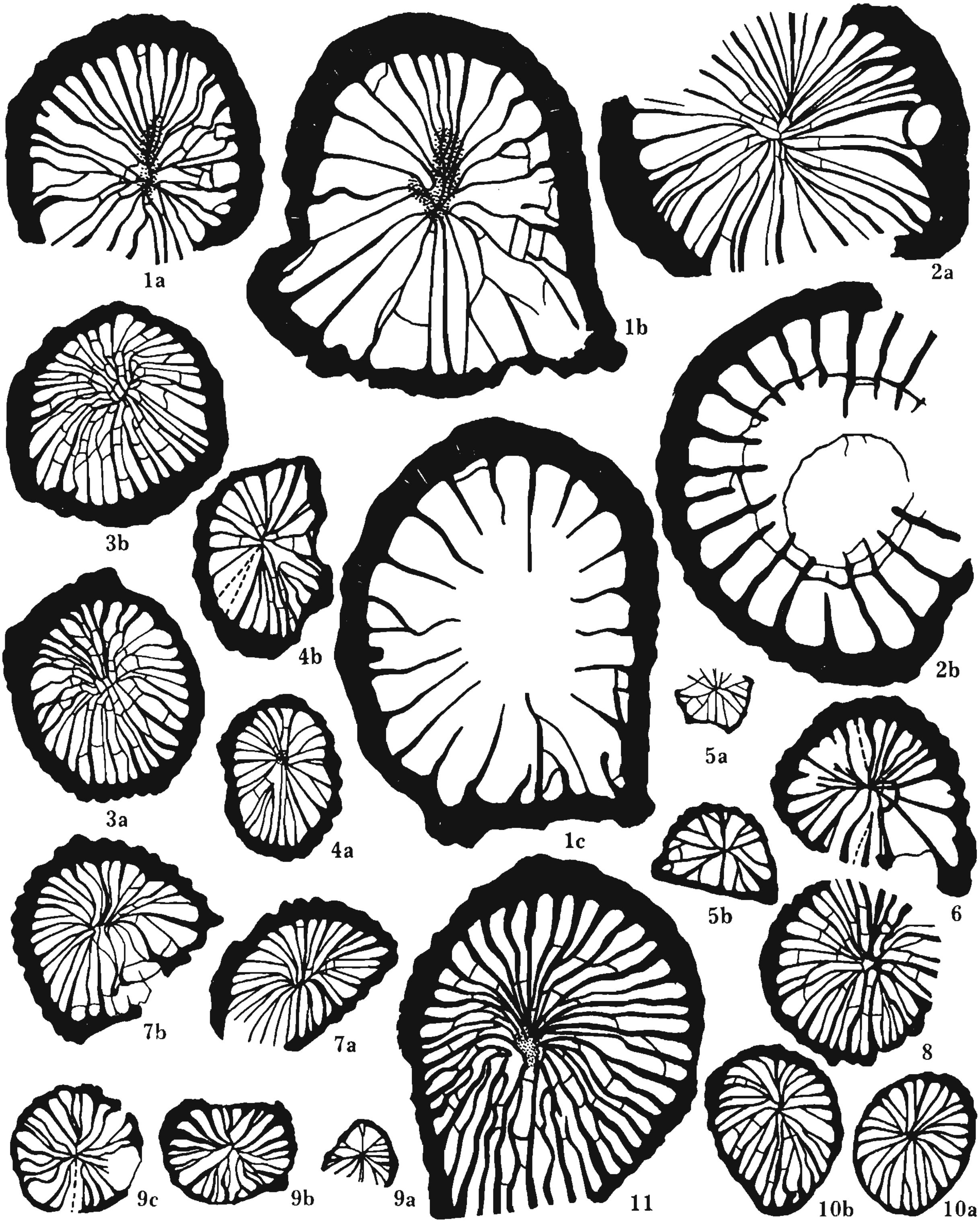
Material. — More than 170 silicified specimens, almost all with calices at least partly preserved. Many with nearly complete but deeply silicified proximal ends. N:d ratio (in mm) for the populations is shown on the fig. 78.

Some features of representative corallites (in mm):

USNM cat. nos.	N:d ratio	Length	Depth of calice	Remarks
197228	24:12.5×11.3	20.5	14.3	calice margin
197239	24:10.0× 9.0	17.0	8.2	„ „
197227	23:10.8×10.0	23.0	14.2	„ „
197202	23: 9.3× 7.5	20.0	11.3	„ „
„	13: 2.8× 2.7			just beneath calice
197234	22: 9.1× 9·1	16.0	9.1	calice margin
197237	22: 8.0× 8.0	17.0	5.8	„ „
197194	22: 8.8× 6.7	incompl.	incompl.	near calice floor
„	22: 8.0× 8.0			calice floor
„	17: 5.6× 5.3			just beneath calice
197199	20: 7.6× 7.4	14.0	8.3	calice margin
197231	20: 7.1× 7.1	7.5	6.2	calice margin
197233	20: 7.1× 7.0	15.5	10.0	„ „
197220	19: 9.4× 7.7	15.5	11.0	„ „
197241	19: 6.8× 5.8	12.0	5.0	„ „
197221	18: 7.5× 6.7	15.0	9.6	„ „
197217	18: 6.5× 5.8	14.5	8.8	„ „
197230	17: 6.0× 4.6	10.0	5.2	„ „
197225	16: 4.6× 4.0	10.0	5.8	„ „
197216	15: 3.5× 3.3	6.0	3.5	„ „
197214	14: 3.4× 3.2	10.0	5.5	„ „

Fig. 77.

Paraduplophyllum (*Vacoea*) *tubaeformis tubaeformis* subsp. n. 1. Specimen USNM 197194. Locality USNM 728e, Lower Bone Spring Formation. Transverse sections; a — ephebic stage; b — partly above, partly beneath calice floor; c — above calice floor except for most peripheral portions of some septal loculi. 2. Specimen USNM 197195. Locality USNM 727u Skinner Ranch Formation, Decie Ranch member. Transverse sections; a — ephebic stage; b — calice having axial and periaxial rejuvenation. 3. Specimen USNM 197196. Locality USNM 728h, Lower Bone Spring Formation; a, b — successive transverse sections made just beneath calice. 4. Specimen USNM 197197. Locality USNM 728f, Lower Bone Spring



Formation. a, b — transverse sections made just beneath calice but having late neanic morphology. 5. Specimen USNM 197198. Locality and horizon as above. Juvenile corallite; a, b — transverse sections, neanic stage. 6. Specimen USNM 197199. Locality and horizon as above. Transverse section made just beneath calice. 7. Specimen USNM 197200. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Transverse sections; a — early ephebic (?) stage; b — section made just beneath calice floor. 8. Specimen USNM 197201. Locality and horizon as above. Transverse section made just beneath calice floor. 9. Specimen USNM 197202. Holotype. Locality USNM 728f, Lower Bone Spring Formation Transverse sections. a — neanic stage; b, c — successive sections made just beneath calice floor. 10. Specimen USNM 197203. Locality and horizon as above. Juvenile corallite; a, b — transverse sections made just beneath calice floor. 11. Specimen USNM 197204. Locality and horizon as above. Transverse section, ephebic stage. All, ×8.

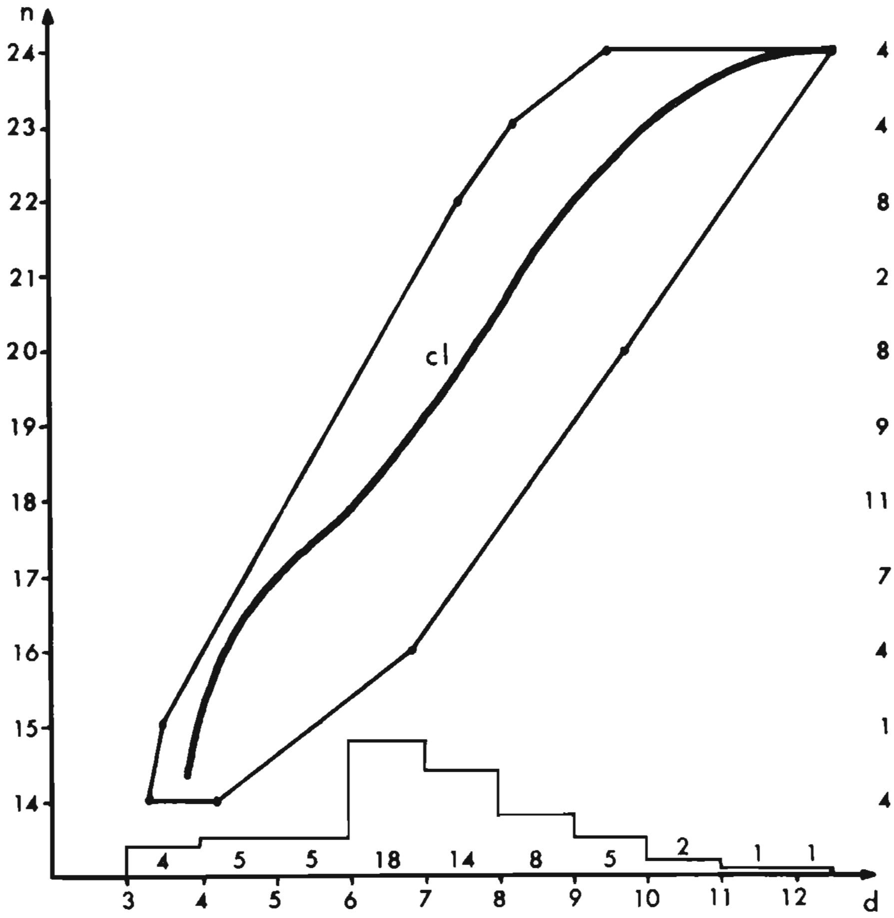


Fig. 78.
Paraduplophyllum (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Septal index, n: d (in mm) at calice margins. Points corresponding to extreme specimens are united by lines. Correlation line of n: d ratio (cl) is a mean line for individual classes. Numbers on right side of the picture illustrate amount of specimens possessing given number of major septa.

Diagnosis. — *P.* (*Vacoea*) *tubaeformis* having n: d ratio at calice margin up to 24:12.0, most commonly 18—20:6—8; major septa thin, most commonly meet in corallite axis, near calice axis protruded; minor septa beneath calice long, contrafused.

Description of the holotype. — **External characters** (pl. 34:22a, b). More than half the length of the specimen and all of its distinctly widened part is occupied by a calice. It looks empty because of shallow foundations of septa passing gently into very short and narrow blades of major septa (pl. 34:22b). Underdeveloped minor septa become visible only at the calice floor. The latter is deeper at the counter side. A narrow axial elevation, moderately protruded, is eccentric and located closer to the cardinal septum. Elevations of septa on the calice floor are only slightly marked.

In sections made just beneath the calice floor (fig. 77:9c) the slightly wavy major septa, united at the corallite axis, are grouped in systems, with none of them dominating. Minor septa are very irregularly developed. Some of them are as long as the major septa and some are short. Being all contrafused, they may join the adjacent major septa at small or comparatively large angles.

In the youngest known section (fig. 77:9a), all septa are thin and straight and arranged typically for the family and genus. All minor septa are short and contrafused. One of those neighbouring the counter septum is not yet present in the corallite lumen.

Ontogeny. — Observations made on several tips of specimens broken at different growth stages show full agreement with comparable growth stages of other species of this genus. Some very young specimens found within the collection provide new data as observed in calices. The youngest specimen, almost complete but coarsely silicified in part, is 2.2 mm long and 1.9 × 1.6 mm wide at the calice margin. It is almost trochoid, with only a slightly curved apical region (pl. 34:13b). The deep and wide calice (pl. 34:13b) occupies more than 2/3 of the corallite length and bears on its margin approximately 14 shallow curves or concavities, i. e. foundations of septa. The wall of the inner zone of the calice is almost smooth, with no protruding septal blades. The true sclerosepta, probably 7 in number, are seen only at the calice floor. Their real number is uncertain, because of an inadequate state of preservation. The cardinal and the counter septa are united to form a distinct axial septum. The alar and counter-lateral septa join the axial septum laterally. At least one metaseptum (or a minor septum adjacent to the counter-lateral septum) is also present in the counter quadrant. A pair of minor septa might have been already inserted near the counter septum, but this portion of the calice is coarsely silicified. Also, the partly preserved apex, with 3 protosepta well seen and 3 (?) other covered with silica (pl. 34:13a), shows two bodies neighbouring the counter septum. These bodies are most possibly the foundations of the first minor septa. No other minor septa occur.

Young corallites at the growth stage slightly more advanced than that described above demonstrate a considerable variability of the calice floor morphology. Closer examination and comparison of several specimens suggest a kind of heterochronism in appearance of individual structures when compared to the diameter of calices. It seems most probable that axial ends of septa at the beginning of ontogeny are not, or very slightly exposed above the last tabula (pl. 34:5a, 10, 11, 15a). This stage of development is probably a period of short duration in most specimens, because it is only sporadically represented within the collection studied. Young corallites showing axial ends of septa protruded are much more abundant. The morphology of this axial part of the calices varies. It may be slightly dominated by a single (counter or cardinal) septum (pl. 34:9), by both of these septa (pl. 34:4b, 8a, 21a) forming an axial septum, or by axial ends of several septa (pl. 34:6a, 14a, 16a). This protruded axial area is low in most very young corallites. Rare specimens, however, have this area highly elevated in a very early stage of development (pls. 34:8a, b, 14a, 16a, 21a; 36:3). An arrangement of septa in systems is only seldom well seen at this early growth stage (e. g. pl. 34:11, 14a), but the biform tabularium may be already well developed and clearly documented by differences in position of tabulae within the triad and next to it (pl. 34:16a).

Rejuvenation. — This phenomenon is rare within the subspecies discussed. When it occurs, a normal repetition of younger morphology is in most cases observed (pl. 36: 1d, 2a right, 7a). The deeply laterally rejuvenated corallite (pl. 36:7a) shows a moderately elevated axial area of the calice, with well developed cardinal septum retained from the old calice. The new counter septum is elevated higher than the other major septa.

A single specimen (pl. 36:4a, b) shows a very rare kind of rejuvenescence, comparable only to that described in *Assimulia compacta* n. sp. The specimen is deeply laterally rejuvenated, leaving at first almost 2/3 of its old calice (pl. 36:4a right, 4b upper). In the course of the second phase of rejuvenation, it left another half or so of the formerly rejuvenated calice. The latter chanse is incomplete, however, and both calices remain united by a narrow, common part of the margin. The skeleton (external wall) produced in this area is horizontal, with foundations of septa developed similar to those in calices having a wide and flattened shoulder. This "shoulder" roofed a part of the left over calice. The inner marginal part of the "shoulder" shows a very early stage of increase of new septa (pl. 36:4b) developed fairly irregularly, but always at the side of the cardinal septum.

Septal bodies, located obliquely between some major septa of another rejuvenated corallite (pl. 36:1a, d) form the next phenomenon worth mentioning. Those septal bodies, developed in the loculi occupied by minor septa of the older part of the calice (pl. 36:1 a, upper), do not replace minor septa. This is best documented by two left of them illustrated (pl. 36:1 a). Their function is uncertain, but it should not have been important, because of rarity of similar bodies. They were traced for only two more times in the subspecies discussed (pls. 36:10a, 37:2a).

The replacement of the minor septa of the old calice by the major septa of the rejuvenated one (pl. 36:1 d, lower) is another phenomenon of the corallite discussed, fairly rare in the collection studied. Unfortunately, the state of preservation of the corallite predicted any more detailed study.

Individual variation. — Specimens assigned to the subspecies discussed differ widely in particular morphological characters, which in turn permit recognition of some distinct groups of specimens. Individual groups are connected by specimens of intermediate morphology and do not differ from each other in dimensions. In such a situation any formal taxonomic distinction of these groups seems unsupported. Occurrence of main groups is commonly connected with regions and/or stratigraphic levels, which may allow treatment of them at least as distinct populations.

Almost all specimens derived from the Bone Spring Formation including the holotype, form a single group essential for the species discussed in morphology and modes of variation. Specimens of this group bear the following characteristics:

1. Well developed septal furrows (pls. 34:4a, 5b, 12, 13b, c, 14b, 16b—d, 18b, 19b, 22a; 35:1b, 3, 4a, 5a, 6b, 7a, b, 9b, 10b, c; 36:1b, b, 2b, 5b, 6b, 7b, 10b; 37:1b).
2. Very deep calices, occupying more than half the length of corallites and all widened parts of them. The morphology beneath calices is simple, resembling juvenile corallites (fig. 77:1 a, 4b, 5b, 10b).
3. Short major septa in the inner parts of calices (pls. 34:5a, b, 8a, 10a, 14a, 15a, 19a, 20, 21a; 35:1a, 2, 4b, 5b, 6a, 7c, 8, 10a; 36:3, 9; 37:1a). They elongate along the last tabula to form systems.
4. Minor septa more or less well developed on calice margins, disappearing in their inner parts and becoming long and contrafused along calice floors (see calices mentioned above).
5. The cardinal septum located on the convex side of corallites and/or on the side of attachment. A counter septum is indistinguishable in most cases observed (e. g. pls. 34:18a, 20; 35:5b, 7c, 8; 36:4a).
6. Axial areas of calice floors elevated. This important morphological character is differently accentuated in two unequal groups of specimens. The greater majority of specimens have axial ends of septa joined in more or less regular systems to form an axial structure, slightly similar to that of some species of *Leonardophyllum* MOORE and JEFFORDS, 1945. The upraised axial ends of contratingent minor septa are incorporated in the peripheral part of this structure. In extreme specimens it may reach 1—2 mm in height (pls. 34:8a, b, 14a, 21a; 35:8, 10a; 36:3; 37:1a). These highly elevated structures are not present in very large corallites (e. g. pls. 35:1a, 4b, 5b; 36:1d), but they are fairly common in specimens of late neanic and early ephebic stage (pls. 34:14a, 21a; 35:8; 36:3; 37:1a). Most of the specimens studied have the axial ends of septa moderately elevated and systems of septa irregularly developed (pls. 34:20; 35:6a, 7; 36:7a, 10).

A small group of specimens from the Bone Spring Formation (e. g. pls. 36:6a; 37:2a) have flat calice floors, with major and minor septa elongated along the last tabula and only slightly protruded. The arrangement of septa in systems is clearly seen and may be emphasized by the presence of the distinct cardinal septum and cardinal fossula (pl. 36:6a).

The group mentioned above leads toward the large group of specimens derived mainly from USNM locality 7221 (Skinner Ranch Formation, Sullivan Peak member). The main distinguishing characters of specimens of this group are: fairly long blades of major septa in inner regions of calices, and calice floors flat with septal blades not protruded in their axial parts.

Several corallites of this group have slightly better developed counter septum (pls. 34:9; 36:8) Some of them have distinct foundations of septa and minor septa developed down to half the depth of the calice (pl. 34:17). A trend leading in the latter respect directly to the group essential for the subspecies is much more common, however.

Remarks. — Differences between this and other subspecies of this species are discussed with the latter. More general remarks are given in remarks on the species.

Occurrence. — AMNH 628:1, 631:1, 696:1; USNM 725c:5, 728e:5, 728f:80, 728h:30, Lower Bone Spring Formation; 707b:7, 7221:33, Skinner Ranch Formation, Sullivan Peak member; 705a:7, Skinner Ranch Formation, base of *Scacchinella* beds; 707a:3, 707 w:12, 727u:1, Skinner Ranch Formation, Decie Ranch member; 707ha:1, Skinner Ranch Formation, Poplar Tank member; 732e:1, 7331:1, Skinner Ranch Formation, Dugout Mountain member. Upper Wolfcampian.

Paraduplophyllum (*Vacoea*) *tubaeformis reductum* subsp. n.

(fig. 79:1, 2; pls. 37:10—20; 38:1—8; 41:1, 2)

Holotype: Specimen USNM 197247, fig. 78:2a—c; pl. 37:10a, b.
Type locality: USNM 728f.
Type horizon: Lower Bone Spring Formation.
Derivation of the name: lat. ***reductus, a, um*** — distant, remote — after reduction of major septa in corallite axis.

Material. — 25 silicified specimens having at least fragments of calices preserved. Proximal ends often complete.

Some features of representative corallites (in mm):

USNM cat. nos.	N:d ratio	Length	Depth of calice	Remarks
197246	23:10.9× 9.3	incompl.	13.5	calice margin
197254	23: 9.5× 9.1	»	10.5	» »
197260	23: 8.3× 7.0	»	?	calice floor
197251	22:10.7×10.4	20.5	12.2	calice margin
»	19: 6.8× 5.5			beneath calice
197261	22: 9.3× 8.2	17.0	11.5	calice margin
197247	21: 9.2× 8.4	17.0	9.5	» »
»	16: 5.7× 5.1			just beneath calice
»	16: 4.4× 4.0			slightly lower
197264	20: 9.1× 7.9	17.0	8.8	calice margin
197252	20: 8.3× 7.7	19.0	8.0	» »
»	17: 4.7× 4.5			beneath calice
197263	17: 6.0× 5.5	8.2	3.2	calice margin
197250	16: 4.9× 4.7	9.8	5.2	» »
197255	14: 4.3× 4.3	9.0	5.0	» »

Diagnosis. — *P.* (*Vacoea*) *tubaeformis* having maximum n:d ratio at calice margin 23:10.1; major septa stop short of corallite axis; cardinal and counter septum not differentiated in length.

Description of the holotype. — External characters (pl. 37:10a, b). The specimen is widely horn-shaped. The convex, cardinal side of its curved apical part is armed with distinct attachment processes. The external surface, having very distinct septal furrows, bears also delicate growth striae. The wide, empty calice occupies almost 2/3 of the corallite length. Its upper margin is wavy due to the equally developed foundations of major and minor septa. Deeper in the calice,

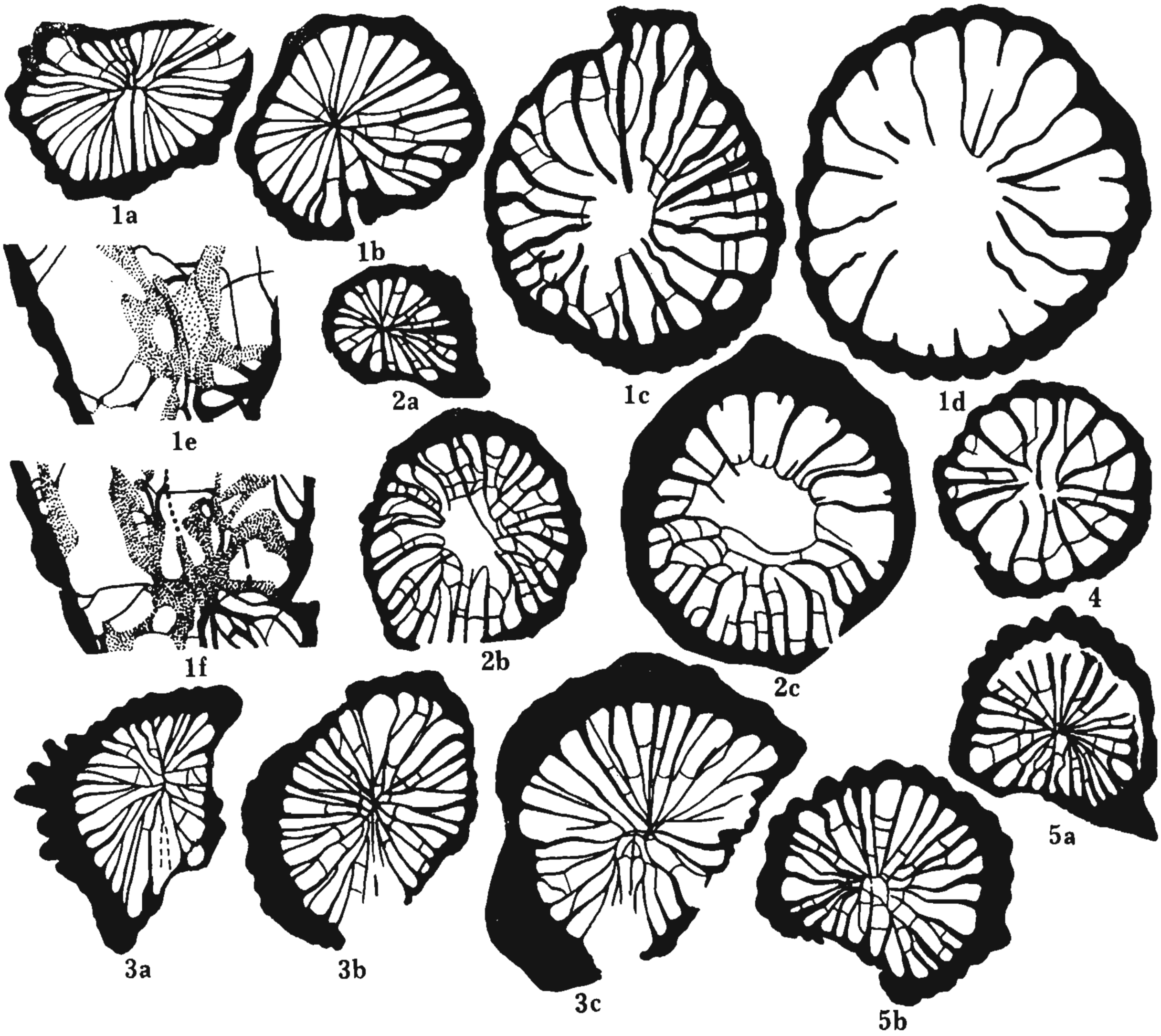


Fig. 79.

1, 2. *Paraduplophyllum* (*Vacoea*) *tubaeformis reductum* subsp. n. 1. Specimen USNM 197246. Locality USNM 728f, Lower Bone Spring Formation; a, b — transverse sections, late neanic stage; c — transverse section, ephebic stage; d — transverse section, lower part of calice; e, f — successive longitudinal sections. 2. Specimen USNM 197247. Holotype. Locality and horizon as above. Transverse sections; a — neanic stage; b — ephebic stage; c — near calice floor. 3—5. *Paraduplophyllum* (*Vacoea*) *tubaeformis lophotichioides* subsp. n. 3. Specimen USNM 197265. Holotype. Locality and horizon as above. Transverse sections; a, b — late neanic/early ephebic stage; c — ephebic stage. 4. Specimen USNM 197267. Locality USNM 728h, Lower Bone Spring Formation. Transverse section made partly above, partly beneath calice floor. 5. Specimen USNM 197268. Locality USNM 728f, Lower Bone Spring Formation. Transverse sections; a — late neanic stage; b — just beneath calice floor. All, × 8.

the former transform gently into very short, narrow blades, extending for approximately 0.5 to 1.0 mm into the calice lumen. Minor septa disappear in the external wall. No intermediate zone can be distinguished in the calice. The last major septa in quadrants are slightly shortened, making the arrangement of septa zaphrentoidal. The latter is seen also at the calice floor, where all major septa stop short of the corallite axis, leaving a small free axial area. The cardinal septum is distinguishable due to a slight shortening of the neighbouring major septa. The counter septum does not differ in length from other major septa. The uppermost transverse section (fig. 79:2c) made in counter quadrants just above the last tabula, and in cardinal quadrants just below it, shows all major septa distinctly shortened, leaving the free axial area much wider than that in the calice. This is due to the amplexoid character of major septa. Minor septa below the calice floor (fig. 79:2b) are often as long as the adjacent major septa and are commonly contrafused. Their axial ends are protruded slightly higher than periaxial portions, giving the impression of being attached to sections of the last tabula, when transversally sectioned (fig. 79:2c).

In the section spaced approximately 1 mm from the before described one (fig. 79:2b), the major septa are already shortened from the corallite axis. The axial ends of those of the cardinal quadrants are slightly inclined toward the cardinal septum. The latter does not differ in length from the other major septa. The counter septum is slightly elongated. Minor septa, thinner than the major ones, are contrafused or contratingent and long in most loculi, joining major septa at their axial ends. The neanic stage (fig. 79:2a) does not differ in morphology from other species of this group of corals and is not described in detail.

Longitudinal section (fig. 79:1e, f). — As seen on the only sectioned paratype, the biform tabularium consists of widely spaced tabulae. horizontal in Position I and inclined steeply upwards axially in Position II. Axial parts of the tabulae are horizontal.

Individual variation. — Variation observed in calices is not large and concerns inclination of their floors: almost horizontal in the holotype and most paratypes (e. g. pls. 37:14a, 15, 17, 18; 38:4a, 6a), obliquely inclined towards the cardinal septum in some corallites (pls. 37:12, 16; 38:1a, 2a), or irregular (pl. 38:7a). This character may in some specimens be camouflaged by a very beginning stage of an axial rejuvenation (pl. 38:8a) that made a calice floor flat and aseptal.

Several calices, especially those of the ontogenetically young corallites, have middle portions of their floors protruded (pl. 37:18b, 19a). Calice floors of other young corallites (e. g. pl. 37:20) show two positions of tabulae distinctly marked. Also, in the mature corallites the latter character may be observed (pl. 38:3a). Its occurrence is in both instances correlated with presence of long, contrafused or contratingent minor septa.

Corallites of the subspecies discussed exhibit strong differences in ornamentation between the tips and higher portions of their growth (e. g. pls. 37:13b, c, 18a; 38:7b, 8b). The boundary between the septal furrows bearing part and the tip, ornamented only with growth striae, is never sharp. Very delicate furrows, developed just beneath the ribbed portion, can be with some probability traced (pls. 37:13b, c; 38:7b). The septal furrows are surely absent along a few first milimeters of growth of corallites, although the major and the contrafused minor septa are already present there.

The ontogenetically youngest parts of the corallite skeleton (pls. 37:13b, c; 38:7b) is distinctly flattened in the cardinal-counter septa plan, and slightly broadened perpendicularly to that plan. The cardinal side is most commonly attached to the substrate. All completely preserved corallites have attachment flatenings and/or processes well developed (pls. 37:10b, 13b, c, 14b, 19:19b; 38:1b, 3b, 4b, 6b, 8b). Rare of them (pl. 38:2b) have those structures especially strong.

Length of the major septa differs in individual specimens, but they are commonly long in lower part of calice, coming close to the corallite axis (e. g. pls. 37:14a, 15, 17; 38:1a, 2, 3a, 4a, 6a). Minor septa, not seen in calices or only very slightly marked in their middle zone, are irregular in length in sections (fig. 79:1c; pl. 41:2) and sometimes free near calice floors. In the ontogenetically younger sections they are all long and contrafused (fig. 79:1a, b, 2a; pl. 41:1).

Remarks. — The subspecies described differs from the nominative subspecies in having major septa almost equally shortened to form a more or less broad, free axial area. Some extreme corallites of the nominative subspecies (e. g. pl. 36:4a, 6a, 9), having major septa only slightly elevated above a calice floor and with axial areas of calices elevated, may be considered as intermediate specimens, leading from the nominative subspecies to the one here discussed. An absence of any kind of columellae or axial structure in any growth stage makes the distinction between this and the other two subspecies adequate. It should be mentioned, however, that the counter septum may sometimes dominate (pl. 37:14a).

The amplexoid character of septa of the subspecies discussed brings it close to *P.* (*V.*) *amplexoides* sp. n. Differences in n: d ratio, length of specimens to depth of calice ratio, and the arrangement of the major and minor septa permit these taxa to be distinguished. Other species are much less similar and will not be discussed.

Occurrence. — USNM locality 715v:1, Skinner Ranch Formation, Decie Ranch member; 721:1, Lower Hueco Formation; 728e:1, 728f:16, 728h:6, Lower Bone Spring Formation. Upper Wolfcampian.

Paraduplophyllum (*Vacoea*) *tubaeformis lophotichioides* subsp. n.

(fig. 79:3—5; pls. 37:3—9; 38:5; 40:4)

Holotype: Specimen USNM 197265, fig. 79:3a—c; pl. 37:9a, b.
Type locality: USNM 728f.
Type horizon: Lower Bone Spring Formation, Upper Wolfcampian.
Derivation of the name: lophotichioides — after similarity to the genus *Lophotichium* MOORE and JEFFORDS, 1945.

Material. — 13 silicified specimens having calices at least in part preserved. Apices often broken apart.

Some features of representative corallites (in mm):

USNM cat. nos.	N:d ratio	Length	Depth of calice	Remarks
197265	26:10.6× 9.5	20.8	10.5	calice margin
„	20: 6.0× 4.5			beneath calice
197273	21: 9.6× 7.6	incompl.	11.0	calice margin
197268	18: 6.8× 6.0	9.7	4.2	„ „
197267	18: 6.4× 5.2	incompl.	7.0	„ „
197271	17: 6.7× 5.1	10.7	5.0	„ „

Diagnosis. — *P.* (*Vacoea*) *tubaeformis* having maximum n:d ratio 26:10.7×9.3; major septa in calice zaphrentoidally arranged; axial end of counter septum forms simple columella in calice, which is absent beneath it; minor septa irregular.

Description of the holotype. — External characters (pl. 37:9a, b). The irregularly conical specimen is deformed by a strong attachment flattening at the laterally-cardinal side. The partly dissolved external surface bears distinct septal furrows. The deep calice is cupshaped, with the marginal zone built of equally developed foundations of major and minor septa (pl. 37:9b). The latter, seen along 2—3 mm of the upper part of the inner surface of the calice, became quickly incorporated in the thickened external wall. The major septa are gently elongated downwards in the calice, but more distinctly so only in the lower part of its inner zone. Axial ends of the major septa, except for the slightly shortened last pairs in quadrants, meet at the corallite axis. The cardinal septum, slightly broken in its lower part, was possibly less elevated than other fully developed major septa. It meets the corallite axis deeper in the cardinal fossula. The counter septum forms a distinct, but flat, columella extending above the calice floor approximately 1.2 mm higher than the other major septa.

The morphology in the transverse section made just beneath the calice floor (fig. 79:3c), slightly deformed due to the attachment flattening, shows also significant differences in length of minor septa, with the longest of them developed in counter quadrants. In some loculi, the minor septa are absent. The major septa form four irregular systems joined together in cardinal and counter quadrants. Neither the cardinal nor the counter septum dominates in length and thickness. The former is located in a narrow cardinal fossula and penetrates the corallite lumen deeper than the adjacent major septa.

On the lower side of the same section, spaced approximately 0.8 mm (fig. 79:3b), the major septa are more regularly arranged and mostly met in the corallite axis. The minor septa are rather short and still differentiated in length. Only in the section made approximately 1.3 mm lower down (fig. 79:3a) do they became more regular. The arrangement of the major septa of this section does not differ from that described above. The neanic stage, typical for this species and genus, does not need description in detail.

Individual variation. — In addition to differences in dimensions and n:d ratio listed above, the morphology of calices is also individualized. Differences in length of the counter septa seem to be of major importance. In most of the paratypes, these septa are protruded similarly or higher than in the holotype (e. g. pl. 37:3b, 5, 6, 8a), but in some, a columella is indistinct (e. g. pl. 37:4a, 7). Cardinal septa, although less differentiated in length, vary slightly in individual specimens. Shortening of the last pairs of major septa in systems (quadrants) is well accentuated and can be traced down to the calice floor. Minor septa may be slightly marked in some loculi of an inner zone of the calice (pl. 37:7), but in most cases observed, they are fully incorporated in the external wall. In the marginal zone of calices and at their floors, these septa are easily distinguishable.

Variation in sections was studied on two paratypes only (fig. 79:4, 5a, b). Differences between them in development of columellae mentioned above, do not influence their morphology beneath the calices. In both of them, it is very similar to that of the holotype. The columellae do not occur and the counter septa are not longer than other major septa, except for those slightly underdeveloped in systems (quadrants). The uppermost section of one specimen (pl. 40:4) made just above the calice floor shows simple but distinct elongation of the counter septum.

Remarks. — The subspecies described differs from the nominative subspecies in having the calice floors of corallites not elevated axially, but having axial ends of the counter septum protruded in a form of columella. This character brings the subspecies discussed close to *Lophotichium dugoutense* sp. n. Because several other morphological characters of these two taxa are also similar, they might have been considered conspecific. However, the similarity described does not concern calice floors, i. e. the areas of final formation of all skeletal elements. The morphology of these parts in *P.* (*Vacoea*) *tubaeformis lophotichioides* subsp. n. and *Lophotichium dugoutense* sp. n. investigated in sections made just beneath calice floors differs on the level accepted herein as generic: the counter septum in no way dominates in the former taxon, and other characters of it are most closely comparable to *P.* (*V.*) *tubaeformis tubaeformis* subsp. n. Theoretical considerations as to synonymy, relation, or convergence of species exemplified here by *L. dugoutense* sp. n. and *P.* (*V.*) *tubaeformis lophotichioides* subsp. n. are outside these brief remarks. This problem and similar phenomena are more thoroughly discussed in the general part of the last volume of this monograph. It should only be stressed herein that a counter septum in *L. dugoutense* sp. n. started to dominate early in ontogeny. This character proves a decidedly different generic status of the taxa compared.

Occurrence. — USNM locality 728e:2, 728f:9, 728h:2, Lower Bone Spring Formation. Upper Wolfcampian.

Paraduplophyllum (*Vacoea*) *nealranchense* sp. n.

(fig. 80; pls. 33:13—21; 34:1—3)

Holotype: Specimen USNM 197277, fig. 80:4; pl. 33:14a—c.
Type locality: USNM 701k.
Type horizon: Neal Ranch Formation.
Derivation of the name: *nealranchense* — after type horizon.

Material. — More than 30 silicified specimens; majority with calices, many with proximal ends preserved, although deeply silicified, sometimes amorphous.

Some features of representative specimens (in mm):

USNM cat. nos.	N: d ratio	Length	Depth of calice	Remarks
197281	22:6.8	15.8	5.6	calice margin
197277	22:6.3	15.0	8.2	” ”
„	14:3.2			just beneath calice
197279	21:6.4	11.4	6.7	calice margin
„	18:3.7			just beneath calice
197275	18:5.5	≈12.5	7.3	calice margin
„	16:3.6			just beneath calice
197280	16:5.5	incompl.	6.5	calice margin
197283	16:5.4	12.0	5.8	” ”
197274	14:4.3	≈10.0	5.2	” ”
„	13:2.7			just beneath calice
197284	14:3.9	10.7	4.4	calice margin

Diagnosis. — *Paraduplophyllum* (*Vacoea*) having n: d ratio at calice margin up to 22:7.0; calice occupy 1/2 or more of corallite length; major septa distinctly underdeveloped on calice wall, meet axially at its floor; cardinal septum distinct; in maturity minor septa may be reduced; septal furrows delicate.

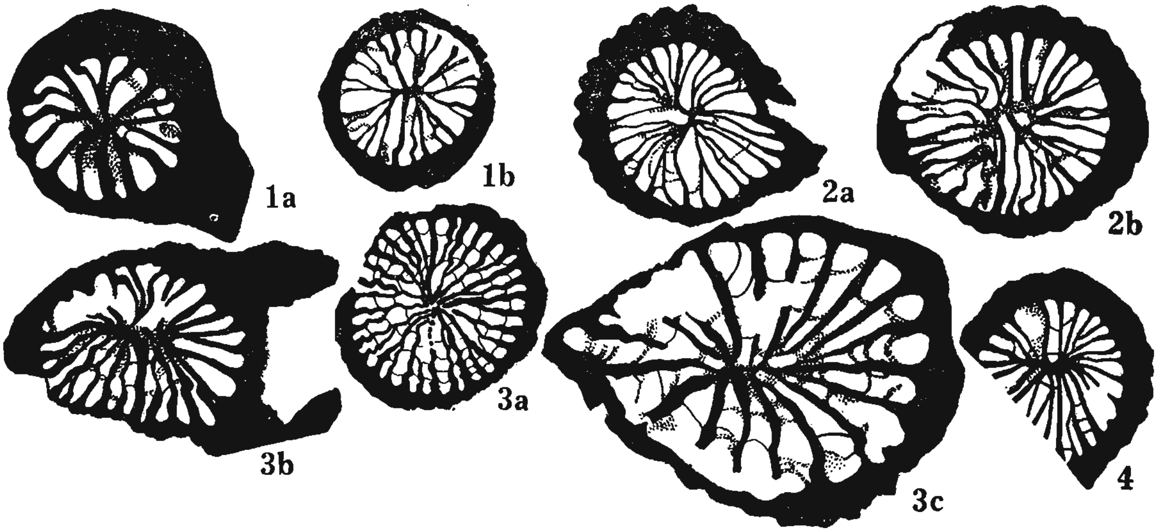


Fig. 80.

Paraduplophyllum (*Vacoea*) *nealranchense* sp. n. 1. Specimen USNM 197274. Locality USNM 701 k, Neal Ranch Formation. Transverse sections; a — neanic stage, × 15; b — ephebic stage, × 10. 2. Specimen USNM 197275. Locality and horizon as above. Transverse sections; a — late neanic stage; b — ephebic stage. Both, × 10. 3. Specimen USNM 197276. Locality USNM 701 d, Neal Ranch Formation. Transverse sections; a — late neanic/early ephebic stage; b — ephebic stage; c — late ephebic stage. All, × 10. 4. Specimen USNM 197277. Holotype. Locality USNM 701 k, Neal Ranch Formation. Transverse section made just beneath calice floor, × 10.

Description of the holotype. — The horn-shaped corallite (pl. 33:14c) is flattened due to a long-lasting attachment to the substrate. The cardinal septum is located in a corner of the flattened portion. Septal furrows are delicate along most of the specimen surface and are absent on its tip, where the growth striae are fairly well developed.

The calice occupies more than half of the corallite length. Its interior is almost empty, because of strong underdevelopment of major septa and absence of minor septa on its wall. Foundations of septa of both cycles are well developed and slightly thickened inside the calice, which make them distinct in spite of having shallow septal furrows (pl. 33:14b). The minor septa are well developed at the calice floor, where the major septa are elongated so as to meet at the calice axis (pl. 33:14a).

The morphology of the calice floor is repeated in the transverse section made just beneath the calice, except for the less regular arrangement of major septa (fig. 80:4). Minor septa are all contrafused or contratingent, but their lengths vary from almost equal to the major septa to reaching only half their size. The counter-lateral minor septa are both long with one of them being thicker than the counter septum itself, and reaching the corallite axis semi-independently. The cardinal septum is long and distinct.

Individual variation.— Septal furrows in more than half the total number of corallites studied are as shallow as in the holotype (pls. 33:16a; 34:1b). There are corallites, however (pls. 33:19a, 20a, 21; 34:2b) showing these furrows fairly well developed. Three corallites, all coming from the locality USNM 727e show an almost smooth external surface (pl. 33:13). The same corallites differ also from the holotype in shape, being narrow and almost cylindrical in their upper portions and having comparatively shallow calices. Two of them (e. g. pl. 33:13) possess major septa hardly seen on the calice wall, although elongated to a corallite axis on their floors. This extent of underdevelopment of the major septa is characteristic for all better preserved young corallites (e. g. pls. 33:17, 20b; 34:1a) independently of slight differences in the arrangement of major septa and length of minor septa at their floors. A corallite slightly older ontogenetically than those mentioned above (pls. 33:19b; 34:2a) may have major septa fairly well developed in the calice. Such specimens may form trend leading toward the comparatively long-septal corallites. They are not numerous in the collection, however (e. g. pl. 33:18).

Two corallites have the axial ends of their counter septa protruding a little higher than other major septa (pls. 33:15; 34:2a). The axial portions of the calice floors of these and other corallites are not elevated, however.

Two other corallites have the minor septa reduced. In the first of them, this might have been caused by an incipient stage of rejuvenation. It has minor septa well developed up to this stage of growth (fig. 80:1a, b). The second specimen possesses minor septa partly (earlier) and completely (beneath the calice) reduced (fig. 80:3b, c). Also the shape of septa in the ontogenetically youngest stage of this corallite differs from that in other specimens of the species discussed, being similar to *Assimulia* n. gen. (fig. 80:3a). All those differences make the taxonomic position of this corallite doubtful. Slight domination in the thickness of the cardinal septum, observed in this corallite, can also be seen in some other specimens (fig. 80:2a, b) including the holotype (pl. 33:14a). A trend of reduction of length of the major septa towards an amplexoid morphology has not been observed.

Remarks. — The species described is most similar to the Upper Wolfcampian *P.* (*V.*) *tubaeformis* sp. n. and especially to the nominative subspecies of the latter. This mainly concerns the relation of the depth of calices to the length of corallites and the morphology of younger parts of corallites beneath the calices. Main differences between these two species are in n:d ratio, with more numerous septa in *P.* (*V.*) *nealranchense* sp. n., in the much weaker development of the major septa in inner parts of the calices and in the non-protruding calice floors in the latter species. These differences are small and indicate a close relation between these two species.

The similarity of the species discussed to *P.* (*V.*) *vermiculare* sp. n. is less distinct because of the different relation of the calice depth to corallite length, a tendency of the latter to form an axial area free of septa and much smaller average dimensions and different n:d ratio.

Occurrence. — USNM 701:2, 701a^3:2, 701d:2, 701k:24, 721g:1, 727e:3, Neal Ranch Formation. Lower Wolfcampian.

