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BIFOLIATE CRYPTOSTOMATA OF THE SIMPSON GROUP ARBUCKLE MOUNTAINS, OKLAHOMA

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in partial fulfillment of the
requirements for the degree of

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by

George Thomas Farmer, Jr.

B.A. University of Virginia 1958

M.S. University of Virginia 1960

UNIVERSITY OF CINCINNATI

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I hereby recommend that the thesis prepared under my supervision by GEORGE THOMAS FARMER, JR.

entitled BIFOLIATE CRYPTOSTOMATA OF THE SIMPSON GROUP ARBUCKLE MOUNTAINS, OKLAHOMA

be accepted as fulfilling this part of the requirements for the degree of DOCTOR OF PHILOSOPHY

Approved by:

Kenneth E. Caster

Richard S. Boardman

William F. Jenks

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CONTENTS

ABSTRACT

The Simpson Group of the Arbuckle Mountains, Oklahoma includes the following formations (in ascending order, from oldest to youngest): Joins, Oil Creek, McLish, Tulip Creek, and Bromide. The oldest two formations are considered Whiterock in age. The youngest three formations are considered Chazyan in age. Each of the formations has a basal sandstone in the area studied which usually does not contain Bryozoa. The Simpson Group contains one of the oldest abundant and well-preserved bryozoan faunas in the world.

The oldest bryozoans to make their appearance in rocks of the Simpson Group are the trepostomatous forms which first appear near the base of the Oil Creek. The first bifoliate cryptostomatous forms appear near the base of the McLish Formation and form a substantial element of the fauna in the McLish, Tulip Creek, and Bromide formations.

The Simpson Group contains a varied and well-preserved fauna except for the sandstone units which have yielded only a few specimens. The brachiopods have been described by Cooper (1956). The ostracods have been described by Harris (1957). Except for a short paper by Loeblich (1942), the Simpson bryozoan fauna has never been described. This report represents an attempt to describe the majority of the bifoliate cryptostomes. Three new genera, *Amalgamoporus*, *Cystostictoporus*, and *Cricodictyum* and fifteen new species

are proposed. Two subgeneric categories are proposed (<u>nomina translata</u>). The bifoliate cryptostomes similar to <u>Escharopora</u> Hall 1847 (similar to those assigned to the "Escharoporid group" of Phillips, 1960) will be described at a later date.

Simple statistics are employed to substantiate the proposed species. No elaborate statistical analysis of the bifoliate cryptostome fauna was attempted.

Three stratigraphic sections are described from the south flank of the Arbuckle Mountains: West Spring Creek-Spring Creek, Murray County, Oklahoma; U. S. Highway 77, Carter County, Oklahoma, and the west branch of Sycamore Creek, Johnston County, Oklahoma. Each of these sections begins at or near the top of the McLish sandstone. The Simpson Group is best developed at the West Spring Creek-Spring Creek section where the bifoliate cryptostome element is best represented in the area studied.

Phylogenetic considerations are discussed where possible for genera, subgenera, and species.

The lack of complete colonies of bifoliate cryptostomes from the Simpson Group, and the highly fragmentary nature of the fauna indicates that the majority of the fauna has been subjected to current action which occurred shortly after death or could possibly have caused death. A detailed paleosynecological analysis of the Simpson Group is not possible at the present due to a lack of knowledge of the taxa, especially those of the Bryozoa.

Previously proposed informal supergeneric categories (e.g. "Stictoporid Group") could not be used in the present study. All forms in the present work are referred to the family Rhinidictyidae Ulrich 1893, which is badly in need of a detailed revision. This, however, is deemed beyond the scope of the present work.

Three basic types of interspaces are recognized in the present work based on the nature of the partitions found within the interspaces of the Simpson bifoliate cryptostomes. These are (1) tabulate, (2) distally cystose, and (3) laterally cystose, each of which is defined in the present work.

A new growth habit which involves the trifurcation of the median plane of bifoliation at regular intervals during zoarial growth is described.

INTRODUCTION

The present study deals with the bifoliate cryptostome segment of the fauna of the Simpson Group from three stratigraphic sections on the south flank of the Arbuckle Mountains in southern Oklahoma. These sections were chosen because of their relative completeness, their abundant and well-preserved bifoliate cryptostomes, and their east-west geographic position.

The Simpson Group (lower Middle Ordovician) of Oklahoma has long been regarded as an important stratigraphic sequence because of the occurrence of petroleum in the sandstones of the group. Rocks of the Simpson have also been used as building stone and glass sand in construction work. The well-known "Wilcox" oil and gas sands are part of the Simpson Group, and have proved exceedingly productive, as in the Oklahoma City uplift. The interbedded limestones and shales of the Simpson Group contain one of the oldest abundant and well-preserved bryozoan faunas in the world. Bryozoa of comparable age occur in the Pogonip limestone of Nevada but are few in number and commonly not well-preserved.

The Simpson Group is in part Whiterock in age. The two lower formations in the group, the Joins and Oil Creek, are considered as belonging to the Whiterock stage of Cooper (1956). The oldest bryozoans of the Simpson Group are trepostomatous forms which first appear near the base of the Oil Creek Formation. The first bifoliates appear near the base of the McLish Formation which, along with the younger formations of the Simpson Group, are considered to be of Chazy age.

Bryozoa of the Simpson Group are abundant and well-preserved, as are representatives of other major fossil groups such as brachiopods and ostracods. The brachiopod fauna has received detailed study by Cooper (1956). The ostracod fauna has been studied in detail by Harris (1957).

As of this writing, only two papers have been published on Simpson Bryozoa: Loeblich (1942) and Merida and Boardman (1967). Only the former paper is primarily taxonomic. Among the bryozoans considered in these studies is one bifoliate cryptostome species described from the Upper Bromide of the Wichita Mountains. The latter paper brings to light the potential importance of Bryozoa in subsurface work and points out the lack of pre-Bromide described taxa. Decker and Merritt (1931) list bifoliate cryptostomes from the McLish, Tulip Creek, and Bromide formations, but no illustration of this element of the fauna was attempted.

The bryozoan element of the Simpson fauna contains representatives of at least three of the four currently recognized (Bassler, 1953) Paleozoic bryozoan orders, the Trepostomata and Cryptostomata being the most abundantly represented. Cyclostomata are relatively rare and Ctenostomata have not been reported.

This work deals with the bifoliate cryptostome element of the fauna. The purpose of the study is to describe the fauna, to draw conclusions as to the relative age of the Simpson Group based on a major element of the fauna, and to infer, where possible, phylogenetic

relationships between the genera represented. Dr. R. S. Boardman of the U. S. National Museum is at present studying the remainder of the Simpson bryozoan fauna. This work was done under the guidance of Dr. Boardman and Dr. K. E. Caster of the University of Cincinnati, both of whom have read the entire manuscript and offered many helpful suggestions. The writer accompanied Dr. Boardman in the field during six weeks of the summer of 1963. Additional material used in this study was collected by Dr. Boardman during the summers of 1961 and 1962. Dr. W. E. Ham of the Oklahoma Geological Survey directed the writer to several collecting localities. Mr. Jesse Merida of the U. S. National Museum offered many helpful suggestions concerning preparation of thin-sections. Mr. Lorenzo Ford of the U. S. National Museum aided the writer in the preparation of both thin-sections and peels. Dr. O. L. Karklins of the U. S. Geological Survey made many helpful suggestions. This work could not have been completed without the constant aid of my wife, Bonnie B. Farmer, who helped with the entire manuscript and completed the typing. The photography was done using the facilities of the U. S. National Museum and Madison College, Harrisonburg, Virginia.

STRATIGRAPHY

The Simpson Group of Oklahoma is regarded by most workers (Cooper 1956, Harris 1957) as being lower Middle Ordovician (Whiterockian, and in part Black Riveran) in age. Decker and Merritt (1931) assign a Chazy-Black River age to the group. The history of the nomenclature of the Simpson Group is discussed fully by Loeblich (1942, pp. 412-416) and Harris (1957, pp. 10-54) and need not be repeated here. Decker and Merritt (1931), Decker (1941), and Harris (1957) have published detailed descriptions of the formations.

On the basis of Decker's work (Decker and Merritt, 1931) five formations are recognized as constituting the Simpson Group. The five formations are, from base up: Joins, Oil Creek, McLish, Tulip Creek, and Bromide. Cooper (1956) divided the Bromide Formation into two members, a lower shaly member called the Mountain Lake, and an upper limy member called the Pooleville.

Bifoliate cryptostomatous Bryozoa first occur in rocks of the McLish Formation near the base and constitute a major element of the bryozoan fauna in the McLish, Tulip Creek, and Bromide formations.

The Simpson Group is primarily a clastic sequence consisting of organoclastic calcarenites, limy shales, and siliciarenites (sandstone). The individual formations can be distinguished on the basis of superposition or by faunal evidence. In the area studied (southern edge of the Arbuckle Mountains) the beds dip to the southwest from 28° to nearly 90°. The Simpson Group is underlain by the massive Arbuckle limestone which has yielded no Bryozoa. The first Simpson formation (Joins) is recognized as beginning with a thin conglomerate above the *Hormotoma* gastropod bed and the algal bed near the top of the Arbuckle limestone. Each of the other formations of the Simpson Group (Oil Creek, McLish, Tulip Creek, Bromide) begins with a basal sandstone and is easily recognized in the field. The Simpson Group is overlain by the Viola limestone.

A detailed analysis of the physical stratigraphy is beyond the scope of this work.

Joins Formation

The name Joins Ranch was first used in an unpublished presentation by Ulrich in 1928 before the Geological Society of America but was first published as a formation name by Decker in 1930 (p. 1495). In 1929 Ulrich published a revised chart in which the name, Joins Ranch, was shortened to Joins.

The type section for the Joins is along Spring Creek on the Joins Ranch northwest of Woodford near the western end of the Arbuckle Mountains.

The Joins Formation has yielded no Bryozoa.

Oil Creek Formation

The name Oil Creek was first published by Ulrich in 1929 (1929 b, p. 73).

The type locality for the Oil Creek is along Oil Creek in sec. 17, T3S, R4E, approximately fourteen miles southeast of Sulphur, Oklahoma.

No bifoliates have been found in the Oil Creek formation although the first trepostomatous Bryozoa do occur here.

McLish Formation

The name McLish was first published by Ulrich in 1929 (1929 b, p. 73).

The type locality for the McLish Formation is on the McLish Ranch, approximately four miles northwest of the town of Bromide, Oklahoma.

The McLish Formation consists of a basal sandstone and overlying thin limestones, shales, and sandstones. The McLish may reach a thickness of approximately 450 feet and ranges from 200 feet to 450 feet in thickness. Most of the limestones are organoclastic calcarenites and most of the shales are calcareous. Bryozoa were not found in the sandstones, and most commonly occur in the limestones. In the eastern part of the Arbuckle Mountains the McLish contains a "birdseye" sequence in the upper twenty feet to thirty feet which did not yield Bryozoa.

The first bifoliate Cryptostomata are found fifty-three feet above the base of the McLish Formation at West Spring Creek (USNM collecting locality 2126), within sixty-eight feet of the base of the McLish at Highway 77 (USNM collecting locality 2114), and within twenty-six feet of the base of the McLish at West Sycamore Creek (USNM collecting locality 2129). The earliest Simpson bifoliates are small specimens of *Stictopora parvus*, n. sp. *Cricodictyum ponderosum*, n. gen. and sp. is reported from zones 2126 D-E from eighty-five feet through 116 feet above the base of the McLish at West Spring Creek. Most species of *Cystostictoporus*, n. gen. are found in the McLish Formation. The bifoliate cryptostome fauna is predominantly a *Stictopora*-*Cystostictoporus* fauna (see table 1, p.).

Tulip Creek Formation

The name Tulip Creek was first published by Ulrich in 1929 (1929 b, p. 73).

The type section for the Tulip Creek Formation is located along Tulip Creek on the southern side of the Arbuckle Mountains on the west side of U. S. Highway 77.

Lowest occurrences of *P.* (*Eopachydictya*) are from eighteen feet to thirty-four feet above the base of the

Tulip Creek and were not found above the Tulip Creek in the area studied.

The Tulip Creek consists of a basal sandstone and an overlying sequence of shale, thin limestones, and a few sandstones. The Tulip Creek ranges in thickness from eighty-five feet at West Sycamore Creek (USNM collecting locality 2128) to approximately 450 feet at West Spring Creek (USNM collecting locality 2146). Shale is the predominant rock type and as a result good exposures are rare. Bryozoa occur in the shales and limestones.

The bifoliate cryptostome fauna of the Tulip Creek can be described as containing forms which are restricted to the Tulip Creek as well as forms found in both the underlying McLish and the overlying Bromide formations. It consists of species of Stictopora, Escharopora, P. (Eopachydictya), and Amalgamoporus. A. typicus, n. gen. and sp. has been found only from the Tulip Creek Formation. The Tulip Creek bifoliate cryptostome fauna is slightly more diverse than that of the underlying McLish and slightly less diverse than the overlying Bromide.

Bromide Formation

The Bromide Formation was proposed by Ulrich (1911, pl. 27).

The type section for the Bromide is near the town of Bromide in Coal County, Sec. 32, T1S, R8E, at the eastern end of the Arbuckle Mountains.

The Bromide consists of a basal sandstone and an overlying sequence of limestones and shales. Bryozoa are abundant in the limestones and shales and especially so in shaly partings in the limestones. The Bromide ranges in thickness from eighty-six feet to 450 feet.

The Bromide contains the most prolific bryozoan fauna of the Simpson Group with the bifoliate cryptostomes being especially abundant. The bifoliate cryptostome fauna consists predominantly of *Pachydictya* and escharoporids. *Cricodictyum*, *Cystostictoporus*, n. gen., and *Amalgamoporus*, n. gen. have not been found in the Bromide.

DESCRIPTION OF COLLECTING LOCALITIES AND STRATIGRAPHIC SECTIONS

Stratigraphic zones are listed alphabetically within each formation from bottom to top.

West Spring Creek

Locality: SC¼ sec. 31, T1S, R1W, three miles east of Pooleville, Murray County, Oklahoma. USNM locality numbers 2126 (McLish Formation) and 2146 (Tulip Creek Formation).

Locality description and access: field exposures along south side of east tributary of West Spring Creek, south of fault. Locality reached through Woodford and Joins Ranch, three miles beyond Spring Creek locality (see p. 25).

Description of stratigraphic section: McLish Formation, USNM locality number 2126, West Spring Creek.

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2126-A	Covered interval. Contact between Oil Creek and McLish estimated. McLish started just beyond Oil Creek brachiopod zone. No appreciable sandstone above or below Oil Creek in this area. No sandstone float seen here, arenaceous limestone at best. Few slabs of arenaceous limestone seen in float, organoclastic, mostly fragments of brachiopod shells.	43'	43'
2126-B	Thin limestones at top and bottom of unit, covered in between. Limestones medium gray, medium crystalline, weathering darker gray, few ramose forms.	10'	53'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2126-C	Covered. Some bifoliates in float. Bifoliates abundant. Some silicification. Stictopora parvus, n. sp.	32'	85'
2126-D	Covered. Small collection. Cricodictyum ponderosum, n. gen. and sp.	13'	98'
2126-E	Ramose forms, some showing no structure, others showing some.	18'	116'
2126-F	Good bifoliate zone seen in ditch. Stictopora dissitus, n. sp.	5'	121'
2126-G	No Bryozoa seen. Interbedded limestone and shale poorly exposed. Crossed to fault block adjacent to stream without losing section.	30'	151'
2126-H	Shale with some interbedded limestone. Limestone at base thin-bedded, organo-	7'	158'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	clastic fossil hash, good bifoliates and ramose forms. Cystostictoporus distalis, n. sp.		
2126-J	Rubbly sandy limestone, weathering mottled rusty and medium gray. No Bryozoa.	4'	162'
2126-K	Covered.	32'	194'
2126-L	Mostly covered. Thin-bedded, medium gray, medium grained crystalline limestone weathering dark gray. Fossils rare.	10'	204'
2126-M	Largely covered. Abundant bryozoans. One foot thick limestone at top, gray to brown, medium to thin-bedded organoclastic; weathering dark gray. Mainly small branching forms. Rubbly lime-	11.5'	215.5'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	stone bed one inch thick at top. Forms are larger. S. miniacanthoporus, n. sp., C. pachyphragmus, n. gen. and sp.		
2126-N	Largely covered, thin-bedded, coarsely crystalline, organoclastic. Rubbly beds near the top. Bryozoa rare. S. flabellatus, n. sp. Zones O through S form a low resistant ridge.	5'	220.5'
2126-O	Largely covered, thin-bedded limestone and mudstone. Limestone with abundant Bryozoa. Limestone organoclastic; weathering yellowish to dark gray. Bifoliates abundant. C. acanthoporus. One specimen of phylloporinid.	6'	226.5'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2126-P	Largely covered. Good collection from float. Massive forms, bifoliates, _C. praegigantius_, n. sp., small ramose forms. Limestone slabs taken. Light gray, finely crystalline. Weathering darker gray; thin-bedded limestone. Limestone outcrop at top. Large sticto-porid as in M.	29'	255.5'
2126-Q	Medium to thin-bedded, medium to coarsely crystalline organoclastic gray to green limestone. Weathering dark gray. Green argillaceous material in matrix. Large sticto-porid, other forms.	11'	266.5'
2126-R	Light gray fine to medium crystalline limestone, weathering darker gray.	13.5'	280'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	Rubble iron-stained, thin-bedded. Interval largely covered. Small collection. Bifoliates rare; first escharoporid seen.		
2126-S	Medium gray, thin-bedded calcarenite, organoclastic. Weathering darker gray, iron-stained. Bifoliates common. Massive forms (stromatoporoids?). Brachiopod zone at top.	11.5'	291.5'
2126-T	Largely covered. Thin-bedded limestone at top. Limestone gray to brown weathering darker gray, iron-stained. Medium to coarse grained. Friable when weathered. Small brachiopods common in limestone at top. Calcarenite. Largely green shale, as seen	18'	309.5'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	in slope. Upper limestone bed sub-lithographic. Section offset to west side of fault. No section lost.		
2126-U	Largely covered. Limestone at top. Thin brachiopod zone about twelve feet from base of zone U. Brachiopods in thin limestone bed one inch thick; badly weathered gray limestone. Bryozoans, mainly bifoliates. Glauconitic (?).	24'	333.5'
2126-V	Mostly covered. Limestone at base. Medium to coarsely crystalline, iron-stained.	14'	347.5'
2126-W	Largely covered. Calcarenite. Lithology as in zone 2126-T. Limestone at base.	9'	356.5'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2126-X	Medium to coarse-grained crystalline limestone; friable when weathered, gray. Iron-stained limestone weathering darker. Organoclastic calcarenite. No bifoliates. Section offset from 2126-X. Measured from top of zone T.	1'	357.5'
2126-zone 1	Largely covered thin limestone and green shale at top. Limestone thin-bedded, gray to green; medium to finely crystalline.	56'	413.5'
2126-zone 2	Thin-bedded limestone, gray to brown.	13.5'	427'
2126-zone 3	Oolitic limestone (?).	4'	431'
2126-zone 4	Five feet on top of oolitic. Section transferred to flat in western gap using oolitic limestone; zone 3 as	5'	436'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	marker. Zone 4 not seen here but thickness allowed in measurement.		
2126-zone 5	Covered.	48.5'	484.5'
2126-zone 6	Thin to medium bedded; badly weathered, friable limestone. Few bryozoans.	4'	488.5'
2126-zone 7	Small ramose bryozoan zone at bottom. Basal five inches ramose zone.	5'	493.5'
2126-zone 8	Covered.	13'	506.5'
2126-zone 9	Lower-most sandstone bed with Bryozoa. Small collection. Tulip Creek sandstone above. Top unit of McLish is a dense limestone, thinly bedded one inch to four inch beds. Few fossils if any, medium grayish brown, weathering lighter gray. About twenty feet	3"	509.75'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	exposed. Massive sandstone immediately below. Tulip Creek sandstone immediately above in high ridge. From here on to Tulip Creek sandstone the McLish is poorly exposed. Interbedded sandstone, shale, and limestone. Limestone is medium crystalline, some sandy, massive, well-bedded, blocky, not nodular. Fine organoclastic hash, few small brachiopods. Sandstone commone in interval.		

Description of stratigraphic section: Tulip Creek formation, USNM locality number 2146, West Spring Creek.

2146-A	Poorly exposed interval of fossiliferous limestone and shale. Float.	24'	24'
2146-B	Exposed poorly in ridge and gully running at slight angle to strike.	20'	44'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	Limestone arenaceous to organoclastic. Not many bryozoans seen.		
2146-C	Covered.	20'	64'
2146-D	Limestone thinly bedded, medium crystalline, light gray. Weathering rusty brown, organoclastic.	68'	132'
2146-E	Green shale. No fossils observed.	28'	160'
2146-F	One inch phosphatic-looking limestone, in largely shale interval.	96'	256'
2146-G	Covered. Base of interval established by measuring from base of TC limestone at USGS bench mark in corner of field.	71'	327'
2146-H	Thin slabby "rusty" weathered limestone filled with mollusks: bivalves, gastropods, and cephalopods. Thick-	1'	328'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	ness estimated.		
2146-J	Covered.	43'	371'
2146-K	Strike ridge littered with limestone float; some limestone in place. Limestone finely to coarsely crystalline. Mostly bifoliates.	12'	383'
2146-L	Covered.	33'	416'
2146-M	Limestone, coarsely organoclastic. Mostly brachiopods and many broken cystid plates. Few Bryozoa.	8'	424'
2146-N	Covered.	10'	434'
2146-P	Medium crystalline, light rusty brown limestone; weathering medium olive brown. No fossils seen. Tulip Creek Formation, USNM locality number 2146. One-half mile west of 2146-P is cattle	2'	436'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	tank in Tulip Creek. Collection of Bryozoa. Much red shale in dump of tank. Tank measured above base of Tulip Creek limestone, 237 feet.		

Spring Creek

Locality: NE¼ sec. 17, T2S, R1W, at the reservoir, Murray County, Oklahoma. USNM locality number 2132 (Bromide Formation).

Locality description and access: the section begins near the base of the Bromide above the Bromide siliciarenite and continues near the reservoir dam to the top of the Bromide Formation. The Viola limestone is identified above the Bromide at this locality. The locality is reached by the following route: west on route 53 from its intersection with U. S. Highway 77 for a distance of eight miles to Woodford. Turn north at the school in Woodford Pass over a low water bridge to a house which is the caretaker's house for Joins Ranch just beyond the low water bridge. Then proceed west through an aluminum gate at the house for a distance of three and one tenth miles. Park at the gate located three and one tenth miles from the house and walk north. The first sandstone encountered is the Tulip Creek sandstone. The section begins just above the second sandstone.

Description of stratigraphic section: Bromide Formation, USNM locality number 2132, Spring Creek.

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2132-B	Considerable covered interval (A) below, only sandstone seen in float. In B, thin slabbly limestone, probably interbedded with shale; limestone medium gray, medium crystalline, coarsely organoclastic. Weathering bright rusty yellow. Zone B probably very close to base of the Bromide limestone.	8'	8'
2132-C	Limestone poorly exposed, medium light bluish gray to medium gray. Medium crystalline, weathers darker rusty gray. No fossils seen.	13'	21'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2132-D	Covered. Probably shale.	16'	37'
2132-E	Interbedded thin limestone and shale. Nodular to irregularly bedded; coarsely organoclastic. Abundant ramose Bryozoa.	16'	53'
2132-F	Few bifoliates, pieces of fistuliporoid and two hemispherical forms. Interbedded limestone and shale; poorly exposed.	10'	63'
2132-G	Mostly spherical colonies about one inch to two inches in diameter.	11'	74'
2132-H	Ramose and bifoliate forms, some large massive colonies. Not common. Interbedded limestone and shale forming rising slope to zone J.	29'	103'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2132-J	Thick limestone. Ridge forming limestone, thinly bedded. Medium gray, medium crystalline. Weathering darker gray; some iron stain. Few fossils seen.	12'	115'
2132-K	Green fissile shale in spillway of dam. No Bryozoa seen.	37'	152'
2132-L	Thin interbedded limestone lenses and shales. Both one inch to three inches thick, deeply iron-stained. Good bryozoan fauna.	13'	165'
2132-M	Orthoceracone zone. Some few Bryozoa found, generally robust forms. Nodular limestone, many complete brachiopods and orthoceracones. Some interbedded shale.	4'	169'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2132-N	Interbedded limestone and shale. Limestone one inch to three inches thick; platy, lithographic, light gray; weathering white to light gray. Olive green shale in beds averaging six inches in thickness.	13'	182'
2132-O	Good varied collection. Large encrusting form on orthoceracone. Limestone and shale interbedded. Limestone thin-bedded, coarsely organoclastic.	16'	198'
2132-P	Limestone light gray, finely crystalline. Weathering light gray and light rusty yellow, little shale, beginning of Bromide dense. Two feet interval at top of unit with colonies of Bryozoa.	28'	226'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2132-Q	Good collection of massive colonies, encrusted orthoceracones, fistuliporoids, ramose forms. Upper six feet has concentration of small ramose forms. Unit begins in bottom of dug spillway, material from basal six feet of unit thrown out on upper part of interval so zone is thicker than might be ordinarily. Interbedded limestone and shale. Limestone nodular, coarsely organoclastic.	22'	248'
2132-R	Limestone, finely crystalline, light yellowish gray, weathering white and gray, few robust colonies collected. More massive medium crystalline limestone in upper two feet.	22'	270'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2132-S	Sandstone.	3'	273'
2132-T	Good collection on top of bedding plane.	13'	286'
2132-U	Big ramose and massive forms, some small ramose forms. In spillway, interbedded limestone and shale.	17'	303'
2132-V	Mostly lithographic limestone.	33'	336'
2132-W	Small ramose and bifoliate Bryozoa.	7'	343'
2132-X	Fairly massive beds of ramose, bifoliate and few massive Bryozoa. One to sixteen blocks from base up; are one foot to three feet intervals.	37'	380'
2132-Y	Mainly massive limestone.	20'	400'

Highway 77

Locality: SE¼ sec. 24, T2S, R1E, and SW¼ sec. 19, T2S, R2E. USNM locality numbers 2114 (McLish Formation), 2115 (Tulip Creek Formation), and 2116 (Bromide Formation).

Locality description and access: field exposures on either side of Route 77 and east of Tulip Creek three miles north of Springer, Carter County, Oklahoma. The Joins-Arbuckle contact marked by Ardmore Chamber of Commerce road sign. Section begins at top of second sandstone.

Description of stratigraphic section: McLish Formation, USNM locality number 2114, Highway 77.

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2114-A	Few bifoliate Bryozoa superjacent to sandstone. Lowest noted occurrence of bifoliates in section 1. Poorly exposed, probably a shale interval.	68'	68'
2114-B	Limestone massive, ridge forming. Light buff. Medium crystalline, weathering slightly darker. No Bryozoa observed.	48'	116'
2114-C	Good bryozoan zone. Bifoliates, trepostomes in weak weathering rubbly beds. Interbedded limestone and shale.	31'	147'
2114-D	No collection. Limestone light buff, resistant; ridge forming; medium crystalline.	34'	181'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2114-E	Good shaly bryozoan zone. <u>Diplotrypa</u>-like Bryozoa, bifoliates, fistuliporoids, smaller ramose trepostomes. Shale olive green at surface. Weathers rubbly.	32'	213'
2114-F	Crystalline limestone, light greenish gray, medium to coarsely crystalline. Poorly fossiliferous. Few bryozoans observed. Ridge forming.	34'	247'
2114-G	Poorly exposed; alternation of limestone and shale. Poor collecting at top of unit in sandstone and base of Tulip Creek. G_1 collected approximately in lowest ten feet of Zone G. G_2 collected in ten feet to twenty	60'	307'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	feet of zone G. Collected east of highway.		

Description of stratigraphic section: Tulip Creek Formation, USNM locality number 2115, Highway 77.

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2115-A	First limestone above the basal sandstone. Bryozoa rare. Limestone medium crystalline, light gray; weathering slightly lighter; forms a bench.	18'	18'
2115-B	Small bifoliate and ramose zone. Bryozoa fairly abundant. Interval poorly exposed, probably mainly shale.	16'	34'
2115-C	Poorly exposed interval. Organoclastic limestone, arenaceous, fine-grained limestone; few Bryozoa.	65'	99'
2115-D	Mostly sandy limestone in float;	40'	139'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	poorly exposed unit. Limestone gray to reddish gray, medium crystalline. Much olive green shale in interval.		
2115-E	Section offset to stream channel. Lower four feet a limestone bed, medium gray, medium crystalline, weathering sandy, upper part of interval an olive green shale.	16'	155'
2115-F	Olive green shale with thin inter-limestone layers. Limestone arenaceous, less than one inch in thickness. A two-inch shale at top of interval.	7'	162'
2115-G	Lower one and one-half feet of sandy limestone designated the bottom or lowest layer. In the upper four inches	2'	164'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	are two layers of limestone, less than one inch thick filled largely with bifoliates. These are designated middle and upper layers in collections. Olive green shale with an interbedded large slab with robust ramose colony from lower bed. All located just beyond bend in stream.		
2115-H	Olive green shale, few thin inter-bedded arenaceous limestones.	21'	185'
2115-J	Prominent ledge of sandstone to arenaceous limestone.	3'	188'
2115-K	Essentially covered, some slabby arenaceous limestone.	53'	241'

Description of stratigraphic section: Bromide Formation, USNM locality number 2116, Highway 77.

Lower Bromide collection on both sides of Highway 77. Collection 2116-A collected on west side of the highway west of second creek. Collections 2116-A_1 to 2116-A_5 collected on east side of Highway 77 just beyond first creek.

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2116-A_1	Sandstone at top of Bromide sandstone sequence. Some Bryozoa.	15'	15'
2116-A_2	Sandstone to arenaceous limestone.	12'	27'
2116-A_3	Arenaceous limestone poorly exposed.	15'	42'
2116-A_4	Rubbly zone. Covered.	10'	52'
2116-A_5	Brown arenaceous limestone ledge near top of unit.	22'	74'

West Branch of Sycamore Creek

Locality: SW¼ sec. 22, T3S, R4E, Johnston County, Oklahoma. USNM locality numbers 2127 (Bromide Formation), 2128 (Tulip Creek Formation), and 2129 (McLish Formation).

Locality description and access: field exposures along west side of west branch of Sycamore Creek. The section is reached by going east from Ardmore, Oklahoma to Dickson, Oklahoma. Turn north on Route 18 and proceed three and three-tenths miles to the Washita River. Go one and three tenths miles beyond the river and turn right onto a gravel road and cross another gravel road which meets the first gravel road at right angles. Proceed six-tenths miles from intersection and turn right around a dilapidated farm house. Continue three and three-tenths miles to a "T" intersection. Turn left through a cattle guard and go three and six-tenths miles to an old barn on the right side of the road. (At one and nine-tenths miles from the above cattle guard take a left and stay on the main road.) Turn into a barn three and six-tenths miles from the above cattle guard and follow faint tracks through a wooden gate to an old corral. The section begins straight ahead down the hill. Go through the third gate and stay along the creek to get above the Oil Creek Formation.

Description of stratigraphic section: Bromide Formation, USNM locality number 2127, west branch of Sycamore Creek.

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2127-A	Shale interval resting on sandstone. Some massive Bryozoa.	6'	6'
2127-B	Generally covered interval, probably interbedded limestone and shale. Limestone medium to coarsely crystalline. Light to medium brownish gray, weathering darker gray. Limestone thinly and irregularly bedded, average one foot, with about five feet shale in between.	26'	32'
2127-G	Interbedded limestone and shale as in zone B. Upper one-half little or nothing seen. Massive three feet limestone at top of unit.	13'	45'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2127-D	Four feet shale unit that has been scooped out and left to weather. Fine collection. Lots of small bifoliates.	4'	49'
2127-E	Mostly shale in interval. Good ramose fauna in middle eight feet unit. Medium sized forms. Upper unit has massive maroon forms.	21'	70'
2127-F	Mostly covered.	25'	95'
2127-G	Nodular limestone, some interbedded shale in middle two feet, limestone medium crystalline to nearly fine-grained. Small ramose forms in colony clusters.	10'	105'
2127-H	Interbedded silty shale and nodular limestone. Shale contains colonies of a ramose form with bulbous base. More	14'	119'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	variety in limestone.		
2127-J	Massive limestone, somewhat nodular, light to medium brownish gray. Medium crystalline, some thin shale partings; all but one specimen came from basal one foot of unit.	8'	127'
2127-K	Covered.	4'	131'
2127-L	Limestone thin bedded, slabby, beds are two inches in thickness; limestone fine grained, medium gray, weathering slightly lighter gray and rusty yellow. Collection in basal one foot. Few nodules of reddish gray chert.	16'	147'
2127-M	Arenaceous limestone. Massive.	4'	151'
2127-N	Covered.	24'	175'
2127-O	Limestone slabby, medium to coarsely	32'	207'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	crystalline, medium blue gray, weathering dark rusty brown. No fossils seen.		
2127-P	Bromide "dense," massive. Fine-grained limestone, light brownish gray, weathering slightly lighter gray.	60'	267'
2127-Q	Covered.	12'	279'
	Viola limestone.		

Description of stratigraphic section: Tulip Creek Formation, USNM locality number 2128, west branch of Sycamore Creek.

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2128-A	Thin-bedded limestone. Good collection of bifoliates. Limestone medium to coarsely crystalline, light gray weathering darker gray.	4'	4'
2128-B	Lower sixteen paces covered. Above, an alternation of thin limestone, four inches	60'	64'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	to six inches and shale. No Bryozoa.		
2128-C	Might correlate with 2115-G. Big ramose colonies, other smaller ramose forms. Interval mostly limestone, some interbedded shale. Limestone light gray, medium crystalline, weathering mottled darker gray and rusty. Nodular.	4'	68'
2128-D	Silty shale, green weathering yellow. Small ramose colony and root of ramose form all that was found.	15'	83'
2128-E	Massive cross-bedded limestone weathering dark brownish gray.	2'	85'

Description of stratigraphic section: McLish Formation, USNM locality number 2129, west branch of Sycamore Creek.