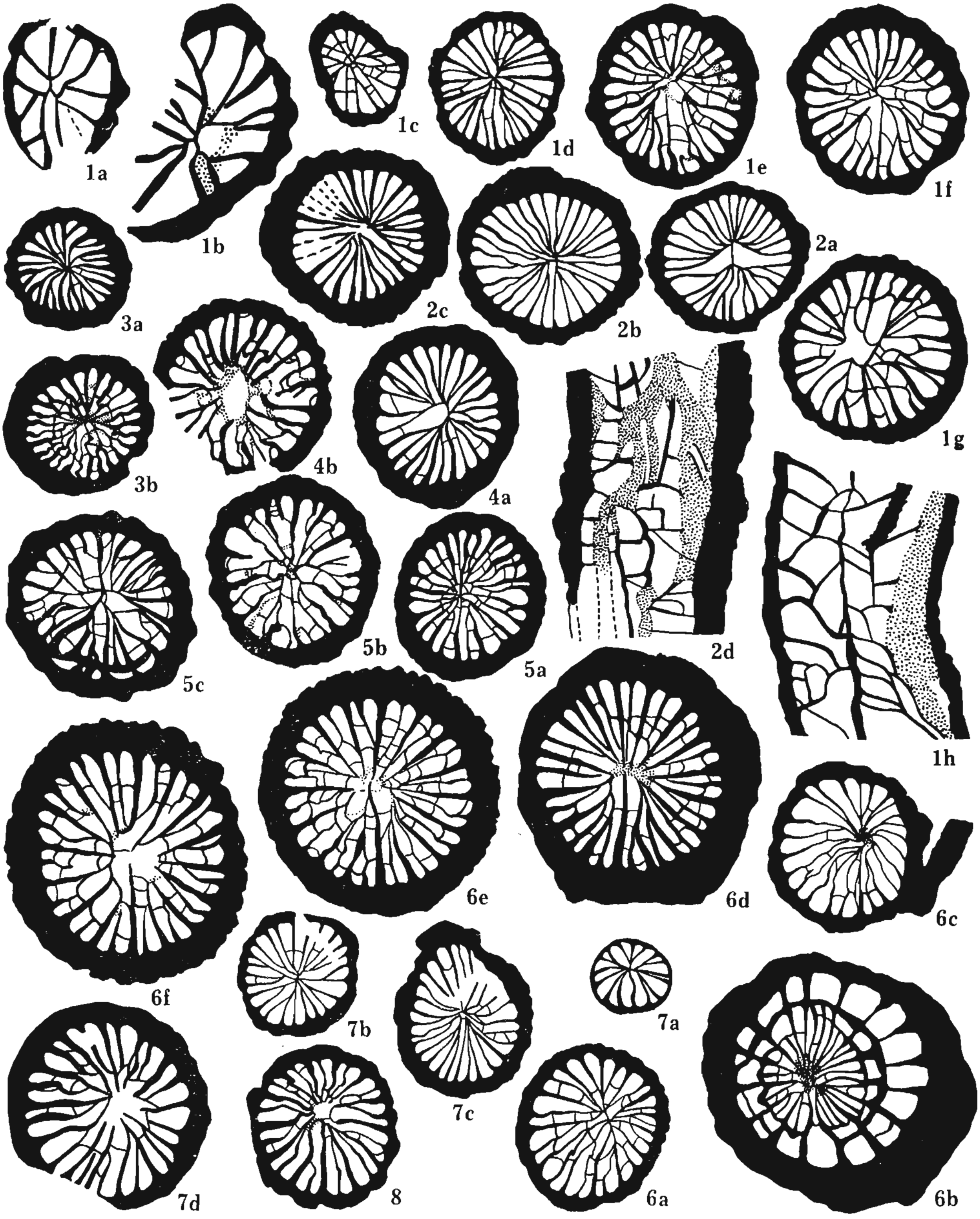


Fig. 81.

Paraduplophyllum (*Vacoea*) *vermiculare* sp. n. Corallites having calice floor flat. 1. Specimen USNM 197288. Locality USNM 720c, Skinner Ranch Formation, base of *Scacchinella* beds; a, b — transverse sections, early neanic stage, × 24, c — transverse section, neanic stage, × 8; d—g — transverse sections, early to late ephebic stage, × 8; h — longitudinal section, × 8. 2. Specimen USNM 197289. Holotype. Locality and horizon as above; a—c — transverse sections, early to late ephebic stage; d — longitudinal section. All, × 8. 3. Specimen USNM 197290. Locality and horizon as above; a, b — transverse sections, early to late ephebic stage, × 8. 4. Specimen USNM 197291. Locality USNM 707w, Skinner

Paraduplophyllum (*Vacoea*) *vermiculare* sp. n.

(figs. 81—84; pls. 38:9—23; 40; 41:3—13; 43:1)

Holotype: Specimen USNM 197289, fig. 81: 2a—d; pl. 39:1a, b.
Type locality: USNM 720e.
Type horizon: Skinner Ranch Formation, base of *Scacchinella* beds.
Derivation of the name: lat. *vermis, is* — worm — after shape of corallites.

Material. — More than 1200 silicified specimens. Calices, preserved in majority of specimens, are often filled in with matrix. Deep silicification made internal structure of many specimens hardly recognizable. N: d ratios are shown on fig. 84.

Some features of representative corallites (in mm):

USNM cat. nos.	N:d ratio	Length	Depth of calice	Remarks
197321	16:5.6	incompl.	8.0	calice margin
197348	16:5.5	18.0	7.0	„ „
197297	16:5.3	25.5	≈ 3.5	near calice margin
„	16:5.2			just beneath calice
„	16:4.5			early ephebic stage
197300	16:4.8	≈20.5	7.0	calice margin
„	14:4.0			just beneath calice
197341	15:5.0	15.0	8.0	calice margin
197289	15:4.5	≈24.5	5.2	„ „
„	15:3.9			just beneath calice
„	14:3.0			early ephebic stage
197326	14:4.3	16.5	5.0	calice margin
197338	14:4.2	25.0	4.5	„ „
197288	14:3.7	≈23.0	4.8	„ „
„	14:3.7			just beneath calice
197319	14:4.5	24.0	3.8	calice margin
197335	13:4.5	10.0	4.5	„ „
197331	13:4.4	14.0	3.0	„ „
197342	13:4.2	28.0	5.5	„ „
197349	13:4.1	11.5	4.3	„ „

Diagnosis. — *Paraduplophyllum* (*Vacoea*) having n: d ratio at calice margin up to 20:6.2, most commonly 14—16:3.0—4·5; major septa may leave small free axial area in ephebic stage; calices shallow; minor septa long and contratingent and/or contrafused at calice floor and in sections.

Description of the holotype. — The specimen is vermiform (pl. 39:1b), with delicate furrows and growth striae. Its proximal end curved almost planispirally for approximately 180°, bears attachment flattening and attachment processes on the lateral side of that curved part. The

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Ranch Formation, Decie Ranch member. Transverse sections; a — early ephebic stage; b — just beneath calice floor; shallow axial rejuvenation. Both, × 8. 5. Specimen USNM 197292. Locality and horizon as above. Transverse sections; a — early ephebic stage; b — morphological changes caused by beginning of rejuvenation, c — peripheral rejuvenation. All, × 8. 6. Specimen USNM 197293. Locality USNM 738r, Cibolo Formation, Breccia Zone. Transverse sections; a — late neanic/early ephebic stage; b — axial rejuvenation showing neanic morphology; c — further growth of the same corallite, morphologically comparable to fig. 6a; d—f — late ephebic growth of rejuvenated corallite. All, × 8. 7. Specimen USNM 197294. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Transverse sections; a — early neanic stage, b — neanic stage; c, d — early and late ephebic stage. All, × 8. 8. Specimen USNM 197295. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse section, ephebic stage, × 8.

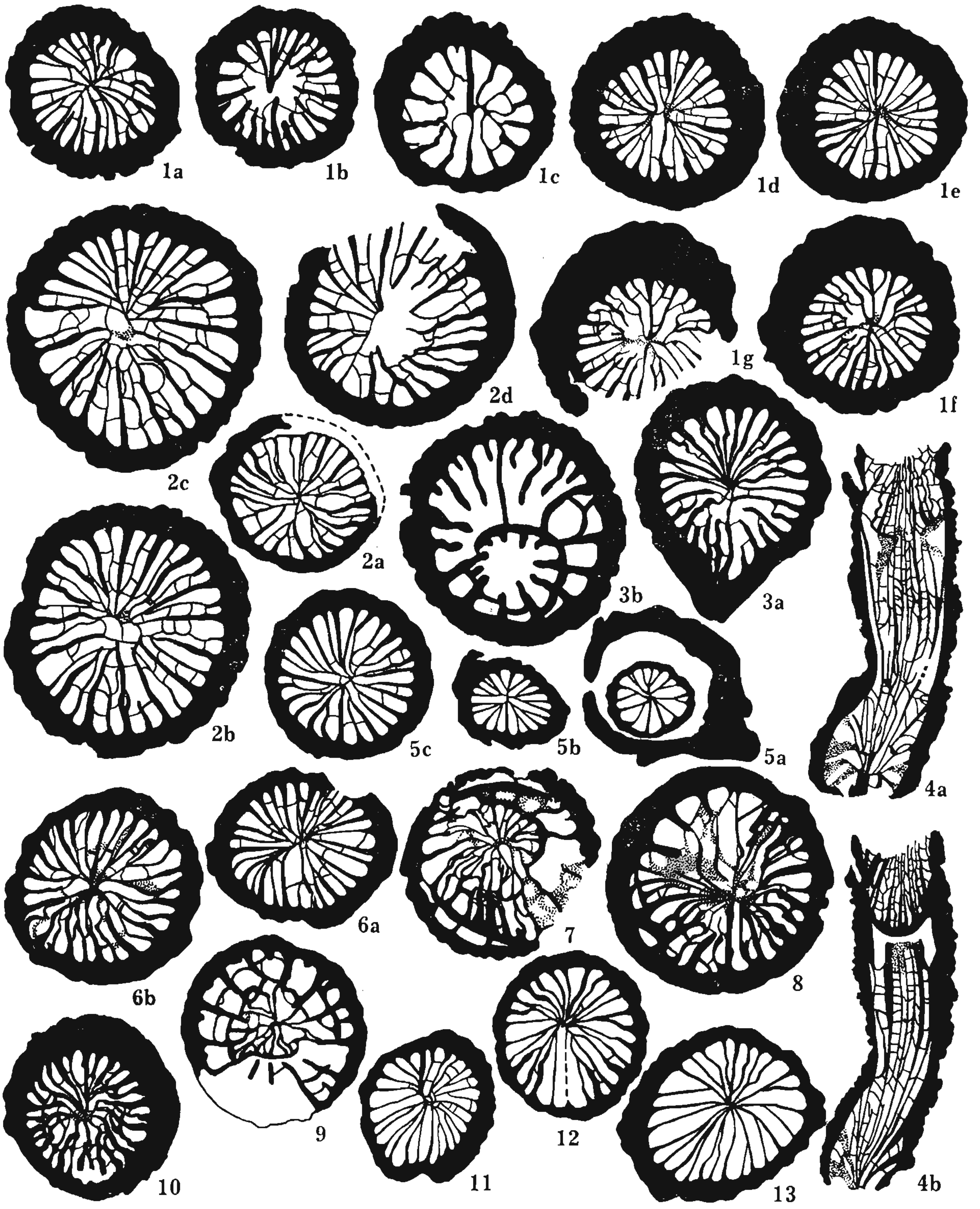

Fig. 82.

Paraduplophyllum (*Vacoea*) *vermiculare* sp. n. Corallites having calice floor differentiated in hight. 1. Specimen USNM 197296. Locality USNM 738r, Cibolo Formation, Breccia Zone. Transverse sections of corallite extremely variable in development of minor septa and counter septum; a—g — early to late ephebic stage, × 8. 2. Specimen USNM 197297. Locality and horizon as above. Transverse sections; a — late neanic stage; b—d — ephebic stage. All, × 8. 3. Specimen USNM 197298. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Transverse sections; a — ephebic stage; b — very deep, laterally-axial rejuvenation. Both, × 8. 4. Specimen USNM 197299. Locality USNM 738r, Cibolo epibiontic cladochonid coral (pl. 39:1b) indicates the living position of the holotype. The calice (pl. 39:1a) is 6 mm deep and occupies slightly less than a quarter of the specimen's length. It consists of rather a narrow peripheral zone with foundations of major and minor septa equally developed and of an inner zone having minor septa hardly seen or completely embedded in the thickened external wall. Major septa only slightly extend inward from the calice wall. The picture (pl. 39:1a) exaggerates this character by overstressing lower parts of the major septa. They elongate rapidly near calice floor, tending to meet each other in the calice axis. Axial parts of all septa at the calice floor are protruded higher than their peripheral parts, which made this region slightly elevated. This have resulted from the shape of tabulae, which highly elevated axially, and not from the exposition of the septal blades themselves. The cardinal septum, located in the cardinal tabular fossula, is slightly less, and the counter septum slightly more elevated than other major septa (pl. 39:1a). Minor septa, long and contrafused or contratingent at the calice floor, are laterally connected with the lateral sides of the major septa by horizontal tabulae in Position I of SUTHERLAND (1965) to form elevations contrasting well with steeply peripherally dipping neighbouring loculi, occupied by tabulae in Position II. The topmost parts of the latter form the elevated axial area of the calice.

The morphology in longitudinal section (fig. 81:2d) confirms observations made in the calice. The horizontal tabulae seen on the left side of the picture are the tabulae in Position I. Those in Position II are less well seen. Only a few of them are exposed at the right side of the picture. Sections of the paratypes described below, show this character more clearly.

On the upper surface of the transverse section made just beneath the calice (fig. 81:2c), the major septa withdraw slightly from the corallite axis, remaining long and mostly in contact, however. The minor septa are slightly thinner, but often almost as long as the major septa. The lower surface of the same section (fig. 81:2b) spaced slightly less than 1 mm from the formerly described one, shows all major septa long, rather thin, grouped in systems which join near the corallite axis, with the cardinal and counter septa directly united. The late neanic or early ephebic stage (fig. 81:2a) shows a direct connection of the cardinal and counter septa with very distinct alar pseudofossulae. This character is developed much better here than in most of the paratypes investigated. The arrangement of septa in the juvenile part of the specimen is typical for the family and has not been investigated in more detail.

Individual variation. — External characters. The shape of the corallites, although naturally variable due to extrinsic factors, remains a function of very slow but permanent increase in diameter. This resulted in their slender, often vermiform shape (pls. 38:9, 10b, 11b, 12, 15b, 16b, 18b, 19, 21, 23; 39:2, 3b, 4b, 7, 12b, 13a, 14b, 16, 18b, 20b, 25b). All better preserved specimens bear delicate growth striae and shallow, but distinct, septal furrows. Apexes are almost smooth. Only the latter parts of corallites bear mostly small and delicate attachment processes. Talons

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Formation, Breccia Zone; a, b — successive longitudinal sections; deep axial rejuvenation in upper portion of growth, ×4. 5. Specimen USNM 197300. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Transverse sections; a — deep axial rejuvenation having early neanic morphology; b — neanic morphology; c — ephebic morphology. All, ×8. 6. Specimen USNM 197301. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds; a, b — transverse sections, early ephebic and ephebic stage, ×8. 7. Specimen USNM 197302. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Transverse section of a few subsequent axial and lateral rejuvenations, ×8. 8. Specimen USNM 197303. Locality and horizon as above. Transverse sections; changes in morphology caused by early stage of rejuvenation, ×8. 9. Specimen USNM 197304. Locality and horizon as above. Transverse section. Two subsequent rejuvenations; the second having early neanic morphology, ×8. 10. Specimen USNM 197305. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse section, ephebic stage; septa wavy and major septa bent in axial portions, ×8. 11. Specimen USNM 197306. Locality USNM 738r, Cibolo Formation, Breccia Zone. Transverse section made just beneath calice floor but having late neanic morphology, ×8. 12. Specimen USNM 197307. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse section made just beneath calice floor, but having early ephebic morphology, ×8. 13. Specimen USNM 197308. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Transverse section made just beneath calice floor, but having late neanic morphology, ×8.

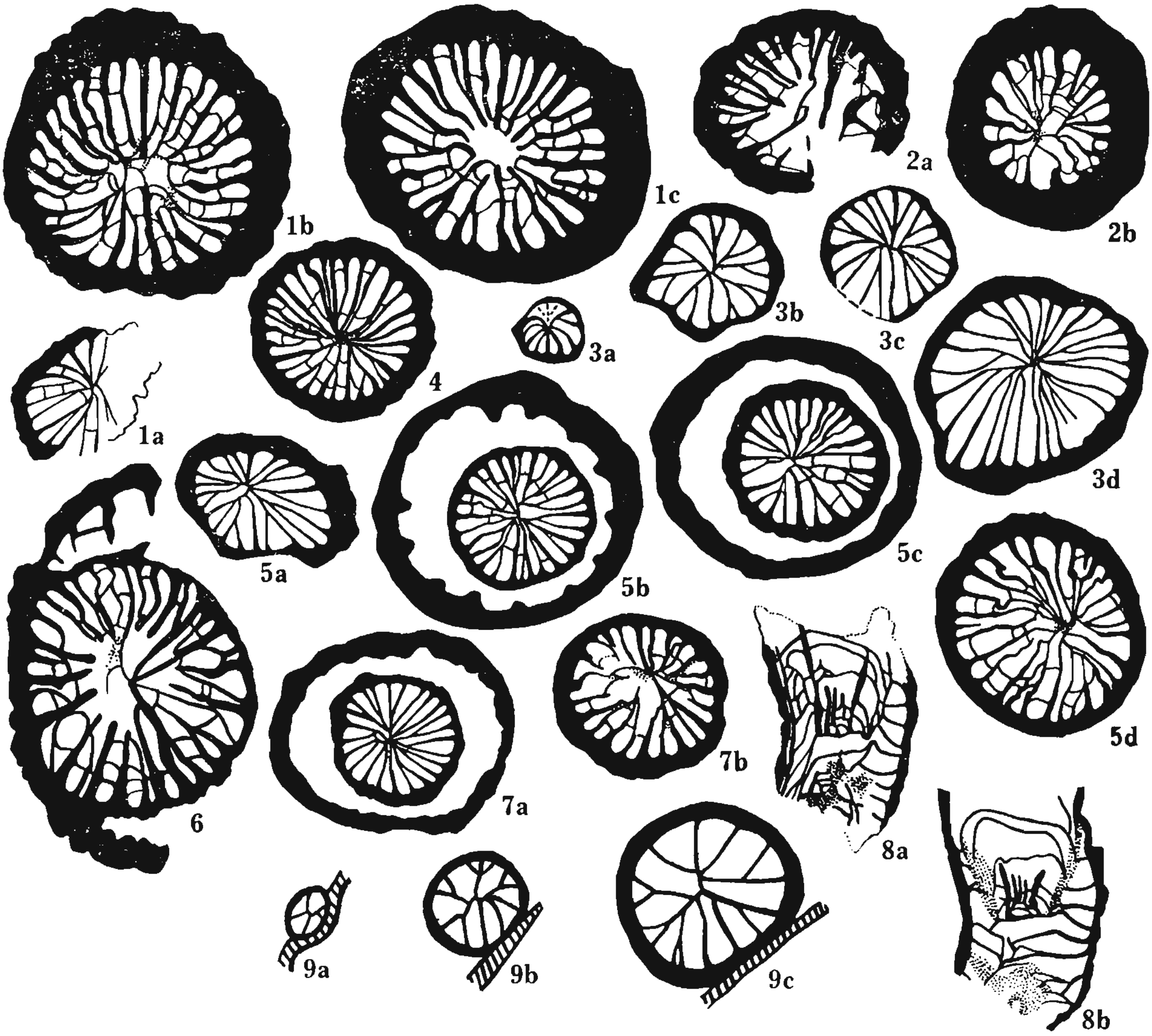

Fig. 83.

Paraduplophyllum (*Vacoea*) *verniculare* sp. n. Specimens USNM having calice floor flat. 1. Specimen USNM 197309. Locality USNM 738r, Cibolo Formation, Breccia Zone. Transverse sections; a — neanic stage; b, c — ephebic stage. All, × 8. 2. Specimen USNM 197310. Locality and horizon as above; a, b — transverse sections, ephebic stage; short septal specimen, × 8. 3. Specimen USNM 197311. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member, Transverse sections; a—c — early to late neanic stage; d — just beneath calice floor, but retaining neanic morphology. All, × 8. 4. Specimen USNM 197312. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse section made just beneath calice floor, × 8. 5. Specimen USNM 197313. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Transverse sections; a — neanic stage; b, c — deep axial rejuvenation having neanic morphology; d — ephebic stage. All, × 8. 6. Specimen USNM 197314. Locality USNM 702d, Hess Formation, Taylor Ranch member. Transverse section of lateral rejuvenation having mature morphology, × 8. 7. Specimen USNM 197315. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Transverse sections; a — axial rejuvenation having late neanic morphology; b — ephebic stage. Both, × 8. 8. Specimen USNM 197316. Locality USNM 72d, Hess Formation, Taylor Ranch member; a, b — successive longitudinal sections; biform arrangement of peripheral parts of tabulae (left) and deep axial rejuvenation (middle), × 4. 9. Specimen USNM 197317. Locality USNM 738r, Cibolo Formation, Breccia Zone. Transverse sections; a—c — very early to early neanic stage, × 24.

or strong attachment processes or attachment surfaces are very rare (e. g. pls. 38:16b, 22b, 23b; 39:12b, 23b). Many specimens have proximal ends strongly curved (e. g pls. 38:11b, 12, 21, 22b; 39:25b) and some are even coiled (pl. 38:13). Attachment processes and surfaces of coiled specimens, if present, are never developed inside the ring, but always on its lateral

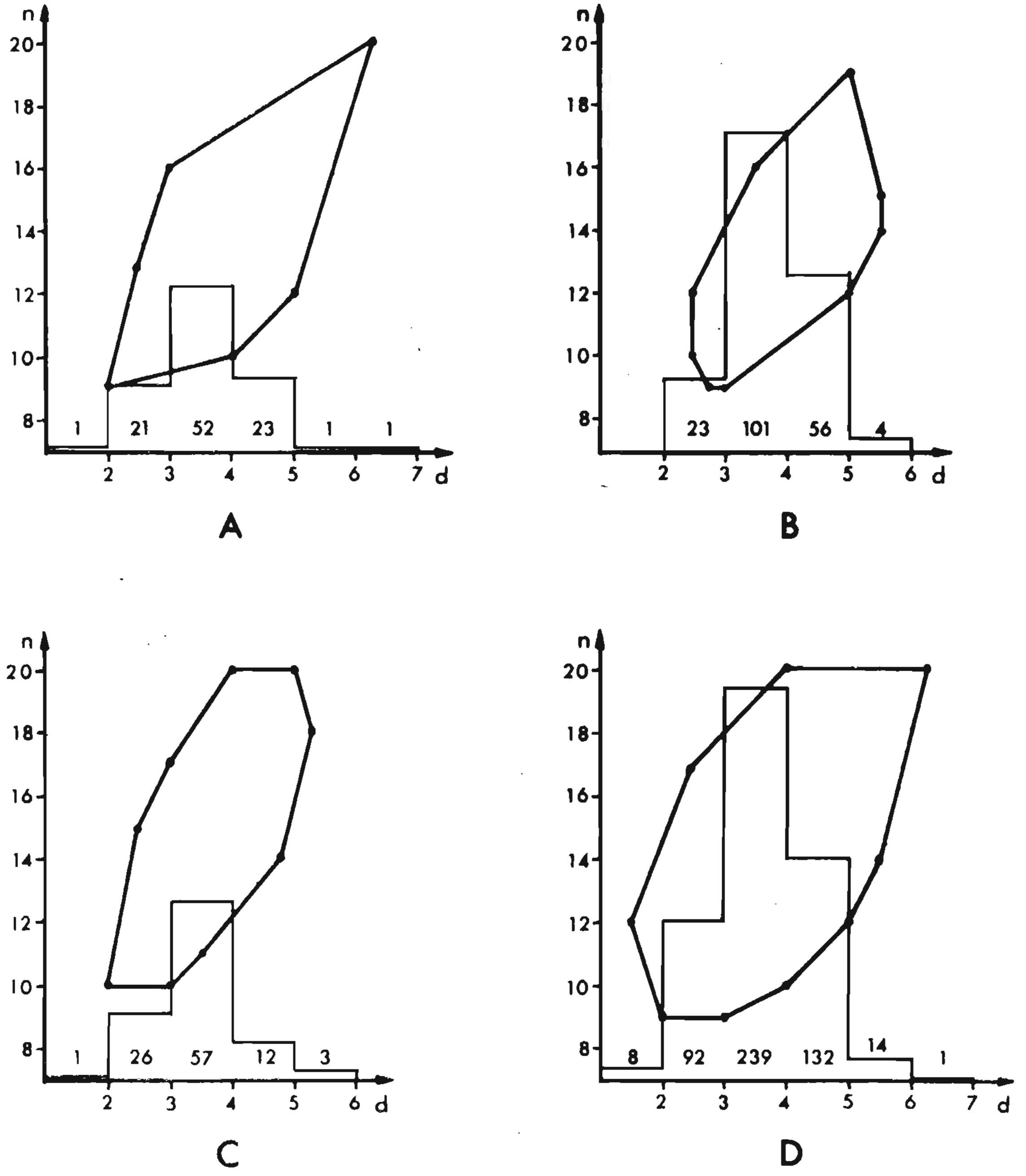

Fig. 84.

Paraduplophyllum (*Vacoea*) *vermiculare* sp. n. N: d ratio of three groups of specimens derived from particular localities A—C) and of the whole species (D). Points corresponding to extreme specimens are united by lines. Numbers in individual classes of frequency diagram correspond to amount of corallites measured in given classes. A — locality USNM 738r (Cibolo Formation, Breccia Zone), B — locality USNM 707w (Skinner Ranch Formation, Decie Ranch member), 3 — locality USNM 720e (Skinner Ranch Formation, base of *Scacchinella* beds), D — data for the whole species, collected from most of localities.

or lower side, which suggests that they hung from or coiled around vertically oriented objects. Some corallites may rapidly change direction of their growth (pl. 39:16).

Calices are 4.5—8.0 mm deep, occupying a third to a fifth, very seldom up to an eigth of the corallite length. Their marginal zones show very little variation, being slightly wider or narrower, but always of the kind described for the holotype (e. g. pls. 37:10a, 14, 22a; 39:5, 12a, 14a, 26b). Variability of the inner zones is larger. Major septa, always short, may protrude a little more (pls. 38:14, 18a, 23a; 39:5, 9a, 17, 27) or a little less (pls. 38:10a, 15a, 19a; 39:4a, 23a, 26b) from external walls. Length of the minor septa varies more distinctly. The greater majority of specimens have these septa very short, sometimes hardly recognizable and, similar to the holotype, rapidly elongated near calice floors. They form pairs with major septa there, being both, contrafused and connected to them by the tabulae in Position I. This and deep peripheral depressions of the tabulae in Position II may give the impression of a great thickness of septa of a single cycle (pls. 38:17, 20; 39:6, 8a, 10a, 11, 23a, 28). In a large number of specimens, reduction of length of minor septa along internal walls of calices is so advanced as to make loculi between adjacent major septa smooth (pls. 38:10a, 11a, 22a; 39:3a, 5, 9a, 14a, 23a). This character does not depend on the structure of the calice floors. Specimens of the opposite extreme, i. e. with well distinguishable minor septa on the walls, are not common. This character appears mainly in specimens having comparatively long major septa, which made them similar to *Assimulia* gen. n. (pls. 38:14, 17, 18a, 23a; 39:25a). In rare specimens (pl. 39:22) an unique increase in minor septa occurs in the calice. The marginal zone of equally developed major and minor septa, passes down into regular major septa of the inner zone of the calice. Minor septa there became contratingent to the adjacent major septa, while deeper in the calice, and with no connection with the formerly mentioned minor septa, other septal structures appear between major septa (pl. 39.22).

Variability in development of septa at calice floors and, consequently, the morphology of the latter, is the largest and most controversial. It will be discussed in more detail in the general part of the last volume of this monograph, together with other aspects of the growth of rugose coral skeletons. In the following discussion only facts without interpretations are presented.

Two groups can be distinguished: one with major and minor septa exposed above the last tabula in a calice versus the specimens having this tabula almost smooth. The second group, being in greater minority, contains only a few specimens with really broad and flat last tabula (e. g. pls. 38:10a, 15a, 16a; 39:4a, 5). The other ones tend towards the specimens of the first group (pl. 38:11a, 14, 19a, 22a, 23a). The holotype (pl. 39:1a) has been chosen among such intermediate corallites. Rare specimens of this group have counter septum protruding slightly above a calice floor (e. g. pl. 39:24a).

Corallites having differentiated calice floors can be grouped as follows: specimens having exposition of septa more or less equal (pls. 38:18a; 39:6, 10a, 21, 26b), specimens with axial parts of major septa forming a kind of knob (pl. 39:14a, 20a, 23a, 25a), and specimens having either the counter septum itself or a plate in the cardinal/counter septa plan more exposed than the other major septa (pls. 38:17, 20; 39:9a, 15a, 18a, 24a, 28). In most cases observed, the mentioned plate is directly connected with the counter septum, leading this group of specimens towards Lophotichium Moore and Jeffords, 1945. In some corallites, however, both the cardinal and the counter septum participate equally in formation of that plate. In rare instances (pl. 39:17a), major septa form not a knob, but a depression at the calice axis, being united deeper in the calice but having their periaxial ends free and exposed high above the last tabula and the point of junction.

The cardinal septum and the cardinal fossula are the next variable characters of taxonomical value. Both these features are often recognizable, but seldom conspicuous. This again has no direct connection with the morphology of the calice floors. The cardinal septum in deeper parts of calices is, in most cases, less exposed than other major septa, but it is not shortened, reaching the corallite axis along the cardinal fossula floor (pls. 38:11a, 17; 39:6, 18a). It may extend as high as other major septa, however (pl. 39:14a, 21, 24a, 25a, 26b, 27) or become recognizable only due to the arrangement and position of other major septa and, first of all, the minor septa. Development and shape of the cardinal fossula depend on the variable arrangement of the major septa, exposition of the cardinal septum, and length of adjacent major and minor septa. All of these made it very variable and not always recognizable. The alar pseudofossulae, often fairly well seen in transverse sections of immature portions of specimens, are hardly or not at all seen in their calices.

The variability of transverse sections of mature parts of the corallites is fairly large, but only two groups of variants are of greater importance: specimens with straight versus vavy septa and specimens with septa united at the corallite axis versus slightly shortened. Specimens with strongly wavy septa are in the great minority within the collection studied. They are always small and thick-walled, with septa comparatively thick and permanently met at corallite axes. Specimens with flat (fig. 81:3a, b; pl. 40:9) and diversified (fig. 82:10; pl. 41:5) calice floors do not differ morphologically in sections made just beneath calices. This group of specimens tends strongly towards *Assimulia* (*Ericina*) *flexibilis* sp. n. The morphology of the calices is in fact the only criterion of distinction between them. On the other hand intermediate specimens between these and the typically built corallites are present (fig. 82:3a, 6b, 8; pls. 41:4, 11, 16; 42: 6, 12).

Differences in morphology of specimens having straight septa are larger independently of the morphology of the calice floors. Among several trends observed the following seem most important:

1. Specimens having well developed cardinal fossula and sometimes also alar pseudofossulae. Septa may permanently be in contact at corallite axes (fig. 82:11—13) or slightly shortened (fig. 81:1e, f, 6d—f; pl. 40:8a, b, 13). This morphology, as well as other discussed, may change in the course of corallite growth.
2. Specimens with major and minor septa long, thin, permanently in contact, with the main protosepta hardly distinguishable (fig. 83:3a—d; pl. 40:15).
3. This group, the largest group within the collection, contains specimens having septa arranged irregularly, either in contact at corallite axes (figs. 81:5a—c; 82:6a, b; 83:5a—d; pl. 40:10, 11, 14) or irregularly withdrawn from them (figs. 81:7a—d; 82:2a—d; 83:6; pl. 40:16). Such a shortening of septa may be permanent or temporary, long- and short-lasting. In some specimens septa are united and elevated in a calice, although they have been shortened in younger growth stages. Quite a few specimens of this group retain their juvenile arrangement and shape of septa up to a comparatively wide diameter.

Variants in development of alar pseudofossulae are independent of the afore designated groups of specimens. In some corallites, they could be very distinct in some stages of growth, while in the others, they are hardly distinguishable (see figures and plates mentioned above). Sometimes only a single alar pseudofossula is developed (e. g. fig. 81:4a; 82:5b; pl. 41:6). It pays the role of the false cardinal fossula.

A single specimen (fig. 82:1a—g; pl. 41:7a—c) shows an extraordinarily variable ontogeny. Its septal apparatus became irregularly arranged in early ephebic stage tending towards reduction of length of septa (fig. 82:1b) and then to a total reduction of minor septa in the corallite lumen (fig. 82:1c). This stage of growth is soon replaced by a regular morphology (fig. 82:1d, e), tending again towards irregularity in arrangement and slight reduction of length of septa below the calice (fig. 82:1f, g). No reasonable explanation for the events described is available. They rather should not be interpreted as genetic, and the specimen was left within the species discussed.

Longitudinal section. — Observations made on several specimens (e. g. figs. 81:1h, 2d; 82:4a, b; 83:8a, b; pls. 40:7; 41:13a, b), although variable in details show the same main characters as the holotype. Tabulae in Position I are either horizontal or directed slightly downward axially. Those in Position II are inclined steeply upward in peripheral parts and oblique or horizontal, sometimes trapezoidal at corallite axes. This picture is especially clear in the short-septal specimens (e. g. fig. 83:8a, b).

Ontogeny. — Specimens in an aseptal stage of development are not present in the collection studied. The ontogenetically youngest transverse section investigated (fig. 83:9a), 0.2×0.4 mm in diameter, have the initial septal apparatus already developed. It can be hypothesized, however, that the post-larval calices were aseptal. Insertion of septa in the calices must have preceded the appearance of the first tabula. The only way to retain traces of existance of an aseptal morphology would have been an opposite sequence of appearance of basal and radial structural elements. This has, for instance, been observed by RÓŻKOWSKA (1956) in the Middle Devonian genus *Protomacgeea* RÓŻKOWSKA, 1956.

An increase in septa in *P.* (*V.*) *vermiculare* sp. n. is a function of increase in corallite diameter and is very slow. Long and narrow specimens (pl. 39:11, 28) illustrate this well. Comparison of polished surfaces of their apices with calices documents an increase in septa in sequence. The first metasepta may be inserted either in the counter or in the cardinal quadrants. Insertion of the minor septa is not quite clear. This concerns first of all the counter-lateral minor septa. They look like being inserted prior to the appearance of first lateral protosepta in some specimens and after appearance of all protosepta in the others. This problem will be studied in more detail separately, if a less silicified material is found. The present results (figs. 81:1a, b; 83:9a—c) are not convincing.

Rejuvenation. — The following variants have been recognized: 1) A very shallow, peripheral rejuvenation (figs. 81:5a—c; 82:8; pls. 40:10; 41:12). Only small fragments of the old external wall are left behind newly built skeletons. Fragments of a new wall look like dissepiments. Some septa, mainly minor, may be reduced. Some other, new or reconstructed, may appear. All these processes made sections of this variant very distinct from the standard morphology. In contrast to this, the morphology of the inner parts of calices change very little (e. g. pl. 38:15a, 22a).

2) A deep axially-lateral rejuvenation (fig. 82:7, 9; pl. 41:8, 10). Axial parts of some old septa are incorporated in the skeleton of the new calice, but most of them are left behind. New septa are inserted at the new external wall. In the periaxial longitudinal section (fig. 82:4b), this process can give the impression of a total discontinuity of lower and upper parts of a skeleton.

3) A deep lateral rejuvenation (fig. 83:6; pl. 41:9) leads to total incorporation of one part of an old calice into the new one and a total separation from the rest of it.

4) An axial rejuvenation (figs. 82:5a—c; 83:5b, c, 7a) leads towards complete separation of a new calice from an old one. This process, similar to other variants discussed, might have appeared one time only and lead to survival of the coral (polyp). It might also have been repeated several times (fig. 81:6b). Such a series of rejuvenations is often unsuccessful. Also a deep and single rejuvenation (fig. 82:3a, b; pl. 41:11) might not have resulted in survival of a specimen. The morphology of the latter variant differs greatly from the standard one. An aseptal early stage of axial rejuvenation (fig. 81:4b; pl. 41:4) has only been observed once. It gave a weak, small new calice, restricted to the floor part of the old one.

Remarks. — The species discussed is a key-taxon for understanding of the whole group of related or morphologically similar genera and species, and for some more general considerations as well. It comes close to *P.* (*P.*) *oppositum* sp. n. and *P.* (*V.*) *tubaeformis* sp. n. It is distinguishable from the former by the different arrangement of major and minor septa and the morphology of the tabularium. From the latter, more closely related species, it differs by having much smaller dimensions, different n: d ratio, and shallower calices.

Occurrence. — Locality USNM 724p:172, 724q:1, Skinner Ranch Formation, undivided; 712p:26, base of Skinner Ranch Formation; 714p:1, 716t:19, 720f:1, 720g:1, Lower Skinner Ranch Formation; 707a:165, 707w:295, 715v:1, Skinner Ranch Formation, Decie Ranch member; 705a:17, 720e:295, Skinner Ranch Formation, base of *Scacchinella* beds; 707h:3, Skinner Ranch Formation, Poplar Tank member; 707d:2, 7221:4, 733j:1, Skinner Ranch Formation, Sullivan Peak member; 702d:4, 702c:4, Hess Formation, Taylor Ranch member; 738r:284, Cibolo Formation, Breccia Zone; 728e:1, 728f:3, 728h:1, Lower Bone Spring Formation. Upper Wolfcampian.

Paraduplophyllum (*Vacoea*) *amplexoides* sp. n.

Holotype: Specimen USNM 197358, fig. 85:2a—i; pl. 43:2a—c.
Type locality: USNM 720e.
Type horizon: Skinner Ranch Formation, base of *Scacchinella* beds.
Derivation of the name: *amplexoides* — after amplexoid mature stage.
Subspecies assigned: *P.* (*V.*) *amplexoides amplexoides* subsp. n., *P.* (*V.*) *amplexoides longiseptatum* subsp. n.

Diagnosis. — *Paraduplophyllum* (*Vacoea*) having n: d ratio at calice floor up to 20:7.5; major septa in ephebic stage almost equally shortened, with cardinal and counter septa tending to elongation; minor septa either reduced or well developed, contrafused only in early ontogeny.

Remarks. — All specimens assigned to this species can easily be divided into two groups on the basis of length of minor septa in the ephebic stage. This is the main criterion for the subspecies distinction. A slightly different n:d ratio, with small specimens dominating in *P.* (*V.*) *amplexoides longiseptatum* subsp. n., is the next difference.

The latter subspecies is fairly close to the short-septal variants of *P.* (*V.*) *vermiculare* sp. n. and can possibly be derived from them. For three reasons, *P.* (*V.*) *amplexoides* sp. n. has been distinguished as an independent species: 1) The amplexoid character appears early in phylogeny of the discussed group of specimens, reaching a high level of development almost immediately (*P.* (*V.*) *amplexoides amplexoides* subsp. n.). This can be interpreted as an early, independent offspring from the main stock. 2) The short-septal specimens of *P.* (*V.*) *vermiculare* sp. n. never reach a distinct level of reduction of length of major septa, which always come fairly close to the corallite axis. In the course of growth of individual specimens, the more amplexoid stage is often replaced by long-septal one showing inconstance and fortuity of this character. 3) The nominative subspecies shows distinct and early reduction of minor septa. This is much less well developed in *P.* (*V.*) *amplexoides longiseptatum* subsp. n., but also the latter subspecies has most of the minor septa free and not contratingent in maturity.

The nominative subspecies shows also a great homeomorphic similarity to some specimens of *Lophotichium simulatum* sp. n. Such ampleximorph specimens of the latter species can be distinguished from *P.* (*V.*) *amplexoides* sp. n. mainly on the early ephebic stage, which has normally developed, dominating counter septum and long minor septa.

Occurrence. — As for the subspecies.

Paraduplophyllum (*Vacoea*) *amplexoides amplexoides* subsp. n.

(fig. 85; pls. 41:14, 15; 42:1—3; 43:2—11)

Holotype, type locality, type horizon and *derivation of the name:* as for the species.

Material. — More than 70 differently preserved specimens; all silicified, some deeply and coarsely so. Several specimens with almost complete calices and/or proximal ends.

Some features of representative specimens (in mm):

USNM cat. nos.	N:d ratio	Length	Depth of calice	Remarks
197370	23:8.2 × 8.2	18.5	rejuven.	calice margin
197364	21:9.5 × 8.3	incompl.	≿ 9.0	just beneath calice
197357	20:9.0 × 7.4	40.5	?	calice margin
,,	20:8.9 × 7.2			beneath calice
,,	19:7.0 × 6.8			early ephebic stage
197367	19:7.8 × 6.5	22.5	6.0	calice margin

197358	19:6.2 × 6.2	≈25.5	≈ 3.7	near calice margin
„	19:5.8 × 5.5			just beneath calice
„	16:5.0 × 5.0			late neanic stage
197362	18:6.3 × 6.1	incompl.	5.6	calice margin
„	18:5.2 × 4.8			just beneath calice
„	17:4.4 × 4.0			early ephebic stage
197373	18:6.0 × 5.6	incompl.	incompl.	calice floor
197372	17:6.1 × 5.0	„	„	calice floor
197366	17:5.7 × 5.5	„	4.7	calice margin
197365	16:5.5 × 5.5	„	?	middle of calice

Diagnosis. — *Paraduplophyllum* (*Vacoea*) *amplexoides* having minor septa very short, often completely reduced in ephebic stage.

Description of the holotype. — The specimen is horn-shaped (pl. 43:2c), and internally silicified in part, with incomplete calice and proximal end. The inner zone of the calice bears very short major septa, that became equally elongated along the calice floor, reaching up to half the corallite radius. None of these septa can be distinguished by its length. The cardinal tabular fossula is probably absent or very shallow, when present. Location of the cardinal and counter septa is deduced from the arrangement of the last tabula in Position I. Minor septa are completely reduced. The flat axial area that occupies approximately half the calice diameter dips gently toward the concave side of the corallite.

The section made beneath the calice floor (fig. 85:2f) is typically amplexoid, with major septa arranged radially, equally thick, and shortened. Minor septa are completely reduced in almost all loculi. As in the calice (pl. 43:2a, b) the cardinal and the counter septum are indicated only by the tabula in Position I.

Sections made 4.5 and 3.0 lower down respectively (fig. 85:2d, e) show a different morphology, considered herein as late neanic or early ephebic. All major septa are long, reaching or almost reaching the corallite axis, but not being united there. The cardinal and the counter septum are as long as the other major septa. Minor septa vary considerably in length and are almost reduced in some loculi. Those neighbouring the counter septum do not differ from the other ones.

The early ontogeny (fig. 85:2a—c) is disturbed by a shallow lateral rejuvenation and by a coarse silicification at the tip. It does not differ from that typical for the genus, however. All septa are thin, with minor septa long and contrafused and/or contratingent.

Rejuvenation. — In early ontogeny, the holotype underwent a shallow rejuvenation (fig. 85:2b, c). The general rule in this process is to retain the major septa and to increase new minor septa on the new wall that is built between the former ones. In some loculi (fig. 85:2b, c, right side) one minor septum is inserted normally, i. e. toward the cardinal septum and the second one toward the counter septum. This caused a rearrangement of major and minor septa in the whole quadrant and the replacement of the latter by the former in the rejuvenated calice. At the beginning stage discussed, this rearrangement is marked by an increase of two septa of the rejuvenated calice from a common base offered by the former major septum of the old calice (fig. 85:2b, lower right two pairs of septa).