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2129-A	Six-feet limestone at base of unit four feet thick. Light yellowish gray, medium to coarsely crystalline. Weathers medium gray. Unit poorly exposed above, few thin limestones, somewhat nodular. Probably some shale in interval. A few bifoliates collected.	26'	26'
2129-B	Nodular and rubbly limestone in basal one-third of unit, poorly exposed. Green fissile shale above. Few bifoliates.	19'	45'
2129-C	Coarsely organoclastic limestone at base of unit. Two feet thick, well	27'	72'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
	bedded, slabby, weathering rusty. Some coarse trilobite fragments, green shale and another limestone, then green shale above. Second limestone sixteen feet above base. Two feet thick. No bryozoans seen.		
2129-D	Limestone at base of unit. Medium to coarsely crystalline. Light yellowish to gray, weathers medium to dark gray. Thinly bedded. Three feet thick. Above is shale to bottom of small gully paralleling strike. Small ramose trepostomes and bifoliates thick in upper limestone of basal unit. May be some in shale topographically below as there are loose forms.	20'	92'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2129-E	Fistuliporid zone in alternating limestone and shale. Also small ramose and bifoliate forms. Limestone as below. Limestone at top of six feet.	31'	123'
2129-F	Generally shaly interval, poorly fossiliferous. Eleven feet of limestone at top. Limestone thin-bedded, medium crystalline, light gray weathering darker gray. Most Bryozoa found in shales or on surface of thin limestones interbedded with shale.	30'	153'
2129-G	Shale with four feet of limestone above.	15'	168'
2129-H	Four feet limestone above, shale below. Limestone cross-bedded.	10'	178'
2129-J	Seven feet of limestone at top of unit.	18'	196'

Field Designation of Zone	Description of Zone	Thickness of Zone	Accumulative Thickness
2129-K	Yellowish bedded limestones.	8'	204'
2129-L	Shaly interval, some thin interbedded limestones.	8'	212'
2129-M	Upper fourteen feet varies from silt-stone to sandstone, to arenaceous lime-stone. No Bryozoa from upper fourteen feet interval. Fistuliporoid zone in lower one-half of unit that is general-ly shaly, poorly exposed.	30'	242'
2129-N	Poorly exposed shaly interval with a few limestone layers.	17'	259'
2129-O	Limestone and shale with a two feet cross-bedded sandstone in middle of unit. Bryozoa common in lower three feet of limestone and shale.	8'	267'
2129-P	Shaly interval, poorly exposed. Bryozoa rare.	11'	278'

TABLE 1

Formation and USNM Locality	Zone	*Stictopora parvus*, n. sp.	*S. dissitus*, n. sp.	*S. miniacanthoporus*, n. sp.	*S. flabellatus*, n. sp.	*S. praecox*, n. sp.	*S. intermedia*, n. sp.	*S.* sp. indet.	*Cystostictoporus distalis*, n. sp.	*C. pachyphragmus*, n. sp.	*C. acanthoporus*, n. sp.	*C. pregigantius*, n. sp.
McLish Locality 2126	C	c										
	D											
	E											
	F		c									
	H								a			
	L			r								
	M			c						a		
	N				r							
	O										c	
	P											c
	Q											
	R											

a : abundant; c : common; r : rare

Formation and USNM Locality	Zone	*Stictopora parvus*, n. sp.	*S. dissitus*, n. sp.	*S. miniacanthoporus*, n. sp.	*S. flabellatus*, n. sp.	*S. praecox*, n. sp.	*S. intermedia*, n. sp.	*S.* sp. indet.	*Cystostictoporus distalis*, n. sp.	*C. pachyphragmus*, n. sp.	*C. acanthoporus*, n. sp.	*C. pregigantius*, n. sp.
McLish Locality 2126	S				c							
	T											
	U											
	W											
	4							r				
	6					c						
	7											
Tulip Creek Locality 2146	A					r						
	B					r		c				
	D					r						
	K											
	M											
	Float											

Formation and USNM Locality	Zone	*Stictopora parvus*, n. sp.	*S. dissitus*, n. sp.	*S. miniacanthoporus*, n. sp.	*S. flabellatus*, n. sp.	*S. praecox*, n. sp.	*S. intermedia*, n. sp.	*S.* sp. indet.	*Cystostictoporus distalis*, n. sp.	*C. pachyphragmus*, n. sp.	*C. acanthoporus*, n. sp.	*C. pregigantius*, n. sp.
Tulip Creek Locality 2146	Tank						c					
Bromide Locality 2132	B											
	E											
	F											
	G											
	H											
	K											
	L											
	M											
	O											
	P											
	Q											
	T											

Formation and USNM Locality	Zone	*Stictopora parvus*, n. sp.	*S. dissitus*, n. sp.	*S. miniacanthoporus*, n. sp.	*S. flabellatus*, n. sp.	*S. praecox*, n. sp.	*S. intermedia*, n. sp.	*S.* sp. indet.	*Cystostictoporus distalis*, n. sp.	*C. pachyphragmus*, n. sp.	*C. acanthoporus*, n. sp.	*C. pregigantius*, n. sp.
Bromide Locality 2132	U											
	X											
	Xa											
McLish Locality 2114	A		r		c				r			
	C		r	r	r							
	E		c	r								
	F		r	r								r
Tulip Creek Locality 2115	A											
	B											
	F							c				
	G											
Bromide Locality 2116	A											
	C											

Formation and USNM Locality	Zone	Stictopora parvus, n. sp.	S. dissitus, n. sp.	S. miniacanthoporus, n. sp.	S. flabellatus, n. sp.	S. praecox, n. sp.	S. intermedia, n. sp.	S. sp. indet.	Cystostictoporus distalis, n. sp.	C. pachyphragmus, n. sp.	C. acanthoporus, n. sp.	C. pregigantius, n. sp.
Bromide Locality 2116	D											
	E											
	H											
	J											
	L											
McLish Locality 2129	A		r									
	B	r	r									
	D	r	r									
	E	r	c									
	F									r		
	G			c								
	H			c								
	J									r		

Formation and USNM Locality	Zone	*Stictopora parvus*, n. sp.	*S. dissitus*, n. sp.	*S. miniacanthoporus*, n. sp.	*S. flabellatus*, n. sp.	*S. praecox*, n. sp.	*S. intermedia*, n. sp.	*S.* sp. indet.	*Cystostictoporus distalis*, n. sp.	*C. pachyphragmus*, n. sp.	*C. acanthoporus*, n. sp.	*C. pregigantius*, n. sp.
McLish Locality 2129	L											
	M										c	
	N										r	
Tulip Creek Locality 2128	A					r						
Bromide Locality 2127	A			r								
	B											
	C			r								
	D			a								
	E											
	G							r				
	H			r								

Formation and USNM Locality	Zone	*C. gigantius*, n. sp.	*C.* sp. indet.	*C. cryptophragmus*, n. sp.	*Cricodictyum ponderosum*, n. sp.	*Eopachydictya segregata*, n. sp.	*Pachydictya robusta*, Ulrich	pachydictyid, gen. and sp. indet.	*Amalgamoporus typicus*, n. sp.	*A.* sp. indet.	escharoporid, gen. and sp. undet.	*Escharopora*, sp. undet.
McLish Locality 2126	C											
	D				r							
	E				r							
	F											
	H											
	L											
	M											
	N											
	O											
	P											
	Q	c										
	R										r	
	S			r								

Formation and USNM Locality	Zone	*C. gigantius*, n. sp.	*C.* sp. indet.	*C. cryptophragmus*, n. sp.	*Cricodictyum ponderosum*, n. sp.	*Eopachydictya segregata*, n. sp.	*Pachydictya robusta*, Ulrich	pachydictyid, gen. and sp. indet.	*Amalgamoporus typicus*, n. sp.	*A.* sp. indet.	escharoporid, gen. and sp. undet.	*Escharopora*, sp. undet.
McLish Locality 2126	T			r								
	U		c									
	W		c	r								
	4											
	6											
	7										c	
Tulip Creek Locality 2146	A											
	B											
	D											
	K		r						r			
	M								r			
	Float					c				r		
	Tank											

Formation and USNM Locality	Zone	C. gigantius, n. sp.	C. sp. indet.	C. cryptophragmus, n. sp.	Cricodictyum ponderosum, n. sp.	Eopachydictya segregata, n. sp.	Pachydictya robusta, Ulrich	pachydictyid, gen. and sp. indet.	Amalgamoporus typicus, n. sp.	A. sp. indet.	escharoporid, gen. and sp. undet.	Escharopora, sp. undet.
	B									r		
	E						r			c	c	
	F						c					
	G						a					
	H						c					
	K										r	
Bromide Locality 2132	L						r					
	M						r					
	O						c					
	P											
	Q						c					
	T						r					
	U											

Formation and USNM Locality	Zone	*C. gigantius*, n. sp.	*C.* sp. indet.	*C. cryptophragmus*, n. sp.	*Cricodictyum ponderosum*, n. sp.	*Eopachydictya segregata*, n. sp.	*Pachydictya robusta*, Ulrich	pachydictyid, gen. and sp. indet.	*Amalgamoporus typicus*, n. sp.	*A.* sp. indet.	escharoporid, gen. and sp. undet.	*Escharopora*, sp. undet.
Bromide Locality 2132	X						c					r
	Xa									c		
McLish Locality 2114	A											
	C											
	E		r									
	F											
Tulip Creek Locality 2115	A										c	
	B					r					c	
	F											
	G		c			r						
Bromide Locality 2116	A										r	
	C						r					
	D						c					

Formation and USNM Locality	Zone	C. *gigantius*, n. sp.	C. sp. indet.	C. *cryptophragmus*, n. sp.	*Cricodictyum ponderosum*, n. sp.	*Eopachydictya segregata*, n. sp.	*Pachydictya robusta*, Ulrich	pachydictyid, gen. and sp. indet.	*Amalgamoporus typicus*, n. sp.	A. sp. indet.	escharoporid, gen. and sp. undet.	*Escharopora*, sp. undet.
Bromide Locality 2116	E											
	H						r					
	J										r	
	L										r	
McLish Locality 2129	A											
	B											
	D	r						r			r	
	E											
	F			r								
	G											
	H		r									
	J											
	L			r								

Formation and USNM Locality	Zone	*C. gigantius*, n. sp.	*C.* sp. indet.	*C. cryptophragmus*, n. sp.	*Cricodictyum ponderosum*, n. sp.	*Eopachydictya segregata*, n. sp.	*Pachydictya robusta*, Ulrich	pachydictyid, gen. and sp. indet.	*Amalgamoporus typicus*, n. sp.	*A.* sp. indet.	escharoporid, gen. and sp. undet.	*Esharopora*, sp. undet.
McLish Locality 2129	M			r								
	N											
Tulip Creek Locality 2128	A					r						
Bromide Locality 2127	A											
	B										r	
	C										c	
	D										a	
	E										a	
	G										r	
	H										r	

Formation and USNM Locality	Zone	Graptodictya, sp. undet.	Stictoporella, sp. undet.	multiacanthoporid escharoporid n. sp. undet.	Phaenoporella ?, sp. undet.
McLish Locality 2126	C				
	D				
	E				
	F				
	H				
	L				
	M				
	N				
	O				
	P				
	Q				
	R				
	S				

Formation and USNM Locality	Zone	*Graptodictya*, sp. undet	*Stictoporella*, sp. undet.	multiacanthoporid escharoporid n. sp. undet.	*Phaenoporella* ?, sp. undet.
McLish Locality 2126	T				
	U				
	W				
	4				
	6				
	7				
Tulip Creek Locality 2146	A				
	B				
	D				
	K				
	M				
	Float				
	Tank				

Formation and USNM Locality	Zone	*Graptodictya*, sp. undet.	*Stictoporella*, sp. undet.	multiacanthoporid escharoporid n. sp. undet.	*Phaenoporella* ?, sp. undet.
Bromide Locality 2132	B				
	E				
	F			r	
	G				
	H				
	K				
	L				
	M				
	O				
	P	r			
	Q	r		c	r
	T				
	U	r			

Formation and USNM Locality	Zone	*Graptodictya*, sp. undet.	*Stictoporella*, sp. undet.	multiacanthoporid escharoporid n. sp. undet.	*Phaenoporella* ?, sp. undet.
Bromide Locality 2132	X	c			
	X_a	c			
McLish Locality 2114	A				
	C				
	E				
	F				
Tulip Creek Locality 2115	A				
	B				
	F				
	G				
Bromide Locality 2116	A				
	C			r	
	D				

Formation and USNM Locality	Zone	*Graptodictya*, sp. undet.	*Stictoporella*, sp. undet.	multiacanthoporid escharoporid n. sp. undet.	*Phaenoporella* ?, sp. undet.
Bromide Locality 2116	E			r	
	H				
	J				
	L				
McLish Locality 2129	A				
	B				
	D				
	E				
	F				
	G				
	H				
	J				
	L				

Formation and USNM Locality	Zone	Graptodictya, sp. undet.	Stictoporella, sp. undet.	multiacanthoporid escharoporid n. sp. undet.	Phaenoporella ?, sp. undet.
McLish Locality 2129	M				
	N				
Tulip Creek Locality 2128	A				
Bromide Locality 2127	A				
	B				
	C				
	D				
	E				
	G				
	H			r	

METHODS OF STUDY

In the course of this study, over two thousand thin-sections and peels were prepared from the bifoliate cryptostomes of the three stratigraphic sections involved. Serial peels were made whenever necessary to determine the origin and development of certain morphological characters.

Selection of Specimens for Preparation

Fossil Bryozoa can rarely be identified to species by their external appearance. External homeomorphy is as common a condition in the Bryozoa as in any other group of fossils. As a result, the preparation of specimens to reveal internal structures is necessary. Preliminary sorting by external characters can often be done at the generic level and was the first step in the preparation of the forms studied for the present work.

Large specimens of Simpson rock containing observable bifoliates on weathered surfaces were cut into thin slabs and examined while wet under a dissecting microscope for the possible presence of bifoliates. A selected number of oblique views of specimens obtained in this manner were thin-sectioned or peeled. They were reoriented whenever it was possible.

Specimens freed from their matrix by weathering were collected in the field whenever it was certain that their occurrence was essentially *in situ*. The selection of freed specimens for preparation was made by initial sorting into groups according to external characters such as size and shape of colony, shape of zooecial apertures, and presence or absence of acanthopores and mesopores. At least one specimen was prepared from each group. It was usually necessary, before initial sorting, first to clean the freed specimens in an ultrasonic vibrator. Some specimens were cleaned by boiling in a strong solution of detergent and water.

Where sorting by external characters was not possible, initial sorting was accomplished by making peels of a large number of specimens. From the peels it was possible to select representatives of each species present in a stratigraphic interval and to prepare thin-sections from the best preserved specimens which had been peeled. This method substantially reduced the number of time-consuming thin-sections to be prepared.

The number of sectioned and peeled specimens is a relatively small proportion of the total number of bifoliate specimens available. An attempt was made to obtain the three standard orientations of each form present within a stratigraphic interval. As many specimens as possible were sectioned or peeled from each zone. At least five specimens of similar appearing forms were prepared from each zone.

Method of Preparing Peels

A peel is an impression on a piece of transparent laminated acetate resulting in an acetate replica of a slightly etched polished surface.

The method used is essentially that described by Boardman and Utgaard (1964) as a dry peel method of obtaining acetate replicas of polished specimens. The materials used are the following: microslides of transparent laminated cellulose acetate, acetone as a solvent, a 1:20 solution of formic acid, a grinding compound, and a polishing compound.

The surface of the oriented specimen is first flattened and smoothed by a fine grinding compound (such as carborundum grit number 800 or 1,000) holding the specimen with the fingers and grinding with an evenly applied pressure on a flat glass plate. The surface is then brought to a high polish using a polishing wheel and jewelers rouge. The polishing process is an essential step in obtaining the best quality peels as it removes the finer loose particles from the oriented surface to be peeled and results in better differential etching of the surface.

After polishing, the specimen is then etched in a 1:20 solution of formic acid for a period of two to ten seconds. The specimen is then immediately washed in water to stop the etching process and thoroughly dried by using either compressed air or allowing the specimen to dry by unaided evaporation. The length of the etching time depends on the nature of the filling of the zooecial voids. It is necessary to experiment to obtain the best results, as types of preservation of fossil Bryozoa vary considerably.

The dried specimen is submerged in acetone and then transferred to an acetate microslide. The acetone acts as a solvent for the acetate. When the acetone has dried the specimen is removed from the slide and a surface replica remains.

This dry peel method renders excellent results. The only objection is that it cannot be used exclusively in the study of fossil Bryozoa, as it lacks the three-dimensional aspect of thin-sections. It does, however, allow the investigator to observe essential structures such as wall laminae, zooecial shape, mesopores, and acanthopores. It does not reveal all boundary lines between adjacent zooecia, which result from the irregular intersection of individual wall laminae.

Advantages to this method are that it is very rapid compared with thin-sectioning, it is a convenient and accurate method for recording surfaces in serial sectioning, and it is not a completely destructive process. The polished faces are still available for actual thin-sectioning if desired. Measurement is facilitated for biometric analysis of large numbers of specimens.

Method of Preparing Thin-Sections

Thin-sections are at present the most completely satisfactory means of studying fossil Bryozoa. Both isochronous and heterochronous external homeomorphy are very common in fossil Bryozoa. The subsequent sectioning of syntypic suites of species based on external features alone have revealed more than one genus in several studies (Boardman, 1959, p. 1). Peels reveal most microscopic structures but are surface impressions of a specimen and thus do not reveal structures which show up optically when a three-dimensional specimen is used. A standard thin-section (between 0.02 mm and 0.03 mm in thickness) is a three-dimensional specimen. The preparation is very time-consuming, and the completion of sixty to seventy-five thin-sections in a forty-hour work week may be considered an average figure. Thin-sectioning is a destructive process in that it is necessary to grind most of the sectioned fragment away in order to reduce the desired face to transparency. It is therefore necessary to conserve a part of the original specimen. Even the most gifted thin-section workers admit that it is inevitable that a few specimens will be lost from a given sample due to errors during the thin-sectioning process.

It is desirable to obtain the three standard views of each specimen chosen to be sectioned. If the specimen is large enough, it is cut or broken into four pieces, saving the smaller piece as insurance against ruining a section during or after preparation. The remnant can also be used in describing external features. The remaining three fragments are then cut or ground into longitudinal, tangential, and transverse orientations, which are the three standard views of a specimen.

Longitudinal sections are cut parallel to the colony growth direction, usually the long axis of the colony, and normal to the median plane, revealing the length of the zooecium in profile. They are necessary for study of ontogeny of zooecia. They reveal the zooecial growth from the point of budding on the median plane to the development of the latest structures at the surface of the colony. They also reveal changes in direction of zooecial growth.

Tangential sections are tangent to the colony surface. They may be shallow or deep planes. One made just under the colony surface is a shallow tangential section and reveals structures developed during late ontogeny. Deep tangential sections are obtained by grinding further into the colony, and are useful mainly for observing the arrangement of zooecia during early astogeny. Ideal tangential sections are cut parallel to the median plane.

Transverse sections are cut normal to the growth direction of the colony, the median plane, and the longitudinal section. Sections are essential for study of the characters of the median plane and the nature of zooecial arrangement. Earlier studies seldom employed sections, but Boardman and Utgaard (1966) made extensive use of transverse sections in a successful study of the basic shape and arrangement of zooecia in the Paleozoic bifoliate trepostome genus *Peronopora*, and established a precedent in bifoliate study.

In sectioning, the fragment is first cut or ground to the desired orientation, then refined by grinding with fine (800 or 1,000) grit. The prepared surface is then attached to a glass microslide after both slide and specimen have been warmed on a hotplate to eliminate moisture. Fixation is best accomplished by using a thermoplastic cement (e.g., Lakeside #70 Cement). A temperature of about 325°F is best for heating slide and specimen, and melting the cement. A solid stick of cement is rubbed on the glass slide until a quantity large enough to cover the area of the prepared face is melted. For best results, the cut surface of the specimen is also covered with melted cement. The specimen is immediately placed on the slide and all air bubbles are removed by pressing the specimen down firmly on the slide using a circular motion. The specimen is then ground to transparency. If the mounted piece is large, the main mass of material may be sawed away, parallel to the cemented plane. This shortens the grinding time.

When it is necessary to prepare a large number of thin-sections, it is more efficient to complete each step in the thin-sectioning process with all specimens under study at the moment, instead of completing one specimen at a time. Thus all specimens are first oriented, then smoothed, mounted, etc.

Grinding to transparency is best accomplished with a vertically mounted abrasive wheel (on a cut-off saw armature) which can be adjusted vertically. The specimen is held on the movable stage in a slide holder and movedback and forth beneath the wheel which is lowered until the specimen has been reduced to the desired transparency.

Thin-sections are made permanent by application of a cover-slip over the specimen. The cover-slip is best attached by liquid balsam. After the balsam has hardened by being kept at room temperature for several days, the slide is cleaned of excess balsam, and the cover-slip is sealed with liquid varnish, which makes it air-tight and prevents future drying out of the balsam.

Methods of Studying Thin-Sections and Peels

Transmitted light is necessary to study detailed structures in thin-sections of Bryozoa. A Bausch and Lomb Dyna-Zoom microscope with a maximum magnification of 860X was used in the present study both of thin-sections and peels. Three sectioned views per specimen are usually necessary to study the form in three-dimensions. A magnification of 100X is usually sufficient to study the most common structures.

Measuring is efficiently accomplished by using a Leitz Prado microslide projector. The thin-section or peel is projected against a screen at a convenient distance from the specimen. The projected image is correlated with a correspondingly magnified micrometer scale. The enlarged scale is prepared by projecting the micrometer scale on a transparent sheet of plastic at the prescribed distance and marking thereon the divisions.

PALEONTOLOGY

Introduction

The different bifoliate cryptostome taxa of the Simpson Group have been determined by the writer by considering as many morphologic traits as were visible under magnifications of from 1X to 450X. These characters are essentially those which have been used in the past in studying bifoliate cryptostomes, e.g., basic wall structure, nature of the laminae of the walls, nature of the zooecial boundary or boundaries, size and shape of zooecial voids at or near the zoarial surface, arrangement of zooecia at or near the zoarial surface, the number of whole zooecia in 1 mm square, presence or absence and nature of acanthopores, the angle of budding from the median plane, the number and nature of zooecial diaphragms, the nature of tabulated or cystose interspaces where present, and the arrangement of the median tubuli.

Study cards were prepared from photomicrographs of a prepared sample from each stratigraphic zone. The cards were then sorted into what were considered to be preliminary generic assignments. Comparing these photographs with the study card file at the Division of Invertebrate Paleontology, U. S. National Museum, definite generic assignments were established. Each group of cards representing a genus was re-sorted into species categories in conjunction with the microscopic examination of the thin-sections and peels in the writer's collection.

An elaborate statistical design was not devised for the present study. Bork and Perry (1967) in a study of Champlainian trepostomes from the mid-continent region concluded that statistical tests for the comparison of means was not, at that time, a satisfactory method for differentiating taxa of fossil ectoprocts. Cryptostomatous forms may be more amenable to statistical analysis than trepostomes because of the greater degree of regularity within a single zoarium. This appears to be true especially for forms occurring in rocks younger in age than the Simpson Group.

Paleosynecology

Cryptostomata are confined to rocks of marine origin. They generally built fragile, upright colonies which indicate that they inhabited relatively quiet waters (Stach, 1937). Their occurrence in rocks of the Simpson Group is mainly along bedding planes, especially shaly partings in limestone, and as fragments incorporated in organoclastic limestones. They are associated with a typical epifaunal assemblage of brachiopods, echinoderms, and ostracods which represent a thanatocoenose which shows evidence of having been subjected to current action, e.g., scattered cystid plates, fragmentary nature of the cryptostome specimens. These currents could possibly have been due to storm waves in the Simpson basin of deposition.

Repository of Material Studied

All material studied is in the collections of the U. S. National Museum (USNM).

SYSTEMATIC PALEONTOLOGY

Phylum BRYOZOA Ehrenberg, 1831
(= POLYZOA J. V. Thompson, 1830)
Subphylum ECTOPROCTA Nitsche, 1869
Class GYMNOLAEMATA Allman, 1856
Order CRYPTOSTOMATA Vine, 1883
Family RHINIDICTYIDAE Ulrich, 1893
Genus STICTOPORA Hall, 1847

Stictopora Hall, J., 1847, Nat. Hist. New York, Paleontology, vol. 1, p. 73; Nickles, J. M. and Bassler, R. S., 1900, United States Geol. Surv., Bull. 173, pp. 47, 411; Bassler, R. S., 1915, United States Geol. Surv., Bull. 92, p. 1189; Phillips, J. R. P., 1960, Paleontology, vol. 3, p. 7; Ross, J. P., 1966, Journ. Paleont., vol. 40, no. 6, pp. 1400-1401.

Rhinidictya Ulrich, E. O., 1882, Cincinnati Society of Nat. Hist. Journ., vol. 5, p. 152; Bassler, R. S., 1915, United States Nat. Mus., Bull., vol. 92, p. 1106; 1934, Fossilium Catalogus, Pars 67, p. 190; 1953, Treatise on Invertebrate Paleontology, Part G, Bryozoa, p. G140; Coryell, H. N., 1921, Indiana Acad. of Sci., Proc. for 1919, p. 300; Nekhoroshev, V. P., 1961, Vsesoyuzny Nauchno-Issledovatel'skii Geologischeskii Institut Ministerstva Geologii i

Okran Nedr U. S. S. R., Trudy (USEGEI), vol. 41, p. 142; Astrova G. G., 1965, Paleontologicheskogo Instituta, U. S. S. R., Trudi, vol. 106, p. 279.

Type Species

Stictopora fenestratus Hall (1847, p. 16), subsequent designation, Ulrich (1886, p. 67). Redescribed by Phillips (1960, p. 7).

Diagnosis

Zoaria bifoliate or encrusting; branches straight, usually lack surface ornament; zooecia arranged in longitudinal and diagonal ranges at zoarial surface; zooecial boundaries distinct, serrate, and U-shaped in tangential view; walls longitudinally laminate with steeply dipping inner portion which gives the appearance of a zooecial lining in tangential view; median plane with straight or offset, regularly spaced, distinct median tubuli.

Emended Description

Zoaria are bifoliate or encrusting, explanate, and branching or straight. Basal attachments are encrusting and unilaminate, and the entire zoarium is rarely encrusting. Zoarial branches are straight, thin, transversely biconvex, and commonly lack surface ornament such as monticules, maculae, or annuli. Zoarial margins are sharp to rounded. Median tubuli are present at the zoarial surface along the zoarial margin.

Zooecia are arranged in either longitudinal and diagonal ranges, or both, at or near the zoarial surface. Interspaces between zooecia are plain or with pustules or acanthopores. Lateral interspaces are flush or slightly raised above the zoarial surface. Longitudinal interspaces are commonly elevated above the zoarial surface proximal to the zooecia.

Zooecia are straight, gradually curved, or sharply curved tubes. They bud from the median plane at varying angles. Angles of budding become more constant in younger species, are highly variable in older species. Budding is alternate on opposite sides of the median plane, as seen in both longitudinal and transverse sections. Zooecia bear keels and sinuses at their proximal ends in those species with curved zooecial tubes.

Zooecial walls are longitudinally laminate with a steeply inclined inner portion. Boundary zones between zooecia are distinct, often serrate, and result from abutting laminae from adjacent zooecia. They are U-shaped in tangential view. Laminae on opposite sides of the zooecial boundary abut at very low angles. Zooecial walls thicken gradually in a distal direction. Endozone and exozone are not distinct in species which do not have a sharp zooecial curvature.

The median plane extends the full width of the zoarium. Laminae of the median plane are continuous with those in the endozone. The median plane is divided by a distinct boundary within which occur median tubuli. The median tubuli are regularly spaced, straight to gently curved rod-like openings in the median plane which are filled with hyaline calcite. They are oval to circular in cross-section, are straight near the center of the zoarium, and gently curved toward the zoarial margins away from the center. They may open to the exterior along the margins. They may appear as marginal striae on some forms.

Pustules occur in some forms and appear to be blister-like extensions from the zoarial surface. They have been observed only in shallow tangential sections.

Acanthopores occur in some forms and are small, usually poorly defined, without a distinct core in some species. They arise in the early exozone and become arranged in longitudinal series at the zoarial surface in some forms. In other forms, acanthopores appear to ring the zooecium. They are formed by cone-shaped flexures of the zooecial wall laminae. They are commonly most abundant in areas of bifurcation or near the margins in some species.

Tabulate interspaces may be present or absent. They begin at the base of the exozone and in older species begin with cystiphragm-like growths. In younger species, they contain tabulae which are short and slightly curved. Laminae of the tabulae merge with the zooecial wall laminae.

Diaphragms are thin, few in most species, absent in others. They may be randomly spaced, emplaced early or late in ontogeny. They may be planar or slightly curved. Laminae of diaphragms merge with the zooecial wall laminae.

Hemisepta are absent in most species, present in some. They are thin, hook-like projections into the zooecial cavity which are formed by a laminate extension of the zooecial wall at the base of the exozone.

Monticules are rare, small, and few per zoarium. They appear to be randomly spaced. Maculae are also rare, usually with abundant acanthopores.

Remarks

Species of *Stictopora* are quite variable. Those in the McLish Formation are the most generalized forms as well as being the first bifoliate cryptostomes to appear in rocks of the Simpson Group. Species in the McLish are more variable and more generalized than those in the Tulip Creek and Bromide formations. Species generally show a gradual increase in zoarial size from the base of the McLish Formation through the Bromide Formation.

Stictopora parvus, n. sp.

Plate 1, figs. 1-7

Material Studied

Specimens are from within 213 feet above the basal sandstone of the McLish Formation. At West Spring Creek (USNM locality 2126) the specimens occur within eighty-five feet above the top of the basal sandstone. At west branch of Sycamore Creek they occur within 123 feet above the top of the basal sandstone. At. U. S. Highway 77 (USNM locality 2114) they occur with 213 feet above the top of the basal sandstone.

Eleven sectioned fragments from 2126-C; three peeled fragments from 2129-B questionably assigned to the species; eleven peeled fragments from 2129-D questionably assigned to the species; three peeled fragments from 2129-E; twelve peeled fragments from 2129-E questionably assigned to the species; one sectioned and one peeled fragment from 2114-E.

Diagnosis

Zoaria small, bifoliate, branching, explanate; pustules present or absent; acanthopores absent; one or two diaphragms per zooecium; more proximal diaphragm appears early in ontogeny; angle of budding greatly variable.

Description

Zoaria are bifoliate, branching, and explanate. They grow from an encrusting basal attachment to upright colonies which branch at irregular intervals and low angles. Zoaria are small, ranging in width of a branch from 2.4 mm to 3.5 mm and in thickness of a branch from 0.5 mm to 1.0 mm. Zooecia intersect the zoarial surface obliquely at an angle varying from 22° to 45°. Pustules are either present or absent; when present they are seen only in shallow tangential section.

Zooecia are oval at the zoarial surface and show in tangential view an apparent zooecial lining in older growth stages ranging in thickness from 0.01 mm to 0.06 mm. Zooecia are gently curved from their point of budding to the surface; some are sigmoidal. The angle of budding is quite variable, ranging from 6.5° to 74°. The angle of exozone to median plane is also variable, ranging from 19° to 51°.

There are one or two diaphragms per zooecium. The more proximal diaphragm appears early in ontogeny, 0.2 mm to 0.4 mm distally from point of budding. Diaphragms may be flat, or slightly concave or convex.

Zooecial endozone and exozone are not distinct. The exozone results from gradual thickening of the walls. Maximum thickness of a zooecial wall in the exozone in 0.10 mm. The zooecial boundary is distinct and serrate.

The median plane is distinct and continuous with regularly spaced median tubuli, three median tubuli per zooecium. The median tubuli number from eight to twelve per 0.5 mm along the median plane. Maximum diameter of the median tubuli ranges from 0.015 mm to 0.075 mm.

Remarks

S. parvus appears to be unique among the species assigned to *Stictopora* in showing a wide variability in the angle of budding, and in having one or two diaphragms, the more proximal diaphragm having been emplaced early in ontogeny.

Types

Holotype USNM No. 162077, figured paratypes USNM Nos. 162078, 162080, 162081, 162082, and 162083, from the McLish Formation at West Spring Creek (USNM locality 2126).

Occurrence and Relative Abundance

Common in the McLish Formation, zone C, at West Spring Creek (USNM locality 2126). At the west branch of Sycamore Creek (USNM locality 2129) poorly preserved specimens questionably assigned to the species are rare in the McLish Formation, zone B; common in the McLish Formation, zones D and E. At U. S. Highway 77 (USNM locality 2114) the species is rare in zone E.

TABLE 2

<u>Stictopora parvus</u>, n. sp.

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	10-16	14	13.2	1.79	10	8
Maximum zooecial void dimension	0.14-0.44	.22 .20	0.23	0.06	98	8
Minimum zooecial void dimension	0.07-0.17	0.1	0.11	0.02	101	8
Number of longitudinal ranges in 1 mm	5-9	6	6.6	1.24	15	8
Number of diagonal ranges in 1 mm	2-5	4.5	4.3	0.89	14	8

Stictopora dissitus, n. sp.

Plate 2, figs. 1-3
Plate 3, figs. 1-3

Material Studied

Specimens are from the McLish Formation within 213 feet of the top of the basal sandstone. Its geographic and stratigraphic occurrence overlaps that of *S. parvus*, n. sp. At West Spring Creek (USNM locality 2126) it occurs 121 feet above the basal McLish sandstone. At west branch of Sycamore Creek it occurs within 123 feet of the top of the McLish sandstone. At U. S. Highway 77 it occurs within 213 feet of the top of the basal sandstone.

Eleven peeled fragments, nine of which are sectioned, from 2126-F; six sectioned fragments and two peeled fragments from 2114-A; four peeled fragments from 2114-A questionably assigned to the species; one peeled fragment from 2114-C questionably assigned to the species; three peeled fragments from 2114-E; four peeled fragments from 2114-E questionably assigned to the species; four peeled fragments from 2114-E; one peeled fragment questionably assigned to the species; three peeled fragments from 2129-A; three peeled fragments from 2129-A questionably assigned to the species; one peeled fragment from 2129-B questionably assigned to the species; one peeled fragment from 2129-D; thirteen peeled fragments from 2129-E; three peeled fragments from 2129-E questionably assigned to the species.

Diagnosis

Zoaria dichotomously branching or encrusting; pustules absent; acanthopores absent; cystose interspaces present in some zoaria, absent in others; one or two diaphragms per zooecium emplaced late in ontogeny.