The very early stage of the axially-lateral rejuvenation observed in the calice of one paratype (pl. 43:5a) explains the relation between old and new septa and the foundation of new structural elements. Old septa have been continuing to develop only in the deeper part of the calice. Lateral thickenings — foundations of the external wall — separate them from their upper parts and from the minor septa, which were left behind the newly formed calice. The inner side of the thickening adjacent to the cardinal septum shows secondary foliations, interpreted herein as foundations of septa. All these structures, secondarily thickened in the process ef diagenesis, can be closely compared with septal swellings (FEDOROWSKI 1978) characteristic of very early stage of offsetting. The drastic shortening of the old septa just above the thickenings (foundations

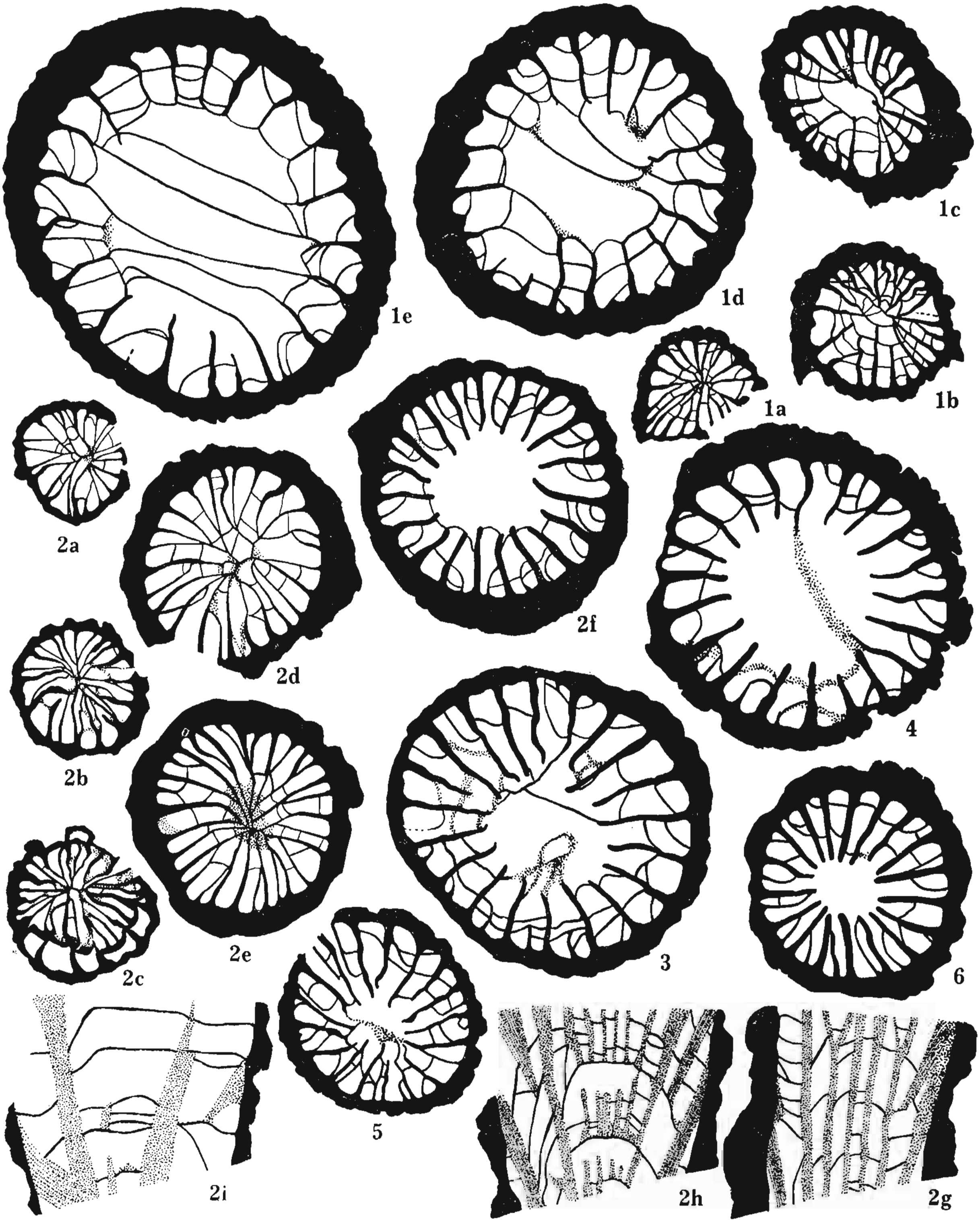

Fig. 85.

Paraduplophyllum (*Vacoea*) *amplexoides amplexoides* subsp. n. 1. Specimen USNM 197357. Locality USNM 7281, Cibolo Formation, Breccia Zone. Transverse sections; a — neanic stage; b, c — early ephebic stage; d, e — ephebic stage. 2. Specimen USNM 197358. Holotype. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds; a — transverse section, neanic stage; b — transverse section, very early stage of rejuvenation; c — transverse section, lateral rejuvenation; d, e—transverse sections, late neanic morphology; f — transverse section, ephebic stage; g—i — successive longitudinal sections made from corallite periphery to its axis. 3. Specimen USNM 197359. Locality and horizon as above, Transverse section, ephebic stage. 4. Specimen USNM 197360. Locality and horizon as above. Transverse section, ephebic stage 5. Specimen USNM 197361. Locality 705a, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse section, early, ephebic stage. 6. Specimen USNM 197362. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse section, ephebic stage. All, ×8.

of the external wall) may either be diagenetic or, more probably, resulted from the original break in secretion of calcium carbonate.

The structure bounding the rest of the newly founded calice forms a low, semicircular elevation of the tabula, being clearly of basal origin (pl. 43:5a). This elevation does not show any foliations, making that side of the newly formed calice aseptal.

Longitudinal section. — In the section made almost exactly axially (fig. 85:2i), middle parts of tabulae are widely spaced (4 for 4.2 mm), horizontal and with some accessory axial tabellae in the more juvenile part of the corallite. In the amplexoid part of the specimen (fig. 85:2i, upper portion) the tabellae are lacking. Lateral parts of the tabulae in Position II dip toward the external wall (fig. 85:2i, lower right, 2h). In Position I (fig. 85:2i, upper left and right; 2h, lower left; 2g, upper left, lower right) they are almost horizontal or inclined slightly downward. The more peripheral section (fig. 85:2h) shows the amplexoid character of the major septa in the corallite axis.

Individual variation. — The variation established is not large. All well preserved calices (e. g. pl. 43:4, 5a, 8) have foundations of major and minor septa equally developed at the marginal zone and either distinctly underdeveloped or completely reduced minor septa in the inner zone (pl. 43:3, 4, 5a, 7, 10). All major septa are equal in length in individual calices, but their length between calices vary a little. This is especially so at the floors where, in some calices, septa remain restricted to the peripheral part (pl. 43:3, 7, 10), while in the other ones (pl. 43:4, 9a, 11a) they came fairly close to the calice axes. The latter specimens form the majority of the collection. Skewness of the calice floor is another variable character. Being always oblique, the calice floor may be almost horizontal in some specimens (e. g. pl. 43:3, 7, 11a) and steeply inclined in others (e. g. pl. 43:7).

Variability in sections is mainly in the length of the major and minor septa, which vary in individual specimens from rather long-septal (fig. 85:5, 6; pl. 42:3a, b) to very short-septal, with almost no minor septa developed (fig. 85:1d, e, 4; pls. 41:14, 15; 42:1, 2e). The moment of reaching the amplexoid stage differs in individual specimens. In most of them, it is restricted to the uppermost 2—4 mm of growth only (e. g. fig. 85:5, 6, and the holotype, fig. 85:2f). In some others, this stage starts fairly early in ontogeny and lasts along the major part of corallite growth (fig. 85:1b—e; pl. 42:2c—e). No replacement of amplexoid and long-septal stages has been observed in the course of growth of a single specimen.

Occurrence. — Locality USNM 705a:1, 720e:62, Skinner Ranch Formation, base of *Scacchinella* beds; 702d:2, 702e:6, Hess Formation, Taylor Ranch member; 726n:2, Upper Hess Formation, ? 728e:1, Lower Bone Spring Formation; 7281:1, Cibolo Formation, Breccia Zone. Upper Wolfcampian.

Paraduplophyllum (*Vacoea*) *amplexoides longiseptatum* subsp. n.

(figs. 86, 87; pls. 42:4—7; 43:12, 13)

Holotype: Specimen USNM 197374, fig. 86:1a—m; pl. 42:6a—c.
Type locality: USNM 733j.
Type horizon: Skinner Ranch Formation, Sullivan Peak member.
Derivation of the name: *longiseptatum* — after long minor septa.

Material. — 34 silicified specimens, almost all having calices and/or proximal ends at least in part preserved.

Some features of representative specimens (in mm):

USNM cat. nos.	N:d ratio	Length	Depth of calice	Remarks
197374	20:6.9×6.6	≈22.0	≈10.0	calice margin
„	18:6.7×6.5			beneath calice
„	17:5.5×5.0			early ephebic stage
197385	19:7.3×7.0	incompl.	≈ 7.0	calice margin
197383	18:6.0×5.7	18.0	?	beneath calice
„	18:5.0×4.8			middle of growth
197379	17:6.2×5.8	19.0	6.0	calice margin
„	16:6.0×5.3			just beneath calice
197377	15:5.0×5.0	≈20.0	?	middle of rejuvenation
197382	14:3.7×3.5	22.7	≈ 5.0	calice margin
..	14:3.6×3.6			beneath calice

Diagnosis. — *Paraduplophyllum* (*Vacoea*) *amplexoides* having long minor septa in all growth stages.

Description of the holotype. — The twice rejuvenated specimen is horn-shaped, with the cardinal septum located on its convex side. The old calice of the upper rejuvenation is 10 mm deep and 6.9×6.6 mm in diameter. The young one has approximately 6 mm and 4.6×4.0 mm respectively. The counter septum of the young calice dominates, being higher and penetrating the calice farther axially than other major septa. The cardinal septum does not differ from the short, radially arranged major septa. Minor septa, except for their foundations at the marginal zone, are completely reduced.

The ontogenetically most advanced section (fig. 86:1e; pl. 42:6b) is amplexoid, with the cardinal and counter septa slightly longer than other major septa. The former is also slightly thicker. Most of the major septa, much thicker peripherally, thin rapidly axially. Some are slightly shortened. Minor septa are longer and more clearly contratingent or contraclined in the counter quadrants. Those neighbouring the cardinal septum and some other major septa in the cardinal quadrants are reduced.

In the younger mature cross section (fig. 86:1d; pl. 42:6a) the cardinal and counter septa may be distinctly elongated. Minor septa are all long and mostly contratingent, although some are contrafused. The specimen rejuvenated for the first time early in ontogeny, producing a mature-like morphology there (fig. 86:1a). In further growth of the rejuvenated part (fig. 86:1b), with all major septa long and straight, mostly met at the corallite axis, and with straight, contrafused minor septa, the morphology is typical of less specialized species of the genus discussed.

The deep lateral rejuvenation of the upper part of the holotype caused a complete reconstruction of its morphology. The earliest stage available for study (fig. 86:1f, g), aseptal in part, can well be considered as following the morphology of a very early stage of rejuvenation observed in a calice of one of the paratypes of the nominative subspecies (pl. 43:5a) described earlier. The rejuvenated calice is dual in a character, being in one half composed of the unchanged, old cardinal quadrants, and, on the opposite side, built of a completely new wall, with some foundations of new septa on it. The new wall is supported by the old alar septa and the old counter septum, which is the only unshortened septum of the counter quadrants. Only some of the major septa, i. e. the cardinal, counter, and alar protosepta and possibly also one or two metasepta underwent rejuvenation and continued to develop as thin, new septa in the new calice (fig. 86:1f—j). Most of the metasepta are either newly inserted on the new wall (fig. 86:1g—k, left side) or their origin is uncertain. They may have been inherited from the old

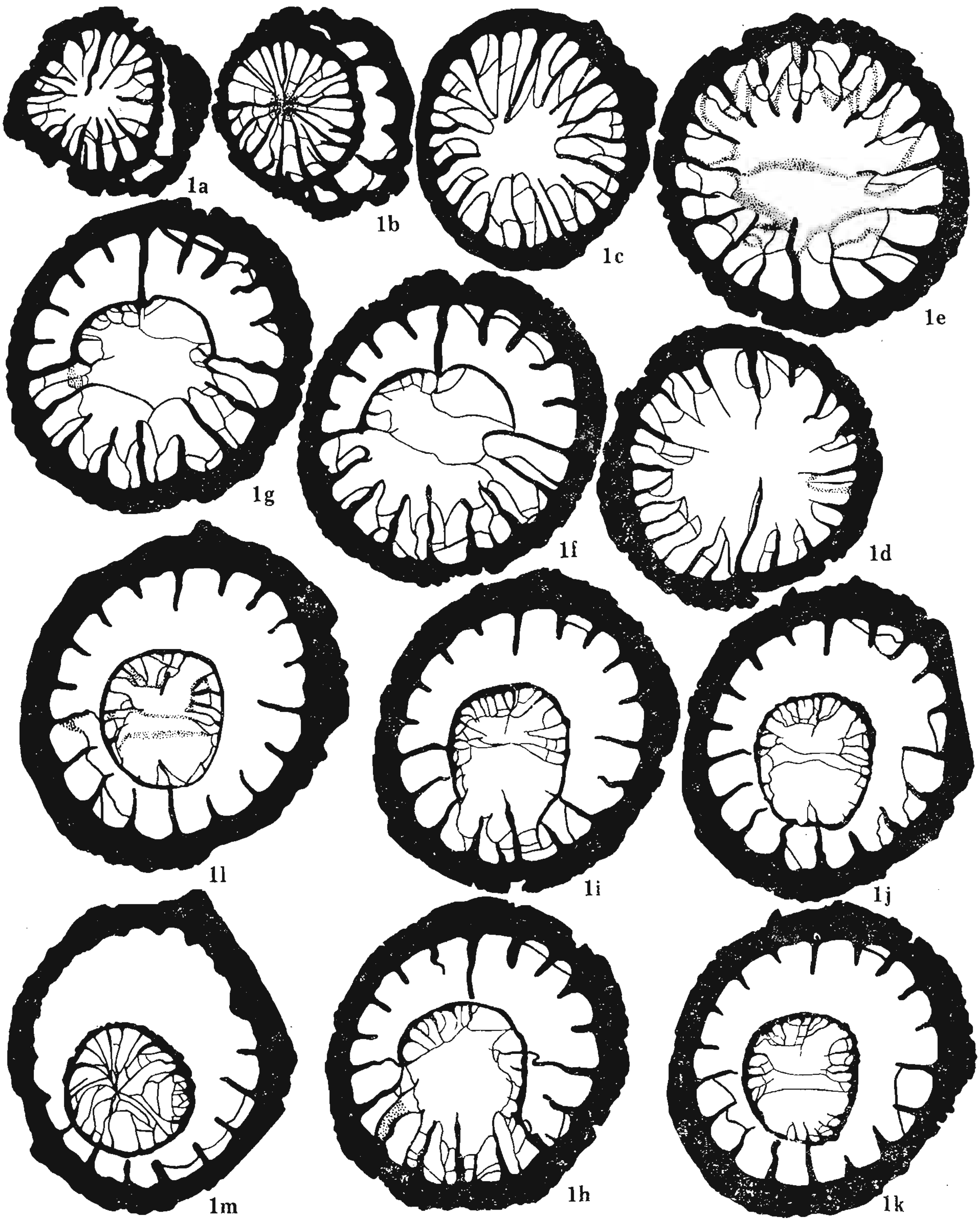

Fig. 86.

Paraduplophyllum (*Vacoea*) *amplexoides longiseptatum* subsp. n. Specimen USNM 197374. Holotype. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Transverse sections; a, b — first rejuvenation of corallite, having late neanic/early ephebic morphology; c—e — ephebic stage; f—m — successive sections of laterally axial rejuvenation, with counter septum supporting rejuvenated calice lowermost. All, ×8.

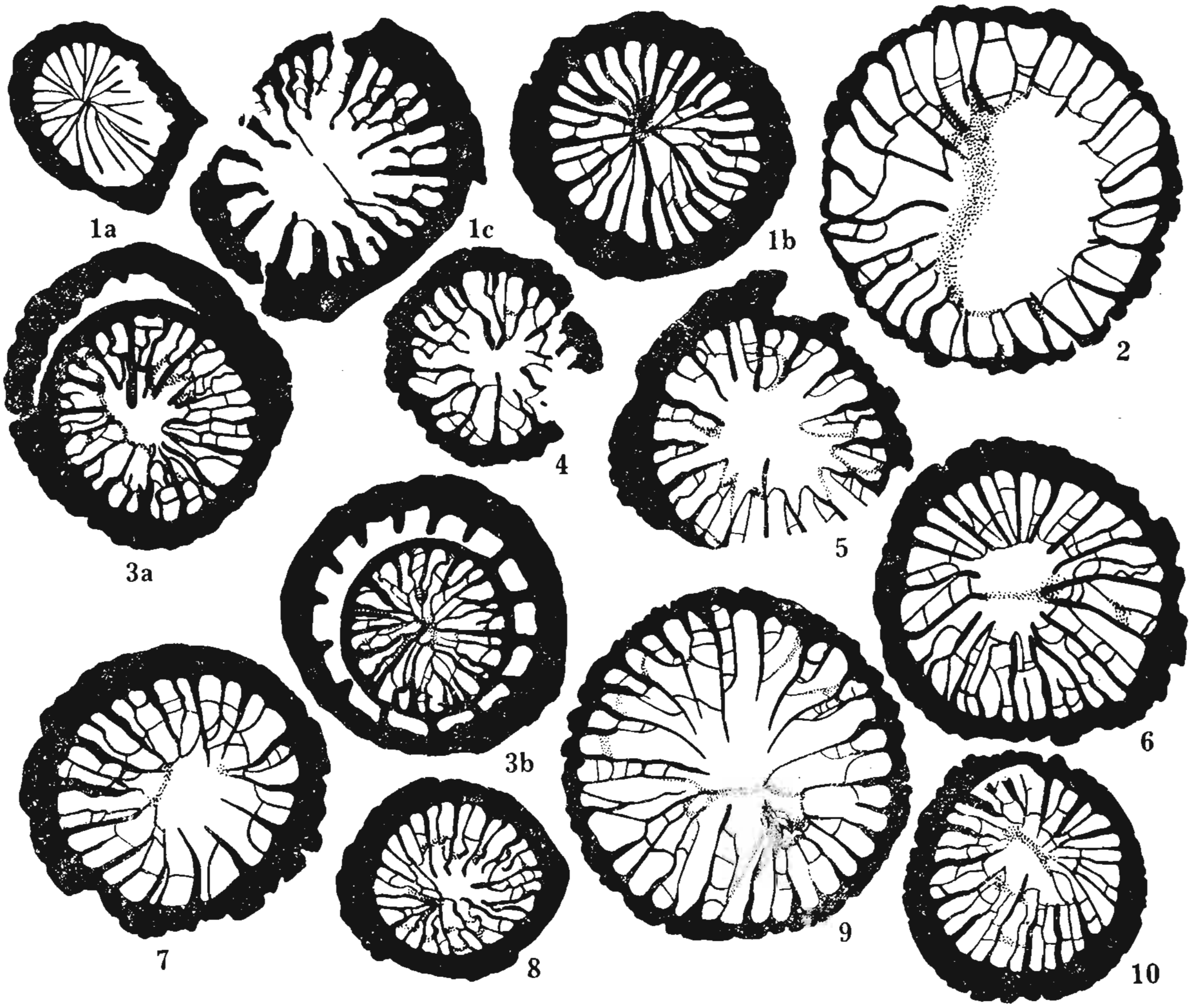

Fig. 87.

Paraduplophyllum (*Vacoea*) *amplexoides longiseptatum* subsp. n. 1. Specimen USNM 197375. Locality USNM 738r, Cibolo Formation, Breccia Zone. Transverse sections; a — neanic stage; b — early ephebic stage; c — ephebic stage. 2. Specimen USNM 197376. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse section, ephebic stage. 3. Specimen USNM 197377. Locality USNM 724p, Skinner Ranch Formation, undivided. Transverse sections of rejuvenated corallite; a — ephebic morphology; b — late neanic morphology. 4. Specimen USNM 197378. Locality USNM 716t, Lower Skinner Ranch Formation. Transverse section, ephebic stage. 5. Specimen USNM 197379. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Transverse section, ephebic stage. 6. Specimen USNM 197380. Locality USNM 705a, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse section, ephebic stage. 7. Specimen USNM 197381. Locality USNM 738r, Cibolo Formation, Breccia Zone. Transverse section, ephebic stage. 8. Specimen USNM 197382, Locality USNM 724p, Skinner Ranch Formation, undivided. Transverse section, ephebic stage. 9. Specimen USNM 197383. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Transverse section, ephebic stage. 10. Specimen USNM 197384. Locality USNM 738r, Cibolo Formation, Breccia Zone. Transverse section, ephebic stage. All, ×8.

part of the calice (fig. 86:1i, upper right), then reduced (fig. 86:1j, k), and reinserted again (fig. 86:1k, l). However they appeared, they are always located opposite to the remnants of the old major septa.

Old minor septa were reduced in the course of rejuvenation without being inherited in the rejuvenated calice. New, never contratingent minor septa are inserted early and serially, but at least in part between the already existing major septa (fig. 86:1f—h, right). They tend to be contratingent or contrafused, reaching this arrangement individually (fig. 86:1i, k), but mainly only at the long-septal stage that ends the process described, bringing the morphology of the corallite back to the irregularly neanic stage (fig. 86:1 m).

Individual variation. — Differences in the neanic and early ephebic stage are small and were caused either by a curvature of specimen, a development of attachment processes, or the other extrinsic factors. The individualized moment of reaching mature morphology is more important. Specimens having the amplexoid stage restricted to the uppermost portion of the corallites prevail. Variation of the mature, amplexoid stage concerns first of all the length of the major septa, which may sometimes be very short (fig. 87:2), but commonly are fairly long (fig. 87:3a, 4, 6; pl. 42:7b). The holotype and several paratypes are intermediate between these two variants. Extremely long-septal specimens (fig. 87:8, 10), which are morphologically close to some corallites of *P.* (*V.*) *vermiculare* sp. n., are all young corallites and should be considered as incompletely mature individuals.

Length of the cardinal and counter septa vary to a certain extent, but only in elongation, not in shortening. In some specimens or some stages of growth (fig. 87:3a, 4, 5, 9; pl. 42:4, 5, 7b), they are longer than other major septa, while in other corallites they do not extend beyond the average (fig. 87:1c, 2, 6, 7, 8). This is true for both the long- and the short-septal specimens. In some corallites (e. g. fig. 87:1a—c, 7), minor septa in some loculi of the cardinal quadrants became regularly reduced toward the cardinal septum. This is a very rare variant. More frequent, but also uncommon, is an incidental reduction of minor septa in some loculi. The great majority of the specimens observed have all minor septa well developed.

Remarks. — *P.* (*V.*) *amplexoides longiseptata* subsp. n. differs from the nominative subspecies first of all in possessing long minor septa permanently and almost invariably present. The slight difference in n: d ratio is not fully confirmed because of the inadequate number of specimens available for study.

The subspecies discussed shows also a close similarity to *Kabakovitchiella* WEYER, 1972. FEDOROWSKI (1986) pointed out the uncertain family position of that genus and its possible location within Lophotichiidae WEYER, 1972. If this concept is confirmed by study of the ontogeny of the topotypes of that genus, a new solution for the amplexoid taxa of *Paraduplophyllum* will be necessary. They will then fit in the diagnosis of *Kabakovithiella.* Consequently, the genus *Paraduplophyllum* or at least *Vacoea* subgen. n. may be a junior synonym of *Kabakovitchiella,* unless amplexoid morphology is accepted as a distinguishing subgeneric character, which has not been done in this paper.

Occurrence. - Locality USNM 724p;6, Skinner Ranch Formation, undivided; 716t:1, Lower Skinner Ranch Formation; 705a:6, 720e:7, Skinner Ranch Formation, base of *Scacchinella* beds; 707w:w, Skinner Ranch Formation, Decie Ranch member; 733j:8, Skinner Ranch Formation, Sullivan Peak member; 738r:5, Cibolo Formation, Breccia Zone; 728e:1, Lower Bone Spring Formation. Upper Wolfcampian.

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EXPLANATION OF PLATES 1—43

PLATE 1

1. ? *Allotropiochisma* (? *Allotropiochisma*) *uddenitense* sp. n. Specimen USNM 196695. Holotype. Locality USNM 701 p, Gaptank Fm., *Uddenites*-bearing member; a, b — transverse sections, ephebic stage, × 3.
2. ? *Allotropiochisma* (? *Allotropiochisma*) *uddenitense* sp. n. Specimen USNM 196696. Locality and horizon as above. Transverse sections; a — early ephebic stage × 5, b — late neanic stage, × 10.
3. *Allotropiochisma* (*Alligia*) *flabellum* sp. n. Specimen USNM 139777. Locality and horizon as above. (= *Amplexizaphrentis* sp. A. Ross and Ross, 1963, pl. 49:3). Transverse section, ephebic stage, × 3.
4. *Allotropiochisma* (*Alligia*) *flabellum* sp. n. Specimen USNM 139775. Locality and horizon as above (= *Amplexizaphrentis* sp. A. Ross and Ross, 1963, pl. 48:7). Longitudinal section, × 3.
5. *Allotropiochisma* (*Alligia*) *flabellum* sp. n. Specimen USNM 196701. Locality and horizon as above. Transverse section, ephebic stage, × 3.
6. *Allotropiochisma* (*Alligia*) *flabellum* sp. n. Specimen USNM 196699. Locality and horizon as above. Transverse section, neanic stage, × 10.
7. *Allotropiochisma* (*Abeophyllum*) *texanum* sp. n. Specimen USNM 196707. Locality and horizon as above. Transverse section, ephebic stage, × 5.
8. *Allotropiochisma* (*Abeophyllum*) *texanum* sp. n. Specimen USNM 196705. Holotype. Locality and horizon as above. Transverse sections; a — neanic stage, × 4; b — ephebic stage, part of cardinal fossula sectioned above last tabula, × 3.
9. *Allotropiochisma* (*Abeophyllum*) *texanum* sp. n. Specimen USNM 196703. Locality and horizon as above. Transverse sections, ephebic stage, × 3.

PLATE 2

1. ? *Euryphyllum profundum* sp. n. Specimen USNM 196719. Locality USNM 728f, Lower Bone Spring Fm. a — side view with entrance of commensal? worm tube, × 2; b — relation of septa to worm tube inside calice, × 2; c — calice with deep cardinal fossula, × 2.
2. *Allotropiochisma* (*Alligia*) *flabellum* sp. n. Specimen USNM 196697, Holotype. Locality USNM 701c, Neal Ranch Fm. Calice floor, × 2.
3. ? *Euryphyllum profundum* sp. n. Specimen USNM 196720. Locality USNM 728e, Lower Bone Spring Fm; a — calice, × 4; b — side view, × 2.

4. *Allotropiochisma* (*Alligia*) *flabellum* sp. n. Specimen USNM 196698. Locality USNM 706x, Neal Ranch Fm; a — calice floor with axial depression, cardinal fossula upwards; b — reversed side of weathered tabula of juvenile part of corallite, cardinal fossula upwards, ×4.
5. ? *Euryphyllum profundum* sp. n. Specimen USNM 196721. Locality USNM 728e, Lower Bone Spring Fm; a — external view of juvenile corallite, ×4; b — calice. ×4.
6. ? *Euryphyllum profundum* sp. n. Specimen USNM 196722. Locality 728f, horizon as above; a — calice with well developed counter septum; cardinal septum on concave side; b — external view, both, ×4.
7. ? *Euryphyllum profundum* sp. n. Specimen USNM 196715. Locality USNM 728e, horizon as above; a — external view of juvenile specimen with strong attachment on cardinal septum side, ×2; b — calice, ×4.
8. ? *Euryphyllum profundum* sp. n. Specimen USNM 196723. Locality and horizon as above; a — external view, ×2; b — calice, ×4.
9. ? *Euryphyllum profundum* sp. n. Specimen USNM 196724. Locality and horizon as above; a — view from tip with proximal end of corallite originally twisted around worm tube (now dissolved) and entrance of tube into corallite wall; compare fig. 9c, right, ×6; b — external view, ×4; c — calice with embeded vorm tube right, ×4.
10. ? *Euryphyllum profundum* sp. n. Specimen USNM 196725. Locality and horizon as above. Calice, ×4.
11. ? *Euryphyllum profundum* sp. n. Specimen USNM 196713. Locality and horizon as above; a — external view, ×3; b — calice oriented obliquely to show morphology of cardinal fossula, ×3.
12. ? *Euryphyllum profundum* sp. n. Specimen USNM 196714. Locality and horizon as above; a — calice, ×4; b — external view, ×2.
13. ? *Euryphyllum profundum* sp. n. Specimen USNM 196716. Holotype. Locality USNM 728f, horizon as above; a — external view, ×2; b — calice; inner ends of major septa bend to frame deep cardinal fossula, ×4.

PLATE 3

1. *Actinophrentis columnare* sp. n. Specimen USNM 196729. Locality USNM 701, Neal Ranch Fm. Calice, ×5.
2. *Actinophrentis columnare* sp. n. Specimen USNM 196726. Locality USNM 702t, Neal Ranch Fm. Calice floor, ×4.
3. ? *Euryphyllum robustum* sp. n. Specimen USNM 196712. Holotype. Locality USNM 705a, Skinner Ranch Fm. External view and marginal zone of calice; foundations of major and minor septa equally developed, ×2.
4. ? *Euryphyllum robustum* sp. n. Specimen USNM 196708. Locality USNM 706x, Neal Ranch Fm. Broken and partly weathered tip showing arrangement of major septa and shape of cardinal fossula, ×4.
5. *Actinophrentis columnare* sp. n. Specimen USNM 196730. Locality USNM 7221, Skinner Ranch Fm., Sullivan Peak member. Calice without minor septa, ×4.
6. *Actinophrentis columnare* sp. n. Specimen USNM 196728. Locality 701, Neal Ranch Fm. Calice with foundations of minor septa present, ×4.
7. *Bradyphyllum postwannense* sp. n. Specimen USNM 196739. Locality USNM 701 p, Gaptank Fm., *Uddenites*-bearing member. External view with contemporaneous increase of major and minor septum next to alar septum, ×4.
8. *Actinophrentis bonespringense* sp. n. Specimen USNM 196731. Holotype. Locality USNM 728e. Lower Bone Spring Fm; a — external view showing increase of septal furrows; minor septum marked by arrow with letter „m", alar septum with letter „A", ×6; b — external view; overgrowth of worm tube left, ×4; c — fragment of calice (cardinal septum to the right); youngest major septum apparently much longer than its furrow shown on fig. 8a, ×6; d — calice; clearly elongated counter septum and pinnate arrangement of major septa, ×4.
9. *Actinophrentis bonespringense* sp. n. Specimen USNM 196732. Locality USNM 728h, horizon as above. Juvenile specimen; a — calice, ×6; b — external view with strong attachment on left, ×4.
10. *Lytvolasma aucta* sp. n. Specimen USNM 196759. Locality USNM 701 p, Gaptank Fm., *Uddenites*-bearing member; a — external view with furrow of alar septum marked „A" and furrows of major and minor septa marked „M" and „m" respectively, ×6; b — view from cardinal septum side with surface of attachment lowermost, ×2.
11. *Allotropiochisma* (*Alligia*) *flabellum* sp. n. Specimen USNM 196699. Locality and horizon as above. Calice floor with cardinal fossula extending to its axis, ×2.
12. *Actinophrentis bonespringense* sp. n. Specimen USNM 196733. Locality USNM 728e, Lower Bone Spring Fm. Juvenile specimen; a — external view, ×2; b — calice with well developed columella, ×4.
13. *Actinophrentis bonespringense* sp. n. Specimen USNM 196734. Locality and horizon as above; a — external view, ×2; b — calice with only slight elongation of counter septum, ×4.
14. *Lytvolasma aucta* sp. n. Specimen USNM 196761. Locality USNM 701 p, Gaptank Fm., *Uddenites*-bearing member. Epitheca partly eroded but septal furrows recognizable, ×2.
15. *Actinophrentis bonespringense* sp. n. Specimen USNM 196735. Locality 728e, Lower Bone Spring Fm. Juvenile specimen; a — calice, ×4; b — external view; septal furrows hardly if at all distinguishable on apex but distinct uppermore, ×2.

PLATE 4

1. ? *Euryphyllum robustum* sp. n. Specimen USNM 196708. Locality USNM 706x. Neal Ranch Fm.; a — transverse section, neanic stage, × 5; b — transverse section, ephebic stage, × 3; c — longitudinal section near calice floor in cardinal-counter septa plan; cardinal fossula right, × 3.
2. ? *Euryphyllum robustum* sp. n. Specimen USNM 196711. Locality and horizon as above. Transverse sections; a — ephebic stage, b — late neanic stage. Both, × 3.
3. ? *Euryphyllum robustum* sp. n. Specimen USNM 196710. Locality and horizon as above. Transverse sections; a — neanic stage, × 10; b — ephebic stage, × 3.
4. ? *Euryphyllum robustum* sp. n. Specimen USNM 196712. Holotype. Locality and horizon as above. Transverse section, ephebic stage, × 3.
5. ? *Euryphyllum profundum* sp. n. Specimen USNM 196715. Locality USNM 728e, Lower Bone Spring Fm; a, b — transverse sections, neanic stage, × 20.
6. ? *Euryphyllum profundum* sp. n. Specimen USNM 196718. Locality and horizon as above. Transverse section, ephebic stage; commensal? worm tube embedded in external wall, × 10.
7. ? *Euryphyllum profundum* sp. n. Specimen USNM 196714. Locality and horizon as above. Transverse section, ephebic stage, × 5.
8. *Actinophrentis columnare* sp. n. Specimen USNM 196726. Locality USNM 702t, Neal Ranch Fm. Transverse sections; a, b — neanic stage, × 10; c — ephebic stage, × 5.
9. *Actinophrentis columnare* sp. n. Specimen USNM 196727. Holotype. Locality USNM 706x, Neal Ranch Fm. Transverse sections; a — early neanic stage, × 10; b — late neanic stage, × 5.
10. *Actinophrentis bonespringense* sp. n. Specimen USNM 196731. Locality USNM 728e, Lower Bone Spring Fm. Transverse sections, a, b — early neanic stage, × 20; c — neanic stage with commensal worm tube, × 20; d — late neanic/early ephebic stage, × 10.
11. *Actinophrentis columnare* sp. n. Specimen USNM 196728. Locality USNM 701, Neal Ranch Fm. Transverse sections; a — neanic stage, × 10; b — ephebic stage, × 5.

PLATE 5

1. *Bradyphyllum* sp. 2. Specimen USNM 196750. Locality USNM 728e, Lower Bone Spring Fm.; a—c — transverse sections, late neanic to early ephebic stage, × 5.
2. *Lytvolasma asymmetrica* SOSHKINA, 1925. Specimen 803/146. Holotype. Housed in Paleontological Institute of the Academy of Sci. of the USSR, Moscow. Transverse sections; a — early ephebic stage = SOSHKINA 1925, pl. 1:1a; b — ephebic stage = SOSHKINA, 1925, pl. 1:1.
3. *Lytvolasma aucta* sp. n. Specimen USNM 196760. Locality USNM 701 p, Gaptank Fm., *Uddenites*-bearing member. Transverse sections; a — early neanic stage; b, c — late neanic stage; all × 10, d — ephebic stage, × 5.
4. *Lytvolasma aucta* sp. n. Specimen USNM 196756. Locality and horizon as above. Transverse section, ephebic stage, × 5.
5. *Monophyllum cassum* sp. n. Specimen USNM 196766. Locality and horizon as above; a, b — transverse sections, early ephebic stage, × 5.
6. *Lytvolasma aucta* sp. n. Specimen USNM 196762. Locality and horizon as above. Transverse section, neanic stage, × 10.
7. ? *Lytvolasma* sp. Specimen USNM 196763. Locality USNM 728e, Lower Bone Spring Formation. Transverse sections; a — early neanic stage, × 10; b — ephebic stage, × 5.
8. *Lytvolasma aucta* sp. n. Specimen USNM 196759. Locality USNM 701 p, Gaptank Formation, *Uddenites*-bearing member. Transverse section, ephebic stage, × 5.
9. *Lytvolasma aucta* sp. n. Specimen USNM 196761. Locality and horizon as above. Transverse section, late ephebic stage, × 5.
10. *Falsiamplexus reductus* sp. n. Specimen USNM 196808. Locality USNM 700, Gaptank Formation, Upper (?) Missourian. Transverse sections; a, b — late neanic and early ephebic stage, × 10.
11. *Monophyllum cassum* sp. n. Specimen USNM 196764. Locality USNM 701 p, Gaptank Formation, *Uddenites*-bearing member. Transverse sections; a — early ephebic stage, × 5; b — late ephebic stage showing incipient axial rejuvenation, × 5.
12. *Monophyllum cassum* sp. n. Specimen USNM 196767. Holotype. Locality USNM 702t, Neal Ranch Formation. Transverse section, ephebic stage, × 5.
13. *Falsiamplexus reductus* sp. n. Specimen USNM 196807. Locality USNM 700, Gaptank Formation, Upper (?) Missourian. Transverse sections; a, b — ephebic stage, × 5.

14. *Falsiamplexus reductus* sp. n. Specimen USNM 196809. Locality and horizon as above; a — transverse section, ephebic stage, b — longitudinal section. Both, ×5.
15. *Falsiamplexus reductus* sp. n. Specimen USNM 196806. Holotype. Locality USNM 700a, Gaptank Formation, Upper (?) Missourian. Transverse sections; a—e — early neanic stage; f, g — late neanic/early ephebic stage; h — ephebic stage, All×10.

PLATE 6

1. *Bradyphyllum counterseptatum* sp. n. Specimen USNM 196743. Locality USNM 701, Neal Ranch Formation; a — calice having shallow rejuvenation and showing amplexoid character of major septa, ×4; b — external view, ×2.
2. *Bradyphyllum* sp. 2. Specimen USNM 196750. Locality USNM 728e, Lower Bone Spring Formation. Calice, ×4.
3. *Falsiamplexus delicatus* (Ross and Ross, 1963). Specimen USNM 196772. Locality USNM 700g. Gaptank Formation, Virgilian. Group of corallites attached to each other to form apparent colony, ×2.
4. *Falsiamplexus flexibilis* sp. n. Specimen USNM 196803. Locality USNM 728e, Lower Bone Spring Formation; a — calice, ×4; b — external view showing worm tube embeded in external wall, ×4.
5. *Falsiamplexus flexibilis* sp. n. Specimen USNM 196804. Locality and horizon as above. Calice, ×4.
6. *Monophyllum cassum* sp. n. Specimen USNM 196768. Locality USNM 701 d, Neal Ranch Formation. Calice floor, ×4.
7. Monophyllum sp. Specimen USNM 196770. Locality USNM 728e, Lower Bone Spring Formation; a — external view of two corallites, ×2; b — calice of juvenile corallite and upper part of calice of large corallite showing foundations of septa and shape of their upper ridges; ×4; c — calice of large specimen, ×4.
8. *Falsiamplexus flexibilis* sp. n. Specimen USNM 196798. Holotype. Locality and horizon as above; a — relation of major septa so lower surface of tabula seen in broken specimen; depression (bulge on the picture) of card inal fossula lower left, ×4; b — external view of upper portion of corallite, ×2; c — calice, ×4.
9. *Falsiamplexus elongatus* sp. n. Specimen USNM 196778. Locality USNM 701 h, Neal Ranch Formation. Calice, ×4.
10. *Falsiamplexus flexibilis* sp. n. Specimen USNM 196805. Locality USNM 728e, Lower Bone Spring Formation; a — calice strongly disturbed by worm tube, ×4; b — external view, ×2.
11. *Monophyllum cassum* sp. n. Specimen USNM 196769. Locality USNM 701, Neal Ranch Formation; a — external view, ×2; b — calice, ×4.
12. *Falsiamplexus flexibilis* sp. n. Specimen USNM 196802. Locality USNM 7221, Skinner Ranch Formation, Sullivanl Peak member; a — rejuvenated calice having irregular floor; b — external view; broken part exhibits horizontal axia, tabulae. Both, ×2.

PLATE 7

1. *Falsiamplexus delicatus* (Ross and Ross, 1963). Specimen USNM 196771. Locality USNM 700g, Gaptank Formation, Virgilian; a — corallite 1, longitudinal, slightly oblique section, ×3, b — section of fragment of biohermal limestone with group of corallites, ×3; c — another section of the same sample; corallites 3 and 4 (compare fig. 26:2, 3) in the middle, ×3.
2. *Falsiamplexus delicatus* (Ross and Ross, 1963). Specimen USNM 196772. Locality and horizon as above. Section of fragment of biohermal limestone with group of corallites at different stage of growth, ×3.
3. *Falsiamplexus elongatus* sp. n. Specimen USNM 196779. Locality USNM 701 k, Neal Ranch Formation. Transverse section, ephebic stage, ×3.
4. *Falsiamplexus flexibilis* sp. n. Specimen USNM 196796. Locality USNM 728e, Lower Bone Spring Formation; a, b — transverse section, ephebic stage, ×5.
5. *Falsiamplexus flexibilis* sp. n. Specimen USNM 196801. Locality and horizon as above. Transverse sections; a — early neanic stage, ×10; b, c — neanic and late neanic stage, ×5; d, e — ephebic stage, ×5.
6. *Falsiamplexus elongatus* sp. n. Specimen USNM 196780. Locality USNM 701 h, Neal Ranch Formation. Transverse section, ephebic stage, ×3.
7. *Falsiamplexus flexibilis* sp. n. Specimen USNM 196802. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Transverse section, ephebic stage, ×5.
8. *Falsiamplexus flexibilis* sp. n. Specimen USNM 196795. Locality USNM 728e, Lower Bone Spring Formation. Transverse section, early ephebic stage, ×10.

9. *Falsiamplexus flexibilis* sp. n. Specimen USNM 196799. Locality and horizon as above. Transverse section, ephebic stage, ×5.
10. *Falsiamplexus flexibilis* sp. n. Specimen USNM 196798. Holotype. Locality and horizon as above; a — late neanic stage, ×10; b — early ephebic stage, ×10, c — ephebic stage, ×10; d — late ephebic stage, ×5.

PLATE 8

1. ? *Lytvolasma* sp. Specimen USNM 196763. Locality USNM 728e, Lower Bone Spring Formation. Calice; major septa overgrow worm tube; cardinal fossula upwards, ×8.
2. *Falsiamplexus elongatus* sp. n. Specimen USNM 196783. Locality USNM 701k, Neal Ranch Formation; a — calice with small sponge attached to major septum; b — broken part showing trapezoid tabulae. Both, ×4.
3. *Falsiamplexus elongatus* sp. n. Specimen USNM 196784. Locality 701, horizon as above. External view; peculiar attachment to brachiopod shell, ×2.
4. *Falsiamplexus elongatus* sp. n. Specimen USNM 196785. Locality USNM 701h, horizon as above. External view of two corallites attached to each other, ×2.
5. *Falsiamplexus elongatus* sp. n. Specimen USNM 196774. Locality USNM 701k, horizon as above. External view, ×2.
6. *Falsiamplexus elongatus* sp. n. Specimen USNM 196773. Holotype. Locality USNM 701h, horizon as above; a — external view; b — calice having axial rejuvenation. Both, ×2.
7. *Falsiamplexus elongatus* sp. n. Specimen USNM 196786. Locality USNM 701k, horizon as above. Calice having three shallow rejuvenations, ×4.
8. *Falsiamplexus elongatus* sp. n. Specimen USNM 196787. Locality USNM 701h, horizon as above; a — calice having several rejuvenations, ×4, b — external view, ×2.
9. *Falsiamplexus elongatus* sp. n. Specimen USNM 196788. Locality USNM 721g, Upper Neal Ranch Formation. Juvenile specimen; a — calice, ×6; b — external view and calice, ×6.
10. *Falsiamplexus elongatus* sp. n. Specimen USNM 196789. Locality USNM 701k, Neal Ranch Formation; a — calice having deep rejuvenation; partly broken; b — brozoan colony attached to external surface of corallite. Both, ×2.
11. *Falsiamplexus elongatus* sp. n. Specimen USNM 196790. Locality and horizon as above. Different ornamentation of tip and uppermore portion of corallite, ×2.
12. *Falsiamplexus elongatus* sp. n. Specimen USNM 196791. Locality and horizon as above. Calice having deep rejuvenation at its floor and commensal worm tube at upper right margin, ×4.
13. *Falsiamplexus elongatus* sp. n. Specimen USNM 196792. Locality and horizon as above; a — arrangement of septa below tabula in late neanic stage; cardinal fossula lower left, ×6; b — calice, ×4.
14. *Falsiamplexus elongatus* sp n. Specimen USNM 196793. Locality USNM 742c, Neal Ranch Formation. Periphery of broken calice showing arrangement of peripheral tabulae (lower) and shallow rejuvenation, ×4.
15. *Falsiamplexus elongatus* sp. n. Specimen USNM 196794. Locality USNM 701, horizon as above. Juvenile specimen; a — calice, ×4; b — external view, ×2.
16. *Falsiamplexus reductus* sp. n. Specimen USNM 196806. Holotype. Locality USNM 700a, Upper (?) Missourian. External view of corallite attached to bryozoan colony, ×2.
17. *Falsiamplexus reductus* sp. n. Specimen USNM 196807. Locality USNM 700, Upper (?) Missourian; a, b — external view of corallite showing peculiar rejuvenation.
18. *Lophophyllidium* (*Lophophyllidium*) *compressum* (JEFFORDS, 1942). Specimen USNM 196876. Locality and horizon as above. Trace of fish (?) teeth on external surface of corallite, ×6.
19. *Lophophyllidium* (*Lophophyllidium*) *compressum* (JEFFORDS, 1942). Specimen USNM 196873. Locality USNM 701e, Gaptank Formation. *Uddenites*-bearing member. External view, ×2.

PLATE 9

1. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196833. Locality USNM 700a, Gaptank Formation, Upper (?) Missourian; a — transverse section neanic stage, ×10; b — transverse section, early ephebic stage; inner end of cardinal septum attached to abaxial wall of cardinal tabular fossula and absent from middle part of fossula, ×5; c, d — transverse sections, early ephebic stage, ×3; e, f — transverse sections, ephebic stage, ×3; g — longitudinal section exposing stage of disappearance of columella, ×3.

2. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196830. Locality and horizon as above. Transverse sections; a — ephebic stage, × 3; b — early ephebic stage, × 5.
3. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196827. Locality USNM 721. Lower Hueco Formation. Transverse sections; a — early ephebic stage; b — ephebic stage. Both × 3.
4. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196836. Locality USNM 700a, Gaptank Formation, Upper (?) Missourian. Transverse sections; a — late neanic/early ephebic stage, × 5; b — ephebic stage, × 3.
5. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196837. Locality USNM 700, Gaptank Formation, Upper (?) Missourian; a — neanic stage, × 5; b, c — early ephebic stage, × 5; d — ephebic stage, × 5.
6. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196826. Locality USNM 701e, Gaptank Formation, *Uddenites* bearing member; a, b — ephebic stage, × 3.
7. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196838. Locality and horizon as above. a, b — transverse sections, ephebic stage, × 3.
8. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196839. Locality and horizon as above. Transverse section, ephebic stage, × 3.
9. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196832. Locality and horizon as above; a — transverse section, ephebic (?) stage, × 3; b, c — rejuvenation, × 3; d — longitudinal section of columellate portion, × 3.
10. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196840. Locality USNM 700a, Gaptank Formation, Upper (?) Missourian; a — transverse section, ephebic stage; b — longitudinal section. Both, × 5.
11. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196684. Locality USNM 700, Gaptank Formation, Upper (?) Missourian. Transverse section; a — ephebic stage having rudimentary columella; b — ephebic stage showing *Amplexocarinia*-like morphology. Both, × 3.

PLATE 10

1. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196828. Locality USNM 700, Gaptank Formation, Upper (?) Missourian. Trace of fish (?) teeth on former calice ridge, × 6.
2. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196830. Locality USNM 700a, Gaptank Formation, Upper (?) Missourian; a—deep (lower) and two or three shallower (middle) traces of fish (?) teeth, × 2; b — detail of fig. 2a showing destruction and its recover, × 6.
3. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196835. Locality 701e, Gaptank Formation, *Uddenites* bearing member. Calice floor having shallow depression of cardinal fossula and uprising portion next to counter septum, × 2.
4. *Lophophyllidium* (*Lophophyllidium*) *distortum* (WORTHEN, 1875). Specimen USNM 196846. Locality USNM 700, Gaptank Formation, Upper (?) Missourian; a — fragment of fig. 4b enlarged to show contemporaneous increase of two septal furrows, × 60; b — corallite surface; cardinal septum furrow located axially; contemporaneous (left) and in sequence (right) increase of septal furrows, × 10.
5. *Lophophyllidium* (*Lophophyllidium*) *distortum* (WORTHEN, 1875). Specimen USNM 196845. Locality USNM 721g, Neal Ranch Formation. Calice floor having axially irregular columella, × 5.
6. *Lophophyllidium* (*Lophophyllidium*) *distortum* (WORTHEN, 1875). Specimen USNM 196847. Locality USNM 701e. Gaptank Formation, *Uddenites* bearing member. External view, × 2.
7. *Lophophyllidium* (*Lophophyllidium*) *absitum* (JEFFORDS, 1947). Specimen USNM 196888. Locality USNM 720b. Hueco Formation. Calice floor, × 4.
8. *Lophophyllidium* (*Lophophyllidium*) *absitum* (JEFFORDS, 1947). Specimen USNM 196885. Locality USNM 701e. Gaptank Formation, *Uddenites* bearing member. External view, × 2.
9. *Lophophyllidium* (*Lophophyllidium*) *absitum* (JEFFORDS, 1947). Specimen USNM 196886. Locality USNM 720b, Hueco Formation; a — external view; b — calice floor. Both, × 3.
10. *Lophophyllidium* (*Lophophyllidium*) *absitum* (JEFFORDS, 1947). Specimen USNM 196887. Locality USNM 701e, Gaptank Formation, *Uddenites* bearing member; a — external view, × 3; b — zaphrentoid morphology of broken tip, × 3.
11. *Lophophyllidium* (*Lophophyllidium*) *absitum* (JEFFORDS, 1947). Specimen USNM 196889. Locality USNM 720b, Hueco Formation. External view; increase of septal furrows, × 10.
12. *Lophophyllidium* (*Lophophyllidium*) *absitum* (JEFFORDS, 1947). Specimen USNM 196890. Locality USNM 705f, Gaptank Formation, undivided; a — external view; b — calice floor. Both, × 2.

PLATE 11

1. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196834. Locality USNM 701e, Gaptank Formation, *Uddenites* bearing member; a — longitudinal section; b, c — transverse sections, early (?) ephebic stage. All, ×3.
2. *Lophophyllidium* (*Lophophyllidium*) *distortum* (WORTHEN, 1875). Specimen USNM 196848. Locality and horizon as above. Transverse section, ephebic stage, ×2.
3. *Lophophyllidium* (*Lophophyllidium*) *dunbari* MOORE and JEFFORDS, 1941. Specimen USNM 196895. Locality USNM 701d, Neal Ranch Formation. Transverse section, ephebic stage, ×3.
4. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196842. Locality USNM 700a, Upper (?) Missourian. Longitudinal section, ×3.
5. *Lophophyllidium* (*Lophophyllidium*) *distortum* (WORTHEN, 1875). Specimen USNM 196843. Locality USNM 701e, Gaptank Formation, *Uddenites* bearing member; a, b — transverse sections, ephebic stage, ×3.
6. *Lophophyllidium* (*Lophophyllidium*) *distortum* (WORTHEN, 1875). Specimen USNM 196849. Locality and horizon as above; a, b — transverse sections, ephebic stage, ×3.
7. *Lophophyllidium* (*Lophophyllidium*) *dunbari* MOORE and JEFFORDS, 1941. Specimen USNM 196858. Locality USNM 727c. Neal Ranch Formation. Transverse sections; a — ephebic stage, ×2; b — late ephebic stage, ×3.
8. *Lophophyllidium* (*Lophophyllidium*) *dunbari* MOORE and JEFFORDS, 1941. Specimen USNM 196859. Locality USNM 701e, Gaptank Formation, *Uddenites* bearing member. Transverse sections. a — ephebic stage; b — early ephebic stage with morphology disturbed by a strange object. Both, ×3.
9. *Lophophyllidium* (*Lophophyllidium*) *distortum* (WORTHEN, 1875). Specimen USNM 196850. Locality USNM 700a, Gaptank Formation, Upper (?) Missourian. Transverse section, ephebic stage, ×3.
10. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196824. Locality and horizon as above. Transverse section, neanic stage, ×10.
11. *Lophophyllidium* (*Lophophyllidium*) *westii* (BEEDE, 1898). Specimen USNM 196829. Locality USNM 701u, Gaptank Formation, *Uddenites* bearing member. Transverse section, ephebic stage, ×3.
12. *Lophophyllidium* (*Lophophyllidium*) *dunbari* MOORE and JEFFORDS, 1941. Specimen USNM 196851. Locality USNM 701e. Horizon as above; a, b — transverse sections, ephebic stage, ×3.
13. *Lophophyllidium* (*Lophophyllidium*) *dunbari* MOORE and JEFFORDS, 1941. Specimen USNM 196855. Locality USNM 701k, Neal Ranch Formation. Tranverse section, neanic stage, ×3.
14. *Lophophyllidium Lophophyllidium plummeri* JEFFORDS, 1947. Specimen USNM 196896. Locality USNM 706x, Neal Ranch Formation. Transverse section, ephebic stage, ×3.
15. *Lophophyllidium* (*Lophophyllidium*) *dunbari* MOORE and JEFFORDS, 1941. Specimen USNM 196852. Locality USNM 701 e, Gaptank Formation, *Uddenites* bearing member. Transverse section, ephebic stage, ×3.
16. *Lophophyllidium* (*Lophophyllidium*) *dunbari* MOORE and JEFFORDS, 1941. Specimen USNM 196854. Locality USNM 721, Lower Hueco Formation; a, b — transverse sections, ephebic stage, ×5.
17. *Lophophyllidium* (*Lophophyllidium*) *dunbari* MOORE and JEFFORDS, 1941. Specimen USNM 196857. Locality USNM 727 e, Neal Ranch Formation. Transverse section, early ephebic stage, ×5.

PLATE 12

1. *Lophophyllidium* (*Lophophyllidium*) *dunbari* MOORE and JEFFORDS, 1941. Specimen USNM 196855. Locality USNM 701k, Neal Ranch Formation; a — external view; b — calice (cardinal septum left). Both, ×2.
2. *Lophophyllidium* (*Lophophyllidium*) *dunbari* MOORE and JEFFORDS, 1941. Specimen USNM 196860. Locality USNM 701d, Neal Ranch Formation; a — external view, ×2; b — calice having juvenile morphology and large dimensions, ×2; c — complex structure of columella, ×4.
3. *Lophophyllidium* (*Lophophyllidium*) *dunbari* MOORE and JEFFORDS 1941. Specimen USNM 196861. Locality USNM 727e, Neal Ranch Formation. View of specimen attached to hardened upper sheet of sea floor mud (?), ×2.
4. *Lophophyllidium* (*Lophophyllidium*) *dunbari* MOORE and JEFFORDS, 1941. Specimen USNM 196862. Locality USNM 701, Neal Ranch Formation. Calice floor, ×4.
5. *Lophophyllidium* (*Lophophyllidium*) *dunbari* MOORE and JEFFORDS, 1941. Specimen USNM 196852. Locality USNM 701e, Gaptank Formation, *Uddenites* bearing member. External view of corallite overgrown by bryozoan colony, ×2.
6. *Lophophyllidium* (*Lophophyllidium*) *dunbari* MOORE and JEFFORDS, 1941. Specimen USNM 196863. Locality USNM 701k, Neal Ranch Formation; a — external view of young corallite attached to brachiopod shell; b — calice. Both, ×4.
7. *Lophophyllidium* (*Lophophyllidium*) *dunbarii* MOORE and JEFFORDS, 1941. Specimen USNM 196864. Locality and horizon as above; a — external view; b — calice. Both, ×2.

8. *Lophophyllidium* (*Lophophyllidium*) *dunbari* Moore and Jeffords, 1941. Specimen USNM 196865. Locality USNM 701. Horizon as above; a — broken calice with complex columella (cardinal septum upward); b — external view; corallite remains attached to brachiopod shell along its all length. Both, ×2.
9. *Lophophyllidium* (*Lophophyllidium*) *dunbari* Moore and Jeffords, 1941. Specimen USNM 196866. Locality and horizon as above; a — calice; b — external view. Both, ×2.
10. *Lophophyllidium* (*Lophophyllidium*) *dunbari* Moore and Jeffords, 1941. Specimen USNM 196867. Locality USNM 721g, Upper Neal Ranch Formation. Obliquely broken corallite; a — relation of deep lateral rejuvenation to old septa; b — to tabulae. Both, ×4.
11. *Lophophyllidium* (*Lophophyllidium*) *dunbari* Moore and Jeffords, 1941. Specimen USNM 196868. Locality and horizon as above; a — external view; b — calice. Both, ×2.
12. *Lophophyllidium* (*Lophophyllidium*) *dunbari* Moore and Jeffords, 1941. Specimen USNM 196869. Locality USNM 701, Neal Ranch Formation; a — calice; b — external view. Both, ×2.
13. *Lophophyllidium* (*Lophophyllidium*) *dunbari* Moore and Jeffords, 1941. Specimen USNM 196870. Locality and horizon as above. External view of broken corallite, ×2.
14. *Lophophyllidium* (*Lophophyllidium*) *dunbari* Moore and Jeffords, 1941. Specimen USNM 196871. Locality and horizon as above. External view, ×2.
15. *Lophophyllidium* (*Lophophyllidium*) *dunbari* Moore and Jeffords, 1941. Specimen USNM 196872. Locality USNM 701a, horizon as above. Calice, ×2.
16. *Lophophyllidium* (*Lophophyllidium*) *dunbari* Moore and Jeffords, 1941. Specimen USNM 196859. Locality USNM 701e, Gaptank Formation, *Uddenites* bearing member. External view, ×2.
17. *Lophophyllidium* (*Lophophyllidium*) *wewokanum* Jeffords, 1947. Specimen USNM 196900. Locality USNM 705f, Gaptank Formation undivided; a — external view; b — calice floor. Both, ×2.

PLATE 13

1. *Lophophyllidium* (*Lophophyllidium*) *compressum* Jeffords, 1942. Specimen USNM 196877. Locality USNM 700 Gaptank Formation, Upper (?) Missourian. Transverse sections; a — early neanic stage, ×10; b, c — early to late ephebic stage, ×5.
2. *Lophophyllidium* (*Lophophyllidium*) *compressum* Jeffords, 1942. Specimen USNM 196878. Locality USNM 700a, Gaptank Formation, Upper (?) Missourian. Transverse sections; a — neanic stage, ×10; b, c — ephebic stage, ×5.
3. *Lophophyllidium* (*Lophophyllidium*) *compressum* Jeffords, 1942. Specimen USNM 196879. Locality and horizon as above. Transverse section, ephebic stage, ×3.
4. *Lophophyllidium* (*Lophophyllidium*) *compressum* Jeffords, 1942. Specimen USNM 196874. Locality and horizon as above. Transverse sections; a — early ephebic stage; b — ephebic stage. Both, ×3.
5. *Lophophyllidium* (*Lophophyllidium*) *compressum* Jeffords, 1942. Specimen USNM 196880. Locality and horizon as above. Transverse section, ephebic stage, ×2.
6. *Lophophyllidium* (*Lophophyllidium*) *compressum* Jeffords, 1942. Specimen USNM 196881. Locality and horizon as above. Transverse sections; a — neanic stage, ×10; b, c — ephebic stage, ×5.
7. *Lophophyllidium* (*Lophophyllidium*) *compressum* Jeffords, 1942. Specimen USNM 196882. Locality USNM 700, Upper (?) Missourian. Transverse sections; a — early ephebic stage, b — ephebic stage. Both, ×2.
8. *Lophophyllidium* (*Lophophyllidium*) *absitum* Jeffords, 1942. Specimen USNM 196885. Locality USNM 701e, Gaptank Formation, *Uddenites* bearing member. Transverse sections; a — early ephebic stage; b — late ephebic stage. Both, ×3.
9. *Lophophyllidium* (*Lophophyllidium*) *absitum* Jeffords, 1942. Specimen USNM 196886. Locality USNM 720b, Hueco Formation; a—c transverse sections, ephebic stage; a, b×3, c×5.
10. *Lophophyllidium* (*Lophophyllidium*) *absitum* Jeffords, 1942. Specimen USNM 196888. Locality and horizon as above. Transverse section, ephebic stage, ×5.
11. *Lophophyllidium* (*Lophophyllidium*) *absitum* Jeffords, 1942. Specimen USNM 196891. Locality and horizon as above. Transverse section, ephebic stage, ×3.
12. *Lophophyllidium* (*Lophophyllidium*) *absitum* Jeffords, 1942. Specimen USNM 196892. Locality and horizon as above; a, b — transverse sections, ephebic stage, ×3.
13. *Lophophyllidium* (*Lophophyllidium*) *absitum* Jeffords, 1942. Specimen USNM 196893. Locality USNM 705j, Gaptank Formation undivided. Transverse section, ephebic stage, ×3.
14. *Lophophyllidium* (*Lophophyllidium*) *absitum* Jeffords, 1942. Specimen USNM 196883. Locality USNM 720b, Hueco Formation; a, b — transverse section, ephebic stage; c — longitudinal section. All, ×3.
15. *Lophophyllidium* (*Lophophyllidium*) *absitum* Jeffords, 1942. Specimen USNM 139737 (= *L. solidum* Ross and Ross, 1962). Locality USNM 704w, Gaptank Formation undivided. Transverse section, ephebic stage, ×3.

16. *Lophophyllidium* (*Lophophyllidium*) *absitum* Jeffords, 1942. Specimen USNM 196887. Locality USNM 701e, Gaptank Formation, *Uddenites*-bearing member. Transverse section, ephebic stage, ×3.
17. *Lophophyllidium* (*Lophophyllidium*) *absitum* Jeffords, 1942. Specimen USNM 196894. Locality USNM 701v, Gaptank Formation, *Uddenites*-bearing member. Transverse section, ephebic stage, ×3.

PLATE 14

1. *Lophophyllidium* (*Lophophyllidium*) *wewokanum* Jeffords, 1947. Specimen USNM 196898. Locality USNM 701u, Gaptank Formation, *Uddenites*-bearing member. Transverse sections; a — late neanic/early ephebic stage; b, c — ephebic stage. All, ×3.
2. *Lophophyllidium* (*Lophophyllidium*) *wewokanum* Jeffords, 1947. Specimen USNM 196900. Locality USNM 705f, Gaptank Formation undivided. Transverse section, ephebic stage, ×5.
3. *Lophophyllidium* (*Lophophyllidium*) *wewokanum* Jeffords, 1947. Specimen USNM 196901, Locality USNM 708n, Gaptank Formation, beds with *Triticites burgessae*. Transverse section, ephebic stage, ×5.
4. *Lophophyllidium* (*Lophophyllidium*) *skinneri* Ross and Ross, 1962. Specimen USNM 139744 (= Ross and Ross, 1962, pl. 162:18). Transverse section, early ephebic stage, ×5.
5. *Lophophyllidium* (*Lophophyllidium*) cf. *confertum* Jeffords, 1942. Specimen USNM 196904. Locality USNM 705j, Gaptank Formation undivided. Transverse section, ephebic stage, ×3.
6. *Lophophyllidium* (*Lophophyllidium*) *wewokanum* Jeffords, 1947. Specimen USNM 196899. Locality USNM 701u, Gaptank Formation, *Uddenites*-bearing member. Transverse sections; a — ephebic stage, ×3; b — late neanic/early ephebic stage, ×5.
7. *Lophophyllidium* (*Lophophyllidium*) *skinneri* Ross and Ross, 1962. Specimen USNM 196903. Locality USNM 702t, Neal Ranch Formation. Transverse section, ephebic stage, ×5.
8. *Lophophyllidium* (*Lophophyllidium*) cf. *confertum* Jeffords, 1942. Specimen USNM 196905. Locality USNM 705f. Transverse sections; a, b — early and late neanic stage, ×5, c — ephebic stage, ×3.
9. *Lophophyllidium* (*Lophophyllidium*) *wewokanum* Jeffords, 1947. Specimen USNM 19602. Locality USNM 706x, Neal Ranch Formation. Transverse section, ephebic stage, ×3.
10. *Pseudowannerophyllum solidum* (Ross and Ross, 1962). Specimen USNM 196908. Locality USNM 711g, Hess Formation. Transverse section, late neanic stage, ×10.
11. *Pseudowannerophyllum solidum* (Ross and Ross, 1962). Specimen USNM 196909. Locality USNM 701p, Gaptank Formation, *Uddenites*-bearing member. Transverse sections; a — loose columella, ×10; b — ephebic stage, ×5.
12. *Pseudowannerophyllum solidum* (Ross and Ross, 1962). Specimen USNM 196907. Locality and horizon as above. Transverse sections; a — ephebic stage, ×5; b — columella of the above section enlarged to show early stage of increase of secondary lamellae by means of peripheral split, ×20; c — columella of ontogenetically more advanced stage of growth having numerous secondary lamellae, ×10.
13. *Lophophyllidium* (*Lophophyllidium*) sp. Specimen USNM 196911. Locality USNM 721, Lower Hueco Formation. Transverse sections; a — neanic stage, ×10; b — late neanic/early ephebic stage, ×5; c — ephebic stage, ×5.

PLATE 15

1. *Pseudowannerophyllum solidum* (Ross and Ross, 1962). Specimen USNM 196610. Locality USNM 701c, Neal Ranch Formation. Calice floor, ×4.
2. *Pseudowannerophyllum solidum* (Ross and Ross, 1962). Specimen USNM 196909. Locality USNM 701p, Gaptank Formation, *Uddenites* bearing member. Polished transverse section showing biform arrangement of peripheral parts of tabulae and their relation to major and minor septa, ×6.
3. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196920. Locality USNM 722l, Skinner Ranch Formation, Sullivan Peak member; a — group of three corallites and morphology of calice of the lower juvenile one, ×6; b — calice of upper juvenile corallite, ×10.
4. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196921. Locality and horizon as above; a — calice; b, c — external view. All, ×2.
5. *Lophophyllidium* (*Lophbillidium*) *erugum* sp. n. Specimen USNM 196932. Locality and horizon as above. Calice floor having shallow rejuvenation, ×4.

6. *Lophophyllidium* (*Lophbillidium*) *erugum* sp. n. Specimen USNM 196934. Locality and horizon as above. Calice floor having broken columella, ×4.
7. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196922. Locality and horizon as above. Juvenile specimen; a — calice; b — external view. Both, ×6.
8. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196923. Locality and horizon as above. calice of juvenile corallite, ×6.
9. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196924. Locality and horizon as above. Juvenile corallite; a — external view; b — calice. Both, ×6.
10. *Lophophyllidium* (*Lophbillidium*) *erugum* sp. n. Specimen USNM 196933. Locality and horizon as above. Weathered specimen showing relation of peripheral parts of tabulae to major septa, ×4.
11. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196925. Locality and horizon as above; a — external view of corallite overgrown by bryozoan colony; b — calice. Both, ×2.
12. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196917. Locality and horizon as above; a — calice, ×4; b — external view, ×2.
13. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196916. Locality and horizon as above. Calice, ×2.
14. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196926. Locality and horizon as above. a — external view; b — calice floor. Both, ×2.
15. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196927. Locality and horizon as above; a — calice, ×3; b — external view, ×2.
16. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196928. Locality and horizon as above. Juvenile corallite; a — calice, ×6; b — broken tip showing arrangement of septa in early neanic stage, ×10.
17. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196929. Locality and horizon as above. Calice of juvenile corallite having three subsequent rejuvenations, ×10.
18. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196930. Locality and horizon as above; a — external view, ×2; b — calice, ×4.

PLATE 16

1. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196917. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member; a, b — transverse sections, ephebic stage, ×10.
2. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196919. Locality and horizon as above. Transverse section, early ephebic stage, ×10.
3. *Lophophyllidium* (*Lophbillidium*) *erugum* sp. n. Specimen USNM 196931. Holotype. Locality and horizon as above; a — transverse section, ephebic stage, ×10; b — morphology of columella and its relation to inner ends of major septa, ×20.
4. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196918. Locality and horizon as above; a, b — successive transverse sections of columella, ×20.
5. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196912. Holotype. Locality and horizon as above; a — ephebic stage, ×10; b — columella having two lamellae temporary incorporated, ×20.
6. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196913. Locality and horizon as above. Transverse sections; a — lateral attachment of counter septum to columella, ×20; b — late ephebic stage, ×10; c — symmetrical attachment of counter septum to columella, ×20.
7. *Lophophyllidium* (*Lophbillidium*) *cyathaxoniaforme* sp. n. Specimen USNM 196915. Locality and horizon as above. Transverse section, ephebic stage; relation of major septa to columella, ×20.
8. *Lophophyllidium* (*Lophbillidium*) sp. 1. Specimen USNM 196952. Locality USNM 709f, Lenox Hills Formation. Transverse section, ephebic stage, ×5.

PLATE 17

1. *Lophophyllidium* (*Lophbillidium*) *erugum* sp. n. Specimen USNM 196931. Holotype. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member; a — calice, ×4; b — external view, ×2.
2. *Lophophyllidium* (*Lophbillidium*) *erugum* sp. n. Specimen USNM 196935. Locality and horizon as above; a — external view, ×2; b — axial septum of early postlarval growth stage, ×10.

3. *Lophophyllidium* (*Lophbillidium*) *erugum* sp. n. Specimen USNM 196936. Locality and horizon as above. Calice of juvenile corallite, ×6.
4. *Lophophyllidium* (*Lophbillidium*) *erugum* sp. n. Specimen USNM 196937. Locality and horizon as above. Calice of mature corallite having thin columella, ×2.
5. *Lophophyllidium* (*Lophbillidium*) *magnocolumnare* sp. n. Specimen USNM 196939. Holotype. Locality USNM 705a, Lower Skinner Ranch Formation; a — calice; b — external view. Both, ×2.
6. *Lophophyllidium* (*Lophbillidium*) *magnocolumnare* sp. n. Specimen USNM 196944. Locality and horizon as above. Juvenile corallite; a — calice; b — external view. Both, ×2.
7. *Lophophyllidium* (*Lophbillidium*) *magnocolumnare* sp. n. Specimen USNM 196942. Locality and horizon as above; a — calice; b — external view showing traces of rootlets of boring sponges. Both, ×2.
8. *Lophophyllidium* (*Lophbillidium*) *magnocolumnare* sp. n. Specimen USNM 196945. Locality and horizon as above; a — a calice having complex columella; b — external view. Both, ×2.
9. *Lophophyllidium* (*Lophbillidium*) *magnocolumnare* sp. n. Specimen USNM 196946. Locality USNM 720e, Lower Skinner Ranch Formation. Specimen overgrown by bryozoans and alge; a — calice having short and thin columella; b — external view. Both, ×2.
10. ? *Paralleynia acclinis* sp. n. Specimen USNM 196954. Locality USNM 701d, Neal Ranch Formation. Calice, ×5.
11. *Lophophyllidium* (*Lophbillidium*) *magnocolumnare* sp. n. Specimen USNM 196947. Locality USNM 705a, Lower Skinner Ranch Formation. Calice of juvenile corallite, ×2.
12. ? *Paralleynia acclinis* sp. n. Specimen USNM 196955. Locality USNM 701d, Neal Ranch Formation. Broken specimen showing mutual relation of basal and radial skeletal elements, ×5.
13. ? *Paralleynia acclinis* sp. n. Specimen USNM 196956. Locality and horizon as above; a — calice; b — external view. Both, ×5.
14. ? *Paralleynia acclinis* sp. n. Specimen USNM 196957. Locality and horizon as above; a — external view of corallite attached to branching bryozoan colony; b — calice. Both, ×5.

PLATE 18

1. *Lophophyllidium* (*Lophbillidium*) *magnocolumnare* sp. n. Specimen USNM 196943. Locality USNM 720e, Lower Skinner Ranch Formation; a — transverse section, ephebic stage;. b — longitudinal section. Both, ×3.
2. *Lophophyllidium* (*Lophbillidium*) *magnocolumnare* sp. n. Specimen USNM 196940. Locality USNM 707b, Skinner Ranch Formation, Sullivan Peak member. Transverse section, ephebic stage, ×5.
3. *Lophophyllidium* (*Lophbillidium*) *magnocolumnare* sp. n. Specimen USNM 196942. Locality USNM 705a, Lower Skinner Ranch Formation. Transverse section, ephebic stage, ×3.
4. *Lophophyllidium* (*Lophbillidium*) *magnocolumnare* sp. n. Specimen USNM 196948. Locality USNM 707b, Skinner Ranch Formation, Sullivan Peak member. Transverse section, ephebic stage, ×3.
5. *Lophophyllidium* (*Lophbillidium*) *magnocolumnare* sp. n. Specimen USNM 196939. Holotype. Locality USNM 705a, Lower Skinner Ranch Formation; a, b — early ephebic stage, ×5; c — ephebic stage, ×3; d, e — successive longitudinal sections, ×3.
6. *Lophophyllidium* (*Lophbillidium*?) sp. 2. Specimen USNM 196950. Locality and horizon as above; a — transverse section; ephebic stage; b — longitudinal section. Both, ×5.
7. *Lophophyllidium* (*Lophbillidium*?) sp. 2. Specimen USNM 196949. Locality and horizon as above; a, b — transverse sections, ephebic stage, ×5.
8. ? *Paralleynia acclinis* sp. n. Specimen USNM 196958. Locality USNM 701, Neal Ranch Formation. Transverse section, ephebic stage, ×10.
9. *Lophotichium vescum* Moore and Jeffords, 1945. Specimen KU 57326. Paratype (= Moore and Jeffords, 1945, fig. 66). Univ. Kansas Locality 7385, Greenleaf Lake, Oklahoma, Hale Formation, Morrowan; a — transverse section of peripheral part of corallite; counter septum in the middle; arrangement of peripheral parts of tabulae in biform tabularium in the case of reduction of minor septa; diagenetically altered foundations of major and minor septa seen in peripheral part of septotheca, ×30; b — transverse section, ephebic stage, ×5.
10. *Lophotichium rotundiseptum* sp. n. Specimen USNM 196960. Locality USNM 701, Neal Ranch Formation; Transverse sections. a — late neanic/early ephebic stage, ×5; b — early ephebic stage, ×3; c — ephebic stage, ×2.
11. *Lophotichium rotundiseptum* sp. n. Specimen USNM 196962. Locality USNM 701a^3. Neal Ranch Formation; a, b — transverse sections, ephebic stage, ×3.

PLATE 19

1. *Lophophyllidium* (*Lophbillidium*?) sp. 2. Specimen USNM 196950. Locality USNM 705a, Lower Skinner Ranch Formation. Calice, ×4.
2. *Lophophyllidium* (*Lophbillidium*?) sp. 2. Specimen USNM 196949. Locality and horizon as above. External view, ×2.
3. *Lophotichium rotundiseptum* sp. n. Specimen USNM 196963. Locality USNM 727e, Neal Ranch Formation; a — external view; b — calice. Both, ×2.
4. *Lophotichium rotundiseptum* sp. n. Specimen USNM 196964. Locality USNM 701 d, Neal Ranch Formation. Broken corallite showing arrangement of tabulae, ×2.
5. *Lophotichium rotundiseptum* sp. n. Specimen USNM 196964. Locality USNM 701, Neal Ranch Formation. Calice having cardinal fossula well developed, ×4.
6. *Lophotichium rotundiseptum* sp. n. Specimen USNM 196966. Locality and horizon as above; a — external view of corallite having four shallow rejuvenations, b — calice. Both, ×2.
7. *Lophotichium rotundiseptum* sp. n. Specimen USNM 197967. Locality and horizon as above; a — calice; b — polished transverse section made just above calice floor. Both, ×2.
8. *Lophotichium rotundiseptum* sp. n. Specimen USNM 196968. Locality USNM 701 k, Neal Ranch Formation. Calice, ×2.
9. *Lophotichium rotundiseptum* sp. n. Specimen USNM 196969. Locality USNM 701, Neal Ranch Formation. Juvenile specimen; a — external view; b — calice. Both, ×4.
10. *Lophotichium rotundiseptum* sp. n. Specimen USNM 196959. Holotype. Locality and horizon as above; a — calice having deep rejuvenation, ×4; b — external view, ×2.
11. *Lophotichium rotundiseptum* sp. n. Specimen USNM 196970. Locality and horizon as above. External view of corallite having very deep rejuvenation at lower and shallow rejuvenation at upper portion of growth, ×2.
12. *Lophotichium rotundiseptum* sp. n. Specimen USNM 196971. Locality USNM 701 k, Neal Ranch Formation; a — calice, b — external view. Both, ×2.
13. *Lophotichium rotundiseptum* sp. n. Specimen USNM 196972. Locality and horizon as above. Calice, ×4.
14. *Lophotichium rotundiseptum* sp. n. Specimen USNM 196973. Locality USNM 701, Neal Ranch Formation; a — calice, ×4; b — external view and calice, ×2.
15. *Lophotichium rotundiseptum* sp. n. Specimen USNM 196974. Locality and horizon as above. Reversed side of broken specimen showing relation of septa to lower surface of tabula, cardinal tabular fossula (lower) and relation of tabulae to counter septum and columella (middle), ×6.

PLATE 20

1. *Lophophyllidium* (*Lophbillidium*) sp. 1. Specimen USNM 196953. Locality USNM 705a, Lower Skinner Ranch Formation. Calice having very deep axial rejuvenation, ×4.
2. ? *Paralleynia acclinis* sp. n. Specimen USNM 196810. Holotype. Locality USNM 701 d, Neal Ranch Formation; a — external view; b — calice. Both, ×5.
3. ? *Paralleynia acclinis* sp. n. Specimen USNM 196811. Locality and horizon as above. Corallite attached to fenestellid bryozoan colony; a — calice; b — external view. Both, ×4.
4. ? *Paralleynia acclinis* sp. n. Specimen USNM 196812. Locality and horizon as above; a — calice; b — external view. Both, ×5.
5. ? *Paralleynia acclinis* sp. n. Specimen USNM 196813. Locality USNM 701, Neal Ranch Formation; a — external view ×5; b — calice, ×5; c — broken tip having aulos already developed, ×10.
6. ? *Paralleynia acclinis* sp. n. Specimen USNM 196914. Locality USNM 701 d, Neal Ranch Formation. Part of oblique longitudinal section showing trabecular structure of septa, ×60.
7. ? *Paralleynia acclinis* sp. n. Specimen USNM 196815. Locality USNM 701 c, Neal Ranch Formation; a — external view; b — calice. Both, ×4.
8. ? *Paralleynia acclinis* sp. n. Specimen USNM 196816. Locality USNM 701, Neal Ranch Formation; a — external view, ×4; b — broken calice showing structure of aulos and its relation to septa of cardinal quadrants, ×6.
9. ? *Paralleynia acclinis* sp. n. Specimen USNM 196817. Locality and horizon as above; a — calice, ×6; b — neanic stage with aulos not yet developed, ×10.
10. ? *Paralleynia acclinis* sp. n. Specimen USNM 196818. Locality USNM 701 d, Neal Ranch Formation; a — external view, b — calice. Both, ×5.
11. ? *Paralleynia acclinis* sp. n. Specimen USNM 196819. Locality and horizon as above. Calice, ×5.
12. *Lophotichium dugoutense* sp. n. Specimen USNM 196985. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member; a — external view, ×2; b — calice having axial rejuvenation, ×4.

13. ? *Paralleynia acclinis* sp. n. Specimen USNM 196820. Locality USNM 701d, Neal Ranch Formation; a — calice; b — external view. Both, ×5.
14. *Lophotichium dugoutense* sp. n. Specimen USNM 196986. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Calice of rejuvenated, juvenile corallite, ×10.
15. *Lophotichium dugoutense* sp. n. Specimen USNM 196987. Locality and horizon as above. Aseptal (?) growth stage of corallite; a — external view of specimen attached to large corallite, ×10; b — calice, ×8.
16. *Lophotichium dugoutense* sp. n. Specimen USNM 196988. Locality and horizon as above. Juvenile specimen; a — calice, ×10; b — external view, ×6.
17. *Lophotichium dugoutense* sp. n. Specimen USNM 196989. Locality and horizon as above; a — external view, ×2; b — calice showing four subsequent rejuvenations; innermost one aseptal, ×4.
18. *Lophotichium dugoutense* sp. n. Specimen USNM 196978. Locality and horizon as above. Mature calice having well developed columella, ×4.
19. *Lophotichium dugoutense* sp. n. Specimen USNM 196981. Locality and horizon as above; a — external view, ×2; b — calice having counter septum almost equal to other major septa, ×4.
20. *Lophotichium dugoutense* sp. n. Specimen USNM 196990. Locality USNM 738r, Cibolo Formation, Breccia Zone; a — external view, ×2; b — calice, ×4.
21. *Lophotichium dugoutense* sp. n. Specimen USNM 196991. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Juvenile specimen; a — calice, ×4; b — external view showing very deep rejuvenation, ×2.

PLATE 21

1. *Lophotichium vescum* Moore and Jeffords, 1945. Specimen KU 57352. Paratype. Univ. Kansas locality 7385, Greenleafe Lake, Oklahoma. Hale Formation, Morrowan. Housed in the Kansas University Museum. Transverse sections; a — late neanic/early ephebic stage; contratingent minor septa present at all but last major septa in quadrants; cardinal septum very long, ×30; b — late ephebic stage, ×5; c — fragment of fig. 1b showing carinae-like modifications of major septa on both sides of counter septum, ×60.
2. *Lophotichium vescum* Moore and Jeffords, 1945. Specimen KU 57330. Paratype. Locality, horizon, and depository as above. Transverse section, ephebic stage, ×5.
3. *Lophotichium vescum* Moore and Jeffords, 1945. Specimen KU 57333. Paratype. Locality, horizon, and depository as above; a — transverse section, early ephebic stage; „interruptions" and „duplications" of counter-lateral minor septa resulted from their strong waviness near or at some tabulae; b — longitudinal section showing counter-lateral minor septa „interrupted" and strongly bent columella (lower part). Both, ×30.

PLATE 22

1. *Lophotichium dugoutense* sp. n. Specimen USNM 196975. Holotype. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Transverse section of rejuvenated corallite having early ephebic morphology, ×5.
2. *Lophotichium dugoutense* sp. n. Specimen USNM 196992. Locality and horizon as above. Transverse section, ephebic stage, ×5.
3. *Lophotichium dugoutense* sp. n. Specimen USNM 196882. Locality and horizon as above. Transverse section of rejuvenated corallite having late neanic morphology, ×5.
4. *Lophotichium dugoutense* sp. n. Specimen USNM 196983. Locality and horizon as above. Transverse section, ephebic stage, ×5.
5. *Lophotichium dugoutense* sp. n. Specimen USNM 196976. Locality USNM 728e, Lower Bone Spring Formation. Transverse section, ephebic stage, ×10.
6. *Lophotichium dugoutense* sp. n. Specimen USNM 196981. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Transverse section of lateral rejuvenation, ephebic stage, ×5.
7. *Lophotichium simulatum* sp. n. Specimen USNM 197020. Locality and horizon as above. Transverse section, ephebic stage, ×5.
8. *Lophotichium simulatum* sp. n. Specimen USNM 197012. Locality USNM 728e, Lower Bone Spring Formation. Transverse section, ephebic stage, ×5.
9. *Lophotichium simulatum* sp. n. Specimen USNM 197921. Locality and horizon as above. Transverse section, ephebic stage, ×5.

10. *Lophotichium simulatum* sp. n. Specimen USNM 197013. Locality USNM 705a, Lower Skinner Ranch Formation; a, b — successive transverse sections, ephebic stage, × 5.
11. *Lophotichium simulatum* sp. n. Specimen USNM 197018. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Transverse section, ephebic stage, × 5.
12. *Lophotichium simulatum* sp. n. Specimen USNM 197022. Locality USNM 7281, Cibolo Formation, Breccia Zone; a, b — successive transverse sections, ephebic stage, × 5.
13. *Lophotichium simulatum* sp. n. Specimen USNM 197016. Locality USNM 702d. Hess Ranch Formation, Taylor Ranch member. Transverse section, ephebic stage, × 5.
14. *Lophotichium simulatum* sp. n. Specimen USNM 197023. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Transverse section, ephebic stage, × 5.
15. *Lophotichium simulatum* sp. n. Specimen USNM 197024. Locality USNM 720e, Lower Skinner Ranch Formation. Transverse section, ephebic stage, × 5.
16. *Lophotichium simulatum* sp. n. Specimen USNM 197025. Locality and horizon as above. Transverse section, ephebic stage, × 5.
17. *Lophotichium simulatum* sp. n. Specimen USNM 197026. Locality and horizon as above. Transverse section, ephebic stage, × 5.
18. *Lophotichium simulatum* sp. n. Specimen USNM 197010. Locality and horizon as above. Transverse section, ephebic stage, × 5.
19. *Assimulia* (*Assimulia*) *tergida* (Ross and Ross, 1962). Specimen USNM 197056. Locality USNM 705a, Skinner Ranch Formation, base of *Scacchinella* beds; a — transverse section, × 3; b — longitudinal section, × 5.
20. *Assimulia* (*Assimulia*) *tergida* (Ross and Ross, 1962). Specimen USNM 197050. Locality and horizon as above. Transverse section, early ephebic stage, × 5.
21. *Assimulia* (*Assimulia*) *tergida* (Ross and Ross, 1962). Specimen USNM 197050. Locality and horizon as above. Transverse sections; a — just beneath calice; coarsely recrystallized axial area is bordered by sections of tabulae (compare fig. 60:1c), × 3; b — ephebic stage having commensal organism tube in axial area, × 5.
22. *Assimulia* (*Assimulia*) *tergida* (Ross and Ross, 1962). Specimen USNM 197057. Locality and horizon as above. Transverse section, ephebic stage, × 3.5.
23. *Assimulia* (*Assimulia*) *tergida* (Ross and Ross, 1962). Specimen USNM 197049. Locality and horizon as above. Longitudinal section, × 3.
24. *Assimulia* (*Assimulia*) *tergida* (Ross and Ross, 1962). Specimen USNM 197046. Locality and horizon as above. Transverse section, ephebic stage (compare fig. 61:1a), × 3.
25. *Assimulia* (*Assimulia*) *tergida* (Ross and Ross, 1962). Specimen USNM 197058. Locality and horizon as above. Transverse section, ephebic stage, × 3.5.
26. *Assimulia* (*Assimulia*) *tergida* (Ross and Ross, 1962). Specimen YPM 21815. Holotype. Locality 68, Leonox Hills Formation. Transverse section, ephebic stage, × 10.

PLATE 23

1. *Lophotichium dugoutense* sp. n. Specimen USNM 196993. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Juvenile corallite; a — external view of corallite attached to brachiopod shell; b — calice having four (?) septa already inserted. Both, × 8.
2. *Lophotichium dugoutense* sp. n. Specimen USNM 196994. Locality and horizon as above. Rejuvenated calice having mature morphology, × 5.
3. *Lophotichium dugoutense* sp. n. Specimens USNM 196995a, b. Locality and horizon as above. Two corallites attached to bryozoan colony; a — calice of corallite „a" having counter septum distinctly elongated, × 5; b — broken, rejuvenated calice of corallite „b", × 4.
4. *Lophotichium dugoutense* sp. n. Specimen USNM 196996. Locality and horizon as above. Calice having very deep axial rejuvenation of early neanic morphology, × 6.
5. *Lophotichium dugoutense* sp. n. Specimen USNM 196997. Locality and horizon as above. Calice of juvenile corallite, × 10.
6. *Lophotichium dugoutense* sp. n. Specimen USNM 196998. Locality and horizon as above. Calice of ephebic corallite having counter septum weakly developed, × 4.
7. *Lophotichium dugoutense* sp. n. Specimen USNM 196999. Locality and horizon as above. Calice; very deep, almost aseptal, axial rejuvenation, × 6.
8. *Lophotichium dugoutense* sp. n. Specimen USNM 197000. Locality and horizon as above. Calice, × 4.
9. *Lophotichium dugoutense* sp. n. Specimen USNM 197001. Locality and horizon as above. Juvenile corallite. Inner

surface of calice wall showing relation of foundations of septa to their blades and disappearance of minor septa. Cardinal septum left, ×6.

10. *Lophotichium dugoutense* sp. n. Specimen USNM 196976. Locality USNM 728e, Lower Bone Spring Formation; a — calice having deep axial rejuvenation, ×4; b — external view, ×2.
11. *Lophotichium dugoutense* sp. n. Specimen USNM 197002. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Partly broken calice having laterally-axial rejuvenation, ×4.
12. *Lophotichium dugoutense* sp. n. Specimen USNM 197003. Locality and horizon as above. Slightly broken calice, ephebic stage, ×4.
13. *Lophotichium simulatum* sp. n. Specimen USNM 197011. Locality USNM 720e, Lower Skinner Ranch Formation. Calice, ×4.
14. *Lophotichium dugoutense* sp. n. Specimen USNM 197005. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Calice margin showing union of some septa, ×8.
15. *Lophotichium dugoutense* sp. n. Specimen USNM 197006. Locality and horizon as above. Juvenile corallite attached to bryozoan colony, ×2.
16. *Lophotichium simulatum* sp. n. Specimen USNM 197027. Locality USNM 728h, Lower Bone Spring Formation; a — calice; b — external view. Both, ×4.
17. *Lophotichium simulatum* sp. n. Specimen USNM 197015. Locality USNM 728e, Lower Bone Spring Formation. Calice, ×4.
18. *Lophotichium simulatum* sp. n. Specimen USNM 197029. Locality USNM 720e, Lower Skinner Ranch Formation; a — calice (cardinal septum upwards), ×4; b — external view, ×2.
19. *Lophotichium simulatum* sp. n. Specimen USNM 197030. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Calice floor, ×4.
20. *Lophotichium simulatum* sp. n. Specimen USNM 197025. Locality USNM 720e, Lower Skinner Ranch Formation. Calice having offset connected to two old major septa, ×4.