Description

Zoaria are dichotomously branching, encrusting, or bifoliate. Branching occurs at irregular intervals and variable angles. The nature of the basal attachment has not been observed. Branch width ranges from 2.87 mm to 5.0 mm. Branch thickness ranges from 0.86 mm to 1.16 mm. Zoarial surfaces are smooth, without monticules or maculae. Pustules and acanthopores have not been observed. Zooecia intersect the zoarial surface obliquely at an angle varying from 21° to 58°.

Zooecia are oval at the zoarial surface. They are gently curved from their point of budding to the surface; some are sigmoidal. The angle of budding is highly variable, ranging from 12° to 87.5°. Sigmoidal zooecia consistently show a much higher angle of budding than others. The angle of exozone to the median plane ranges from 20° to 57°. Diaphragms are planar and number from one to two, the more proximal one being emplaced well into the exozone or late in ontogeny.

Zooecial walls are longitudinally laminate. Endozone and exozone are not distinct, the exozone resulting from a gradual thickening of the walls. Maximum thickness of the zooecial wall in the exozone is 0.14 mm. The zooecial boundary is distinct, continuous, and jagged.

The median plane is distinct, bilaminate, continuous, and contains regularly spaced median tubuli. There are three or four median tubuli per zooecium. The median tubuli are circular to oval in cross-section and number from ten to fifteen per 0.5 mm along the median plane. Maximum diameter of the median tubuli is 0.04 mm.

Cystose interspaces are present in some zoaria, absent in most.

Remarks

S. dissitus differs from *S. parvus* in having slightly larger zoaria, more distally emplaced diaphragms, the development of cystose interspaces in some zoaria, and the absence of pustules. The angle of budding from the median plane is more variable than in *S. parvus*. The specific name is derived from the Latin *dissitus* (apart, remote) and refers to the distal emplacement of the most proximal diaphragm.

Types

Holotype USNM No. 162084, figured paratypes USNM Nos. 162085, 162086, 162087, 162088, and 162089, from the McLish Formation, West Spring Creek (USNM locality 2126).

Occurrence and Relative Abundance

Common in the McLish Formation, zone F, West Spring Creek (USNM locality 2126). Rare in the McLish Formation, zones A and F and common in zone D at U. S. Highway 77 (USNM locality 2114). Rare in the McLish Formation, zones A, B, D, and E and common in zone E at the west branch of Sycamore Creek (USNM locality 2129).

TABLE 3

<u>Stictopora</u> <u>dissitus</u>, n. sp.

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	10-18	15	13.9	2.92	10	8
Maximum zooecial void dimension	0.11-0.3	0.2	0.2	.05	70	8
Minimum zooecial void dimension	0.06-0.16	0.09	0.098	.92	70	8
Number of longitudinal ranges in 1 mm	3-8	8, 5, 6	5.77	1.71	9	8
Number of diagonal ranges in 1 mm	4-5	5	4.55	.52	9	8

Stictopora praecox, n. sp.

Plate 4, figs. 1-4

Material Studied

The stratigraphic range of the species if from the upper twenty feet of the McLish Formation above the basal sandstone and the lower 132 feet of the Tulip Creek Formation above the basal sandstone at West Spring Creek (USNM localities 2126 and 2146, respectively). One peeled fragment questionably referred to the species is from the lower four feet of the Tulip Creek Formation above the basal sandstone at the west branch of Sycamore Creek (USNM locality 2128).

Thirteen sectioned fragments from 2126-6; four sectioned fragments from 2146-A; three sectioned fragments questionably assigned to the species from 2146-B; two sectioned fragments from 2146-D; two sectioned fragments from 2146-D questionably assigned to the species; one peeled fragment questionably referred to the species from 2128-A.

Diagnosis

Zoaria bifoliate, rarely encrusting, with acanthopores; zooecia oval at zoarial surface, with short endozone, long thick exozone; zooecial boundary discontinuous with inflections which give the appearance of acanthopores in tangential view.

Description

Zoaria are dichotomously branching, bifoliate, or rarely encrusting. Branch width ranges from 2.0 mm to 4.0 mm. Branch thickness ranges from 0.6 mm to 1.6 mm. Acanthopores are present at the zoarial surface. The zoarial surface lacks monticules or maculae. Zooecia are oval at the zoarial surface and are arranged in both longitudinal and diagonal ranges.

Zooecia are sigmoidal from the median plane to the early part of the exozone, then are straight or slightly curved to the zoarial surface. The angle of budding from the median plane varies from 25° to 80°. The angle of exozone to median plane varies from 31° to 64.5°. Zooecia intersect the zoarial surface at an angle of from 39° to 66°. The endozone and exozone are not distinct. The exozone is taken to begin at the sharp zooecial bend. Zooecia may contain from zero to four planar diaphragms which, when present, are emplaced in the exozone. Cystose interspaces are rare except in encrusting forms where they are commonly developed. They contain cystiphragms which overlap in the direction of zooecial growth.

The zooecial wall in the exozone is thick, ranging from 0.045 mm to 0.13 mm. There is no zooecial lining. The zooecial boundary is distinct, commonly discontinuous, and has inflections. The inflections in the zooecial boundary may give the appearance of acanthopores in the tangential view.

Acanthopores occur in the zooecial wall and are straight tubes oriented normal to the zoarial surface. They do not have distinct boundaries and appear as tubes filled with hyaline calcite. They are more common near the edges of zoaria. Acanthopores are restricted to the exozone.

The median plane is bilaminate with a central dark line in which median tubuli occur. The number of median tubuli per 0.5 mm along the median plane ranges from twelve to seventeen. There are three or four median tubuli per zooecium.

Remarks

S. praecox is larger with thicker zoaria than *S. parvus* and *S. dissitus* from the Simpson Group. The angle of budding is quite variable, but less variable than in *S. parvus* and *S. dissitus*. The zooecial shape with short sigmoidal endozone and long straight or gently curved exozone further characterizes this species. *S. praecox* is most similar to *S. mutabilis* Ulrich 1886 from the "middle third of the Trenton shales, Minneapolis and St. Paul," Minnesota (Ulrich, 1895) but differs in having discontinuous zooecial boundaries with inflections, and less well-developed acanthopores.

Types

Holotype USNM No. 162090, figured paratypes USNM Nos. 162091, 162092, and 162093 from the McLish Formation, West Spring Creek, (USNM locality 2126).

Occurrence and Relative Abundance

Common in the McLish Formation, zone 6, at West Spring Creek (USNM locality 2126). Rare in the Tulip Creek Formation, zones A, B, D, and Float, at West Spring Creek (USNM locality 2146). One poorly preserved fragment from the Tulip Creek Formation, zone A, at the west branch of Sycamore Creek questionably assigned to the species.

TABLE 4

Stictopora praecox, n. sp.

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	9-18	14,15	14.78	1.905	23	7
Maximum zooecial void dimension	0.1-0.45	0.2	0.16	0.104	64	7
Minimum zooecial void dimension	0.05-0.13	0.1	0.08	0.02	64	7
Number of longitudinal ranges in 1 mm	5-7	6	6	0.6	19	7
Number of diagonal ranges in 1 mm	4-6	4,5	5	0.73	19	7

Stictopora miniacanthoporus, n. sp.

Plate 5, figs. 1-4

Material Studied

Specimens studied are from the McLish Formation in a 11.5 feet interval from 204 feet to 215.5 feet above the basal sandstone of the McLish Formation at West Spring Creek (USNM locality 2126); from 116 feet to 246 feet above the basal McLish sandstone at U. S. Highway 77 (USNM locality 2114); from seventy-two feet to 178 feet above the basal McLish sandstone at the west branch of Sycamore Creek (USNM locality 2129).

Eight sectioned fragments from 2126-M; one sectioned fragment from 2126-M questionably assigned to the species; two peeled fragments from 2114-C; eight peeled fragments from 2114-E; one sectioned fragment from 2114-E; three peeled fragments from 2114-F; one peeled fragment from 2129-D; five peeled fragments from 2129-G; one peeled fragment from 2129-G questionably assigned to the species; seven peeled fragments from 2129-H; one peeled fragment from 2129-H questionably assigned to the species.

Diagnosis

Zoaria bifoliate; fragments small, narrow, and thin; small acanthopores concentrated in the zooecial boundary zone; diaphragms number from one to three per zooecium and are emplaced in the exozone.

Description

Zoaria bifoliate. Branching has not been observed, possibly because the specimens are small and fragmentary. Zooecial width ranges from 1.65 mm to 3.25 mm. Zooecial thickness ranges from 0.33 mm to 0.74 mm. Zoarial surface without monticules, maculae, or annuli. Shallow tangential sections show very small acanthopores concentrated in the zooecial boundary zone. Zooecia are arranged in both longitudinal and diagonal ranges near the zoarial surface.

Zooecia are oval to nearly round at the zoarial surface. They leave the median plane at an angle of from 27° to 64°. Zooecia may be sigmoidal with the greatest curvature in the endozone or may reach the surface by curving gradually from the median plane to the zoarial surface. Diaphragms number from one to three per zooecium and are emplaced in the exozone.

The zooecial wall in the exozone ranges in thickness from 0.04 mm to 0.12 mm. The zooecial boundary is distinct and serrate. Acanthopores are concentrated in the zooecial boundary zone.

Tabulated interspaces have not been observed.

The median plane is bilaminate with evenly spaced median tubuli. The number of median tubuli per 0.5 mm along the median plane ranges from ten to fourteen. The median tubuli range in diameter from 0.022 mm to 0.04 mm. The number of median tubuli per zooecium is either three or four.

Remarks

S. miniacanthoporus, n. sp. differs from other species of the genus by having small acanthopores concentrated in the zooecial boundary zone. The angle of budding from the median plane is less variable than *S. parvus*, *S. dissitus*, and *S. praematurus*. The specific name refers to the size of the acanthopores.

Types

Holotype USNM No. 162094, figured paratypes USNM Nos. 162095, 162096, and 162097 from the McLish Formation, West Spring Creek (USNM locality 2126).

Occurrence and Relative Abundance

Rare in zone L and common in zone M of the McLish Formation, West Spring Creek (USNM locality 2126). Rare in zones C and F, common in zone E of the McLish Formation, U. S. Highway 77 (USNM locality 2114). Rare in zones D, G, and H of the McLish Formation, west branch of Sycamore Creek (USNM locality 2129).

TABLE 5

Stictopora miniacanthoporus, n. sp.

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	12-18	15, 16	16	1.96	6	4
Maximum zooecial void dimension	0.13-0.22	.17	.17	.0469	36	4
Minimum zooecial void dimension	0.075-0.12	.08	.09	.01	36	4
Number of longitudinal ranges in 1 mm	4-6	5	5.16	0.754	6	3
Number of diagonal ranges in 1 mm	4-6	6	5.33	0.817	6	3

Stictopora flabellatus, n. sp.

Plate 6, figs. 1-2

Material Studied

The specimens studied are found in the McLish Formation in an interval from 215.5 feet through 291.5 feet above the basal sandstone at West Spring Creek (USNM locality 2126); in an interval from zero to sixty-eight feet above the basal sandstone at U. S. Highway 77 (USNM locality 2114).

One sectioned fragment from 2126-N; one peeled fragment from 2126-N; one sectioned fragment from 2126-P questionably assigned to the species; one sectioned fragment from 2126-R questionably assigned to the species; eleven sectioned fragments from 2126-S; one sectioned fragment from 2126-S questionably assigned to the species; one sectioned fragment from 2114-A_1; three peeled fragments from 2114-C.

Diagnosis

Zoaria bifoliate, straight or branching, flabellate; zoarial surface with large acanthopores but without other surface ornamentation; zooecia with diaphragms numbering from three to five.

Description

Zoaria are bifoliate and may or may not be branching. Observed specimens are mainly fragments. Zoaria vary in width from 3.55 mm to 4.5 mm, and in thickness from 0.76 mm to 2.0 mm. The zoarial surface bears numerous acanthopores. No maculae or monticules have been observed. Zooecia at the zoarial surface are arranged in both longitudinal and diagonal ranges.

Zooecia are oval at the zoarial surface. They arise from the median plane at an angle of from 27° to 72° depending on the longitudinal zooecial shape, which varies from sigmoidal to nearly straight. The angle of exozone to the median plane ranges from 27° to 44°. The number of diaphragms per zooecium ranges from two to five, all of which are emplaced in the exozone. Diaphragms are either planar or curved.

The zooecial wall in the exozone ranges from 0.10 mm to 0.14 mm. The zooecial boundary is continuous and jagged. Acanthopores occur in the zooecial walls and extend to a depth of about one-half the zooecial length. In the proximal part of the zooecial wall the acanthopores extend no deeper than the zooecial boundary. The acanthopores are straight or slightly curved and result from inflections in the wall laminae. In tangential view the acanthopores appear to have a central lumen. Longitudinal views reveal, however, that there is no central lumen and that the appearance of one in tangential view is due to the parallelism of the laminae between the inflections and the plane of the section. Acanthopores are large and range in maximum diameter from 0.013 mm to 0.03 mm.

The median plane is bilaminate with large, evenly spaced median tubuli. Median tubuli number from nine to eleven per 0.5 mm along the median plane. Diameter of the median tubuli ranges from 0.03 mm to 0.05 mm.

Remarks

S. flabellatus differs from all other species of *Stictopora* in the flabellate shape of the zoaria and in having large acanthopores. The angle of budding from the median plane is less variable than in *S. parvus*, *S. dissitus*, and *S. praematurus*, and more variable than in *S. miniacanthoporus*.

Types

Holotype USNM No. 162098, figured paratype USNM No. 162099 from the McLish Formation, zone S, at West Spring Creek (USNM locality 2126).

Occurrence and Relative Abundance

Rare in zone N, common in zone S of the McLish Formation, West Spring Creek (USNM locality 2126). Common in zone A and rare in zone C of the McLish Formation, U. S. Highway 77 (USNM locality 2114).

TABLE 6

<u>Stictopora</u> <u>flabellatus</u>, n. sp.

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	4-18	9	8.85	2.622	19	5
Maximum zooecial void dimension	0.08-0.3	0.18	0.17	0.043	50	5
Minimum zooecial void dimension	0.06-0.15	0.1	0.1	0.022	57	5
Number of longitudinal ranges in 1 mm	4-6	6	5.1	0.935	9	5
Number of diagonal ranges in 1 mm	3-6	3	3.89	1.16	9	5

Stictopora intermedius, n. sp.

Plate 7, figs. 1-3

Material Studied

All specimens found are from the middle of the Tulip Creek Formation at West Spring Creek (USNM locality 2146).

Seven sectioned fragments from 2146-tank.

Diagnosis

Zoaria bifoliate, branching, without surface ornamentation; pseudoacanthopores seen only in tangential section; laterally cystose interspaces alternate with zooecia.

Description

Zoaria are bifoliate and dichotomously branching. Zoaria range in width from 0.91 mm to 2.02 mm. All zoaria measured were 0.95 mm in thickness. Zoarial surfaces are without ornamentation. The discontinuous nature of the zooecial boundary results in pseudoacanthopores seen only in the tangential view. Zooecia are arranged in both longitudinal and diagonal ranges at the zoarial surface.

Zooecia are oval in cross-section at the zoarial surface. They are nearly straight to sigmoidal from the median plane to the zoarial surface. The angle of budding from the median plane varies from 36° to 75°. The angle of the exozone and the median plane varies from 51° to 58°.

Diaphragms are either absent or are represented by one or two emplaced in the exozone. Interspaces alternate with zooecia and are laterally cystose.

The thickness of the zooecial wall in the exozone varies from 0.10 mm to 0.22 mm. The zooecial boundary is distinct, discontinuous, and jagged.

The median plane is bilaminate with evenly spaced median tubuli. The median tubuli number from thirteen to sixteen per 0.5 mm along the median plane. There are three or four median tubuli per zooecium.

Remarks

S. intermedius differs from other species of *Stictopora* in the greater thickness of the zooecial wall and in the character of the interspaces. The interspaces are laterally cystose but do not begin as a series of overlapping cystiphragm-like structures as do those in the species of *Cystostictopora*. The angle of budding from the median plane is less variable than other species of *Stictopora* from the Simpson Group with the exception of *S. miniacanthopora*. The interspaces are similar to those in *Eopachydictya* but do not alternate with the zooecia.

Types

Holotype USNM No. 162100, figured paratypes USNM No. 162101, 162102 from the Tulip Creek Formation, West Spring

Creek (USNM locality 2146).

Occurrence and Relative Abundance

Common in collection at "tank," zone 2146-tank, in the Tulip Creek Formation (USNM locality 2146).

TABLE 7

<u>Stictopora</u> <u>intermedius</u>, n. sp.

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	7-14	9	9.56	1.57	18	4
Maximum zooecial void dimension	0.17-0.26	0.21	0.207	0.019	57	4
Minimum zooecial void dimension	0.07-0.12	0.09	0.096	0.607	57	4
Number of longitudinal ranges in 1 mm	6	6	6	5.477	3	1
Number of diagonal ranges in 1 mm	3-4	4	3.66	0.480	3	1

Amalgamoporus, n. gen.

Type Species

Amalgamoporus typicus, n. sp.

Diagnosis

Zoaria bifoliate, dichotomously branching, without external ornamentation; zooecial boundaries may be distinct, jagged, or represented by a boundary zone; zooecial wall appears amalgamate in tangential view with dark mural lacunae; median plane with obscure median tubuli.