PLATE 24

1. *Lophotichium simulatum* sp. n. Specimen USNM 197031. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Calice (cardinal septum upper left), ×6.
2. *Lophotichium simulatum* sp. n. Specimen USNM 197032. Locality and horizon as above; a — calice, ×4; b — calice margin showing equal development of foundations of major and minor septa, disappearance of the latter and shape of upper margins of major septa, ×6.
3. *Lophotichium simulatum* sp. n. Specimen USNM 197028. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Calice, ×4.
4. *Lophotichium simulatum* sp. n. Specimen USNM 197033. Locality USNM 728e, Lower Bone Spring Formation; a — calice having deep axial rejuvenation; b — external view. Both, ×2.
5. *Lophotichium simulatum* sp. n. Specimen USNM 197034. Locality USNM 728f, Lower Bone Spring Formation; a — external view, ×2, b — calice, ×4.
6. *Lophotichium simulatum* sp. n. Specimen USNM 197035. Locality USNM 728e, Lower Bone Spring Formation. Calice floor, ×4.
7. *Lophotichium simulatum* sp. n. Specimen USNM 197036. Locality USNM 707ha, Skinner Ranch Formation, Poplar Tank member. Corallite attached to brachiopod shell; a — inner side of calice wall; septa of corallite follow pattern of external sculpture of brachiopod shell; b — calice. Both, ×4.
8. *Lophotichium simulatum* sp. n. Specimen USNM 197037. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. a — external view, ×2; b — calice, ×4; c — very young (aseptal) corallite attached to the older one, ×8.
9. *Lophotichium simulatum* sp. n. Specimen USNM 197038. Locality and horizon as above. Calice having deep lateral rejuvenation, ×4.
10. *Lophotichium simulatum* sp. n. Specimen USNM 197039. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Calice; biform arrangement of tabulae well marked in rejuvenated part, ×4.
11. *Lophotichium simulatum* sp. n. Specimen USNM 197007. Holotype. Locality and horizon as above; a — external surface showing increase of septa furrows; b — calice having young corallite attached to septum. Both, ×4.
12. *Lophotichium simulatum* sp. n. Specimen USNM 197040. Locality USNM 720e. Lower Skinner Ranch Formation. External view, ×2.
13. *Lophotichium simulatum* sp. n. Specimen USNM 197041. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Broken corallite showing tabulae in Position II and slightly amplexoid character of major septa, ×4.

14. *Lophotichium simulatum* sp. n. Specimen USNM 197020. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Slightly broken calice, ×4.
15. *Lophotichium simulatum* sp. n. Specimen USNM 197042. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Calice floor, ×4.

PLATE 25

1. *Assimulia (Assimulia) tergida* (Ross and Ross, 1962). Specimen USNM 197059. Locality USNM 705a, Skinner Ranch Formation, base of *Scacchinella* beds; a — external view; b — calice. Both, ×2.
2. *Assimulia (Assimulia) tergida* (Ross and Ross, 1962). Specimen USNM 197053. Locality and horizon as above. Calice, ×4.
3. *Assimulia (Assimulia) tergida* (Ross and Ross, 1962). Specimen USNM 197060. Locality and horizon as above. Calice having very shallow rejuvenation, ×4.
4. *Assimulia (Assimulia) tergida* (Ross and Ross, 1962). Specimen USNM 197051. Locality and horizon as above; a — external view, ×2; b — calice, ×2.
5. *Assimulia (Assimulia) tergida* (Ross and Ross, 1962). Specimen USNM 197061. Locality and horizon as above; a — external view of slightly abraded corallite; b — calice. Both, ×2.
6. *Assimulia (Assimulia) tergida* (Ross and Ross, 1962). Specimen USNM 197062. Locality and horizon as above. Calice having axial rejuvenation, ×2.
7. *Assimulia (Assimulia) tergida* (Ross and Ross, 1962). Specimen USNM 197055. Locality and horizon as above. Calice, ×4.
8. *Assimulia (Assimulia) tergida* (Ross and Ross, 1962). Specimen USNM 197063. Locality USNM 707a, Skinner Ranch Formation, Decie Ranch member; a — external view of corallite attached to tabulate coral colony; b — calice. Both, ×4.
9. *Assimulia (Assimulia) tergida* (Ross and Ross, 1962). Specimen USNM 197064. Locality USNM 705a, Skinner Ranch Formation, base of *Scacchinella* beds. External view and calice, ×2.
10. *Assimulia (Assimulia) tergida* (Ross and Ross, 1962). Specimen USNM 197065. Locality USNM 727f, Upper Skinner Ranch Formation. Longitudinally broken corallite showing biform arrangement of tabulae, ×4.
11. *Assimulia (Assimulia) tergida* (Ross and Ross, 1962). Specimen USNM 197054. Locality USNM 732e, Skinner Ranch Formation, Dugout Mountain member; a — calice ×6, b — external view, ×2.
12. *Assimulia (Assimulia) tergida* (Ross and Ross, 1962). Specimen USNM 197047. Locality USNM 702d, Hess Formation, Taylor Ranch member. Calice, ×4.
13. *Assimulia (Assimulia) tergida* (Ross and Ross, 1962). Specimen USNM 197066. Locality USNM 705a, Skinner Ranch Formation, base of *Scacchinella* beds; a — calice; b — external view. Both, ×2.
14. *Assimulia (Assimulia) arta* sp. n. Specimen USNM 197068. Locality USNM 706x, Neal Ranch Formation. External view, ×2.
15. *Assimulia (Assimulia) arta* sp. n. Specimen USNM 197067. Holotype. Locality and horizon as above. Transverse section of peripheral part of corallite; double rows of trabeculae in external parts of septa become either united in single rows or one row of trabeculae disappears innerwards, ×20.
16. *Assimulia (Assimulia) abscessa* sp. n. Specimen USNM 197074. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. External view and calice having peculiar rejuvenation or containing strange young corallite, ×6.
17. *Assimulia (Assimulia) abscessa* sp. n. Specimen USNM 197075. Locality USNM 707b, Skinner Ranch Formation, Sullivan Peak member; a — external view, ×2; b — young corallite developed in calice of older one, ×6.

PLATE 26

1. *Assimulia (Assimulia) arta* sp. n. Specimen USNM 197067. Locality USNM 706x, Neal Ranch Formation. Transverse section, ephebic stage, ×2.
2. *Assimulia (Assimulia) abscessa* sp. n. Specimen USNM 197069. Holotype. Locality USNM 707b, Skinner Ranch Formation, Sullivan Peak member; a — transverse section; ephebic stage, b, c — periaxial and axial longitudinal sections. All, ×5.

3. *Assimulia (Assimulia) abscessa* sp. n. Specimen USNM 197076. Locality USNM 705a, Skinner Ranch Formation, base of *Scacchinella* beds; a — transverse section, ephebic stage; b — longitudinal section. Both, × 5.
4. *Assimulia (Assimulia) abscessa* sp. n. Specimen USNM 197073. Locality USNM 728e, Lower Bone Spring Formation; a—c — transverse sections, ephebic stage, × 5.
5. *Assimulia (Assimulia) abscessa* sp. n. Specimen USNM 197077. Locality USNM 707b, Skinner Ranch Formation, Sullivan Peak member. Transverse section, ephebic stage, × 5.
6. *Assimulia (Assimulia) abscessa* sp. n. Specimen USNM 197078. Locality and horizon as above. Transverse section, ephebic stage, × 5.
7. *Assimulia (Assimulia) abscessa* sp. n. Specimen USNM 197072. Locality and horizon as above. Transverse section, ephebic stage, × 5.
8. *Assimulia (Assimulia) abscessa* sp. n. Specimen USNM 197070. Locality and horizon as above; a, b — transverse sections, ephebic stage; c — longitudinal section, × 5; d — longitudinal section of peripheral part of corallite showing mutual relations of major and minor septa and septal carinae (?), × 20.
9. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197080. Locality USNM 728f, Lower Bone Spring Formation. Transverse sections; a — late ephebic stage; b — ephebic stage. Both, × 10.
10. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197090. Locality and horizon as above. Transverse section, ephebic stage, × 10.
11. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197089. Locality and horizon as above. Transverse section, ephebic stage, × 10.
12. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197088. Locality and horizon as above; a, b — transverse sections, ephebic stage, × 10.

PLATE 27

1. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197091. Locality USNM 728f, Lower Bone Spring Formation. Ontogenetically youngest part of corallite showing lack of septal furrows lowermost and occurrence of six septa in broken tip, × 10.
2. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197083. Holotype. Locality and horizon as above; a — external view, × 4; b — calice, × 4.
3. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197085. Locality USNM 728h, Lower Bone Spring Formation; a — calice, × 6; b — external view, × 4.
4. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197086. Locality USNM 728f, Lower Bone Spring Formation. Calice, × 4.
5. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197092. Locality and horizon as above. Calice, × 4.
6. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197093. Locality and horizon as above. Calice, × 4.
7. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197089. Locality and horizon as above; a — calice, × 4; b — external view, × 2.
8. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197094. Locality and horizon as above; a — calice, × 4; b — external view, × 2.
9. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197090. Locality and horizon as above. Calice, × 4.
10. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197095. Locality and horizon as above; a — external view, × 4; b — calice having two shallow periaxial rejuvenations and very deep axial rejuvenation, × 4.
11. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197096. Locality and horizon as above. External view of corallite rapidly reducing its diameter, × 4.
12. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197097. Locality and horizon as above. Young corallite developed inside large calice, × 8.
13. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197098. Locality and horizon as above. External view of corallite having strong attachment processes, × 4.
14. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197099. Locality and horizon as above; a — external view of corallite having strong attachment processes; b — calice. Both, × 4.
15. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197100. Locality and horizon as above. Calice, × 4.
16. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197101. Locality and horizon as above; a — calice having axial area protruded a little; b — external view. Both, × 4.
17. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197102. Locality and horizon as above; a — external view, × 2; b — rejuvenated calice, × 4.
18. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197103. Locality and horizon as above; a — external view; b — calice. Both, × 4.

19. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197104. Locality and horizon as above. Calice showing biformity of tabularium well accentuated, ×4.
20. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197105. Locality and horizon as above; a — external view; b — calice. Both, ×4.
21. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197106. Locality and horizon as above. Calice, ×4.
22. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197107. Locality and horizon as above. Calice, ×4.
23. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197082. Locality and horizon as above. Calice, ×4.
24. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197108. Locality and horizon as above. Calice, ×4.
25. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197109. Locality and horizon as above. Corallite attached to brachiopod shell, ×2.
26. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197110. Locality and horizon as above. Calice floor showing distinct biformity of tabularium, ×6.
27. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197111. Locality USNM 705a, Skinner Ranch Formation, base of *Scacchinella* beds. Juvenile specimen. Calice having axial area protruded, ×6.
28. *Assimulia (Assimulia) flexibilis* sp. n. Specimen USNM 197112. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Calice floor, ×4.

PLATE 28

1. *Assimulia (Assimulia) frequentis* sp. n. Specimen USNM 197116. Locality USNM 728e, Lower Bone Spring Formation; a — calice, ×3; b, c — external view; strong attachment surface in lower and rapid narrowing of diameter in middle part of corallite, ×2.
2. *Assimulia (Assimulia) frequentis* sp. n. Specimen USNM 197122. Locality and horizon as above. Calice having three subsequent rejuvenations, ×5.
3. *Assimulia (Assimulia) frequentis* sp. n. Specimen USNM 197123. Locality and horizon as above; a — external view, ×3; b — lower part of corallite enlarged to show attachment to its own tip, ×6; c — calice, ×4.
4. *Assimulia (Assimulia) frequentis* sp. n. Specimen USNM 197124. Locality and horizon as above. Calice showing shallow rejuvenation and cardinal septum dominating, ×4.
5. *Assimulia (Assimulia) frequentis* sp. n. Specimen USNM 197113. Holotype. Locality and horizon as above; a — calice showing slight domination of cardinal septum, ×4; b — external view, ×4.
6. *Assimulia (Assimulia) frequentis* sp. n. Specimen USNM 197125. Locality and horizon as above; a — external view, ×2; b — calice having deep axial rejuvenation; septa of old calice retained in new one, ×4.
7. *Assimulia (Assimulia) frequentis* sp. n. Specimen USNM 197126. Locality and horizon as above. Juvenile corallite; a — calice; b — external view. Both, ×6.
8. *Assimulia (Assimulia) frequentis* sp. n. Specimen USNM 197127. Locality and horizon as above. Calice having cardinal septum indistinguishable, ×4.
9. *Assimulia (Assimulia) frequentis* sp. n. Specimen USNM 197115. Locality and horizon as above; a — cluster of juvenile corallites attached to mature one, ×2; b — two very young corallites; external view of larger one (upper right) and calice of aseptal (?) one (middle left), ×10.
10. *Assimulia (Assimulia) compacta* sp. n. Specimen USNM 197130. Locality and horizon as above; a — calice of offsetting specimen showing arrangement of septa in hystero-neanic stage (upper right), ×10; b — view of calice of offsetting specimen, ×4; c — basal platform of offset that has only started its growth (upper middle) and its relation to atavosepta, ×10.
11. *Assimulia (Assimulia) compacta* sp. n. Specimen USNM 197129. Locality USNM 728f, Lower Bone Spring Formation; a, b — external view of two sides of corallite having very strong attachment surface, ×2.

PLATE 29

1. *Assimulia (Assimulia) frequentis* sp. n. Specimen USNM 197116. Locality USNM 728e, Lower Bone Spring Formation Transverse section, ephebic stage, ×10.
2. *Assimulia (Assimulia) frequentis* sp. n. Specimen USNM 197114. Locality USNM 714p, Lower Skinner Ranch Formation. Transverse section, ephebic stage, ×10.

3. *Assimulia (Assimulia) frequentis* sp. n. Specimen USNM 197121. Locality USNM 720e, Lower Skinner Ranch Formation; a, b — transverse sections, ephebic stage, × 10.
4. *Assimulia (Assimulia) frequentis* sp. n. Specimen USNM 197113. Holotype. Locality USNM 728e, Lower Bone Spring Formation. a, b — transverse sections, ephebic stage, × 10.
5. *Assimulia (Assimulia) frequentis* sp. n. Specimen USNM 197115. Locality and horizon as above. Transverse section, ephebic stage, × 10.
6. *Assimulia (Ericina) fracta* sp. n. Specimen USNM 197141. Locality USNM 722h, Skinner Ranch Formation, Sullivan Peak member. Transverse sections; a, b — ephebic stage; c — deep peripheral rejuvenation showing neanic morphology. All, × 5.
7. *Assimulia (Ericina) fracta* sp. n. Specimen USNM 197138. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Transverse sections; a — late neanic/early ephebic stage; b, c — ephebic stage. All, × 5.
8. *Assimulia (Ericina) fracta* sp. n. Specimen USNM 197134. Locality and horizon as above. Transverse sections; a — early ephebic stage; b — ephebic stage. Both, × 5.
9. *Assimulia (Ericina) fracta* sp. n. Specimen USNM 197142. Locality and horizon as above. Transverse sections; a — early ephebic stage, × 5; b — ephebic stage, × 10; c — ephebic stage, × 5.
10. *Assimulia (Ericina) fracta* sp. n. Specimen USNM 197135. Locality and horizon as above. Transverse section, ephebic stage, × 5.

PLATE 30

1. *Assimulia (Ericina) fracta* sp. n. Specimen USNM 197140. Holotype. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member; a — transverse section, ephebic stage, × 5; b — carinae-like structure of septum in longitudinal section, × 50.
2. *Assimulia (Ericina) fracta* sp. n. Specimen USNM 197132. Locality and horizon as above; a, b — transverse sections, ephebic stage; c — longitudinal section. All, × 5.
3. *Assimulia (Ericina) fracta* sp. n. Specimen USNM 197143. Locality and horizon as above. Transverse section, ephebic stage, × 5.
4. *Assimulia (Ericina) fracta* sp. n. Specimen USNM 197144. Locality and horizon as above. Transverse section, ephebic stage, × 5.
5. *Assimulia (Ericina) fracta* sp. n. Specimen USNM 197158. Locality USNM 728e, Lower Bone Spring Formation. Transverse sections; a — axial rejuvenation; b — ephebic stage. Both, × 5.
6. *Assimulia (Ericina) recrea* sp. n. Specimen USNM 197156. Locality and horizon as above. Transverse sections; a — ephebic stage; b — stage of growth having major septa withdrawn from corallite axis (compare fig. 73:1c). Both, × 5.
7. *Assimulia (Ericina) recrea* sp. n. Specimen USNM 197151. Holotype. Locality and horizon as above; a, b — transverse sections, early neanic stage, × 20; c — early ephebic stage, × 5; d — ephebic stage, × 5; e — longitudinal axial section, × 5.
8. *Assimulia (Ericina) recrea* sp. n. Specimen USNM 197161. Locality and horizon as above. Transverse sections. a — ephebic stage; b — calice (lower) and continued to growth part of corallite (upper right). Both, × 5.
9. *Assimulia (Ericina) recrea* sp. n. Specimen USNM 197157. Locality USNM 707b, Skinner Ranch Formation, Sullivan Peak member. Transverse section, ephebic stage, × 5.
10. *Assimulia (Ericina) recrea* sp. n. Specimen USNM 197163. Locality and horizon as above. Transverse section, ephebic stage, × 5.
11. *Assimulia (Ericina) recrea* sp. n. Specimen USNM 197162. Locality USNM 728e. Lower Bone Spring Formation. Transverse section, ephebic stage, × 5.
12. *Assimulia (Ericina) recrea* sp. n. Specimen USNM 197155. Locality USNM 722h, Skinner Ranch Formation, Sullivan Peak member. Transverse section, ephebic stage, × 5.
13. *Assimulia (Ericina) recrea* sp. n. Specimen USNM 197160. Locality USNM 728e, Lower Bone Spring Formation. Transverse section, ephebic stage, × 5.
14. *Assimulia (Assimulia)* sp. 1. Specimen USNM 197131. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Transverse section, ephebic stage, × 5.
15. *Paraduplophyllum (Paraduplophyllum) oppositum* sp. n. Specimen USNM 197179. Locality 702d, Hess Formation, Taylor Ranch member. Transverse sections; a — rejuvenation having early ephebic morphology; b — ephebic stage. Both, × 5.
16. *Paraduplophyllum (Paraduplophyllum) oppositum* sp. n. Specimen USNM 197180. Locality and horizon as above. Transverse section, early ephebic stage, × 5.

17. *Paraduplophyllum* (*Paraduplophyllum*) *oppositum* sp. n. Specimen USNM 197176. Holotype. Locality and horizon as above. Transverse section, ephebic stage, × 5.
18. *Paraduplophyllum* (*Paraduplophyllum*) *oppositum* sp. n. Specimen USNM 197181. Locality and horizon as above. Transverse sections of rejuvenated corallite; a — early ephebic morphology; b — ephebic morphology. Both, × 5.

PLATE 31

1. *Assimulia* (*Assimulia*) *compacta* sp. n. Specimen USNM 197128. Holotype. Locality USNM 728f, Lower Bone Spring Formation; a — calice having deep lateral rejuvenation, × 4; b — polished surface of section made just beneath calice floor, showing morphology in transmitted light directed through calice, × 4; c — external view, × 2.
2. *Assimulia* (*Ericina*) *fracta* sp. n. Specimen USNM 197145. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member; a — calice having axial rejuvenation, × 4; b — external view, × 2.
3. *Assimulia* (*Ericina*) *fracta* sp. n. Specimen USNM 197146. Locality and horizon as above; a, b — external view of curved corallite having strong attachment processes on its convex side; b — deep axial rejuvenation. All, × 2.
4. *Assimulia* (*Ericina*) *fracta* sp. n. Specimen USNM 197140. Holotype. Locality and horizon as above; a — very deep calice focused on its floor to show slight domination of counter septum and its connection to cardinal septum, × 4; b — external view, × 2.
5. *Assimulia* (*Ericina*) *fracta* sp. n. Specimen USNM 197150. Locality USNM 721, Lower Hueco Formation. Calice having counter septum elongated a little, × 4.
6. *Assimulia* (*Ericina*) *fracta* sp. n. Specimen USNM 197139. Locality 7221, Skinner Ranch Formation, Sullivan Peak member; a — lower part of broken calice, × 5; b — fragment of the above enlarged to show morphology of septa, × 10.
7. *Assimulia* (*Ericina*) *fracta* sp. n. Specimen USNM 197147. Locality and horizon as above. Broken corallite showing relation of slightly amplexoid septa to flat, axial portions of tabulae, × 4.
8. *Assimulia* (*Ericina*) *fracta* sp. n. Specimen USNM 197148. Locality and horizon as above. Series of shallow rejuvenations in slightly broken calice, × 4.
9. *Assimulia* (*Ericina*) *fracta* sp. n. Specimen USNM 197144. Locality and horizon as above. Lower portion of broken calice, × 4.
10. *Assimulia* (*Ericina*) *fracta* sp. n. Specimen USNM 197132. Locality and horizon as above; a — external view, × 2; b — slightly broken calice, × 4.
11. *Assimulia* (*Ericina*) *fracta* sp. n. Specimen USNM 197149. Locality and horizon as above; a — calice, × 4; b — external view of corallite strongly attached to brachiopod shell, × 2.

PLATE 32

1. *Assimulia* (*Ericina*) *recrea* sp. n. Specimen USNM 197164. Locality USNM 728e, Lower Bone Spring Formation. Several successive rejuvenations leading to reduction of corallite morphology down to aseptal stage, × 6.
2. *Assimulia* (*Ericina*) *recrea* sp. n. Specimen USNM 197165. Locality and horizon as above. External view of corallite having strong attachment processes; uppermost one attached to corallite's own surface near its tip, × 4.
3. *Assimulia* (*Ericina*) *recrea* sp. n. Specimen USNM 197156. Locality and horizon as above; a, b — scolecoid corallite rejuvenated in different portions of its growth, × 2.
4. *Assimulia* (*Ericina*) *recrea* sp. n. Specimen USNM 197166. Locality and horizon as above. Calice of juvenile corallite, × 4.
5. *Assimulia* (*Ericina*) *recrea* sp. n. Specimen USNM 197167. Locality and horizon as above; a — calice having very deep axial rejuvenation, × 2; b — external view of corallite attached to brachiopod shell, × 2; c — rejuvenated calice (enlarged from 5a) showing further rejuvenations leading to appearance of neanic morphology, × 10.
6. *Assimulia* (*Ericina*) *recrea* sp. n. Specimen USNM 197168. Locality and horizon as above; a — calice showing several rejuvenations, × 2; b — external view, × 2; c — youngest rejuvenation (enlarged from fig. 6a) showing zaphrentoid arrangement of septa, × 10.
7. *Assimulia* (*Ericina*) *recrea* sp. n. Specimen USNM 197151. Holotype. Locality and horizon as above; a — calice having several rejuvenations; b — external view; attachment processes (lower left) developed up to middle part of corallite length. Both, × 2.
8. *Assimulia* (*Ericina*) *recrea* sp. n. Specimen USNM 197169. Locality and horizon as above; a — external view showing increase of septal furrows; b — calice having series of lateral rejuvenations. Both, × 4.

9. *Assimulia* (*Ericina*) *recrea* sp. n. Specimen USNM 197170. Locality and horizon as above; a — calice having very deep laterally-axial rejuvenation, × 2; b — rejuvenated part of corallite enlarged to show first trial of rejuvenation, enclosing large portion of calice (upper) by formation of skeletal element connecting inner ends of major septa, and incorporation of three atavo septa in second rejuvenation, × 10.
10. *Assimulia* (*Ericina*) *recrea* sp. n. Specimen USNM 197171. Locality and horizon as above. Calice of juvenile corallite, × 6.
11. *Assimulia* (*Ericina*) *recrea* sp. n. Specimen USNM 197172. Locality and horizon as above. Broken calice showing morphology of series of rejuvenations near calice floor, × 6.
12. *Assimulia* (*Ericina*) *recrea* sp. n. Specimen USNM 197173. Locality and horizon as above; a — calice having several lateral and axial rejuvenations, × 4; b — lateral view, × 4; c — youngest rejuvenation showing reduction of septal apparatus down to aseptal stage, × 10.

PLATE 33

1. *Assimulia* (*Ericina*) *recrea* sp. n. Specimen USNM 197174. Locality USNM 728e, Lower Bone Spring Formation; a — external view × 2; b — calice having incipient stage of axial and lateral (lower right) rejuvenation, × 4.
2. *Assimulia* (*Ericina*) *recrea* sp. n. Specimen USNM 197175. Locality and horizon as above. Juvenile corallite; a — external view; septal furrows are absent lowermost; b — calice having aseptal rejuvenation. Both, × 4.
3. *Assimulia* (*Assimulia*) sp. 1. Specimen USNM 197131. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Calice, × 2.
4. *Paraduplophyllum* (*Paraduplophyllum*) *oppositum* sp. n. Specimen USNM 197182. Locality and horizon as above. Calice floor, × 4.
5. *Paraduplophyllum* (*Paraduplophyllum*) *oppositum* sp. n. Specimen USNM 197183. Locality USNM 702d, Hess Formation, Taylor Ranch member. Calice having peculiar kind of lateral rejuvenation (upper part), × 2.
6. *Paraduplophyllum* (*Paraduplophyllum*) *oppositum* sp. n. Specimen USNM 197184. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Calice floor showing great difference in arrangement of tabulae in two positions, × 6.
7. *Paraduplophyllum* (*Paraduplophyllum*) *oppositum* sp. n. Specimen USNM 197185. Locality USNM 702d, Hess Formation, Taylor Ranch member; a — external view; b — calice showing foundations of major and minor septa equally developed on its margin, disappearance of minor septa in its inner zone, and development of long, contratingent minor septa on its floor, × 4.
8. *Paraduplophyllum* (*Paraduplophyllum*) *oppositum* sp. n. Specimen USNM 197186. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Calice of juvenile corallite, × 8.
9. *Paraduplophyllum* (*Paraduplophyllum*) *oppositum* sp. n. Specimen USNM 197187. Locality USNM 722h, Skinner Ranch Formation, Sullivan Peak member. Calice floor, × 6.
10. *Paraduplophyllum* (*Paraduplophyllum*) *oppositum* sp. n. Specimen USNM 197188. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Juvenile corallite; a, b — external view, × 4; c — calice, × 6.
11. *Paraduplophyllum* (*Paraduplophyllum*) *oppositum* sp. n. Specimen USNM 197189. Locality and horizon as above; a — calice, × 6, b — external view, × 4.
12. *Paraduplophyllum* (*Paraduplophyllum*) *multiplicatum* sp. n. Specimen USNM 197192. Locality and horizon as above. Calice floor, × 4.
13. *Paraduplophyllum* (*Vacoea*) *nealranchense* sp. n. Specimen USNM 197278. Locality USNM 727e, Neal Ranch Formation. Fragment of upper portion of calice wall showing absence of septal blades, × 6.
14. *Paraduplophyllum* (*Vacoea*) *nealranchense* sp. n. Specimen USNM 197277. Holotype. Locality USNM 701k, Neal Ranch Formation; a — calice floor, × 4; b — calice margin, × 4; c — external view, × 2.
15. *Paraduplophyllum* (*Vacoea*) *nealranchense* sp. n. Specimen USNM 197280. Locality and horizon as above. Calice having counter septum protruded, × 4.
16. *Paraduplophyllum* (*Vacoea*) *nealranchense* sp. n. Specimen USNM 197281. Locality and horizon as above; a — external view; b — calice. Both, × 4.
17. *Paraduplophyllum* (*Vacoea*) *nealranchense* sp. n. Specimen USNM 197282. Locality and horizon as above. Calice of juvenile corallite attached inside calice of mature one, × 4.
18. *Paraduplophyllum* (*Vacoea*) *nealranchense* sp. n. Specimen USNM 197279. Locality USNM 701, Neal Ranch Formation. Calice, × 4.
19. *Paraduplophyllum* (*Vacoea*) *nealranchense* sp. n. Specimen USNM 197283. Locality USNM 701k, Neal Ranch Formation; a — external view of corallite attached to brachiopod shell, × 3; b — calice having cardinal septum prominent, × 4.

20. *Paraduplophyllum* (*Vacoea*) *nealranchense* sp. n. Specimen USNM 197284. Locality and horizon as above. Juvenile corallite; a — calice; b — external view. Both, ×4.
21. *Paraduplophyllum* (*Vacoea*) *nealranchense* sp. n. Specimen USNM 197285. Locality USNM 701. Neal Ranch Formation. External view of corallite coiled in its juvenile portion, ×4.

PLATE 34

1. *Paraduplophyllum* (*Vacoea*) *nealranchense* sp. n. Specimen USNM 197286. Locality USNM 721g, Upper Neal Ranch Formation. Juvenile corallite; a — calice; b — external view. Both, ×6.
2. *Paraduplophyllum* (*Vacoea*) *nealranchense* sp. n. Specimen USNM 197275. Locality USNM 701k, Neal Ranch Formation; a — calice ×6; b — external view, ×4.
3. *Paraduplophyllum* (*Vacoea*) *nealranchense* sp. n. Specimen USNM 197276. Locality and horizon as above; a — calice; b — external view of corallite attached to bryozoan colony. Both, ×6.
4. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197205. Locality USNM 728f, Lower Bone Spring Formation; a — external view; b — calice. Both, ×4.
5. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197206. Locality and horizon as above. Juvenile corallite; a — calice; b, c — external view. All, ×4.
6. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197207. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Juvenile corallite attached to one more advanced in growth; a — calice floor; b — external view. Both, ×6.,
7. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197208. Locality USNM 728f, Lower Bone Spring Formation. Some septa of juvenile corallite are cemented directly to brachiopod shell, which it is attached to, ×8.
8. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197209. Locality and horizon as above. Juvenile corallite; a — calice having axial area distinctly protruded, ×6; b — external view expressing lack of septal furrows, ×4.
9. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197210. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Juvenile corallite having calice floor flat, ×4.
10. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197211. Locality USNM 728f, Lower Bone Spring Formation. Juvenile corallite attached to brachiopod shell; a — calice; b — external view. Both, ×4.
11. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197212. Locality USNM 728h, Lower Bone Spring Formation. Juvenile corallite. Calice having its floor almost regularly convex, ×6.
12. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197213. Locality USNM 728f, Lower Bone Spring Formation. External view of juvenile corallite having coiled tip without septal furrows and strong development of the latter at its upper portion, ×4.
13. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197214. Locality USNM 728h, Lower Bone Spring Formation. Juvenile corallite; a — broken tip, ×15; b — calice, ×10; c — external view, ×10.
14. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197215. Locality and horizon as above. Juvenile corallite having deep septal furrows above tip; a — calice; b — external view. Both, ×4.
15. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197216. Locality USNM 728f, Lower Bone Spring Formation. Juvenile corallite; a — calice having flat floor; b — external view. Both, ×4.
16. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197217. Locality and horizon as above; a — calice floor showing arrangement of major and minor septa and two positions of tabulae. Position II best seen at counter septum (upper); b — external view of strongly bent corallite attached to its own tip; c — increase of septal furrows (uppermost); d — increase of septa corresponding to those furrows. Note much greater length of septal blades when compared to length of their furrows. All, ×4.
17. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197218. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Calice of juvenile corallite having foundations of septa very well developed, ×4.
18. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197219. Locality USNM 728f. Lower Bone Spring Formation; a — calice having weak foundations of minor septa, blades of which are absent, ×4; b — external view; arrangement of septal furrows strongly altered by attachment to cylindrical object, ×2.
19. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197220. Locality USNM 728h, Lower Bone Spring Formation. Mature corallite; a — calice, b — external view. Both, ×4.
20. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197221. Locality and horizon as above. Calice of mature corallite, ×4.

21. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197222. Locality USNM 728f, Lower Bone Spring Formation. Juvenile corallite; a — calice having axial area highly protruded (counter septum left) ×8; b — external view and calice margin, ×4.
22. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197202. Holotype. Locality and horizon as above. Mature corallite; a — external view, ×2; b — calice, ×4.

PLATE 35

1. *Paraduplophyllum* (*Vacoea*) *tubaeformist ubaeformis* subsp. n. Specimen USNM 197196. Locality USNM 728h, Lower Bone Spring Formation; a — calice; b — external view; increase of septal furrows (middle) and strong attachment processes (right). Both, ×2.
2. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197223. Locality USNM 728f, Lower Bone Spring Formation. Calice of juvenile corallite, ×6.
3. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197224. Locality USNM 725c, Lower Bone Spring Formation. Mature corallite attached to brachiopod shell. Matrix surrounding middle portion of corallite corresponds probably with upper surface of sea floor mud precipitated with silica, ×2.
4. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197225. Locality USNM 728f, Lower Bone Spring Formation; a — two corallites attached to the same piece of matrix and to each other, ×2; b — calice of larger specimen having counter septum protruded higher than other major septa, ×4.
5. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197226. Locality and horizon as above; a — external view, ×2, b — calice, ×4.
6. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197227. Locality USNM 728h, Lower Bone Spring Formation; a — calice floor protruded a little; b — external view; septal furrows deformed by strong attachment processes. Both, ×4.
7. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197228. Locality USNM 728f, Lower Bone Spring Formation; a, b — external view; strong attachment to productid brachiopod shell; c — calice having its floor moderately protruded. All, ×4.
8. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197229. Locality and horizon as above. Calice having its floor highly protruded, ×4.
9. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197230. Locality and horizon as above. Mature corallite attached to sponge branch; a — calice strongly deformed by attachment; b—external view. Both, ×4.
10. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197231. Locality USNM 728h, Lower, Bone Spring Formation; a — calice; b, c — external view of corallite attached to productid brachiopod shell. Overgrowth of brachiopod spine strongly deformed septal furrows (c), but only slightly septal blades (a, upper). All, ×4.

PLATE 36

1. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197232. Locality USNM 728f, Lower Bone Spring Formation; a — walls of old and rejuvenated calices showing septal bodies located between major septa of new calice not related to old major septa, ×6; b, c — external view, ×4; d — calice, ×4.
2. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197233. Locality and horizon as above. Two corallites attached to each other, only one of which rejuvenated; a — calices, ×4; b — external view, ×2.
3. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197234. Locality USNM 728h, Lower Bone Spring Formation. Juvenile corallite. Calice showing disappearance of minor septa and protruded floor, ×4.
4. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197235. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member; a — fragment of calice having part of its margin not separated during rejuvenation ×8; b — calice ×4; c — external view showing strong attachment processes (left), ×2.
5. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197236. Locality USNM 728h, Lower Bone Spring Formation; a — calice wall; newly inserted septal blades do not correspond in length with their furrows (see 5b); b — external view; insertion of septal furrows. Both, ×4.

6. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197237. Locality USNM 728f, Lower Bone Spring Formation. Mature corallite; a — calice having long cardinal septum located in distinct septal fossula, ×4; b — external view of corallite attached to brachiopod shell, ×2.
7. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197238. Locality USNM 728h, Lower Bone Spring Formation. Juvenile corallite; a — calice having deep lateral rejuvenation; b — external view; simultaneous increase of septal furrows in upper part. Both, ×4.
8. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197239. Locality USNM 722l, Skinner Ranch Formation, Sullivan Peak member. Calice having almost radial arrangement of major septa, ×4.
9. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197240. Locality USNM 729f, Lower Bone Spring Formation. Calice, ×4.
10. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197241. Locality and horizon as above. a — calice having septal bodies comparable to those shown on fig. 1a, ×6; b — external view, ×4.

PLATE 37

1. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197242. Locality USNM 702e, Hess Formation, Taylor Ranch member; a — calice having its floor highly protruded; b — external view illustrating increase of septal furrows. Both, ×4.
2. *Paraduplophyllum* (*Vacoea*) *tubaeformis tubaeformis* subsp. n. Specimen USNM 197243. Locality USNM 728f, Lower Bone Spring Formation; a — calice having blades of some minor septa contratingent to major septa on its wall, ×4; b — external view of corallite attached to brachiopod shell, ×2.
3. *Paraduplophyllum* (*Vacoea*) *tubaeformis lophotichioides* subsp. n. Specimen USNM 197266. Locality and horizon as above; a — external view, ×6; b — calice, ×4.
4. *Paraduplophyllum* (*Vacoea*) *tubaeformis lophotichioides* subsp. n. Specimen USNM 197267. Locality USNM 728h, Lower Bone Spring Formation; a — calice; b, c — external view. All, ×4.
5. *Paraduplophyllum* (*Vacoea*) *tubaeformis lophotichioides* subsp. n. Specimen USNM 197268. Locality USNM 728f, Lower Bone Spring Formation. Calice, ×4.
6. *Paraduplophyllum* (*Vacoea*) *tubaeformis lophotichioides* subsp. n. Specimen USNM 197269. Locality and horizon as above. Juvenile corallite. Calice showing relation of columella-like counter septum to other major septa, ×6.
7. *Paraduplophyllum* (*Vacoea*) *tubaeformis lophotichioides* subsp. n. Specimen USNM 197270. Locality and horizon as above. Calice of juvenile corallite, ×6.
8. *Paraduplophyllum* (*Vacoea*) *tubaeformis lophotichioides* subsp. n. Specimen USNM 197271. Locality USNM 728h, Lower Bone Spring Formation; a — calice having counter septum highly protruded; b — external view of attachment surface; c — external view of counter septum side. All, ×4.
9. *Paraduplophyllum* (*Vacoea*) *tubaeformis lophotichioides* subsp. n. Specimen USNM 197265. Holotype. Locality USNM 728f, Lower Bone Spring Formation; a — external view, ×2; b — calice, ×4.
10. *Paraduplophyllum* (*Vacoea*) *tubaeformis reductum* subsp. n. Specimen USNM 197247. Holotype. Locality and horizon as above; a — calice, ×4; b — external view, ×2.
11. *Paraduplophyllum* (*Vacoea*) *tubaeformis reductum* subsp. n. Specimen USNM 197248. Juvenile corallite; a — calice; b — external view. Both, ×4.
12. *Paraduplophyllum* (*Vacoea*) *tubaeformis reductum* subsp. n. Specimen USNM 197249. Locality USNM 728h, Lower Bone Spring Formation. Calice floor, ×4.
13. *Paraduplophyllum* (*Vacoea*) *tubaeformis reductum* subsp. n. Specimen USNM 197250. Locality USNM 728f, Lower Bone Spring Formation; a — calice, ×4; b, c, — external view of juvenile specimen attached to inner surface of brachiopod shell. Mode of attachment of ontogenetically youngest part of skeleton and absence of septal furrows lowermost are expressed, ×5.
14. *Paraduplophyllum* (*Vacoea*) *tubaeformis reductum* subsp. n. Specimen USNM 197251. Locality and horizon as above. Mature corallite; a — calice having prominent counter septum, b — external view. Both, ×2.
15. *Paraduplophyllum* (*Vacoea*) *tubaeformis reductum* subsp. n. Specimen USNM 197252. Locality USNM 721, Lower Hueco Formation. Calice having shallow lateral rejuvenation, ×4.
16. *Paraduplophyllum* (*Vacoea*) *tubaeformis reductum* subsp. n. Specimen USNM 197253. Locality USNM 728f, Lower Bone Spring Formation. Calice, ×6.
17. *Paraduplophyllum* (*Vacoea*) *tubaeformis reductum* subsp. n. Specimen USNM 197254. Locality and horizon as above. Calice of mature corallite, ×2.
18. *Paraduplophyllum* (*Vacoea*) *tubaeformis reductum* subsp. n. Specimen USNM 197255. Locality USNM 728h, Lower Bone Spring Formation. Juvenile corallite; a — external view; b — calice. Both, ×4.

19. *Paraduplophyllum (Vacoea) tubaeformis reductum* subsp. n. Specimen USNM 197256. Locality USNM 728f, Lower Bone Spring Formation, Juvenile corallite; a — external view; b — calice having axial part of its floor convex. Both, × 4.
20. *Paraduplophyllum (Vacoea) tubaeformis reductum* subsp. n. Specimen USNM 197257. Locality and horizon as above. Calice of juvenile corallite having axial area of floor flat and two positions of tabulae well expressed, × 6.

PLATE 38

1. *Paraduplophyllum (Vacoea) tubaeformis reductum* subsp. n. Specimen USNM 197258. Locality USNM 728f, Lower Bone Spring Formation. Mature corallite; a — calice, × 4; b — external view, × 2.
2. *Paraduplophyllum (Vacoea) tubaeformis reductum* subsp. n. Specimen USNM 197259. Locality and horizon as above. Almost mature corallite; a — calice × 4; b — external view expressing strong attachment processes, × 2.
3. *Paraduplophyllum (Vacoea) tubaeformis reductum* subsp. n. Specimen USNM 197260. Locality USNM 728h, Lower Bone Spring Formation. Mature corallite; a — calice floor having two positions of tabulae well expressed, × 4; b — external view; strong attachment flattening right, × 2.
4. *Paraduplophyllum (Vacoea) tubaeformis reductum* subsp. n. Specimen USNM 197261. Locality and horizon as above; a — calice having cardinal septum well developed; b — external view; attachment to brachiopod shell right. Both, × 2.
5. *Paraduplophyllum (Vacoea) tubaeformis lophotichioides* subsp. n. Specimen USNM 197272. Locality USNM 728f, Lower Bone Spring Formation. Juvenile corallite; a — calice having columella-like counter septum already developed; b — external view expressing lack of septal furrows lowermost. Both, × 6.
6. *Paraduplophyllum (Vacoea) tubaeformis reductum* subsp. n. Specimen USNM 19762. Locality USNM 728h, Lower Bone Spring Formation. Mature corallite; a — calice; b — external view. Both, × 2.
7. *Paraduplophyllum (Vacoea) tubaeformis reductum* subsp. n. Specimen USNM 197263. Locality USNM 728f, Lower Bone Spring Formation. Juvenile corallite; a — short-septal calice; b — external view of corallite attached to inner surface of brachiopod shell, expressing mode of attachment of ontogenetically youngest part of skeleton and lack of septal furrows lowermost. Both, × 4.
8. *Paraduplophyllum (Vacoea) tubaeformis reductum* subsp. n. Specimen USNM 197264. Locality and horizon as above. Mature corallite; a — calice having incipient axial rejuvenation; fragments of new wall form carinae-like bodies on some septa (upper right), × 4; b — external view, × 2.
9. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197318. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds. External view, × 2.
10. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197312. Locality and horizon as above; a — calice, × 4; b — external view, × 2.
11. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197319. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member; a — calice having cardinal tabular fossula well marked, × 4; b — external view, × 2.
12. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197320. Locality USNM 738r, Cibolo Formation, Breccia Zone. External view of two corallites strongly cemented to each other, × 2.
13. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197293. Locality and horizon as above. External view of corallite having its ontogenetically youngest portion coiling, × 2.
14. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197321. Locality and horizon as above. Calice, × 4.
15. *Paraduplophyllum (Vacoea) vermiculare* sp. n Specimen USNM 197322. Locality USNM 724p, Skinner Ranch Formation, undivided; a — calice having shallow lateral rejuvenation and distinctly biform arrangement of tabulae on its floor, × 4; b — external view; strong attachment processes at lower part, × 2.
16. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197323. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member; a — calice having flat floor and lateral rejuvenations; b — external view of two corallites attached to each other and to substrate. Both, × 2.
17. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197324. Locality and horizon as above. Calice, × 4.
18. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197325. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds; a — calice, × 4; b — external view, × 2.
19. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197326. Locality and horizon as above; a — calice, × 4, b — external view, × 2.
20. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197327. Locality USNM 738r, Cibolo Formation, Breccia Zone. Calice having two positions of tabulae well accentuated, × 4.
21. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197309. Locality and horizon as above. External view of corallite having septal furrows well developed, × 2.
22. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197328. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member; a — calice, × 4; b — external view of corallite strongly attached to substrate, × 2.
23. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197329. Locality and horizon as above; a — calice, × 4; b — external view of corallite strongly attached to substrate, × 2.

PLATE 39

1. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197289. Holotype. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds; a — calice, ×4; b — external view of corallite with cladochonid attached to its upper portion, ×2.
2. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197330. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. External view of corallite with cladochonid attached to its upper portion, ×2.
3. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197331. Locality and horizon as above; a — calice, ×4; b — external view, ×2.
4. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197288. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds; a — calice having wide, flat floor, ×4; b — external view, ×2.
5. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197332. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Calice, ×4.
6. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197333. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds. Calice, ×4.
7. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197290. Locality and horizon as above. External view, ×2.
8. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197334. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Juvenile corallite; a — calice having two positions of tabulae well accentuated on its floor, ×4; b — external surface slightly damaged by boring organisms, ×2.
9. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197335. Locality and horizon as above; a — calice having most of major septa met axially, ×4; b — external view, ×2.
10. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197336. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds; a — calice, ×4; b — external view; septal furrows developed near the tip, ×10; c — polished surface of section of neanic stage (top of fig. 10b) showing contrafused minor septa, ×20.
11. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197337. Locality USNM 705a, Skinner Ranch Formation, base of *Scacchinella* beds. Calice of juvenile corallite having counter septum slightly longer than other major septa and biformity of tabularium well accentuated, ×6.
12. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197306. Locality USNM 738r, Cibolo Formation, Breccia Zone; a — calice; b — external view. Both, ×2.
13. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197303. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member; a — external view; b — calice having five subsequent rejuvenations. Both, ×2.
14. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197338. Locality and horizon as above; a — calice, ×4; b — external view of very deeply rejuvenated corallite, ×2.
15. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197339. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds; a — calice, ×4; b — external view, ×2.
16. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197340. Locality USNM 707a, Skinner Ranch Formation, Decie Ranch member. External view of corallite attached to fragment of brachiopod (?) shell, changing direction of its growth for 90°, ×4.
17. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197341. Locality USNM 707w. Skinner Ranch Formation, Decie Ranch member; a — calice, ×4; b — external view, ×2.
18. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197342. Locality and horizon as above; a — calice having counter septum more prominent than other major septa, ×4; b — external view, ×2.
19. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197343. Locality USNM 720f, Lower Skinner Ranch Formation. Calice of juvenile corallite, ×6.
20. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197344. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member; a — calice, ×4; b — external view, ×2.
21. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197345. Locality and horizon as above. Calice, ×4.
22. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197346. Locality and horizon as above. Inner side of calice wall showing foundations of major and minor septa in peripheral zone, disappearance of minor septa in middle zone and their reappearance near calice floor, ×4.
23. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197347. Locality and horizon as above; a — calice, ×4; b — external view, ×2.
24. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197348. Locality USNM USNM 738r, Cibolo Formation, Breccia Zone; a — calice; b — external view. Both, ×2.
25. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197307. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds; a — calice, ×4; b — external view, ×2.
26. *Paraduplophyllum (Vacoea) vermiculare* sp. n. Specimen USNM 197349. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member; a — external view of corallite attached to brachiopod shell, ×2; b — calice, ×4.

27. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197350. Locality and horizon as above. Calice, ×4.
28. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197351. Locality USNM 705a, Skinner Ranch Formation, base of *Scacchinella* beds. Calice of juvenile corallite, ×6.

PLATE 40

1. *Paraduplophyllum* (*Paraduplophyllum*) *multiplicatum* sp. n. Specimen USNM 197191. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds; a, b — transverse sections, ephebic stage, ×10.
2. *Paraduplophyllum* (*Paraduplophyllum*) *multiplicatum* sp. n. Specimen USNM 197190. Holotype. Locality 727u, Skinner Ranch Formation, Decie Ranch member; a, b — transverse sections, early and late ephebic stage, ×10; c — axial longitudinal section, ×5.
3. *Paraduplophyllum* (*Paraduplophyllum*) *multiplicatum* sp. n. Specimen USNM 197193. Locality USNM 707a, Skinner Ranch Formation, Decie Ranch member. Transverse sections of rejuvenated corallite; a — late neanic morphology; b — ephebic morphology. Both, ×10.
4. *Paraduplophyllum* (*Vacoea*) *tubaeformis lophotichioides* subsp. n. Specimen USNM 197267. Locality USNM 728h, Lower Bone Spring Formation. Transverse section just above calice floor, ×10.
5. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197315. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Transverse section, ephebic stage, ×10.
6. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197312. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse section, ephebic stage, ×10.
7. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197353. Locality USNM 738r, Cibolo Formation, Breccia Zone. Longitudinal section, ×5.
8. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197293. Locality and horizon as above; a, b — transverse sections, ephebic stage, ×5.
9. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197290. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse section, ephebic stage, ×10.
10. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197292. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Transverse section, ephebic stage, ×10.
11. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197301. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse section, ephebic stage, ×10.
12. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197346. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Transverse section, early neanic stage, ×15.
13. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197288. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse section, ephebic stage, ×10.
14. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197313. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Transverse section, ephebic stage, ×10.
15. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197311. Locality and horizon as above. Transverse section, ephebic stage, ×10.
16. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197294. Locality and horizon as above. Transverse section, ephebic stage, ×10.

PLATE 41

1. *Paraduplophyllum* (*Vacoea*) *tubaeformis reductum* subsp. n. Specimen USNM 197262. Locality USNM 728h, Lower Bone Spring Formation. Transverse section, late neanic/early ephebic stage, ×10.
2. *Paraduplophyllum* (*Vacoea*) *tubaeformis reductum* subsp. n. Specimen USNM 197251. Locality USNM 728f, Lower Bone Spring Formation. Transverse section, ephebic stage, ×10.
3. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197354. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member; a—d — transverse sections, ephebic stage, ×5.
4. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197291. Locality and horizon as above. Transverse section; very early stage of axial rejuvenation, ×10.
5. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197355. Locality USNM 707a, Skinner Ranch Formation, Decie Ranch member. Transverse section, ephebic stage, ×10.

6. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197300. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Transverse section, ephebic stage, × 10.
7. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197296. Locality USNM 738r, Cibolo Formation, Breccia Zone. a—c — successive transverse sections, ephebic stage, × 10.
8. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197304. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member. Transverse section; neanic morphology of youngest rejuvenation, × 10.
9. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197356. Locality and horizon as above. Transverse section; late neanic morphology of rejuvenation, × 10.
10. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197302. Locality and horizon as above. Transverse section of laterally-axial rejuvenation, × 10.
11. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197298. Locality and horizon as above. Transverse section of laterally-axial rejuvenation; minor septa were not inserted, × 10.
12. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197303. Locality and horizon as above. Transverse section of very early stage of lateral rejuvenation, × 10.
13. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197299. Locality USNM 738r, Cibolo Formation, Breccia Zone; a, b — longitudinal sections, × 5.
14. *Paraduplophyllum* (*Vacoea*) *amplexoides amplexoides* subsp. n. Specimen USNM 197360. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds. Transverse section, ephebic stage, × 5.
15. *Paraduplophyllum* (*Vacoea*) *amplexoides amplexoides* subsp. n. Specimen USNM 197359. Locality and horizon as above. Transverse section, ephebic stage, × 10.

PLATE 42

1. *Paraduplophyllum* (*Vacoea*) *amplexoides amplexoides* subsp. n. Specimen USNM 197357. Locality USNM 728l, Cibolo Formation, Breccia Zone. Transverse section, ephebic stage, × 5.
2. *Paraduplophyllum* (*Vacoea*) *amplexoides amplexoides* subsp. n. Specimen USNM 197363. Locality USNM 702e, Hess Formation, Taylor Ranch member. Transverse sections; a — neanic stage, × 10; b — late neanic/early ephebic stage, × 10; c — early ephebic stage, × 10; d — ephebic stage, × 10; e — late ephebic stage, × 5.
3. *Paraduplophyllum* (*Vacoea*) *amplexoides amplexoides* subsp. n. Specimen USNM 197364. Locality USNM 702d, Hess Formation, Taylor Ranch member; a, b — transverse sections, ephebic stage, × 5.
4. *Paraduplophyllum* (*Vacoea*) *amplexoides longiseptatum* subsp. n. Specimen USNM 197383. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member. Transverse section, ephebic stage, × 10.
5. *Paraduplophyllum* (*Vacoea*) *amplexoides longiseptatum* subsp. n. Specimen USNM 197379. Locality and horizon as above. Transverse section, ephebic stage, × 10.
6. *Paraduplophyllum* (*Vacoea*) *amplexoides longiseptatum* subsp. n. Specimen USNM 197374. Holotype. Locality and horizon as above. Transverse sections; a, b — ephebic stage; c — deep laterally axial rejuvenation (compare fig. 86:11). All, × 10.
7. *Paraduplophyllum* (*Vacoea*) *amplexoides longiseptatum* subsp. n. Specimen USNM 197377. Locality USNM 724p, Skinner Ranch Formation undivided. Transverse sections of rejuvenating corallite; a — late neanic morphology; b — ephebic morphology. Both, × 10.

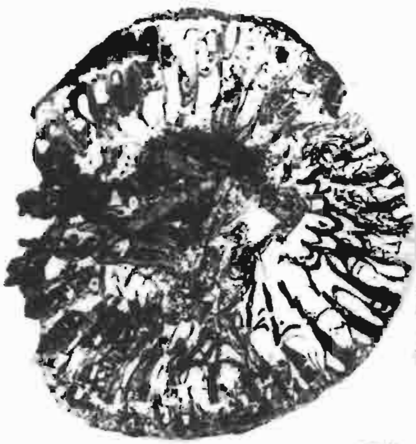
PLATE 43

1. *Paraduplophyllum* (*Vacoea*) *vermiculare* sp. n. Specimen USNM 197352. Locality USNM 707w, Skinner Ranch Formation, Decie Ranch member; a — calice; b — external view of two corallites attached to inner wall of calice of dead specimen. Both, × 4.
2. *Paraduplophyllum* (*Vacoea*) *amplexoides amplexoides* subsp. n. Specimen USNM 197358. Holotype. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds; a, b — calice, × 4; c — external view, × 2.
3. *Paraduplophyllum* (*Vacoea*) *amplexoides amplexoides* subsp. n. Specimen USNM 197365. Locality and horizon as above. Calice, × 4.
4. *Paraduplophyllum* (*Vacoea*) *amplexoides amplexoides* subsp. n. Specimen USNM 197366. Locality and horizon as above. Calice, × 4.

5. *Paraduplophyllum* (*Vacoea*) *amplexoides amplexoides* subsp. n. Specimen USNM 197367. Locality and horizon as above; a — calice having very early rejuvenation, × 6; b — external view, × 2.
6. ? *Paraduplophyllum* (*Vacoea*) *amplexoides amplexoides* subsp. n. Specimen USNM 197368. Locality USNM 728e, Lower Bone Spring Formation. Lower Part of calice. Three subsequent lateral rejuvenations. Some major septa of second rejuvenation elongated on external wall of third rejuvenation (middle right). Two septa of old calice located next to third rejuvenation split axially (upper left), × 8.
7. *Paraduplophyllum* (*Vacoea*) *amplexoides amplexoides* subsp. n. Specimen USNM 197369. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds. Calice, × 4.
8. *Paraduplophyllum* (*Vacoea*) *amplexoides amplexoides* subsp. n. Specimen USNM 197370. Locality USNM 726n, Upper Hess Formation. Calice having deep, laterally-axial rejuvenation, × 2.
9. *Paraduplophyllum* (*Vacoea*) *amplexoides amplexoides* subsp. n. Specimen USNM 197371. Locality USNM 720e, Skinner Ranch Formation, base of *Scacchinella* beds; a — calice, × 4; b — external view, × 2.
10. *Paraduplophyllum* (*Vacoea*) *amplexoides amplexoides* subsp. n. Specimen USNM 197372. Locality and horizon as above. Calice, × 4.
11. *Paraduplophyllum* (*Vacoea*) *amplexoides amplexoides* subsp. n. Specimen USNM 197373. Locality and horizon as above. Calice, × 4.
12. *Paraduplophyllum* (*Vacoea*) *amplexoides longiseptatum* subsp. n. Specimen USNM 197379. Locality USNM 733j, Skinner Ranch Formation, Sullivan Peak member; a — calice, × 4; b — external view, × 2.
13. *Paraduplophyllum* (*Vacoea*) *amplexoides longiseptatum* subsp. n. Specimen USNM 197385. Locality and horizon as above. a — external view of two corallites attached to each other, × 2; b — calice of longer corallite, × 4.

PLATES


1a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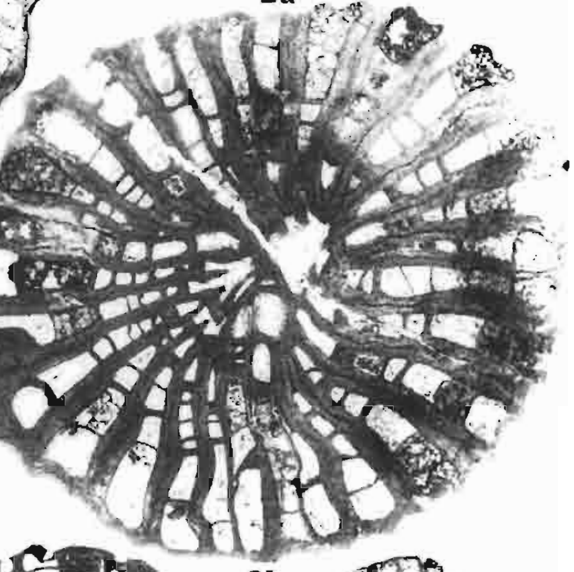
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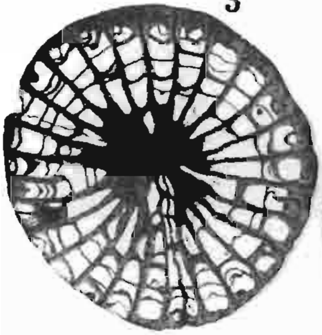
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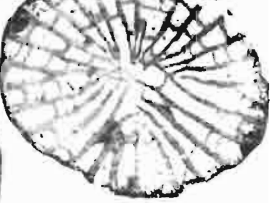
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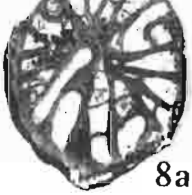
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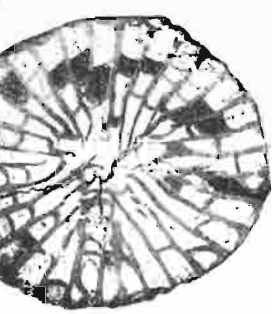
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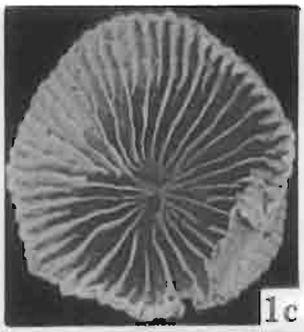
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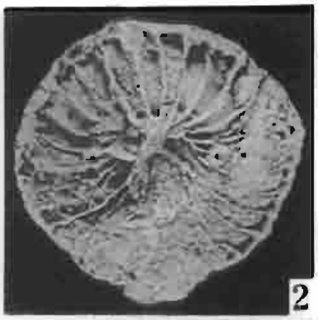
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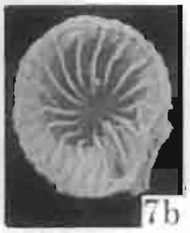
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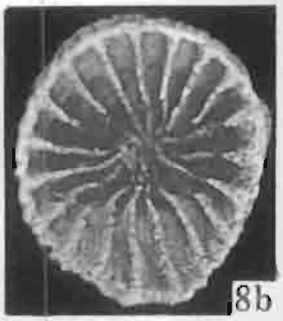
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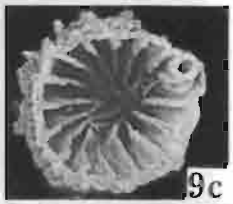
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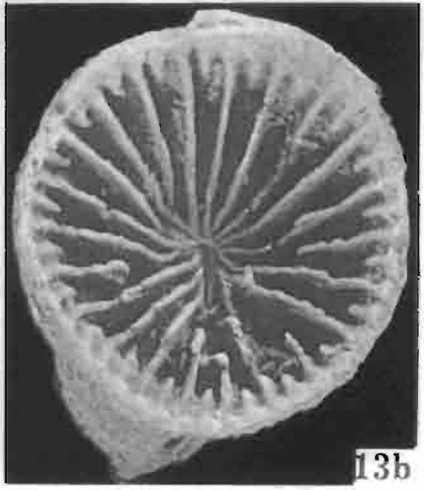
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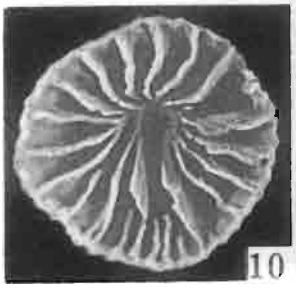
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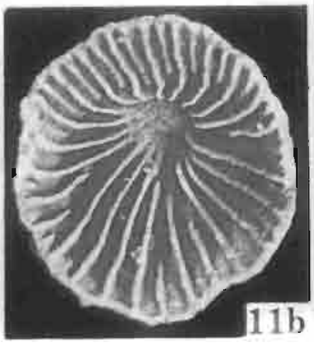
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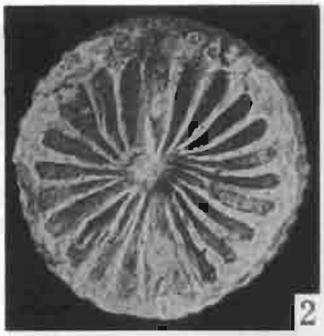
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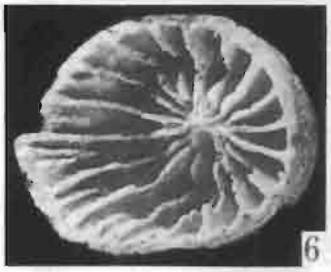
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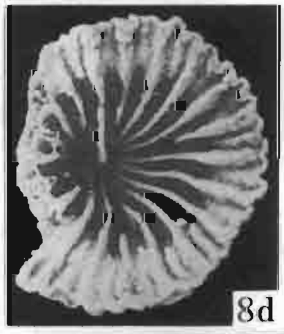
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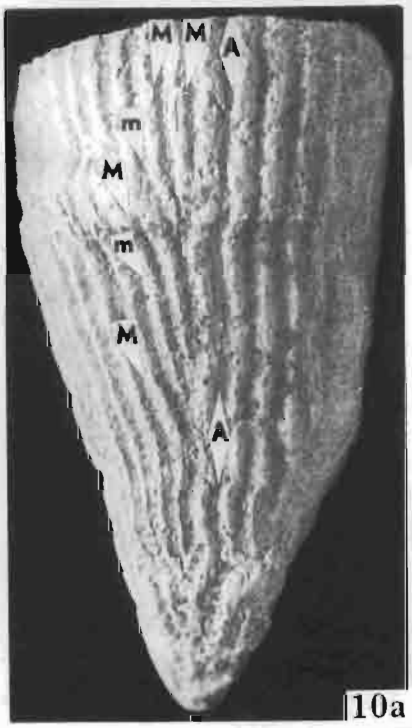

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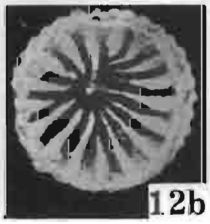
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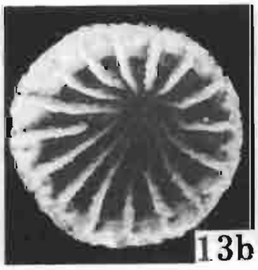
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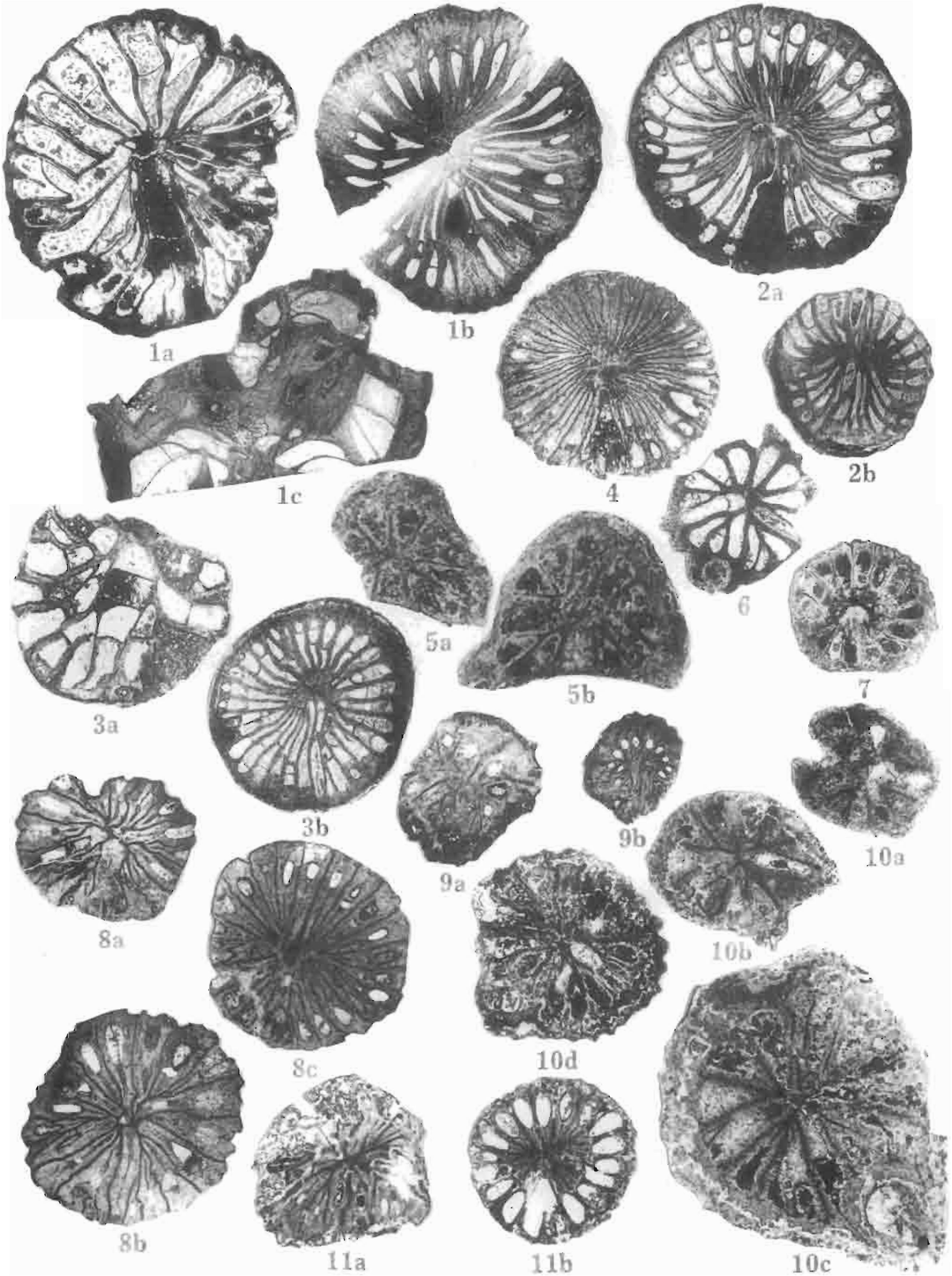
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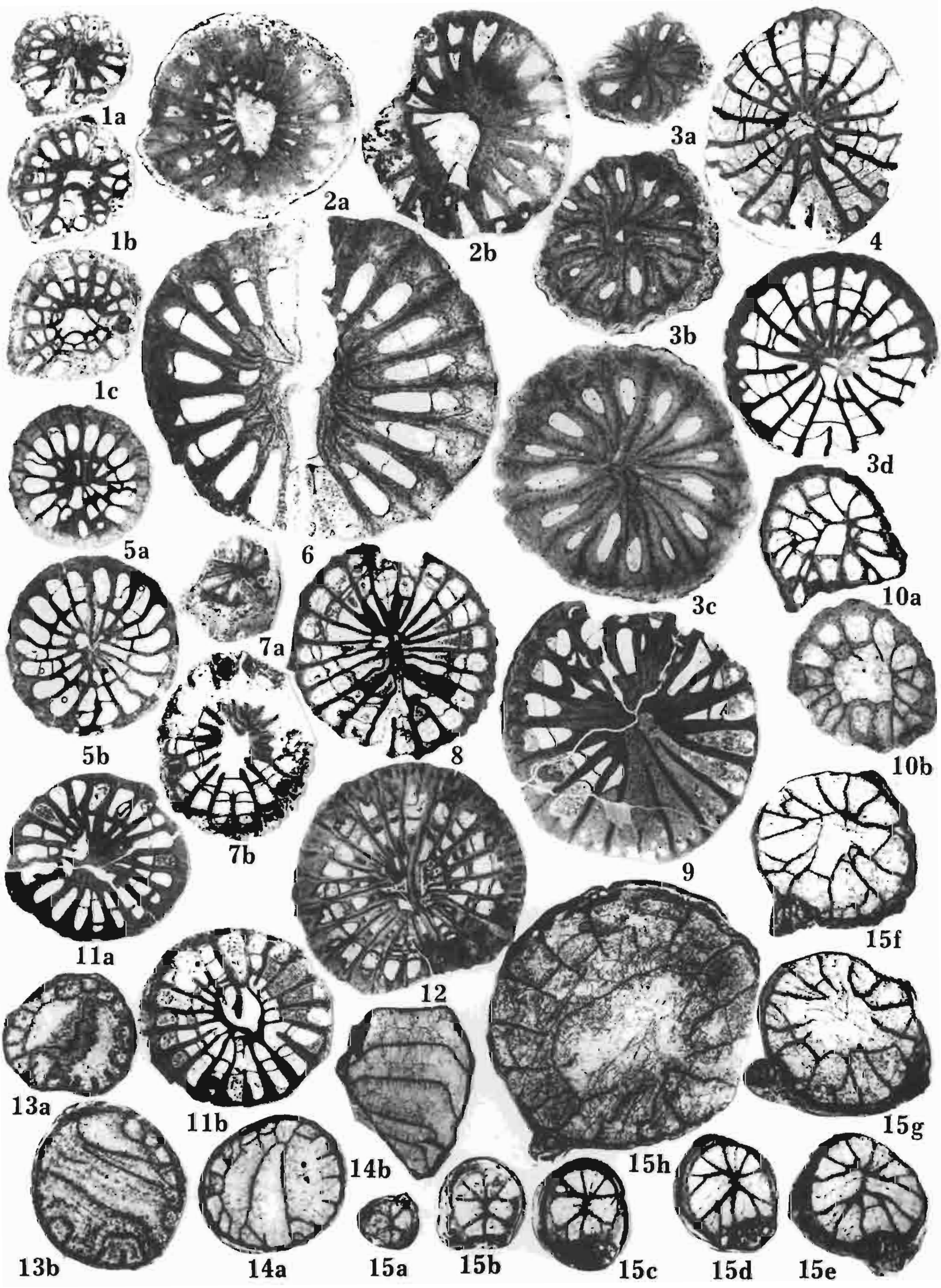
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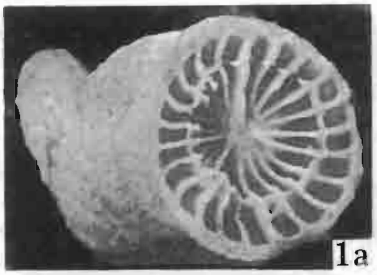
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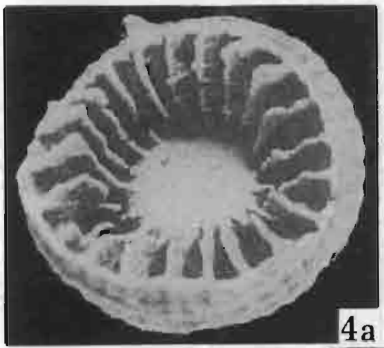
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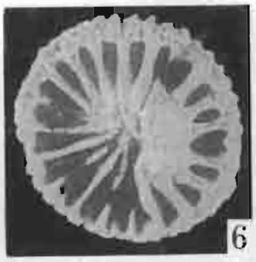
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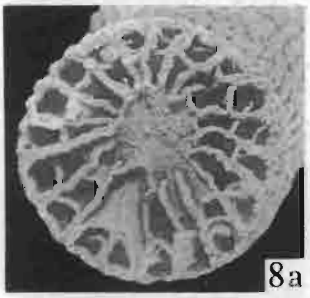
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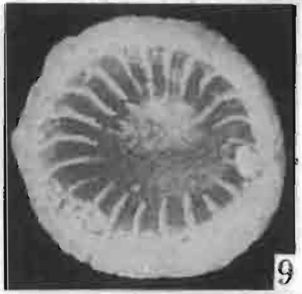
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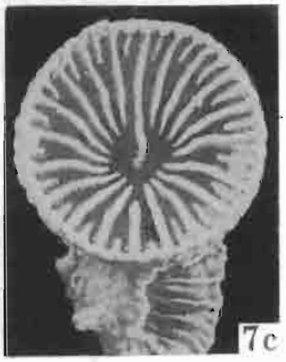
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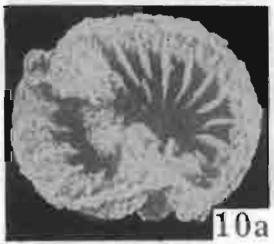
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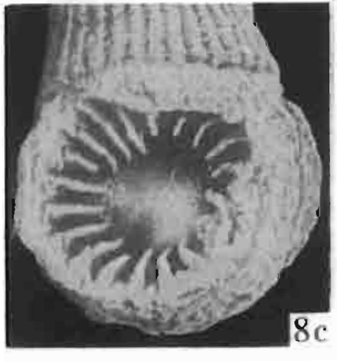
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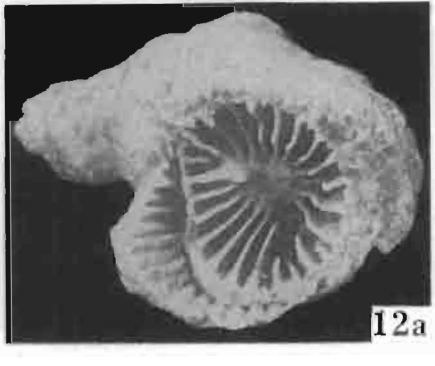
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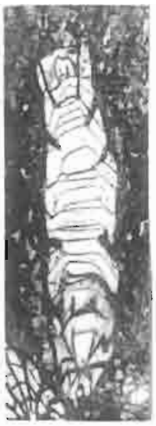
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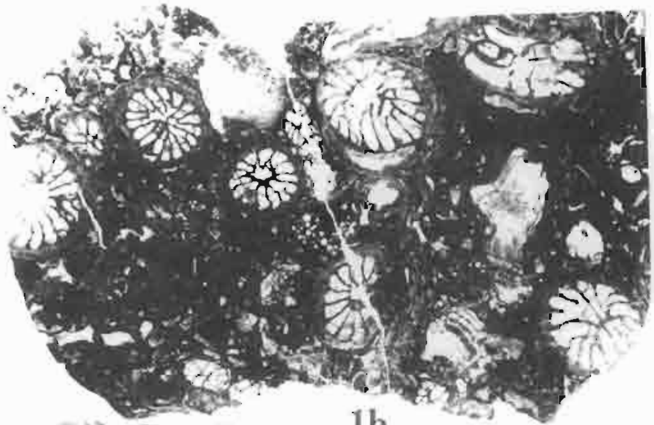
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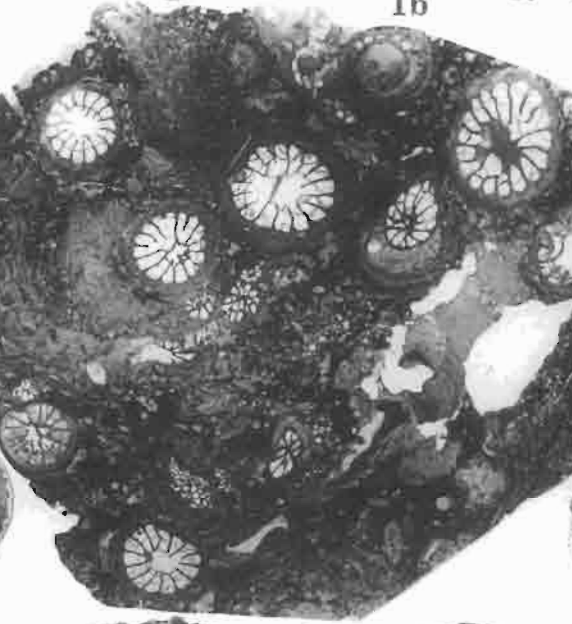
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5a


5b


5c


5d


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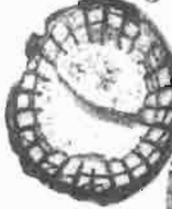
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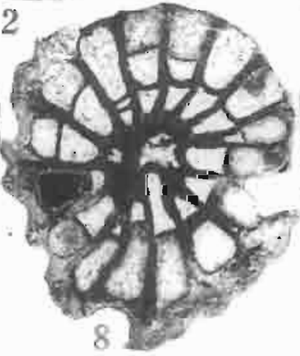
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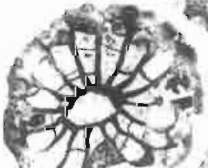
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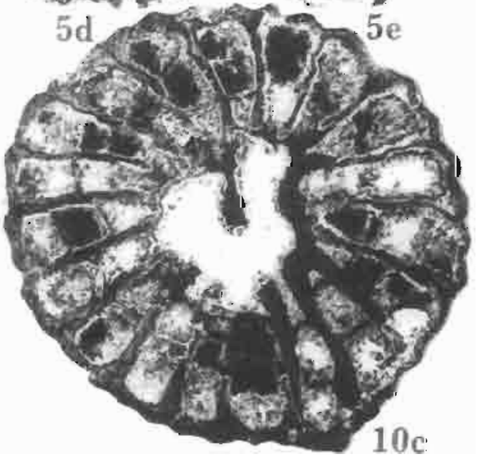
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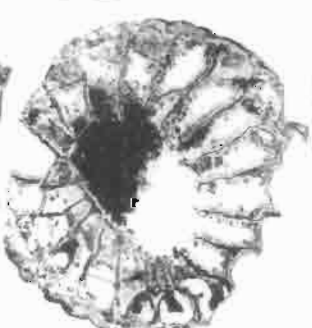
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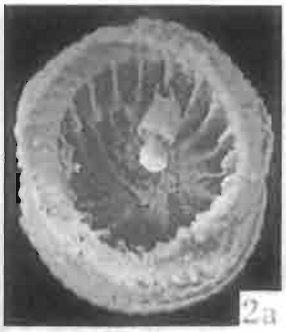
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8a


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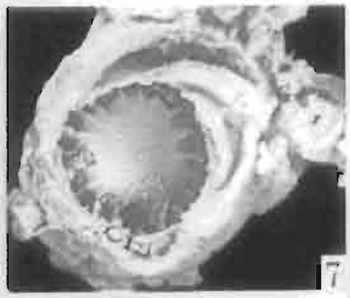
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9a


6b


13a


13b


9b


10b


11


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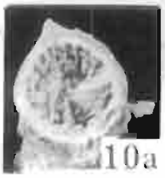
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15a


15b


16

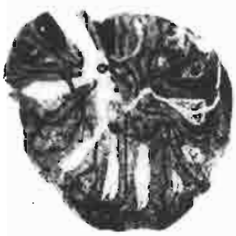

17a


17b


18


19

J. FEDOROWSKI: UPPER PALAEOZOIC RUGOSE CORALS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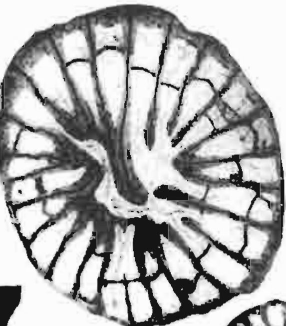
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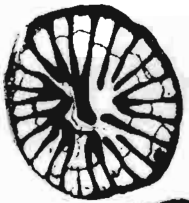
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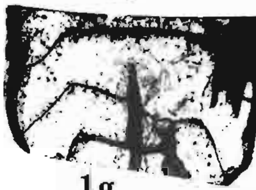
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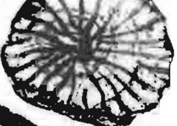
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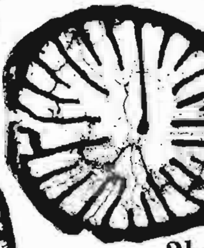
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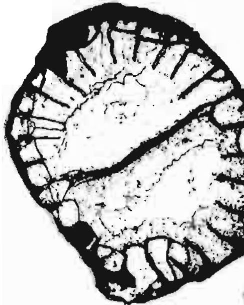
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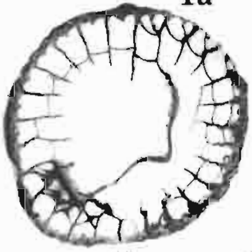
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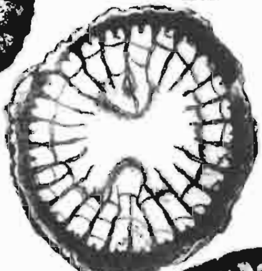
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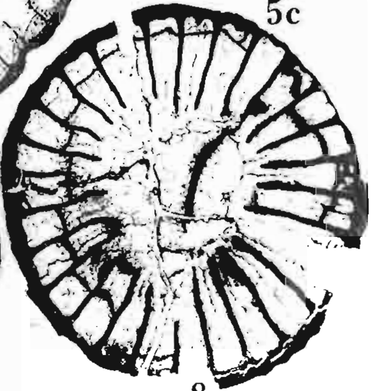
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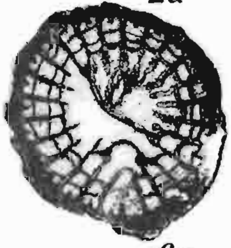
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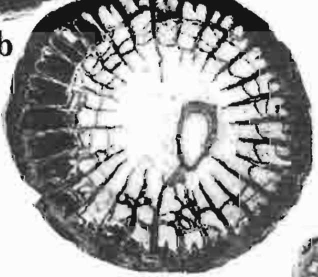
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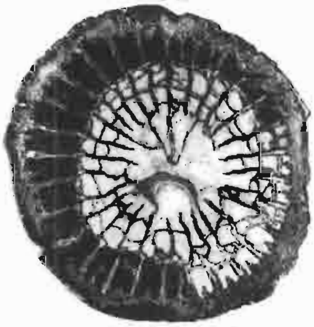
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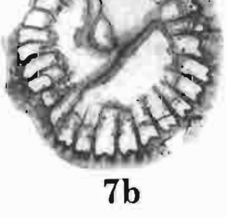
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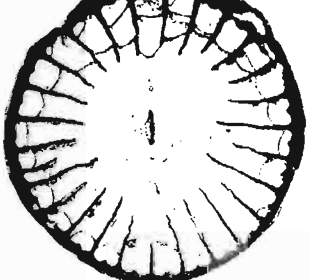
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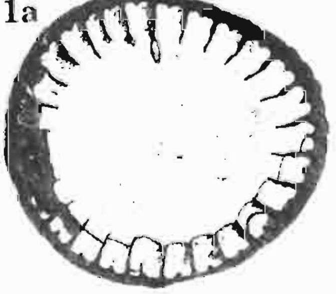
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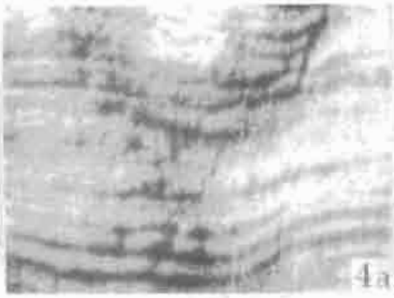
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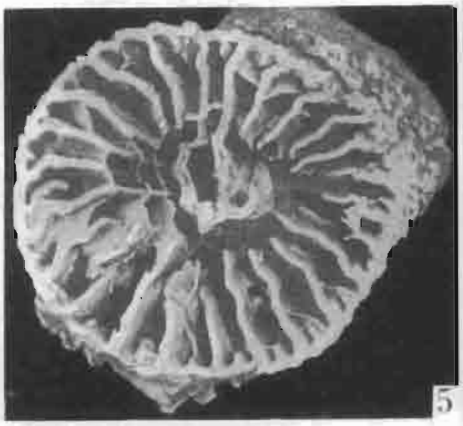
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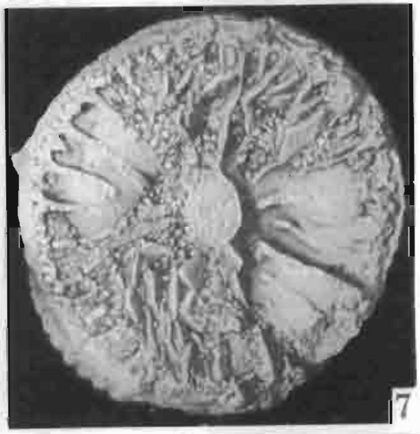
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12a


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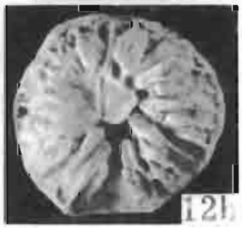
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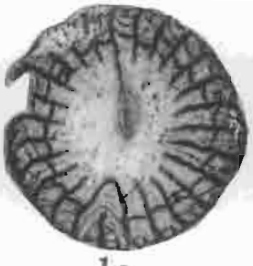
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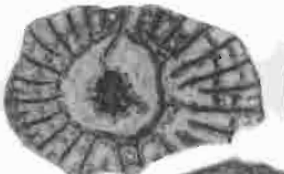
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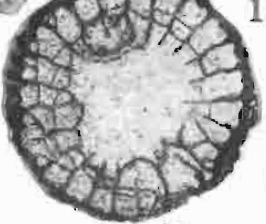
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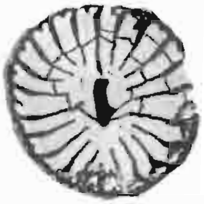
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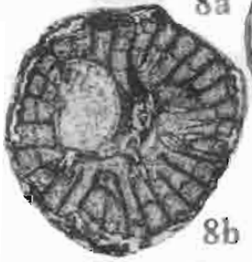
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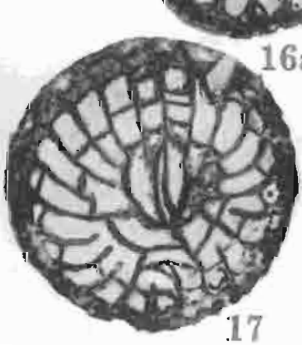
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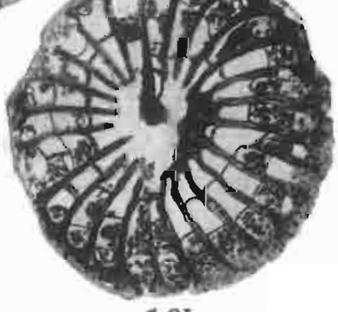
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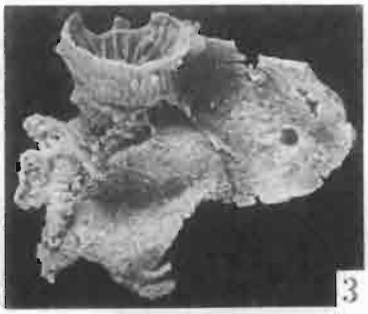
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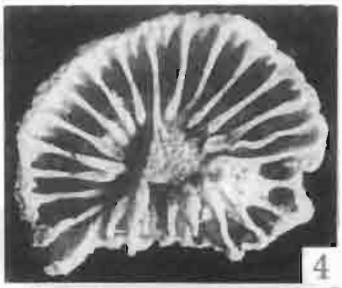
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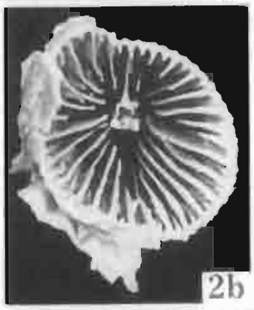
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6b


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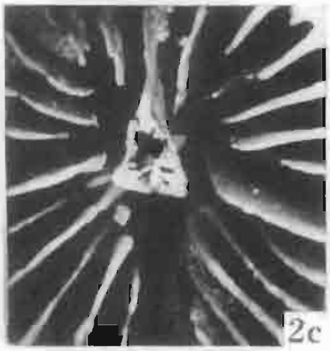
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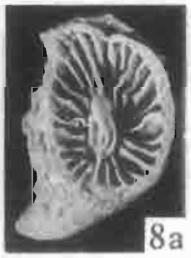
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7b