Definition

Zoaria are bifoliate, dichotomously branching and without surface ornamentation. Zoarial edges are rounded and without zooecia. Median tubuli have not been observed at the zoarial edges.

Zooecia are arranged in both longitudinal and diagonal ranges at the zoarial surface. Interspaces between zooecial voids are solid and are the zooecial walls, or they may be distally cystose.

Zooecia are gently curved or sigmoidal in shape from the median plane to the zoarial surface and are relatively long.

Zooecial walls are longitudinally laminate adjacent to the zooecial voids and are connected by a zone of transverse wall laminae. This results in an amalgamate zooecial wall as seen in tangential view. The endozone and exozone are not distinct.

The median plane is distinct and contains obscure median tubuli.

Remarks

Amalgamoporus is similar to *Stictopora* in that the zooecial boundary may be a distinct, jagged, dark line. It is similar to *Escharopora* in the amalgamate appearance of the zooecial wall in tangential section. It differs from all genera in having a boundary zone with mural lacunae and in having obscure median tubuli. The name refers to the amalgamate appearance of the zooecial walls in tangential section.

Amalgamoporus typicus, n. sp.

Plate 8, figs. 1-3

Material Studied

All specimens studied are from a zone between 371 feet and 383 feet above the top of the Tulip Creek sandstone at West Spring Creek (USNM locality 2146).

Four sectioned fragments from 2146-K; two sectioned fragments from 2146-K questionably assigned to the species.

Diagnosis

Zoaria bifoliate, dichotomously branching, smooth; edges rounded, without zooecia. Zooecia gently curved sigmoidal. Zooecial boundary or boundaries distinct in longitudinal and transverse views, jagged, a boundary zone in some specimens. Wall laminae longitudinal adjacent to zooecial void; transverse in the thickest part of the wall. Median plane with barely distinct median tubuli.

Description

Zoaria are bifoliate and dichotomously branching. Branching occurs at irregular intervals and angles. The nature of the basal attachment has not been observed. Branch width ranges from 1.45 mm to 3.0 mm. Branch thickness ranges from 0.5 mm to 1.43 mm. Zoarial surfaces are smooth. Zoarial edges are solid, without zooecia and rounded. Pustules and acanthopores have not been observed.

Zooecia are arranged in alternate longitudinal ranges and diagonal ranges at the zoarial surface. Zooecia intersect the zoarial surface obliquely at an angle varying from 40° to 80°.

Zooecia are oval at the zoarial surface. They are slightly sigmoidal and gently curved from their point of budding to the zoarial surface. The angle of budding ranges from 40° to 65°. The angle of exozone to the median plane ranges from 38° to 62°. Diaphragms number from one to three, most zooecia having only one diaphragm emplaced early in the exozone. Zooecia that contain two or three diaphragms show the first diaphragm emplaced early in the exozone and the subsequent ones emplaced near the zoarial surface. Diaphragms may be either planar or sigmoidal. The latter are emplaced with the bottom of the S in a ventral zooecial position.

Zooecial walls are longitudinally laminate adjacent to the zooecial void. The longitudinally laminate portions are connected by a zone of transverse laminae. The zooecial boundary results from the intersection of longitudinal laminae and transverse laminae and occurs near the dorsal edge of the zooecial wall. A second boundary line may occur near the ventral edge of the zooecial wall. The boundary line is thick and appears as a discontinuous and jagged zone in some walls. The endozone and exozone are not distinct, the exozone resulting from a gradual thickening of the zooecial wall.

Distally cystose interspaces may or may not be present.

The median plane is distinct, bilaminate, continuous, and contains regularly spaced median tubuli which are not as distinct as in species of *Stictopora*, *Cystostictopora*, *Eopachydictya*, and *Pachydictya*. There are three or four median tubuli per zooecium. The median tubuli are circular to oval in cross-section and number from twelve to fourteen per 0.5 mm along the median plane.

Remarks

A. typicus differs from all other species of bifoliate cryptostomes in having the amalgamoporid wall structure.

Types

Holotype USNM No. 162103, figured paratypes USNM Nos. 162104 and 162105, from the Tulip Creek Formation, West Spring Creek (USNM locality 2146).

Occurrence and Relative Abundance

Rare in zone K, Tulip Creek Formation, West Spring Creek (USNM locality 2146).

TABLE 8

Amalgamoporus typicus, n. sp.

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	7-17	13,15	12.14	3.395	14	4
Maximum zooecial void dimension	0.130-0.350	.24	0.22	0.0574	49	4
Minimum zooecial void dimension	0.08-0.15	0.1	0.11	0.361	49	4
Number of longitudinal ranges in 1 mm	5-7	6	5.75	0.622	12	4
Number of diagonal ranges in 1 mm	4-6	5	4.66	0.651	12	4

Cystostictoporus, n. gen.

Type Species

C. pachyphragmus, n. sp.

Diagnosis

Zoaria bifoliate, branching, large, may be self-encrusting in part; acanthopores present or absent; zooecia long, commonly with several diaphragms; cystiphragm-like structures present in early exozone or late endozone and commonly result in either laterally or distally cystose interspaces; zooecial boundary U-shaped in tangential view; median plane with straight or offset median tubuli.

Definition

Zoaria are bifoliate, irregularly branching, and commonly large. They may be partially self-encrusting. The zoarial surface is either smooth, without surface ornament, or with acanthopores. The zoarial edges are sharp to rounded. The zooecia are arranged in both longitudinal and diagonal ranges at the zoarial surface.

Zooecia are oval to round at the zoarial surface and intersect the zoarial surface obliquely. Zooecia are long and are either straight, gently curved, or slightly sigmoidal from the median plane to the zoarial surface. The angle of budding from the median plane is highly variable. Budding is alternate on opposite sides of the median plane. The zooecia may or may not contain diaphragms. Cystiphragm-like structures are present in the early exozone and may or may not give rise to cystose interspaces. Interspaces may be laterally or distally cystose. Distally cystose interspaces may or may not give rise to laterally cystose interspaces. Zooecia bear keels and sinuses at their proximal ends in those forms with curved zooecial tubes.

Zooecial walls are thick, longitudinally laminate with a steeply inclined inner portion. The boundary zones between zooecia are distinct and may show inflections. They are U-shaped in tangential view. Zooecial walls thicken gradually in a distal direction. The endozone and exozone are not distinct in zooecia which do not have cystiphragm-like structures. When cystiphragm-like structures are present, the first such structure is taken as the base of the exozone.

The median plane may or may not extend the full width of the zoarium. It does not extend the full length of the zoarium in the larger forms. The median plane contains evenly-spaced median tubuli which may be arranged in a straight line or may be offset. The median plane may be straight or slightly curved.

Acanthopores are present in some species and may be small or large, concentrated in the zooecial boundary, or scattered at random in the zooecial walls. Pseudoacanthopores occur in some forms and are restricted to the zooecial boundary. They result from the plane of the tangential section passing through an inflection in the zooecial boundary.

Diaphragms are most commonly present and most species have several per zooecium. They are thin, planar, simply curved, or sigmoidal in longitudinal view. All diaphragms have been emplaced in the exozone.

Remarks

Cystostictoporus is most similar to Phyllodictya in having cystose interspaces but it differs in having the cystiphragm-like structures in the proximal part of the zooecial wall which may or may not give rise to interspaces similar to those in Phyllodictya. Phyllodictya does not have the cystiphragm-like structures proximal to the cystose interspaces.

Cystostictoporus is related to Stictopora in having similar wall structure (stictoporid), in having a distinct and single zooecial boundary, and in possessing median tubuli. But it differs in having well-defined cystiphragm-like structures in the proximal exozone which may give rise to distally or laterally cystose interspaces. Cystostictoporus is similar to Ptilotrypa in possessing cystose interspaces but the latter genus lacks median tubuli.

Cystostictoporus distalis, n. sp.

Plate 9, figs. 1-5

Material Studied

All specimens found are from the McLish Formation, West Spring Creek (USNM locality 2126) and U. S. Highway 77 (USNM locality 2114).

The stratigraphic range of the species is from 151 feet to 158 feet above the top of the McLish sandstone, West Spring Creek (USNM locality 2126), and from 116 feet to 147 feet above the top of the McLish sandstone at U. S. Highway 77 (USNM locality 2114).

Fourteen sectioned fragments from 2126-H; twenty-seven peeled fragments from 2126-H; an undetermined number of unprepared fragments from 2126-H; two sectioned fragments from 2126-H questionably assigned to the species; two peeled fragments and two sectioned fragments from 2114-A questionably assigned to the species; three sectioned fragments from 2114-C; one sectioned fragment from 2114-C questionably assigned to the species.

Diagnosis

Zoaria bifoliate, dichotomously branching, without surface ornamentation; angle of budding highly variable; wall in exozone narrow; few diaphragms; cystiphragm-like structures in the interspaces overlapping in late ontogeny, not overlapping in early ontogeny; median tubuli not offset.

Description

Zoaria are bifoliate and branch dichotomously at varying intervals. Zoaria vary in width from 2.32 mm to 10.1 mm and in thickness from 0.6 mm to 2.6 mm. Zoarial surfaces are smooth and without surface ornamentation. Zooecia are arranged in both longitudinal and diagonal ranges at the zoarial surface.

Zooecia are oval to round at the zoarial surface and intersect the zoarial surface obliquely at an angle of from 143° to 160°. Zooecia are long and straight to slightly sigmoidal from their point of budding from the median plane to the zoarial surface. The angle of budding from the median plane varies from 28° to 88.5° depending on the zooecial shape. Sigmoidal zooecia have a much greater angle of budding than do straight zooecia. Endozone and exozone are not distinct, the exozone arising from gradual thickening of the endozone. The angle of exozone to median plane varies from 6.5° to 54°. The number of diaphragms per zooecium varies from zero to five, all of which are emplaced in the exozone. Most zooecia have one, two, or three exozonal diaphragms. Diaphragms are usually planar, but may be concave or convex. Cystiphragm-like structures are present in the early exozone-late endozone part of the zooecia and may or may not give rise to distally cystose interspaces. Cystiphragm-like structures in the early part of the exozone-late endozone may or may not be overlapping. More distal cystiphragm-like structures are overlapping. The number of cystiphragm-like structures in the distal exozone varies from zero to twelve.

The zooecial wall in the exozone varies in thickness from 0.01 mm to 0.15 mm. The zooecial boundary is continuous and jagged.

The median plane is bilaminate with evenly spaced median tubuli which are not offset. The median tubuli range in size from a maximum diameter of 0.012 mm to 0.045 mm. The number of median tubuli per 0.5 mm along the median plane ranges from eleven to seventeen. The number of median tubuli per zooecium ranges from four to six.

Remarks

C. distalis, n. sp. is the oldest species of the genus reported from rocks of the Simpson Group. It differs from other species of the genus by having thin exozonal walls, lacking acanthopores, and having few diaphragms per zooecium. The specific name refers to the distal endozonal cystiphragm-like structures.

Types

Holotype USNM no. 162106, figured paratypes USNM Nos.

162107-162110.

Occurrence and Relative Abundance

Abundant in the McLish Formation, zone H, West Spring Creek (USNM locality 2126). Rare in the McLish Formation, zones A and C, U. S. Highway 77 (USNM locality 2114).

TABLE 9

Cystostictoporus distalis, n. sp.

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	10-22	-	14.5	4.324	6	5
Maximum zooecial void dimension	0.105-0.27	0.15 0.2	0.17	0.048	67	6
Minimum zooecial void dimension	0.05-0.15	0.11	0.1	0.0169	66	6
Number of longitudinal ranges in 1 mm	4-7	4	4.75	1.034	8	5
Number of diagonal ranges in 1 mm	3-8	4	4.5	2	8	5

Cystostictoporus pachyphragmus, n. sp.

Plate 10, figs. 1-2

Material Studied

All specimens studied are from the McLish Formation from 123 feet to 307 feet above the top of the basal McLish sandstone; from 204 feet to 215.5 feet at West Spring Creek (USNM locality 2126); from 247 feet to 307 feet at U. S. Highway 77 (USNM locality 2114); from 123 feet to 178 feet at the west branch of Sycamore Creek (USNM locality 2129).

Four sectioned fragments from 2126-M; one unprepared fragment from 2126-M; one sectioned fragment from 2114-G questionably assigned to the species; one sectioned fragment from 2129-F; one peeled fragment from 2129-H.

Diagnosis

Zoaria bifoliate, thick, with rounded edges and thick zooecial walls; acanthopores concentrated in the zooecial boundaries; intersection of acanthopores and zooecial boundaries cause an inflection in the zooecial boundary; endozone short, indistinct from exozone; zooecia long.

Description

Zoaria are bifoliate and thick, with rounded edges. Branching has not been observed. The zoarial surface is irregular but without well defined monticules or maculae. Acanthopores are present at the zoarial surface but have been observed only in thin-sections where they are seen to be aligned in the zooecial boundaries. When an acanthopore intersects the zooecial boundary as seen in longitudinal section there is an inflection in the zooecial boundary.

Zooecia are oval at the zoarial surface. They intersect the zoarial surface obliquely at an angle of from 135° to 165°. Zooecia are straight for most of their distance but may be slightly sigmoidal near their point of origin from the median plane. The endozone is short and is indistinguishable from the early part of the exozone. Zooecial length varies from 1.10 mm to 2.48 mm. The angle of budding from the median plane varies from 35° to 75°, depending on the shape of the zooecium. The angle of exozone and median plane varies from 20° to 46°. The number of diaphragms per zooecium varies from two to four. They are always emplaced in the exozone. The diaphragms are either planar or slightly concave or convex. They are distinct diaphragm-wall units. Cystose interspaces are present, but do not alternate with zooecia.

The zooecial wall is thick and ranges in thickness from 0.065 mm to 0.25 mm. An apparent zooecial lining is caused by steeply dipping wall laminae adjacent to the zooecial void. The zooecial boundary is distinct, serrate, and contains inflections.

The median plane is continuous from one zoarial edge to the other and contains evenly spaced centrally placed median tubuli. The median plane is distinctly bilaminate with a central dark line containing the median tubuli. At about 100X in transverse view the laminae of the median plane are seen to continue into the endozone of zooecia. The median tubuli number from eleven to eighteen per 0.5 mm along the median plane.

Remarks

C. pachyphragmus, n. sp. is distinguished by the thick zooecial wall, extremely short endozone, long zooecia, lack of distally emplaced cystiphragm-like structures in the endozone, and the inflections in the zooecial boundary. The specific name is derived from the Greek *pachys* (thick) and *phragmus* (wall) and refers to the nature of the zooecial walls.

Types

Holotype USNM No. 162111, figured paratype USNM No. 162112, from the McLish Formation, West Spring Creek (USNM locality 2126).

Occurrence and Relative Abundance

Rare in the McLish Formation, zone M, West Spring Creek (USNM locality 2126). One fragment from the McLish Formation, zone G, U. S. Highway 77 is questionably assigned to the species. Rare in the McLish Formation, zones F and H, west branch of Sycamore Creek (USNM locality 2127).

TABLE 10

Cystostictoporus pachyphragmus, n. sp.

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	13-15	13	13.5	1	5	4
Maximum zooecial void dimension	0.12-0.23	0.19	0.18	0.0141	44	4
Minimum zooecial void dimension	0.055-0.11	0.08	0.08	0.01	45	4
Number of longitudinal ranges in 1 mm	0-6	5	4	2.345	5	4
Number of diagonal ranges in 1 mm	4-5	4	4.2	0.4472	5	4

Cystostictoporus acanthoporus, n. sp.

Plate 11, figs. 1-2

Material Studied

Specimens are from the McLish Formation from 181 feet to 246 feet above the top of the basal sandstone; from 220.5 feet to 226.5 feet above the top of the basal sandstone at West Spring Creek (USNM locality 2126); from 181 feet to 213 feet above the top of the basal sandstone at U. S. Highway 77 (USNM locality 2114); from 212 feet to 242 feet above the basal sandstone at the west branch of Sycamore Creek (USNM locality 2129).

Six sectioned fragments from 2126-0; three peeled fragments from 2126-0; one peeled fragment from 2126-0 questionably assigned to the species; one peeled fragment from 2114-E; thirteen peeled fragments from 2129-M_1; one peeled fragment from 2129-M_1 questionably assigned to the species.

Diagnosis

Zoaria bifoliate, irregularly branching; acanthopores present, large, shallow; zooecia mainly straight; cystiphragm-like structures commonly present in early exozone.

Description

Zoaria are bifoliate and irregularly branching. They vary in width from 1.5 mm to 5.0 mm within a single zoarium. This is also the range in zoarial width of the sample of the population studied. Zoaria vary in thickness from 0.3 mm to 2.8 mm. Surface features such as monticules, maculae, and annuli have not been observed. Acanthopores have been observed only in thin-sections.