12b


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11b


12a


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17a


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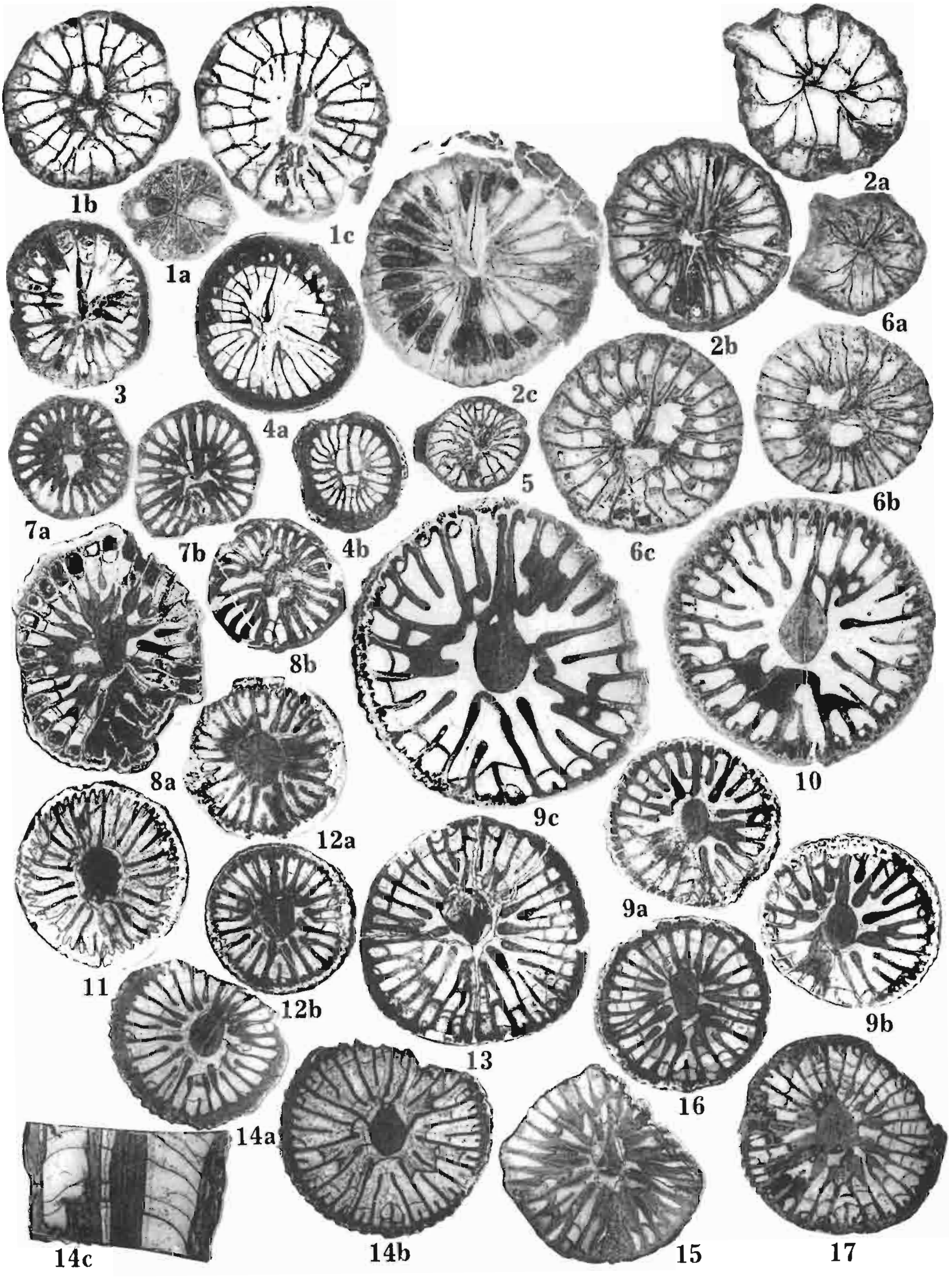
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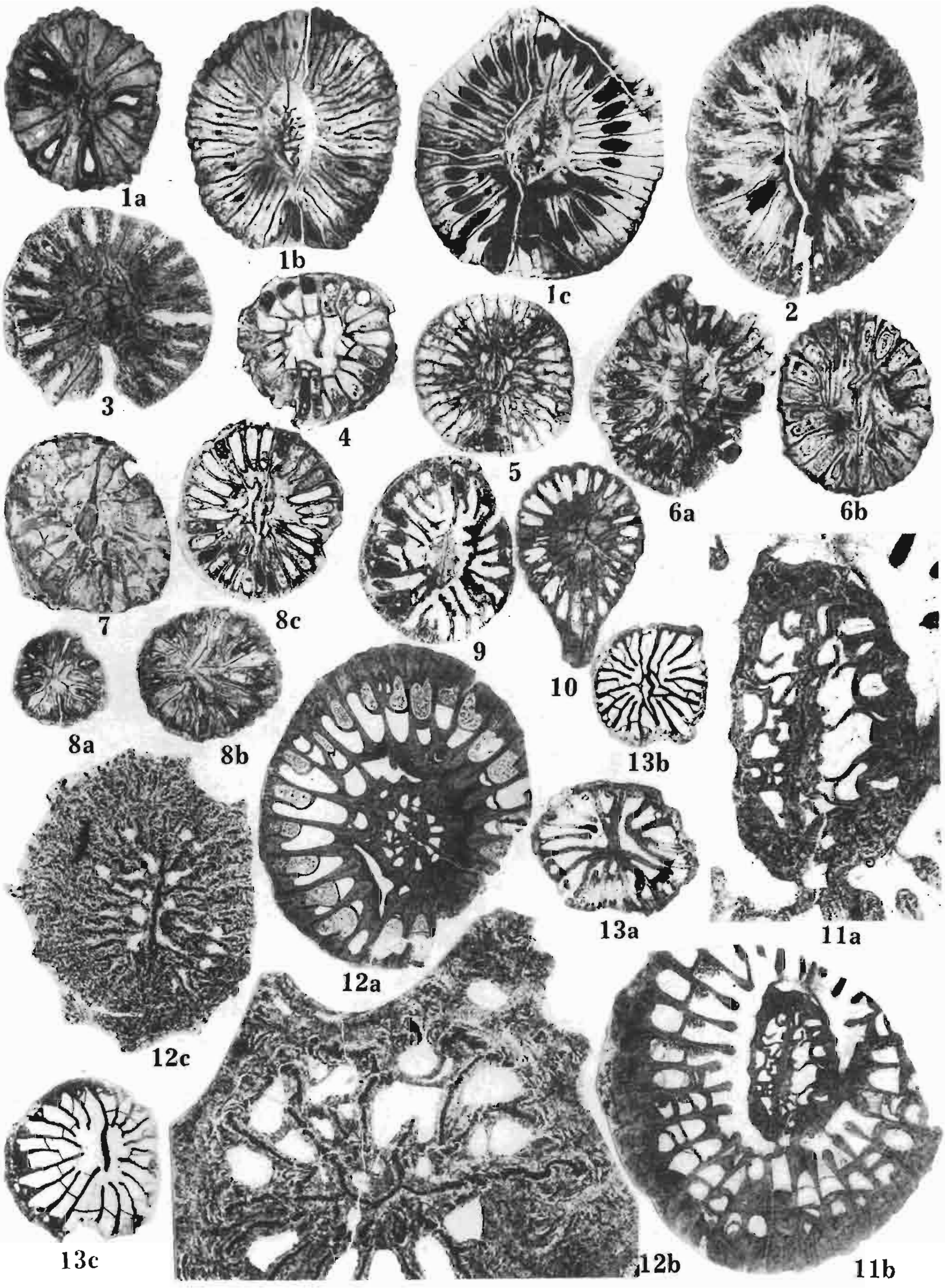
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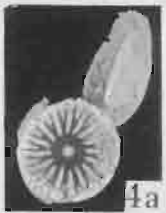
13c
12b
11b


1


2


3a


3b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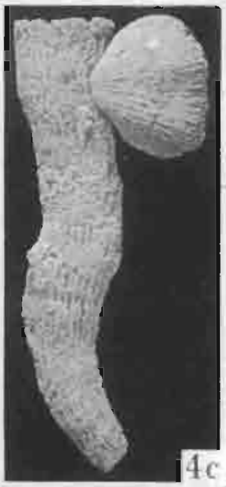
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7a


7b


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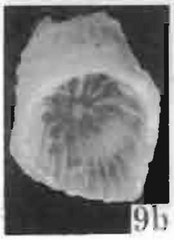
9a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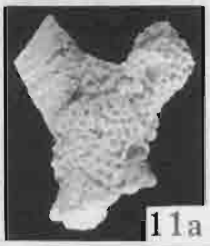
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11b

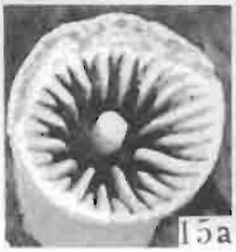

12a


12b


13


14a


14b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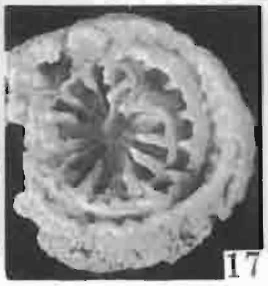
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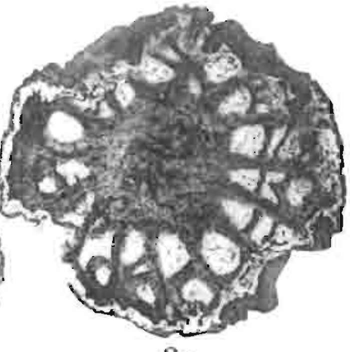
18a


18b


1a


1b


2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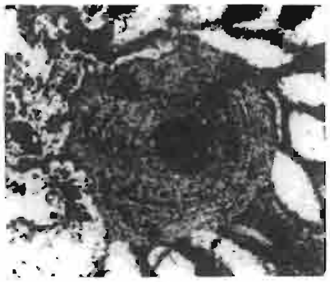
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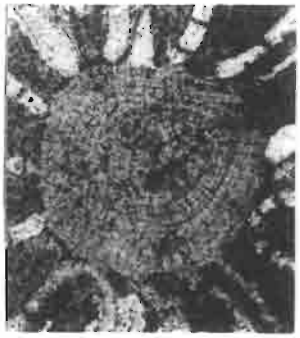
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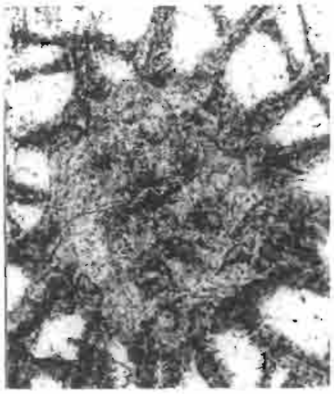
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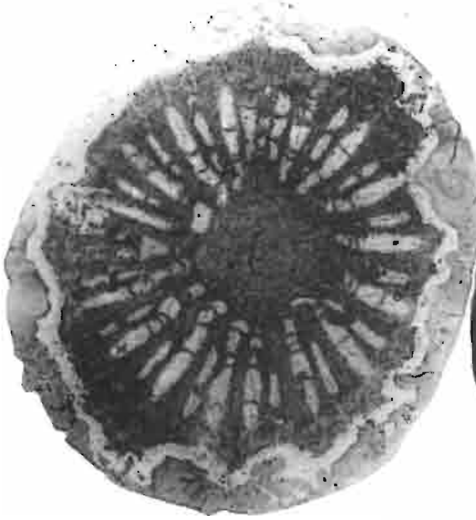
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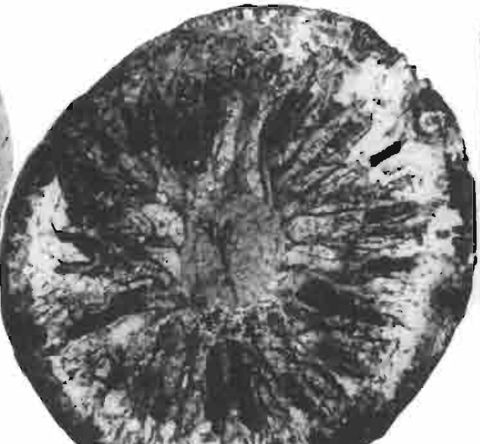
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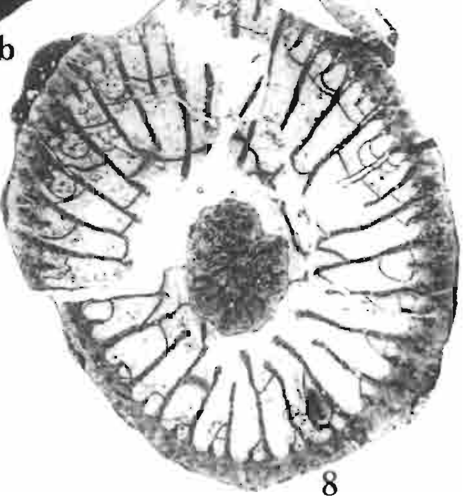
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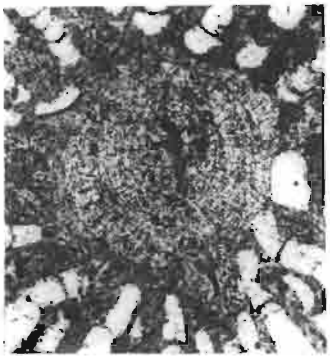
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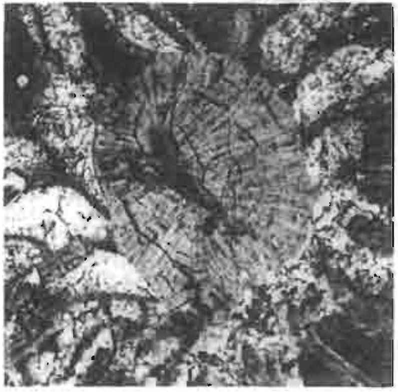
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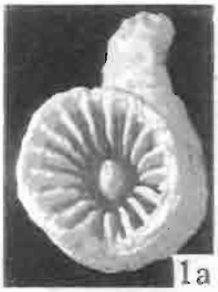
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1b


2a


2b


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4


5a


5b


6a

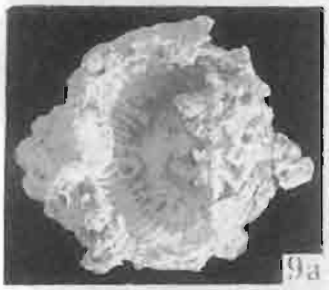

6b


7a


7b


8a


8b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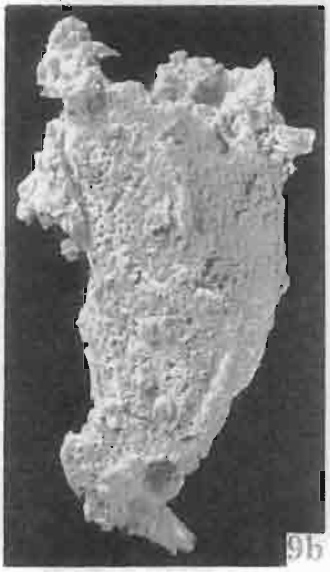
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11


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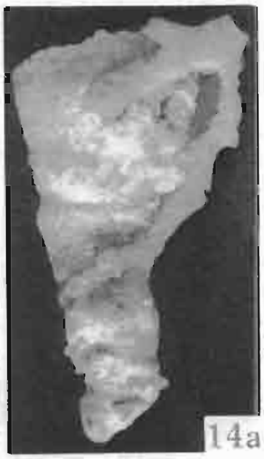
13a


13b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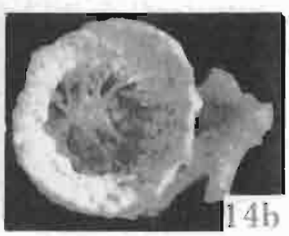
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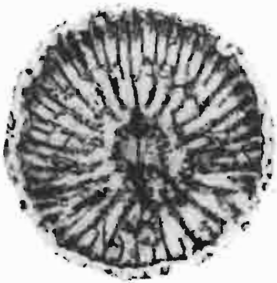
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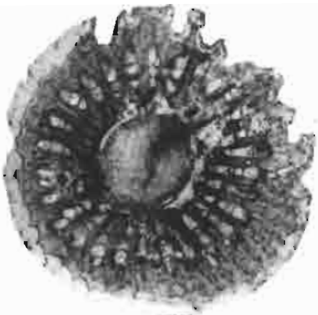
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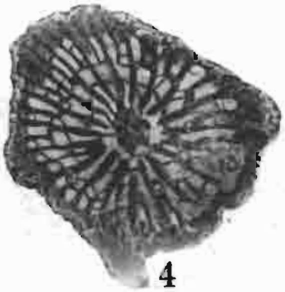
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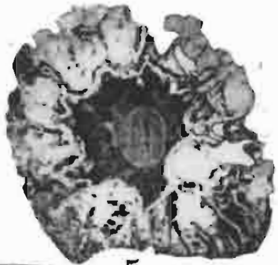
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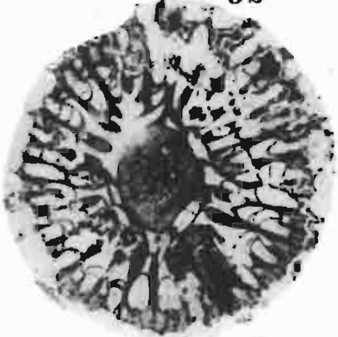
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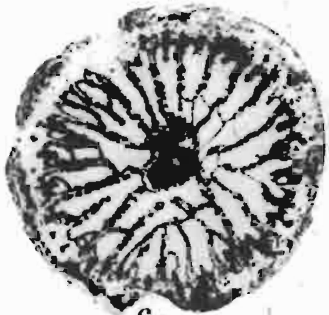
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6b


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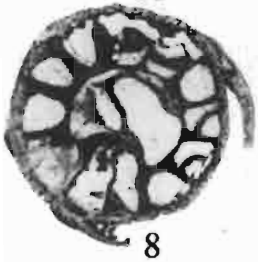
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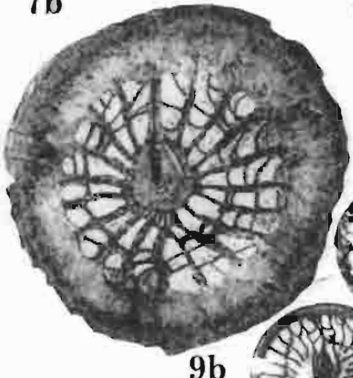
7a


7b


5e


9a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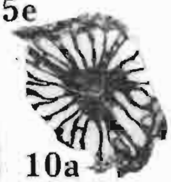
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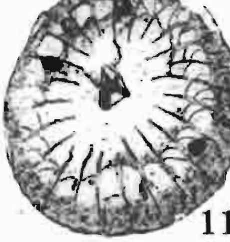
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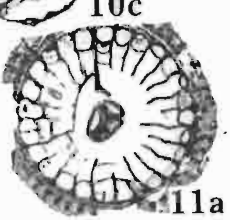
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1


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3a

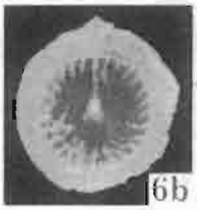

4


5


6a


3b


7b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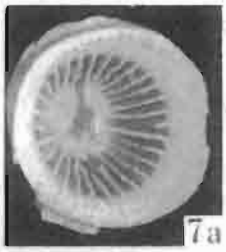
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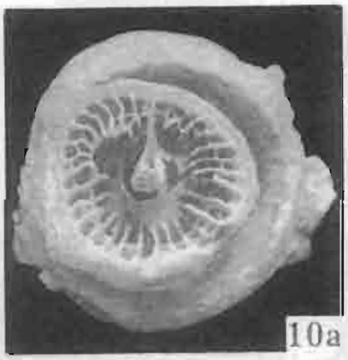
9b


8


9a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10b


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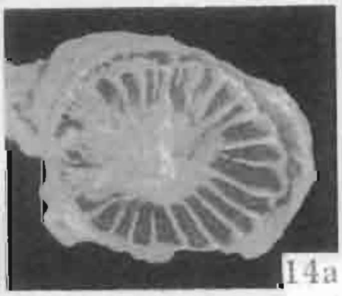
12a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13


14b


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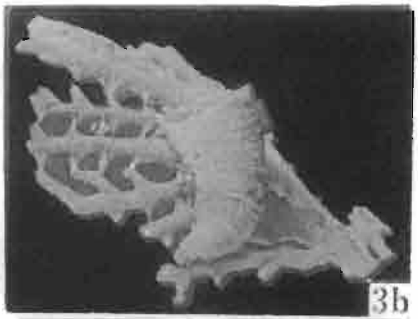
2a


2b


3a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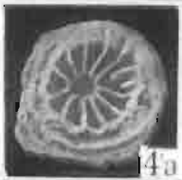
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4b


5a


5b


5c


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8b


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9b


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10b


11


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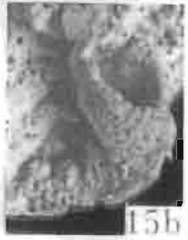
13a


13b


14


15a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16a


16b


17a


17b

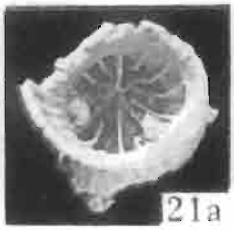

18


19a


19b


20a


20b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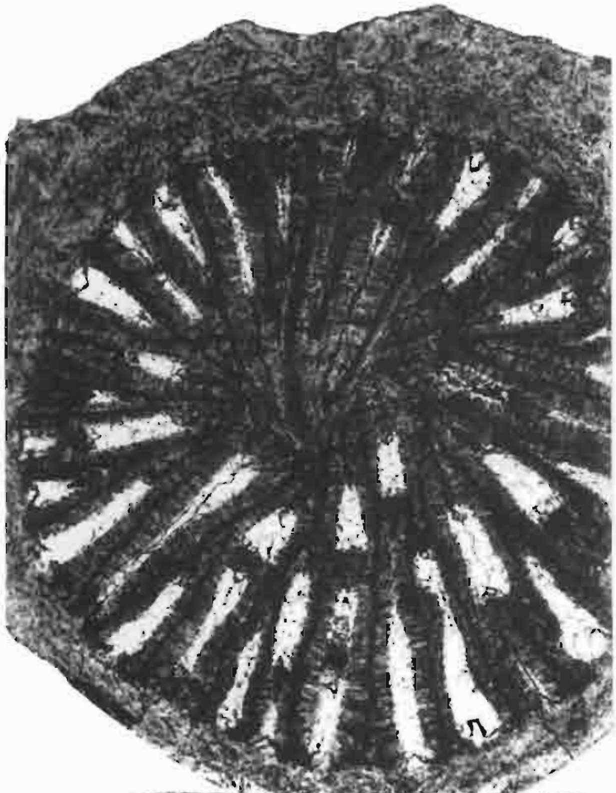

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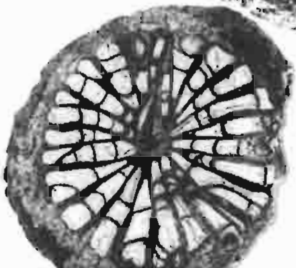

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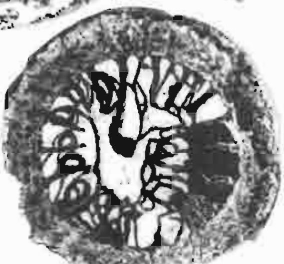

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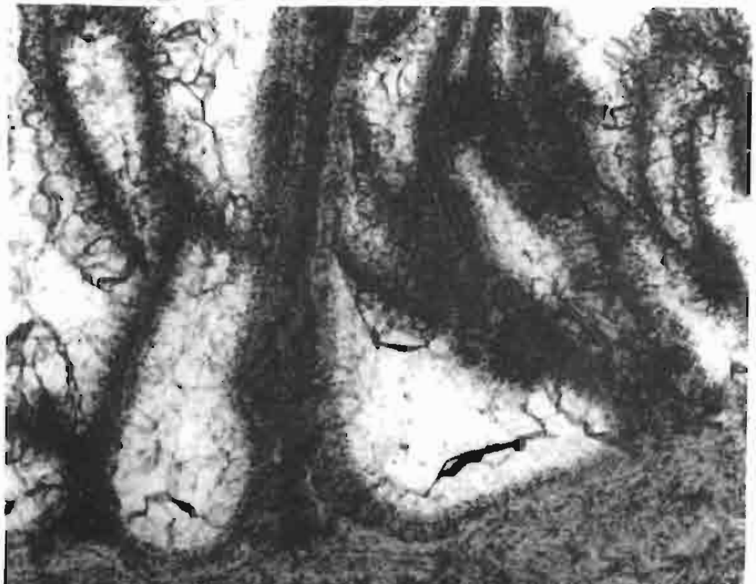

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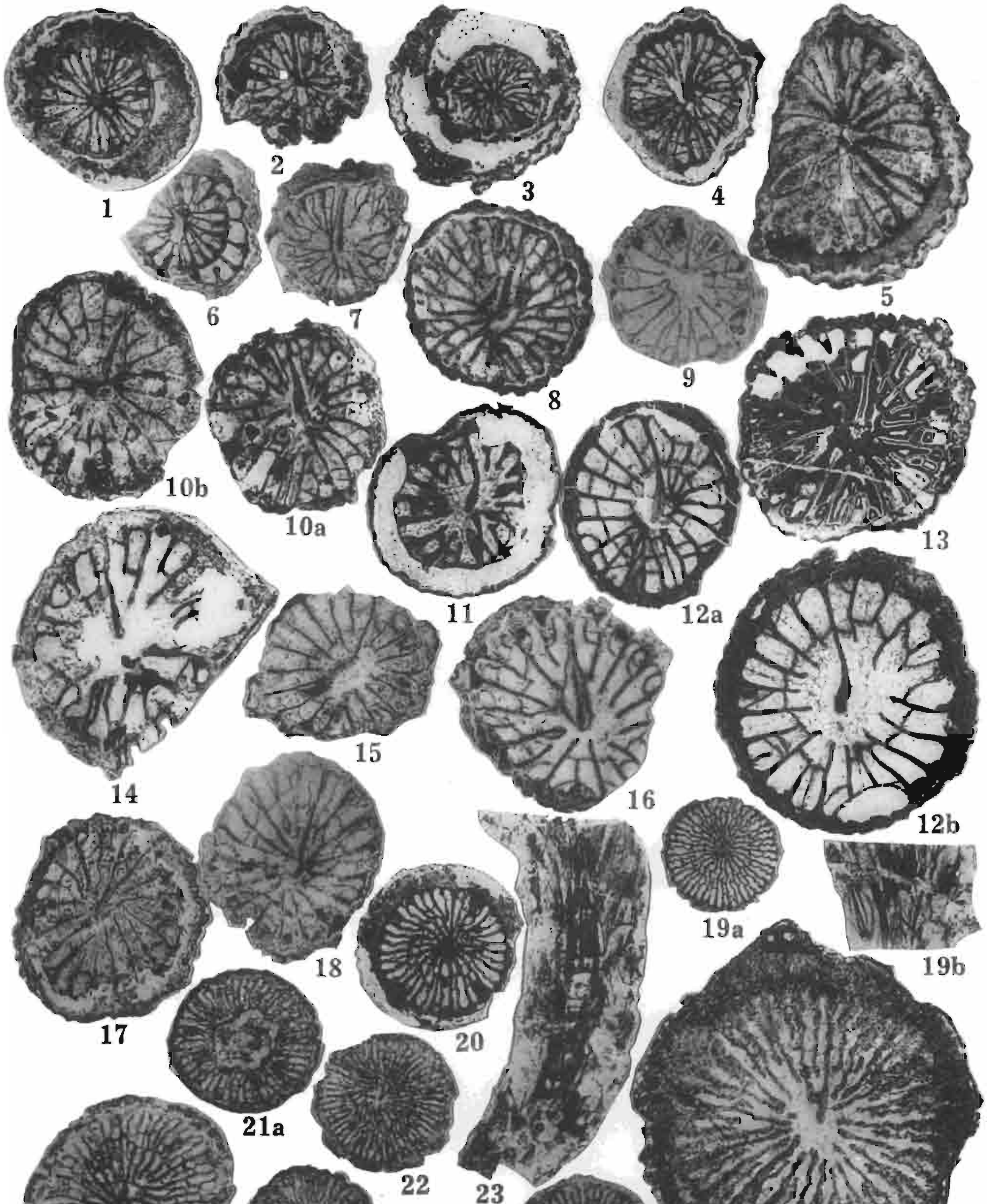
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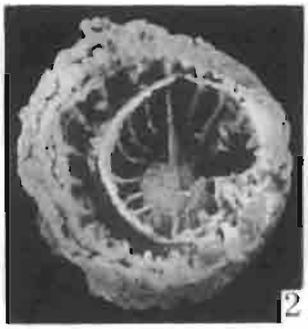
26


1a


1b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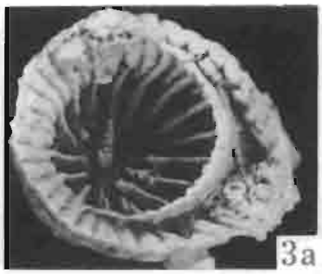
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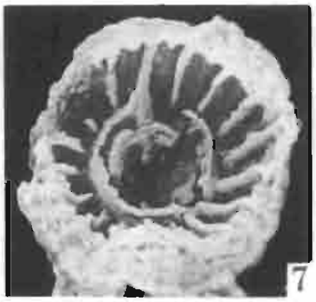
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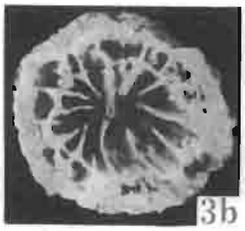
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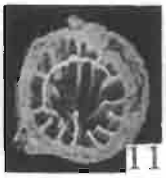
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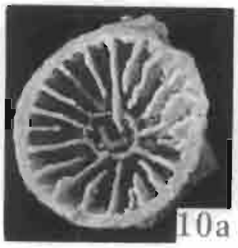
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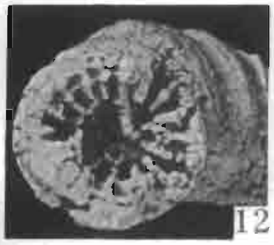
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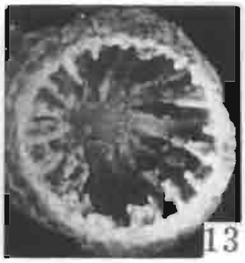
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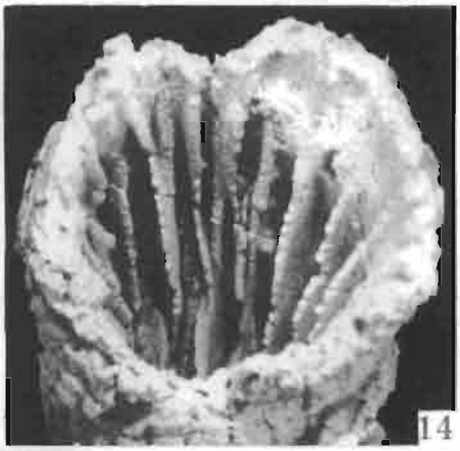
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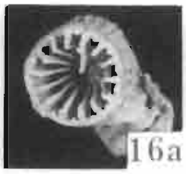
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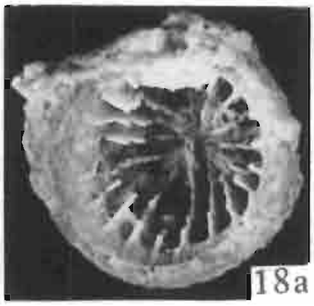
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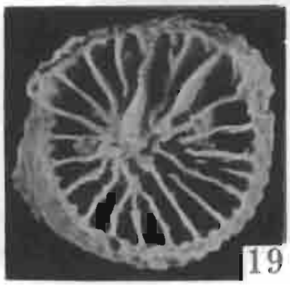
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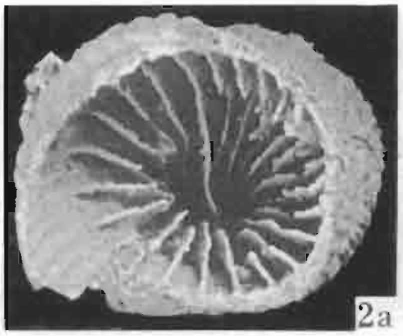
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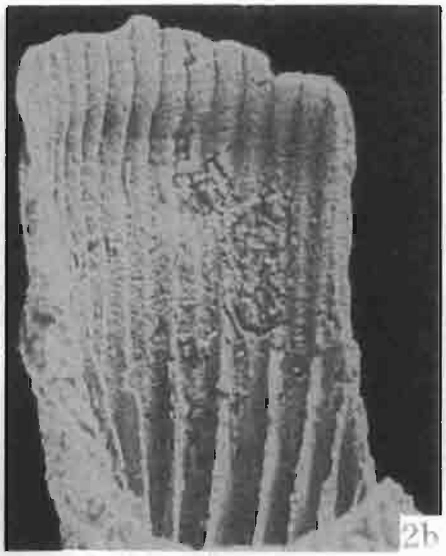
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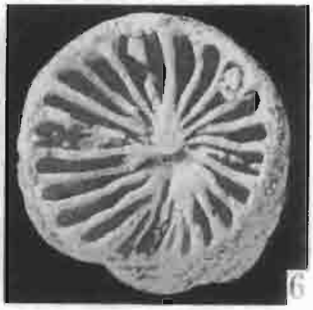
3


4a


4b


5a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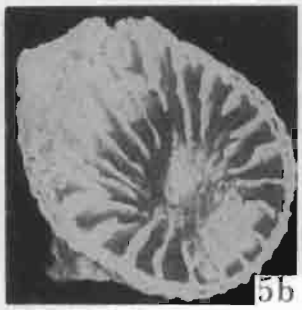

5b


7a

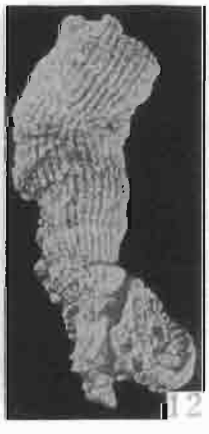

8a


8b


8c


9


11a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7b


10


13


14


11b


15

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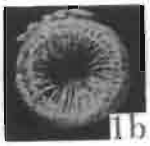

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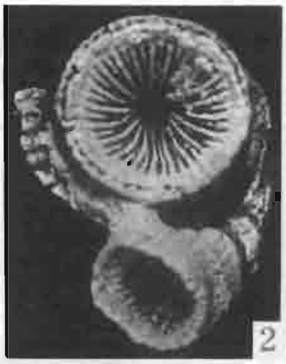

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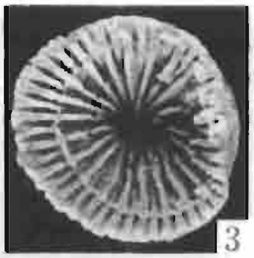

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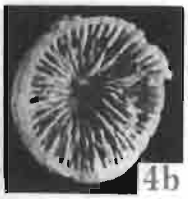

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5a

5b

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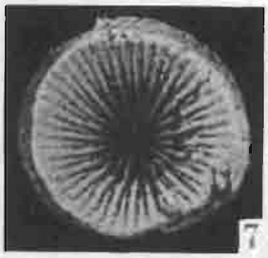

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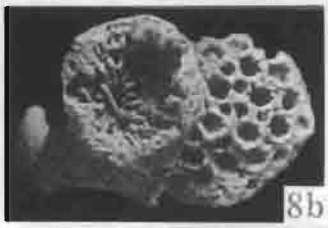

8b

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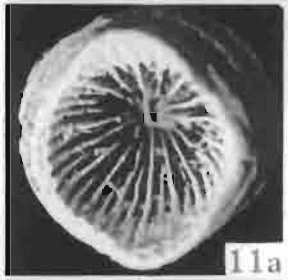

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11b

12

13a

13b

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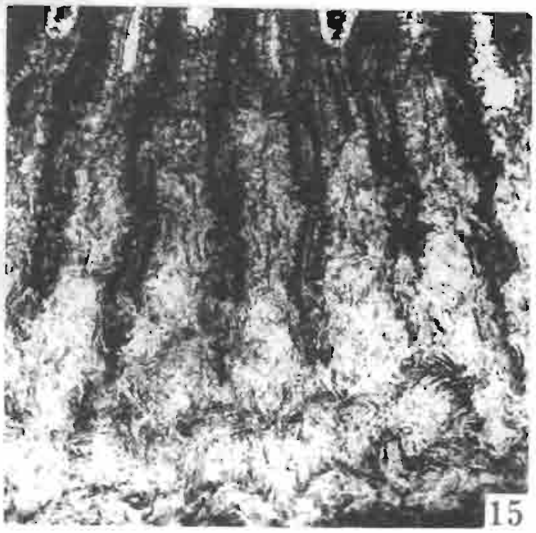

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17a

17b

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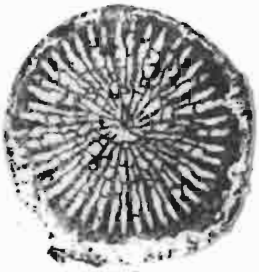

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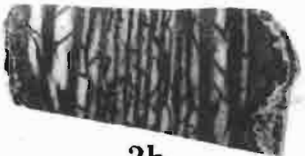

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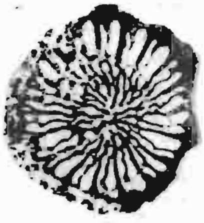

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3b

4a

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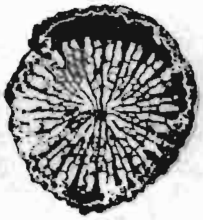

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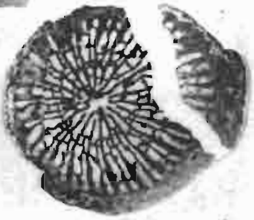

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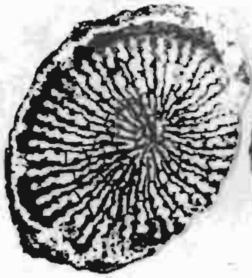

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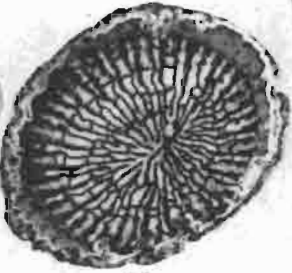

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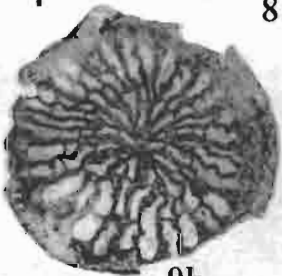

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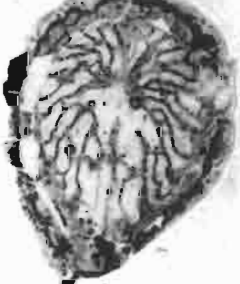

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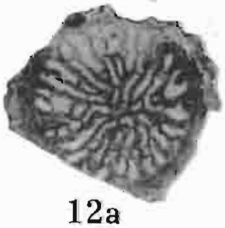

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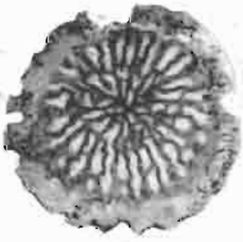

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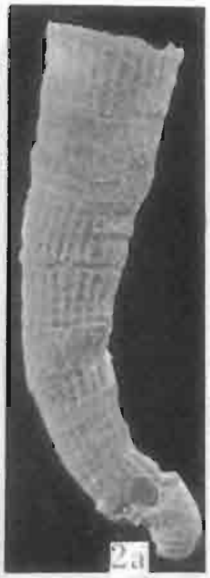
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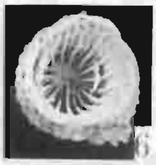
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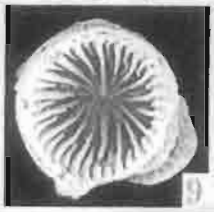
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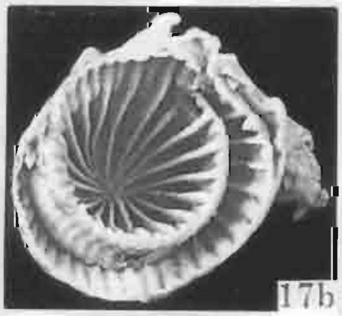
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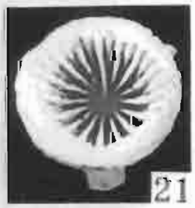
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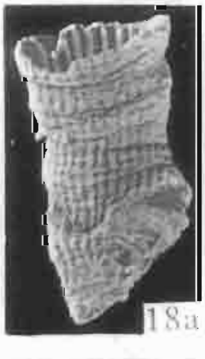
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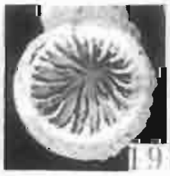
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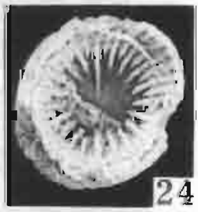
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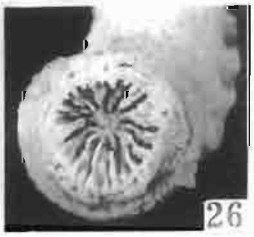
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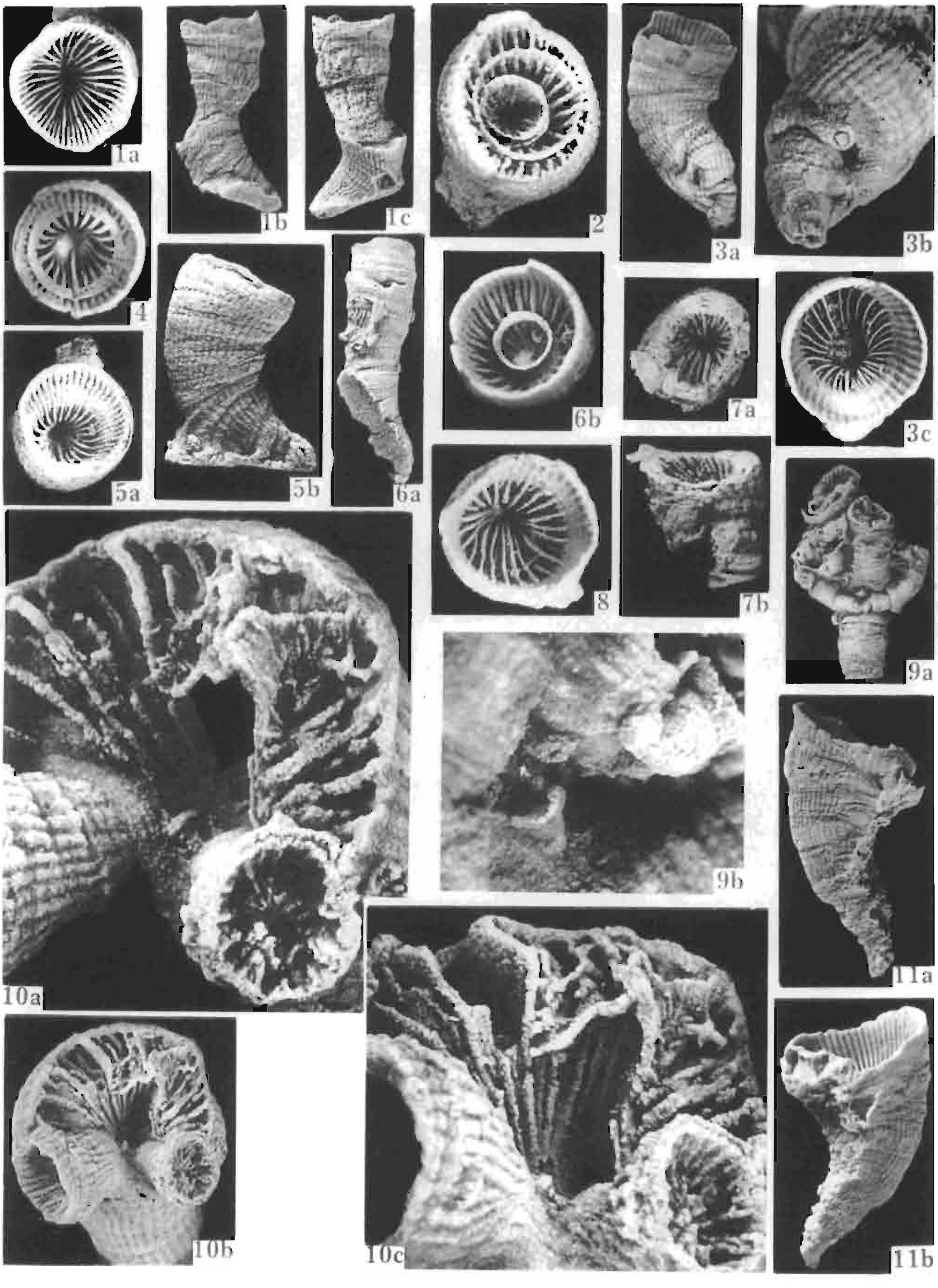
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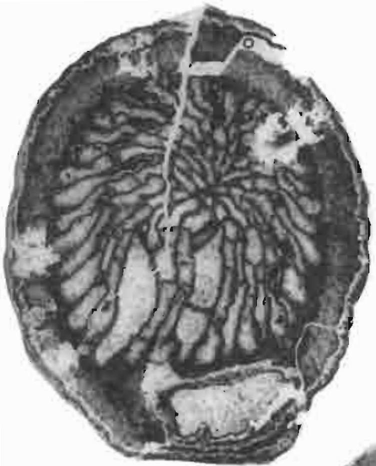
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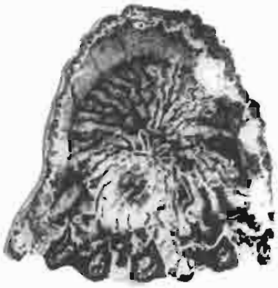
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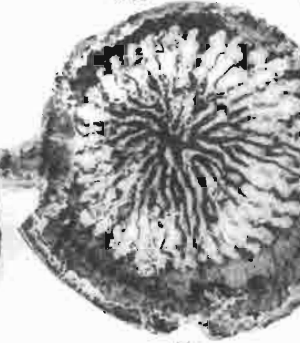
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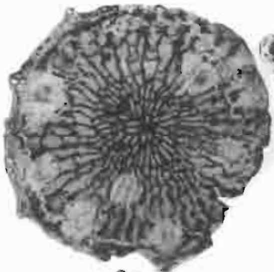
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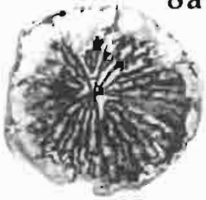
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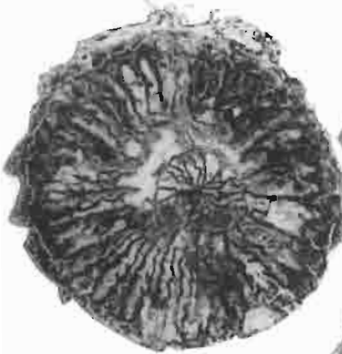
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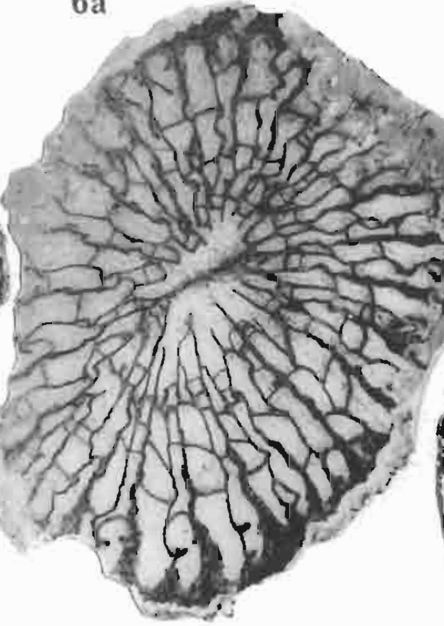
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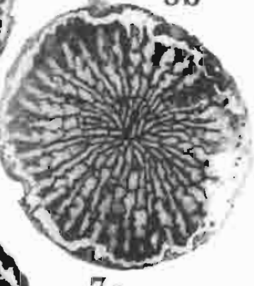
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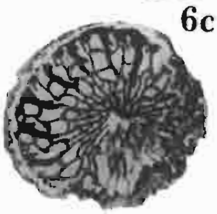
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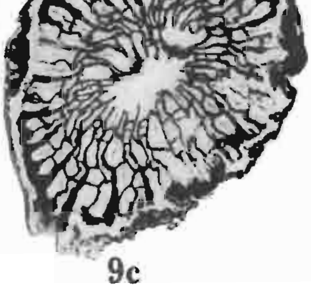
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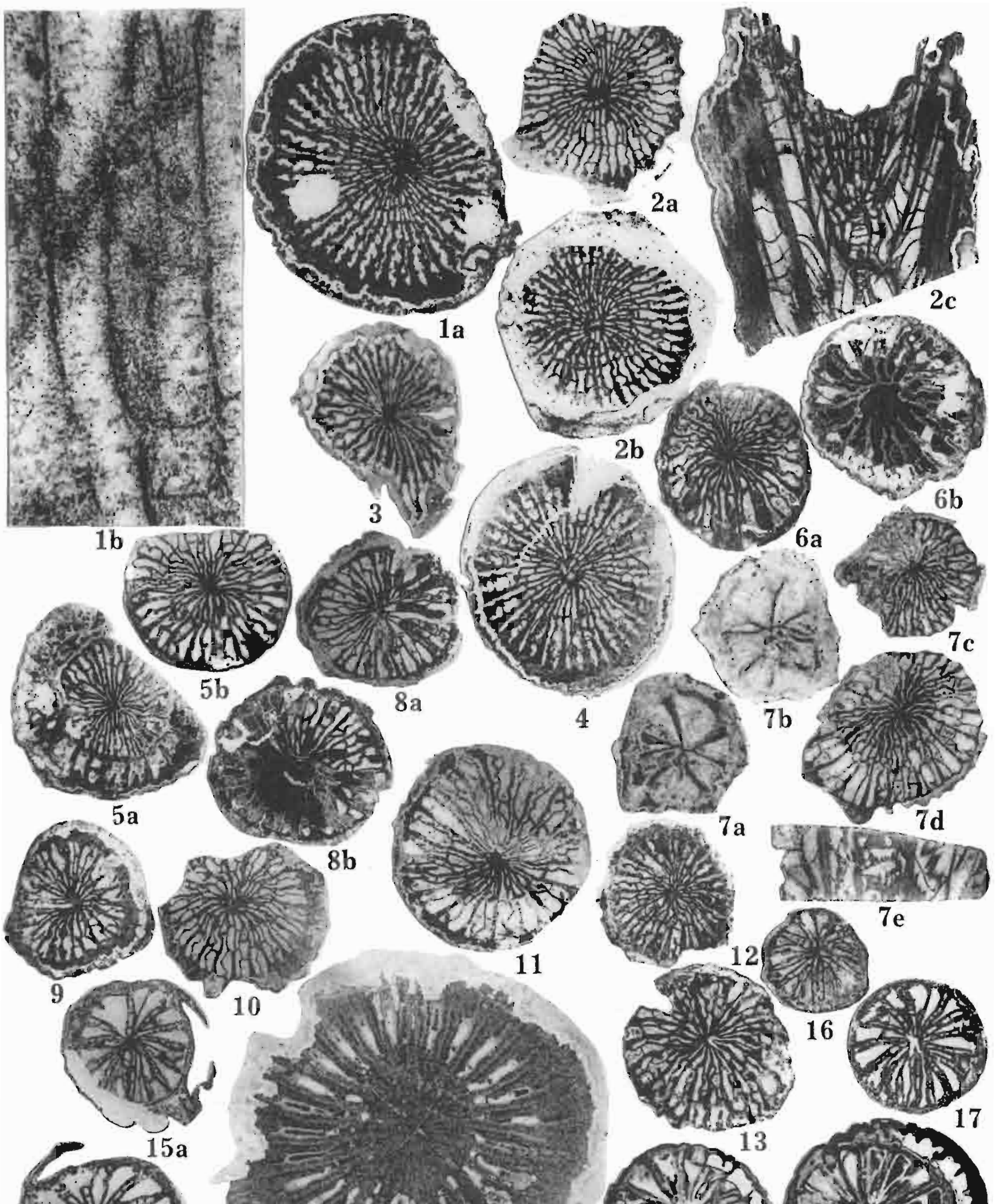
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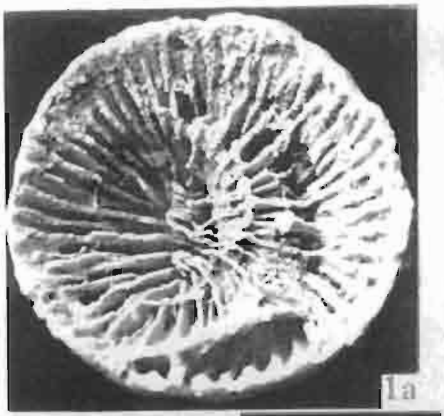
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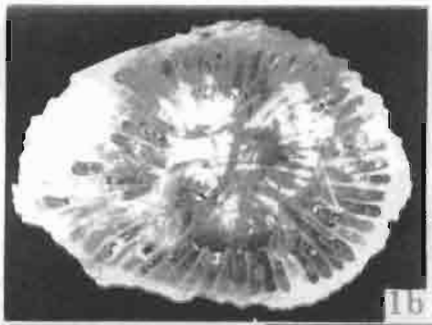
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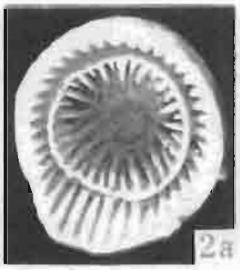
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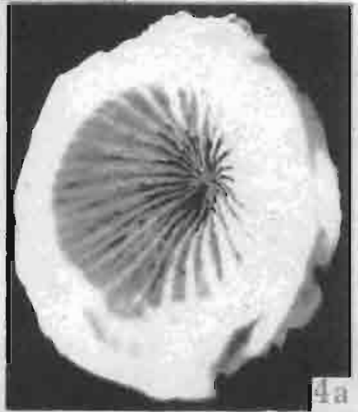
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3b