Zooecia are arranged in both longitudinal and diagonal ranges at the zoarial surface. They are oval in cross-section at the zoarial surface, and intersect the zoarial surface at an angle of from 123° to 157°. Zooecia are straight to gently curved throughout most of their length but may be slightly sigmoidal near their proximal ends. They bud from the median plane at an angle of from 8° to 76° depending on the zooecial shape. The endozone and exozone are not distinguishable, the exozone being formed by a gradual thickening of the endozone. Overlapping cystiphragm-like structures when present, may be considered to mark the base of the exozone. Zooecia vary in length from 0.4 mm to 2.5 mm. Diaphragms number from zero to five per zooecium and are emplaced at varying levels within the zooecia. The diaphragms are usually planar but may be slightly curved. Cystiphragm-like structures are present at the proximal end of the exozone in at least some zooecia in a zoarium. They may develop into cystose interspaces in the distal part of the exozone. The cystose interspaces begin as distally overlapping cystiphragm-like structures and may develop into laterally cystose interspaces.

The zooecial wall in the exozone varies in thickness from 0.04 mm to 0.12 mm. The zooecial boundary is distinct, continuous, and may be serrate.

Acanthopores are distinct and are best seen in tangential section. They are concentrated in the zooecial boundary and occur only in the outer most exozone.

The median plane is distinctly bilaminate with a central dark zone which contains the median tubuli. The median tubuli are either straight or only slightly offset. There are from seven to thirteen median tubuli per 0.5 mm along the median plane. There are from three to five median tubuli per zooecium. Median tubuli range in maximum diameter from 0.02 mm to 0.04 mm. The width of the median plane varies from 0.02 mm to 0.05 mm.

Remarks

C. acanthoporus is distinguished from all other species of *Cystostictoporus* in having distinct, large shallow acanthopores concentrated in the zooecial boundary.

Types

Holotype USNM No. 162113, figured paratype USNM No. 162114.

Occurrence and Relative Abundance

Common in the McLish Formation, zone O, West Spring Creek (USNM locality 2126). One fragment from the McLish Formation, zone E, U. S. Highway 77 (USNM locality 2114). Common in the McLish Formation, zone M, west branch of Sycamore Creek (USNM locality 2129).

TABLE 11

<u>Cystostictoporus</u> <u>acanthoporus</u>, n. sp.

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	6-15	8,10	10.72	2.525	47	8
Maximum zooecial void dimension	0.13-0.38	0.25	0.2362	0.04891	158	8
Minimum zooecial void dimension	0.07-0.2	0.11	0.099	0.03601	158	8
Number of longitudinal ranges in 1 mm	4-7	5	5.17	0.923	35	7
Number of diagonal ranges in 1 mm	3-5	4	3.77	0.6661	35	7

Cystostictoporus cryptophragmus, n. sp.

Plate 12, figs. 1-3
Plate 13, figs. 1-3

Material Studied

All specimens are from the McLish Formation, West Spring Creek (USNM locality 2126). The stratigraphic range is from 226.5 feet to 356.5 feet above the top of the McLish sandstone.

One sectioned fragment from 2126-P; six peeled fragments from 2126-P; two peeled fragments from 2126-Q; three sectioned fragments from 2126-R; two sectioned fragments from 2126-S questionably assigned to the species; one sectioned fragment from 2126-T; one sectioned fragment from 2126-W.

Diagnosis

Zoaria bifoliate, self-encrusting, massive; overlapping cystiphragms occur in exozone of bifoliate portion of zoaria; self-encrustation is cystose or tabulate; median plane does not extend full width of zoarium.

Description

Zoaria are bifoliate during their early growth stages and become cystose and partially self-encrusting during later growth stages. Branching may or may not occur, and the branches may or may not show a self-encrusting, or massive cystose appearance. The zoaria are large, varying in width from 2.0 mm to 14 mm, and in thickness from 0.8 mm to 6 mm. The zoarial surfaces are irregular but without well-defined monticules or maculae. No acanthopores have been observed.

Zooecia are arranged in both longitudinal and diagonal ranges at the zoarial surface in forms with a free bifoliate portion without a self-encrustation. The zoarial surface in a region of self-encrustation appears cystose in shallow tangential section.

Zooecia form an angle with the zoarial surface which ranges from 120° to 155°. They rarely intersect the zoarial surface, but when they do they are oval in cross-section. They are sigmoidal in longitudinal view and bud from the median plane at an angle which varies from 24° to 75°.

The endozone and exozone are indistinct, the exozone arising by a gradual thickening of the endozone. The self-encrustation begins in the exozone and is either cystose or tabulate and may completely envelop the bifoliate portion of the zoarium. The bifoliate portion contains overlapping cystiphragm-like structures.

The zooecial length is impossible to measure because of the self-encrusting nature of the zoaria. Zooecial diaphragms number from zero to three and are emplaced in the exozone. They are either planar or curved in either direction. The thickness of the zooecial wall in the exozone is impossible to measure because of the self-encrusting habit. The zooecial boundary is distinct but becomes discontinuous in the self-encrusting portion of the zoarium.

The median plane does not continue to the edge of the zoarium. Median tubuli are contained within the median plane, are evenly spaced, are not offset, and number from six to eleven per 0.5 mm along the median plane. The median tubuli are from 0.02 mm to 0.03 mm in maximum diameter. They number from three to four per zooecium.

Remarks

C. cryptophragmus, n. sp. is distinguished from all other species in having large, partially self-encrusting zoaria. It is similar to other species of *Cystostictoporus* in its early growth stages, but becomes self-encrusting during later growth stages. The specific name (Greek, *kryptos*, hidden; *phragmos*, wall) refers to the self-encrusting nature of the zoarium.

Types

Holotype USNM No. 162115, figured paratypes USNM Nos. 162116-162120.

Occurrence and Relative Abundance

Rare in the McLish Formation, zones P, Q, R, S, T, and W, West Spring Creek (USNM locality 2126).

TABLE 12

Cystostictoporus cryptophragmus, n. sp.

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	9-17	11	13.37	2.185	27	5
Maximum zooecial void dimension	0.16-0.35	0.2 0.21	0.19	0.0997	110	5
Minimum zooecial void dimension	0.08-0.15	0.11	0.11	0.338	110	5
Number of longitudinal ranges in 1 mm	4-8	5	6	1.224	20	4
Number of diagonal ranges in 1 mm	3-5	4,5	4.2	0.767	20	4

Cystostictoporus pregigantius, n. sp.

Plate 14, figs. 1-3
Plate 15, figs. 1-3

Material Studied

Specimens found are from the McLish Formation, West Spring Creek and U. S. Highway 77; from 226.5 feet to 280 feet above the top of the basal sandstone, West Spring Creek (USNM locality 2126) and from zero to 213 feet above the basal sandstone at U. S. Highway 77 (USNM locality 2114).

Six sectioned fragments from 2126-P; two peeled fragments from 2126-P; one peeled fragment from 2114-A; one peeled fragment from 2114-E questionably assigned to the species.

Diagnosis

Zoaria bifoliate, large, some with insipient conspecific, self-encrustation; zooecia with distinct endozone and exozone when cystiphragms are present; zooecia long with from one to five diaphragms; zooecial boundary commonly with inflections.

Description

Zoaria are bifoliate, variable in thickness, and generally large. The zoarial surfaces may or may not show monticules. No maculae have been observed. The majority of zoarial fragments show regular, smooth surfaces. The width of zoarial fragments varies from 6 mm to 12 mm. The thickness of zoarial fragments varies from 1.3 mm to 2.25 mm. Some zoaria show an insipient conspecific self-encrustation.

Zooecia are arranged in both longitudinal and diagonal ranges at the zoarial surface. They intersect the zoarial surface obliquely at an angle ranging from 26° to 49°, and as a result are oval in cross-section at the zoarial surface. The zooecia are straight to gently curved from the median plane to the zoarial surface and may or may not be sigmoidal near their proximal end. The angle of zooecial budding varies from 34° to 67°. In zooecia that are separated by cystose interspaces, the first cystiphragm is taken as the beginning of the exozone. In zooecia that are not separated by cystose interspaces the endozone and exozone are not distinct. Zooecia are generally long, ranging in length from 0.8 mm to 3.3 mm. The number of diaphragms per zooecium range from one to five. Diaphragms are emplaced at various levels and are most commonly found in the exozone. Cystiphragms are either present or absent. When present they overlap in a distal direction until they begin to overlap laterally. A distally cystose interspace becomes a laterally cystose interspace. The zooecial wall in the exozone varies in thickness from 0.04 mm to 0.11 mm. The zooecial boundary is distinct and may or may not show inflections.

The median plane is distinctly bilaminate with a central dark zone which contains median tubuli. The median tubuli may or may not be offset. The median plane varies in width from 0.02 mm to 0.03 mm. The median tubuli are 0.03 mm in greatest diameter. The number of median tubuli per 0.5 mm along the median plane varies from seven to ten. The number of median tubuli per zooecium varies from three to five.

Remarks

C. pregigantius differs from all other species of the genus in having a small amount of conspecific overgrowth which can be seen to be a self-encrustation. The laminae from the zooecial walls can be traced into the laminae of the self-encrustation. This species may well have given rise to *C. cryptophragmus*, n. sp. by a further development of the self-encrustation. The species *C. gigantius*, n. sp. may have had its origin in *C. pregigantius*.

Types

Holotype USNM No. 162121, figured paratypes USNM Nos. 162122-162126 from the McLish Formation, West Spring Creek (USNM locality 2126).

Occurrence and Relative Abundance

Rare in the McLish Formation, zone P, West Spring Creek (USNM locality 2126). Rare in the McLish Formation, zones A and E (?), U. S. Highway 77 (USNM locality 2114).

TABLE 13

Cystostictoporus pregigantius, n. sp.

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	11-19	13	14.44	2.228	25	5
Maximum zooecial void dimension	0.17-0.38	0.22	0.24	0.064	110	5
Minimum zooecial void dimension	0.07-0.19	0.09	0.11	0.468	110	5
Number of longitudinal ranges in 1 mm	5-8	6	6.4	0.645	25	5
Number of diagonal ranges in 1 mm	3-5	5	4.4	0.763	25	5

Cystostictoporus gigantius, n. sp.

Plate 16, figs. 1-2

Material Studied

All known specimens are from the McLish Formation, West Spring Creek (USNM locality 2126) and show a stratigraphic range of from 255.5 feet to 266.5 feet above the top of the McLish basal sandstone.

Four sectioned fragments from 2126-Q; one peeled fragment from 2126-Q.

Diagnosis

Zoaria bifoliate, branching, large; zooecia arranged in longitudinal ranges and either diagonal or transverse ranges; acanthopores shallow when present; diaphragms may be oblique to the zooecial growth direction; median plane does not extend the width of the zooecium.

Description

Zoaria are bifoliate, branching, and large. Fragments vary in width from 5.5 mm to 10 mm and in thickness from 1.5 mm to 4 mm. The zoarial surface is commonly smooth without surface ornament. Acanthopores may be present and have been observed only in shallow tangential sections. The zooecia are arranged in both longitudinal and diagonal or transverse ranges. Most commonly the arrangement is in longitudinal and diagonal ranges. Zooecia intersect the zoarial surface obliquely at an angle varying from 105° to 152° and are oval at the zoarial surface.

Zooecia are mainly straight to slightly curved proximally from their point of budding from the median plane to the zoarial surface. They may be slightly sigmoidal at their proximal end. They bud from the median plane at an angle which varies from 16° to 52°. The endozone and exozone are not distinct between zooecia which lack cystiphragm-like structures. If these structures are present between zooecia the most proximal one marks the base of the exozone. The length of zooecia varies from 0.9 mm to 3.2 mm. Diaphragms number from zero to eight and are emplaced at random levels in the exozone. They may be planar or curved in either direction. They may be transverse or oblique to the zooecial growth direction. Sigmoidal diaphragms may be present. Cystiphragm-like structures are commonly present in the proximal part of the exozone and may overlap in a single series distally before forming a laterally cystose interspace. Cystose interspaces are not always present between zooecia. The zooecial wall in the exozone varies in maximum thickness from 0.03 mm to 0.1 mm. The zooecial boundary is distinct and most commonly shows inflections.

The median plane is bilaminate, does not extend to the zoarial edge, and contains median tubuli which may or may not be offset. The number of median tubuli per 0.5 mm along the median plane varies from three to nine. There are from three to five median tubuli per zooecium.

Remarks

C. gigantius, n. sp. contains the largest zoaria in diameter known among the bifoliate cryptostomes of the Simpson Group. It differs from all other species of *Cystostictoporus* except *C. cryptophragmus* in having a median plane which does not extend the full width of the zoarium.

Types

Holotype USNM No. 162127, figured paratype USNM No. 162128 from the McLish Formation, West Spring Creek (USNM locality 2126).

Occurrence and Relative Abundance

Rare in the McLish Formation, zone Q, West Spring Creek (USNM locality 2126).

TABLE 14

<u>Cystostictoporus</u> <u>gigantius</u>, n. sp.

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	9-16	12	11.9	2.209	28	5
Maximum zooecial void dimension	0.15-0.32	0.2	0.22	0.0458	110	5
Minimum zooecial void dimension	0.07-0.15	0.1	0.1	0.1918	110	5
Number of longitudinal ranges in 1 mm	4-7	5	5.84	0.9	25	5
Number of diagonal ranges in 1 mm	2-5	4	3.64	2.233	25	5

Cricodictyum, n. gen.

Type Species

Cricodictyum ponderosum, n. sp.

Diagnosis

Zoaria bifoliate, dichotomously branching, annulate, annuli contain extensions of the median plane with median tubuli. Zooecia gently curved, sigmoidal. Zooecial walls longitudinally laminate; boundary zones distinct, often serrate; pachydictyid wall structure. Zooecia in longitudinal ranges in endozone; at zoarial surface zooecia in curved diagonal ranges.

Description

Zoaria are bifoliate, dichotomously branching, rarely encrusting, and have surface annuli which contain branches of the median plane. The basal attachment has not been observed. Branching takes place at irregular intervals and branches are straight, transversely biconvex, and bear transverse surface annuli. Monticules and maculae have not been observed. Zoarial margins are sharp to rounded and contain median tubuli. Interspaces are numerous and are closed at the zoarial surface. They occur between zooecia and are of three distinct types: (1) tabulated, (2) laterally cystose, and (3) distally cystose. Tabulated interspaces contain planar or slightly curved tabulae which are continuous across the interspace. They may contain a few isolated cystiphragm-like structures. Laterally cystose interspaces have cystiphragm-like structures which overlap in a direction roughly at right angles to the zooecial growth direction. Distally cystose interspaces have cystiphragm-like structures which overlap in a distal direction. A laterally cystose interspace may begin as a distally cystose interspace.

Zooecia are arranged in curved diagonal ranges at the zoarial surface. Deep tangential views show that zooecia are arranged in longitudinal ranges in the endozone. Interspaces between zooecia are without pustules or acanthopores, and are usually either depressed below or raised above the zoarial surface.

Zooecia are gently curved, sigmoidal tubes which bud from either the main median plane or its branches. Zooecia nearest the annuli arise from the branches of the median plane. Annuli consist of branches of the median plane plus zooecia which have budded from the branches and associated interspaces. Zooecia which bud from the main median plane generally have a high angle of budding as compared to the low angle of budding from the branches of the median plane. Budding is alternate on opposite sides of the median plane but alternate zooecia may bud very close together. Keels and sinuses have not been observed.

Zooecial walls are longitudinally laminate. Boundary zones between zooecia are distinct, continuous, and often serrate. They result from the abutting laminae of adjacent zooecia which intersect each other at a low angle. The exo-zone begins at the level of the interspaces. Zooecial walls thicken gradually in a distal direction and there is no sharp zooecial curvature. Individual zooecial laminae represent growth lines.

Zooecial packing is arranged so that in tangential view it commonly appears that zooecia are surrounded by interspaces.

The endozone of a zooecium continues into the exozone and forms the dorsal boundary of the interspace. The ven-tral boundary of an interspace is formed by abutting laminae which are continuous with the tabulae or cystiphragm-like structures and the zooecial wall laminae. The proximal end of an interspace is taken to be the beginning of the exozone.

Diaphragms are thin, few, or absent. They appear to be randomly spaced. They may be planar or slightly curved. Laminae of diaphragms merge with the zooecial wall laminae.

Remarks

Cricodictyum is related to *Pachydictya* in the nature of the wall structure, especially as seen in tangential view, the continuous nature of the zooecial boundary as seen in tangential view, and the well-developed structure of the interspaces. It differs from *Pachydictya* and all other presently known *Cryptostomata* in having lateral branches of the median plane from which zooecia bud and which result in surface annuli roughly transverse to the direction of zoarial growth. It is further distinguished by having three distinct types of interspaces.

Cricodictyum ponderosum, n. sp.

Plate 17, figs. 1-2
Plate 18, figs. 1-2
Plate 19, figs. 1-4

Material Studied

All specimens studied are from the McLish Formation, West Spring Creek (USNM locality 2126) and show a stratigraphic range of from ninty-eight feet to 116 feet from the top of the McLish sandstone.

Six sectioned fragments from 2126-D; two peeled fragments from 2126-D; eight sectioned fragments from 2126-E.

Diagnosis

Zoaria bifoliate or encrusting, dichotomously branching, with surface annuli which contain branches of the median plane. Zooecia may be surrounded by interspaces which may be of either of three basic types. Distal zooecial boundaries are continuations of the endozone boundary.

Description

Zoaria are typically bifoliate, rarely encrusting, dichotomously branching, and annulate. They are large, ranging in width of a branch from 5 mm to 10 mm and in thickness of a branch from 0.6 mm to 2 mm. Surface annuli may be sharp to rounded. Median tubuli are observed in the median plane of each annulus in tangential section but are not seen to come to the zoarial surface. The edges of annuli appear solid.