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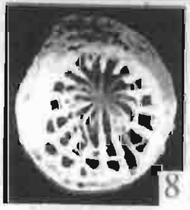
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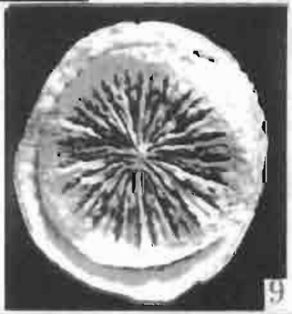
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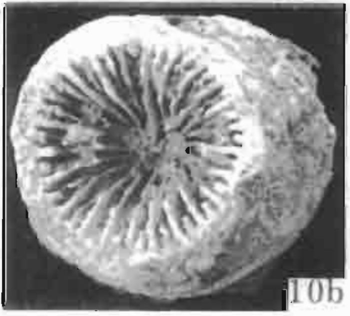
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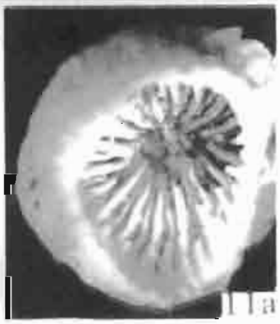
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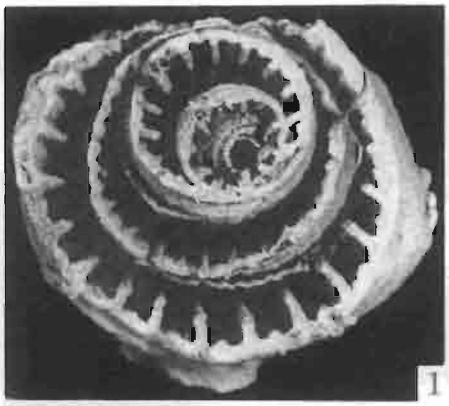
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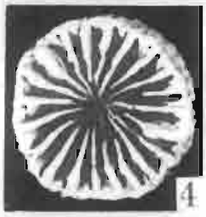
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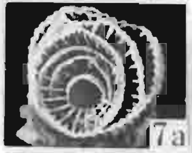
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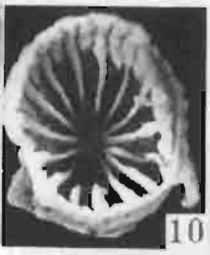
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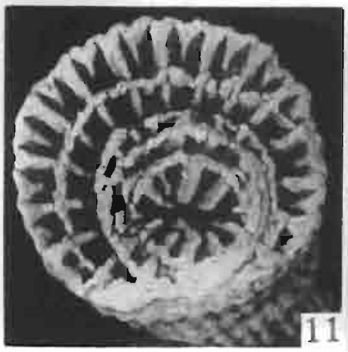
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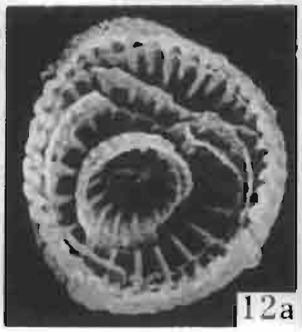
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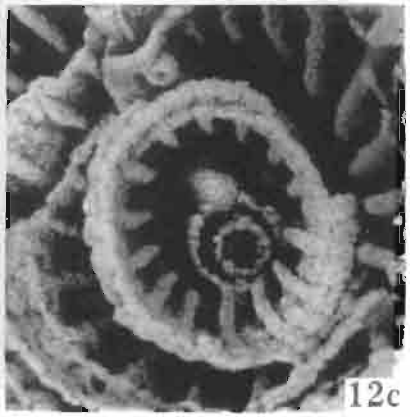
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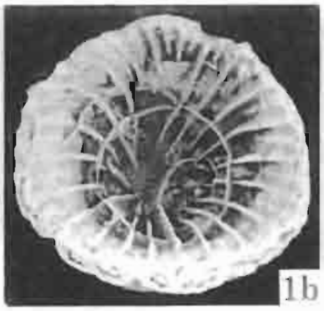
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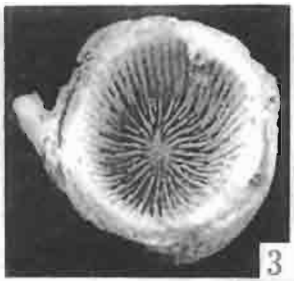
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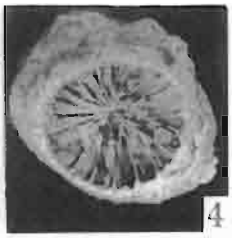
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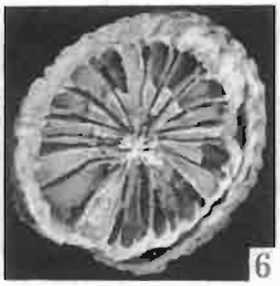
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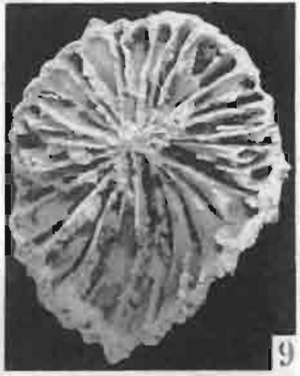
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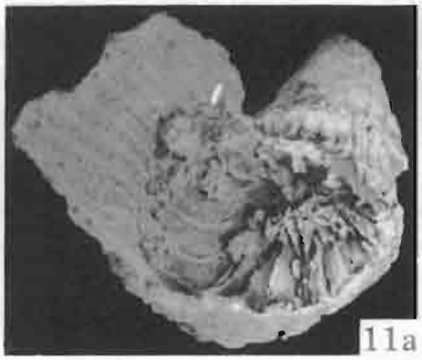
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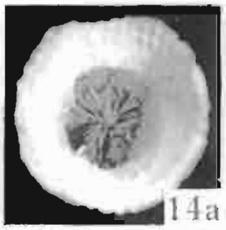
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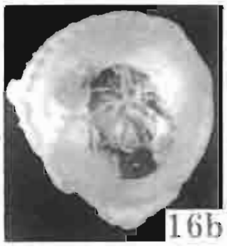
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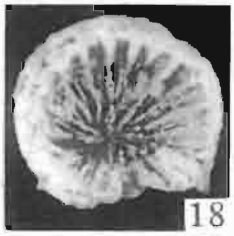
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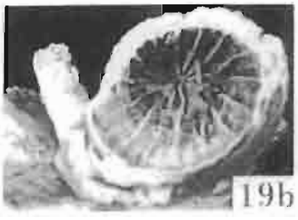
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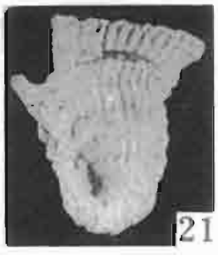
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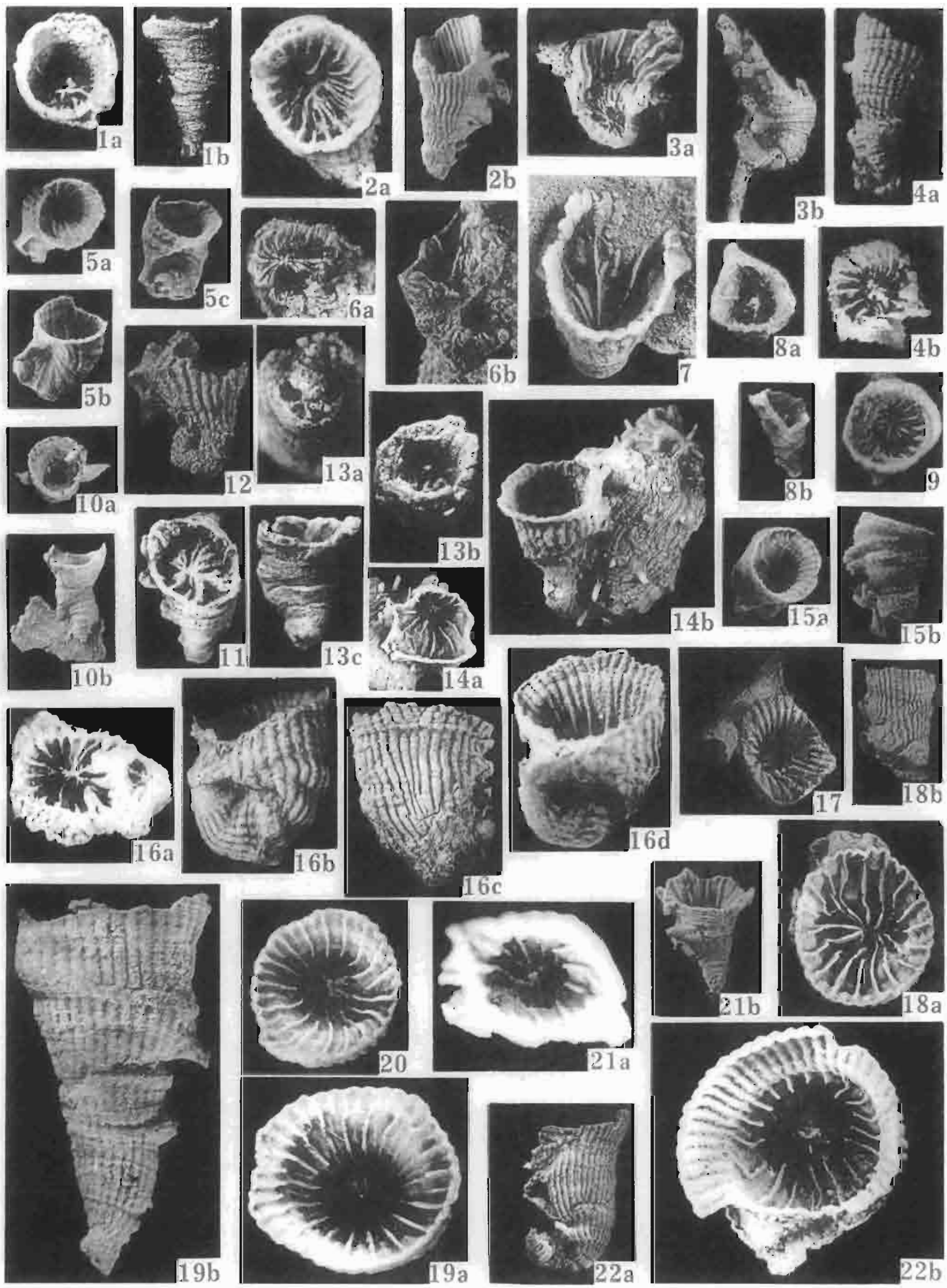
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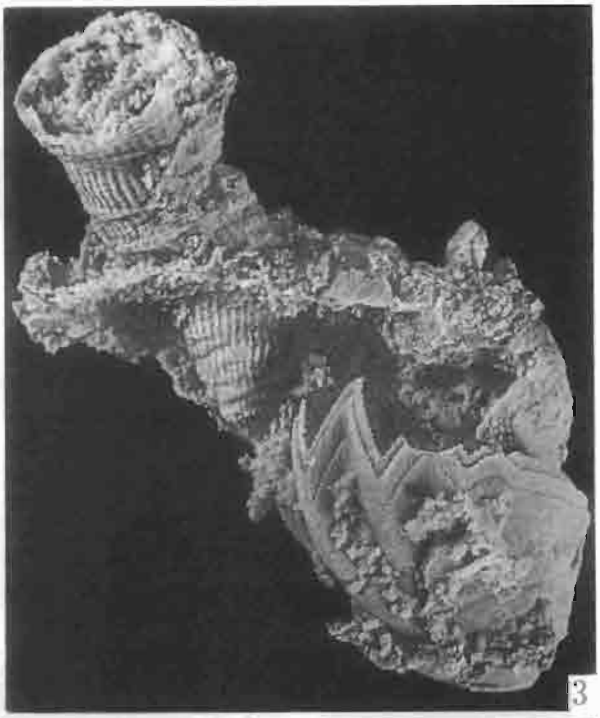
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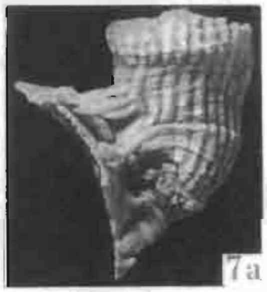
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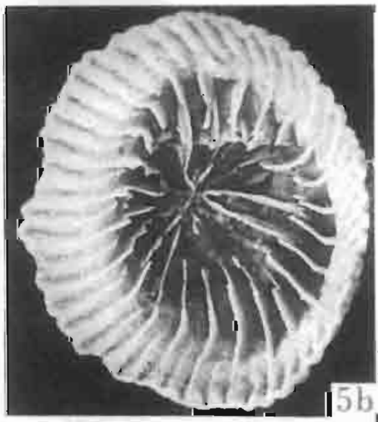
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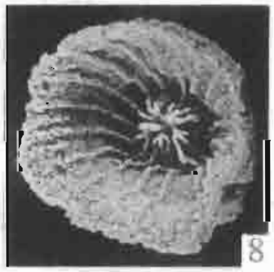
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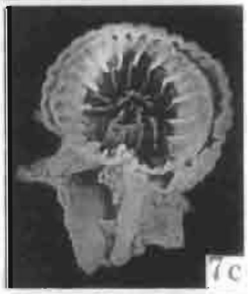
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9b


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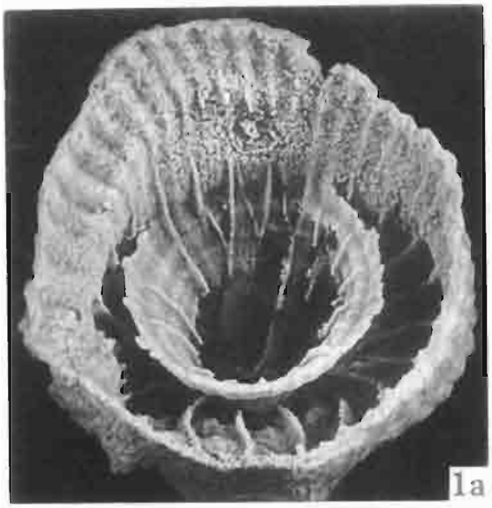
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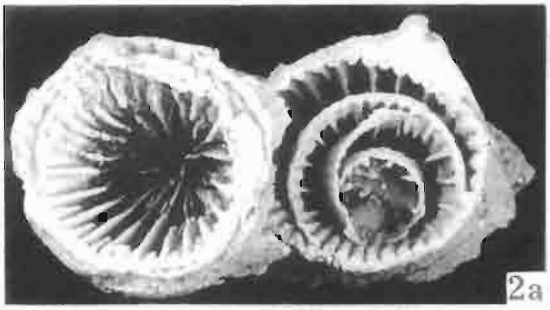
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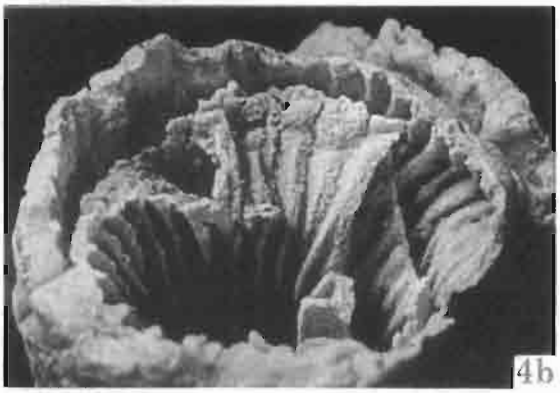
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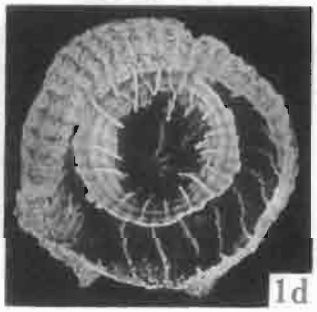
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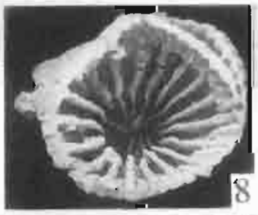
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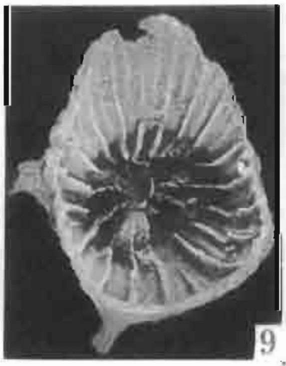
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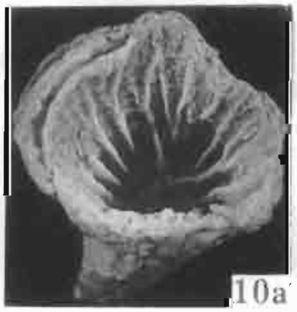
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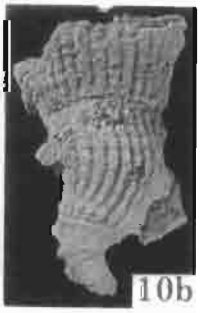
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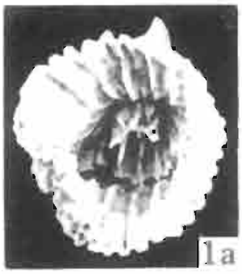
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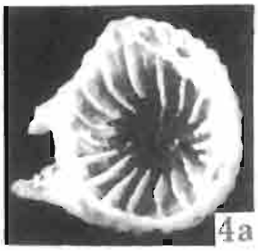
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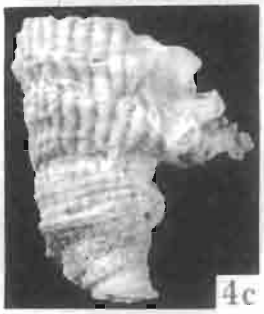
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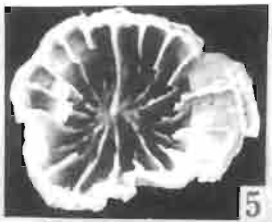
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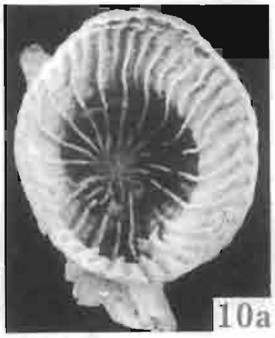
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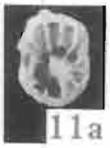
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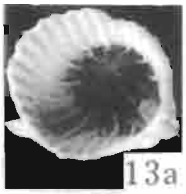
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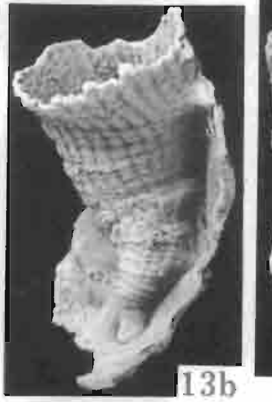
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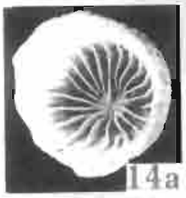
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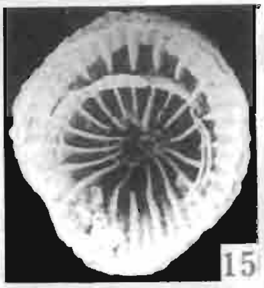
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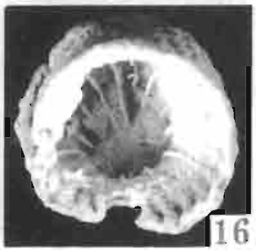
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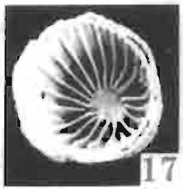
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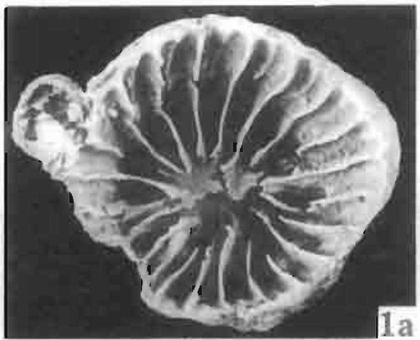
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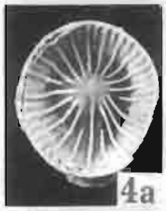
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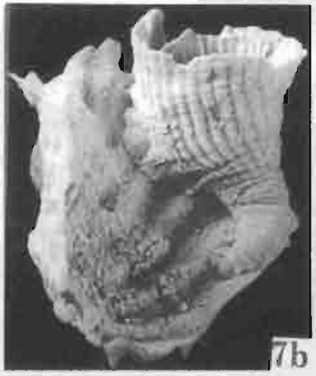
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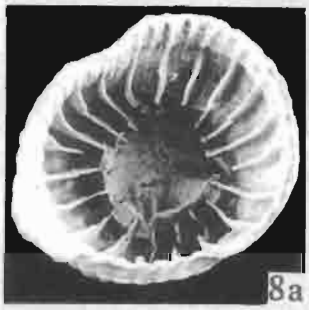
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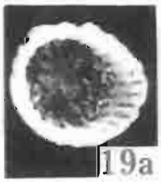
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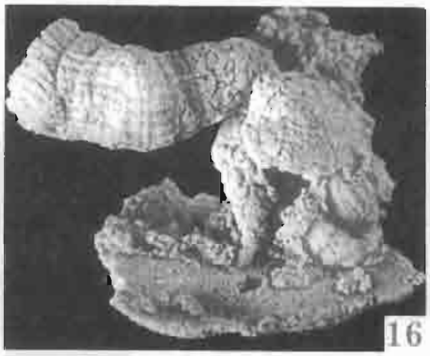
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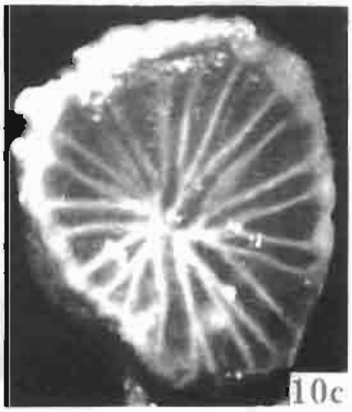
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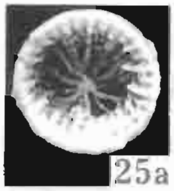
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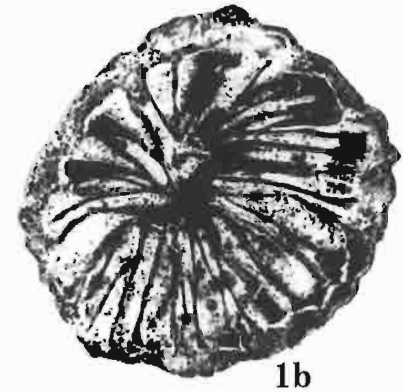
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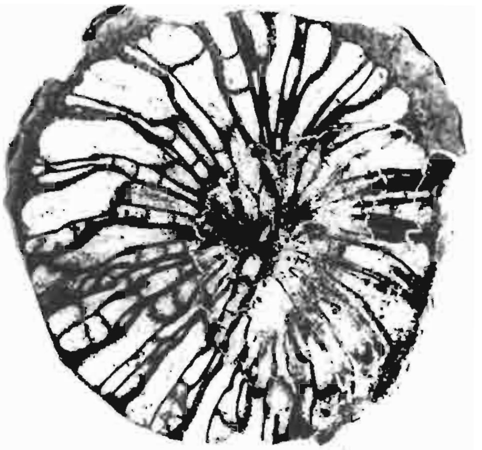
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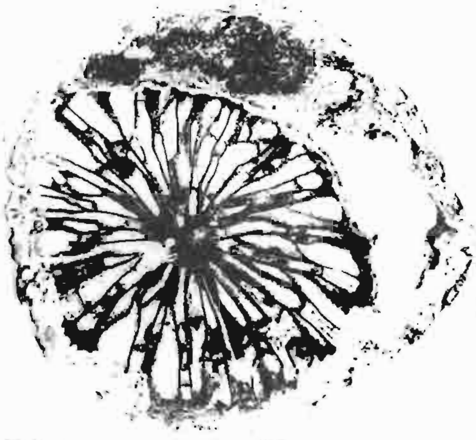
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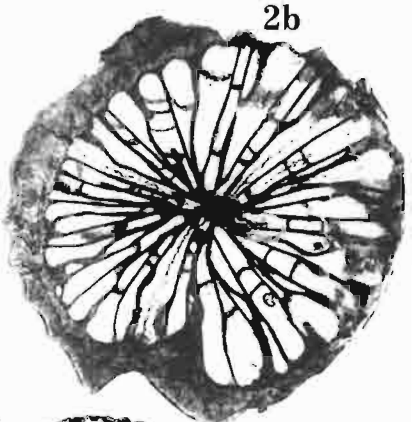
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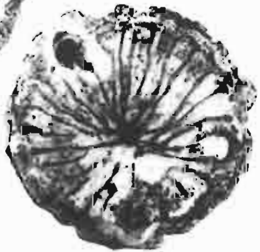
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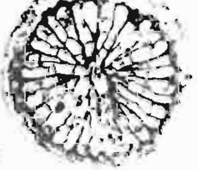
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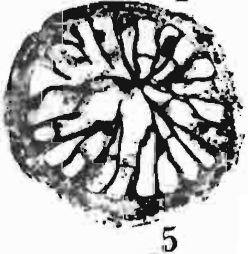
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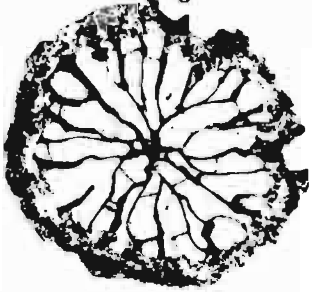
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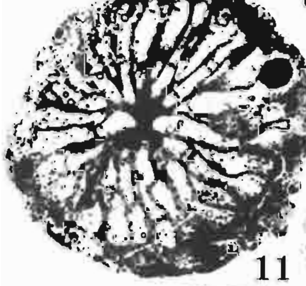
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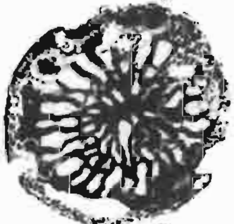
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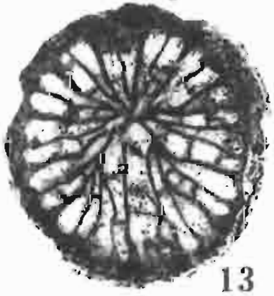
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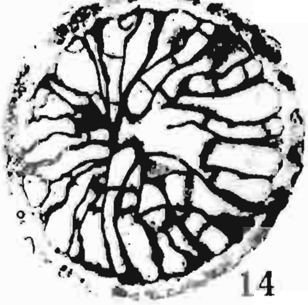
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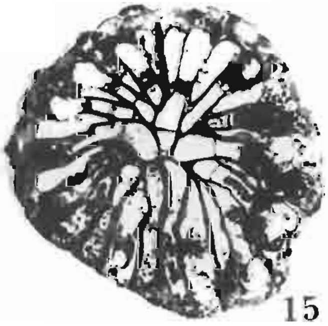
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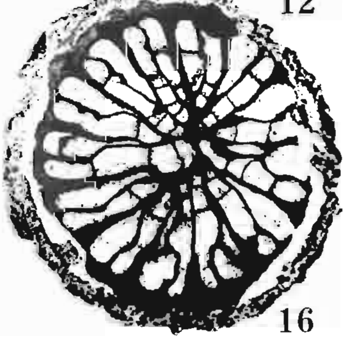
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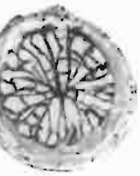
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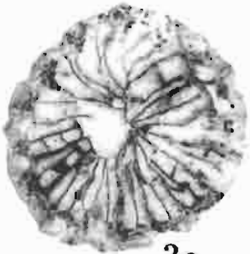
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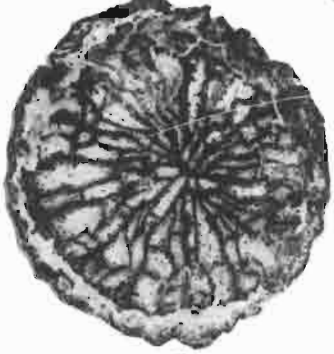
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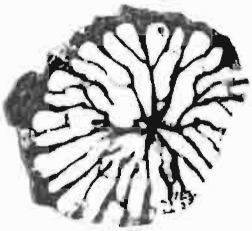
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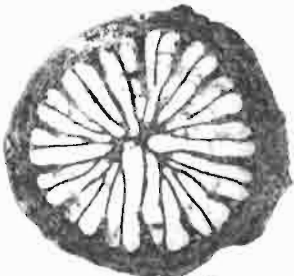
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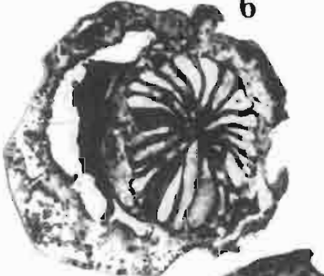
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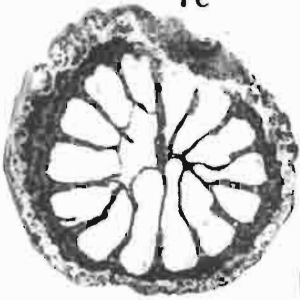
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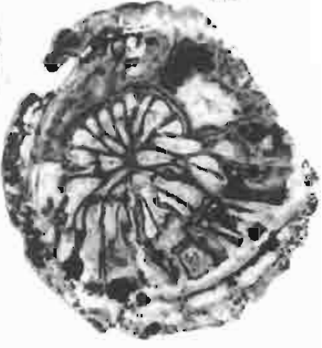
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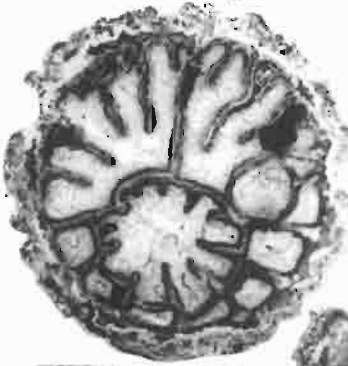
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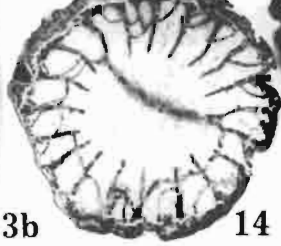
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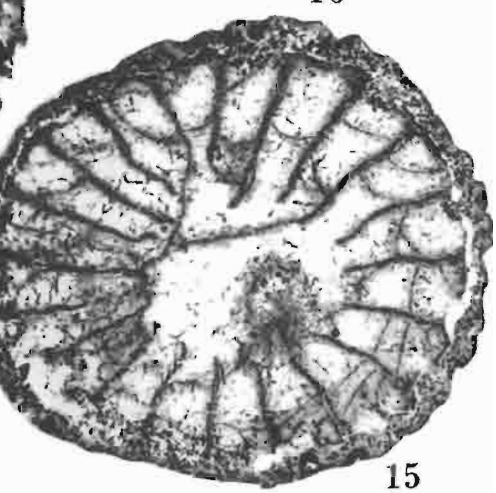
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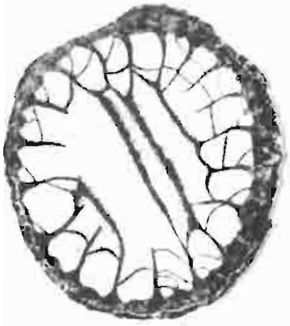
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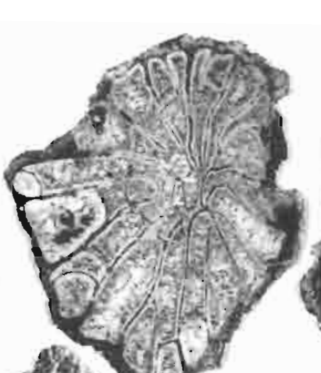
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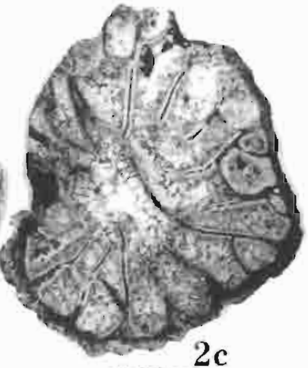
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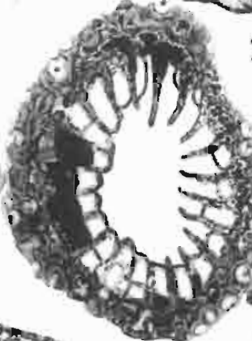
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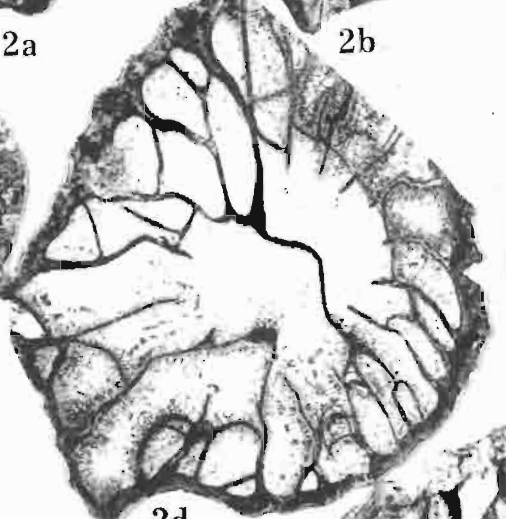
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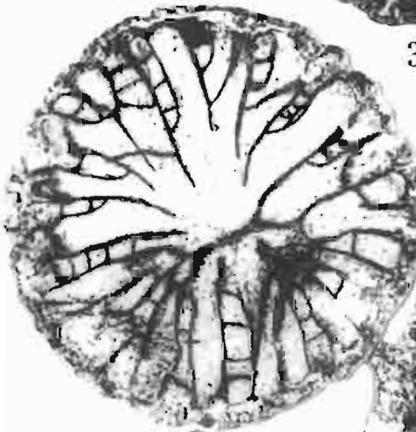
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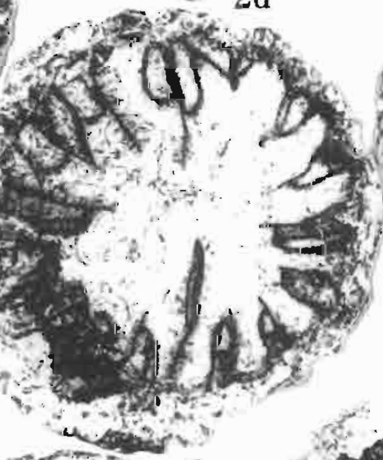
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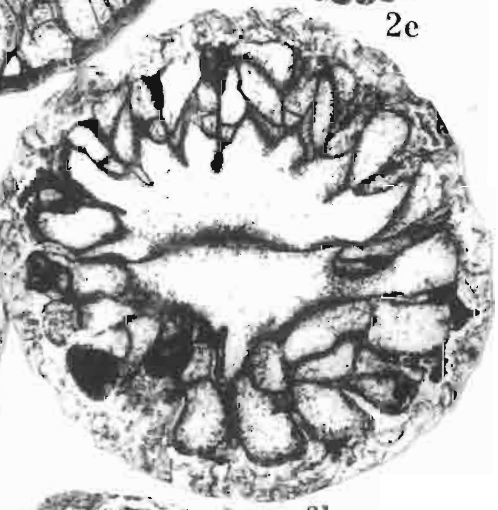
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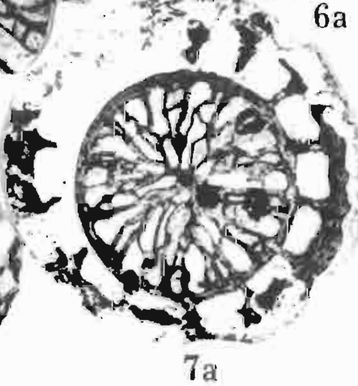
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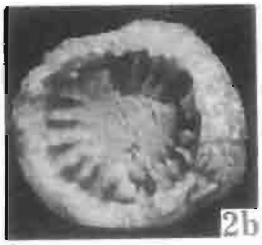
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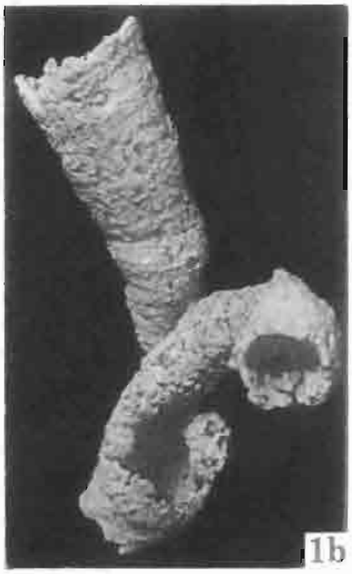
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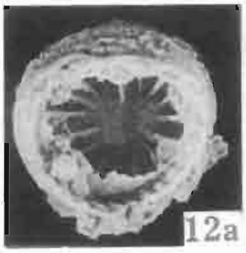
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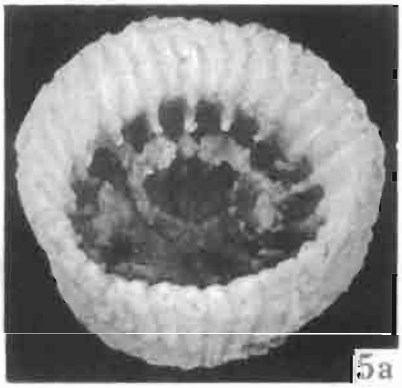
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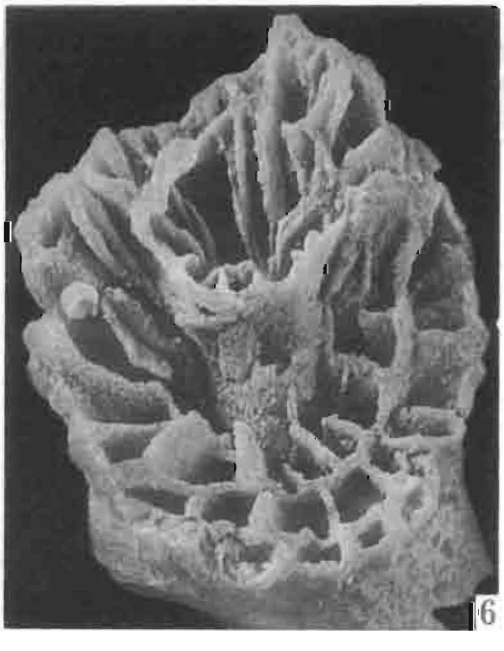
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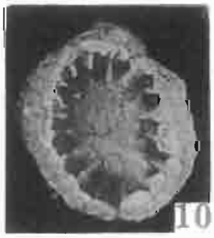
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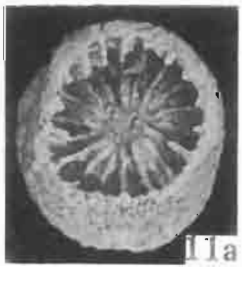
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