Zooecia may form any angle with the zoarial surface. Zooecia are gently curved or sigmoidal from the median plane to the zoarial surface. The angle of budding is quite variable, depending on the zooecial shape, but averages about 45°. The angle of exozone to the median plane ranges from 20.5° to 105°. Diaphragms number from zero to three and are emplaced in the exozone. Diaphragms are planar or curved in a proximal zooecial direction.

Zooecia are commonly surrounded by interspaces which are closed at the zoarial surface. Interspaces may be tabulated, laterally cystose, distally cystose, or a combination.

Zooecial walls are longitudinally laminate. Individual laminae intersect the zooecial boundary at a high angle. The endozone and exozone are not distinct. The zooecial boundary distal to an interspace appears as a continuation into the exozone of the dark line of the endozone. Boundary lines proximal to an interspace are due to the intersection of laminae of interspace structures with zooecial wall laminae.

Maximum thickness of the zooecial wall in the exozone is 0.15 mm. A zooecial lining is not present.

Acanthopores or pustules have not been observed.

The median plane appears as a dark line with regularly spaced median tubuli ranging from nine to eleven per 0.5 mm along the median plane. Diameter of the median tubuli ranges from 0.025 mm to 0.045 mm.

Remarks

C. ponderosum, n. sp. shows the characters of the genus which at this time is monotypic.

Types

Holotype USNM No. 162129, figured paratypes USNM Nos. 162130-162136 from the McLish Formation, West Spring Creek (USNM locality 2126).

Occurrence and Relative Abundance

Rare in the McLish Formation, zones D and E, at West Spring Creek (USNM locality 2126).

TABLE 15

Cricodictyum ponderosum, n. sp.

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	11-18	16	14.6	2.53	6	5
Maximum zooecial void dimension	0.1-0.21	0.17	0.161	0.02	57	5
Minimum zooecial void dimension	0.06-0.195	0.09	0.095	0.036	56	5
Number of longitudinal ranges in 1 mm	5-7	5,6	5.8	0.83	5	5
Number of diagonal ranges in 1 mm	4-7	5	5.2	1.1	5	5

Genus PACHYDICTYA Ulrich 1882

Pachydictya Ulrich, 1882, Cincinnati Soc. Nat. Hist. Jour., Vol. 5, p. 152; Ross, 1961, Jour. Paleont., Vol. 35, pp. 338, 339.

Type Species

Pachydictya robusta Ulrich 1882.

Emended Definition

Colonies are bifoliate, rarely encrusting, and are ribbon-shaped or explanate. Monticules and maculae are common on the zoarial surface. Acanthopores are commonly present but are sometimes visible only in tangential section. They are restricted to the exozone.

Zooecia are arranged in both longitudinal and diagonal ranges at the zoarial surface or are randomly packed. They intersect the zoarial surface at a high angle. The zooecial cross-section at the zoarial surface varies from oval to round.

Zooecia may be straight to slightly curved from the point of budding from the median plane to the zoarial surface. Zooecia bud from the median plane at a variable angle. They begin with a short thin-walled endozone without distinct laminae. The exozone begins with the beginning of the tabulate interspaces. The tabulate interspaces commonly alternate with zooecia in longitudinal section. The interspaces are commonly tabulate with tabulae continuour from one wall to the other, rarely laterally cystose.

Zooecial diaphragms are distinctly diaphragm-wall units. The laminae are seen to be continuous from the diaphragms into the zooecial wall where they aid in the thickening of the zooecial wall in the exozone. Diaphragms are most variable in their number and position of emplacement. Most diaphragms are emplaced in the exozone and the most distal diaphragm may be very near the zoarial surface.

The zooecial boundary occurs either between adjacent zooecia or between a zooecium and an interspace. In either case it is distinct and continuous. The zooecial boundary in transverse sections may be represented by one or as many as five dark lines.

The median plane is distinctly bilaminate in most species with a central dark line containing straight or offset median tubuli. In some species the median plane is a simple dark line which contains median tubuli.

Remarks

Pachydictya is characterized by the nature of the tabulated interspaces. It could have arisen from a form similar to species of *P.* (*Eopachydictya*) Ross 1963, *nomen translatum*, which show primitive or rudimentary tabulated interspaces, by a gradual increase in complexity of the tabulated interspaces. *Pachydictya* is a wide-spread bifoliate cryptostome genus both geographically and stratigraphically in the Simpson Group and elsewhere. A thorough revision of the genus should reveal several subgenera. Two subgenera are herein considered, *P.* (*Pachydictya*) Ulrich, 1882, *nomen translatum*, and *P.* (*Eopachydictya*) Ross, 1963, *nomen translatum.*

P. (*Eopachydictya*) Ross, 1963, *nomen translatum*

Type Species

Eopachydictya gregaria Ross, 1963; Chazy Formation, Isle Le Motte, Vermont.

Diagnosis

Zoaria small, thin, fragile; zooecia separated by short tabulated interspaces with few tabulae; zooecial walls pachydictyid; median plane with evenly-spaced median tubuli.

Emended Definition

Zoaria are small, thin bifoliate, and branch dichotomously. Due to the fragile nature of the zoaria, a collection may contain only straight fragments which do not reveal the dichotomous branching. Zooecia are arranged in both longitudinal and diagonal ranges at the zoarial surface. The lateral interspaces may be slightly elevated. Acanthopores may or may not be present. Monticules and maculae have not been observed. Tabulated interspaces are flush with the zoarial surface. They are closed at the zoarial surface.

Zooecia bud from alternate sides of the median plane.

Adjacent zooecia are separated by rudimentary tabulate interspaces which contain only a few complete tabulae. Zooecial wall structure is pachydictyid as herein redefined (p. 154).

The median plane is distinctly bilaminate and contains evenly spaced median tubuli.

Remarks

Eopachydictya Ross, 1963 was proposed as "a primitive form of Pachydictya" (Ross 1963, p. 591). The writer believes that the morphological and stratigraphic evidence from forms from the Simpson Group warrants the phylogenetic placement of P. (Eopachydictya) as a possible progenitor of species of P. (Pachydictya). P. (Eopachydictya) has thinner walls in diameter and in length, smaller zoaria, smaller zooecia, and less well-developed interspaces than species of P. (Pachydictya). P. (Eopachydictya) also occurs in older Simpson rocks than P. (Pachydictya).

P. (Eopachydictya) is similar to P. (Pachydictya) in basic wall structure, especially as regards the zooecial boundary as seen in tangential view, in having median tubuli, and in having tabulated interspaces separating adjacent zooecia. It is distinguished from Pachydictya in the rudimentary nature of the interspaces in which are emplaced evenly-spaced, simple, thin tabulae or rarely, two laterally overlapping cystiphragm-like structures.

Pachydictya (Eopachydictya) segregata, n. sp.

Plate 20, figs. 1-6

Material Studied

All specimens are from the Tulip Creek Formation, West Spring Creek (USNM locality 2146). It occurs from twenty-four feet to 383 feet above the top of the Tulip Creek sandstone.

One sectioned fragment from 2146-B; two sectioned fragments from 2146-K; ten sectioned fragments from 2146-float; three sectioned fragments from 2146-float questionably assigned to the species.

Diagnosis

Zoaria bifoliate, early portions encrusting; tabulated interspaces alternate with zooecia; tabulated interspaces contain tabulae or cystiphragm-like structures which overlap laterally.

Description

Zoaria are bifoliate and may be encrusting in their early growth stages. They are small, thin, and fragile and as a result occur as small fragments. They branch dichotomously at various angles but most fragments are small and do not show branching. Zoarial fragments vary in width from 1 mm to 4 mm. All measured specimens are 0.55 mm in thickness. Zoarial surfaces are smooth, without monticules or maculae. Acanthopores have not been observed. Zooecia are arranged in both longitudinal and diagonal ranges at the zoarial surface. Zooecia may intersect the zoarial surface at nearly a right angle. This angle of intersection varies only within five degrees. Zooecia are slightly oval to nearly circular at the zoarial surface.

Zooecia are gently curved from the median plane to the zoarial surface. They bud from the median plane at an angle which ranges from 63° to 67°. The exozone and endozone are not distinct. The exozone arises from the endozone by a gradual thickening of the endozone and the development of the interspaces. The beginning of the interspace may be considered to mark the base of the exozone. The zooecia are short with the majority of the zooecial length in the exozone. Zooecia vary in length from 0.34 mm to 0.37 mm. The exozone varies in length from 0.21 mm to 0.32 mm. Zooecial diaphragms may or may not be present. Their emplacement is not consistent within a zoarium except that they are always emplaced in the exozone. They number from zero to three per zooecium and may be planar or curved in either direction. USNM No. 162138 (2146-float) shows the last diaphragm incomplete and overlapped by another incomplete diaphragm (plate 23, fig. 2) in only one zooecium.

The tabulated interspaces alternate with zooecia and may contain complete tabulae or be laterally cystose. The interspaces are narrow, generally less than one-half the width of a zooecium near the zoarial surface. They increase gradually in width distally. The thickness of the zooecial wall in the exozone is difficult to measure due to the interspaces. The zooecial lining varies from 0.02 mm to 0.04 mm in thickness. The zooecial boundary is distinct and either continuous or discontinuous. It is irregular and sometimes serrate as seen under high magnifications (at least 100X).

The median plane contains evenly-spaced median tubuli which vary in maximum diameter from 0.02 mm to 0.02 mm. There are from eight to fourteen median tubuli per 0.5 mm along the median plane. The median plane varies in width from 0.02 mm to 0.04 mm. Median tubuli number either three or four per zooecium.

Remarks

Prior to the present work *P*. (*Eopachydictya*) was monotypic, *E*. *gregaria* Ross, 1963, from the Chazy Formation, Isle Le Motte, Vermont, being the only described species. *P*. (*Eopachydictya*) *segregata*, n. sp. is similar to *P*. (*Eopachydictya* Ross) *gregaria* in the nature of the interspaces and construction of the zooecial wall but differs from *P*. (*Eopachydictya*) *gregaria* in having several more tabulae and laterally overlapping cystiphragm-like structures in the tabulated interspaces and in lacking acanthopores. The specific name (L. *segregatus*, set apart) refers to the wide stratigraphic range of the species in the Tulip Creek Formation.

Types

Holotype USNM No. 162137, figured paratypes USNM Nos. 162138-162142.

Occurrence and Relative Abundance

Rare in the Tulip Creek Formation, zones B and K, and common in zone "float," at West Spring Creek (USNM locality 2146).

TABLE 16

_P_. (_Eopachydictya_) _segregata_, n. sp.

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	9-14	9,10,11	10.4	1.505	10	5
Maximum zooecial void dimension	0.16-0.3	0.23 0.26	0.23	0.036	34	5
Minimum zooecial void dimension	0.08-0.18	0.12	0.124	0.0236	34	5
Number of longitudinal ranges in 1 mm	3-5	4	4	0.7071	4	3
Number of diagonal ranges in 1 mm	3-4	3,4	3.5	0.5744	4	3

Subgenus PACHYDICTYA Ulrich, 1882 *nomen translatum*

Type Species

Pachydictya robusta Ulrich, 1882

Definition

This subgenus includes those species of *Pachydictya* which have well-developed tabulate or cystose interspaces. The interspaces commonly surround the zooecia and appear to alternate with zooecia in longitudinal section.

Remarks

The nominate subgenus includes all of the species of *Pachydictya* which have previously been described outside of the present work.

Pachydictya (*Pachydictya*) *robusta* Ulrich, 1882

Plate 23, fig. 7
Plate 24, figs. 1-2
Plate 25, figs. 1-3
Plate 26, figs. 1-2
Plate 27, figs. 1-2
Plate 28, figs. 1-2

P. robusta Ulrich, 1882, Jour. Cincinnati Soc. Nat. Hist., vol. 5, p. 173, pl. 8, figs. 10 a-c. Phillips, Paleont., vol. 3, pt. 1, p. 14, pls. 4, 5.

P. bromidensis Loeblich, 1942, Jour. Paleont., vol. 16, no. 4, p. 435, pl. 64, figs. 21, 22.

Material Studied

All material studied is from the Bromide Formation, Spring Creek (USNM locality 2132), U. S. Highway 77 (USNM locality 2116) and west branch of Sycamore Creek (USNM locality 2127). Its stratigraphic range is from fifty-three feet to 400 feet above the top of the Bromide sandstone at Spring Creek; from thirty-four feet to 158 feet above the top of the Bromide sandstone at U. S. Highway 77; from 105 feet to 119 feet above the top of the Bromide sandstone at the west branch of Sycamore Creek.

Three sectioned and one peeled fragment from 2132-E; one sectioned and one peeled fragment from 2116-D; thirteen sectioned fragments from 2132-F; four unprepared fragments from 2132-F; fourteen sectioned fragments from 2132-G; eight sectioned fragments from 2132-H; six sectioned fragments from 2132-L; two sectioned fragments from 2132-M; eight sectioned fragments from 2132-O; ten sectioned fragments from 2132-Q; four sectioned fragments from 2132-T; nine sectioned fragments from 2132-X; twelve sectioned fragments from 2132-X_3; five sectioned fragments from 2132-X_5; four sectioned fragments from 2132-X_7; three sectioned fragments from 2132-X_9; two sectioned fragments from 2132-X_{11}; eight sectioned fragments from 2132-X_{13}; eight sectioned fragments from 2132-X_{15}; one peeled fragment from 2116-C; two sectioned specimens from 2116-D; two peeled specimens from 2116-H; three sectioned and one peeled fragment from 2127-H.

Diagnosis

Zoaria bifoliate, explanate, rarely encrusting; zoarial surface with monticules and maculae; zooecial apertures may be elongated and constricted; acanthopores are common and abundant; zooecia are long and contain up to twenty-one diaphragms, not all of which are continuous across the zooecium.

Description

Zoaria are bifoliate, rarely encrusting, wide, thin and dichotomously branching. The zoarial branch width varies from 4.5 mm to 23 mm and in thickness from 0.5 mm to 5.6 mm. Zoarial surfaces are irregular and commonly with well-defined monticules or maculae. Sharp-pointed protuberances from the zoarial surface have been observed, but the adjacent zooecia do not seem to be modified as in the case of other monticules. Solid areas without zooecia may or may not be present at the zoarial surface and may be either slightly elevated or slightly depressed relative to the level of the majority of the zoarial surface. Acanthopores have been observed only in thin-section. Zoarial margins are sharp and may or may not show a border without zooecia.

The zooecia are arranged in both longitudinal and diagonal ranges or may show a random packing at the zoarial surface. The zooecia intersect the zoarial surface at an angle most commonly near 90° but ranging from 85° to 36°. The smaller angle is rare and is observed only on specimens which are considered by the writer to be immature or badly weathered specimens. The zooecia are most commonly oval to round at the zoarial surface but in a few specimens are highly irregular. This is a result of the constriction and accompanying elongation of the aperture. This condition is not common and is most often associated with abundant acanthopores.

The zooecia are nearly straight to only slightly curved from the median plane to the zoarial surface. Laminae from the median plane can be traced into the endozone of the zooecia. The endozone is a median plane-wall unit. The exozone begins where the endozonal wall bifurcates and the bifurcations are connected by tabulae, or where the wall thickens abruptly in the absence of tabulated interspaces. The zooecia vary in length from 0.4 mm to 1.8 mm. The endozone is short, ranging in length from 0.07 mm to 0.5 mm. The majority of the zooecial length is the exozone which ranges in length from 0.38 mm to 1.75 mm.

The number of diaphragms per zooecium varies from zero to twenty-one. There is variation in the number of diaphragms per zooecium in one zoarium of from one to three. Diaphragms may be planar, curved in either direction, complete or incomplete. Incomplete diaphragms commonly curve proximally and abut against the adjacent diaphragm. These incomplete diaphragms rarely form an overlapping series for a short distance distally, then are succeeded by normal diaphragms. The diaphragms are distinctly diaphragm-wall units, and are emplaced at varying levels in the exozone.

Tabulated interspaces are well-developed and most commonly alternate with zooecia. They consist most commonly of complete tabulae, but rarely may show a laterally cystose structure.

The thickness of the zooecial wall in the exozone varies from 0.02 mm to 1 mm. The zooecial boundary is distinct, irregular and separates the zooecial wall from the wall of a tabulated interspace. The tabulae in the tabulated interspaces consist of laminae which abut sharply against laminae of the diaphragm-wall units of the zooecial wall and form the zooecial boundary. The tabulated interspaces are generally solid with laminae near and at the zoarial surface. If tabulated interspaces are absent between zooecia, the zooecial wall is shared by adjacent zooecia and the boundary line is due to the laminae of adjacent zooecia abutting sharply against each other.

Acanthopores are seen only in sectioned or peeled specimens and may form a ring around the zooecial void. They are most abundant in the solid areas of the zoarial surface. They are large with a large lumen and may be as large as 0.066 mm in diameter. They are circular in cross-section and are restricted to the exozone.

The median plane is distinctly bilaminate with a central dark line containing median tubuli. The median plane ranges in thickness from 0.02 mm to 0.05 mm. The median tubuli range in maximum diameter from 0.015 mm to 0.05 mm.

There are from five to sixteen median tubuli per 0.5 mm along the median plane and they vary from four to six per zooecium. The median tubuli may or may not be offset.

Remarks

P. (*Pachydictya*) *robusta* is distinguished from all other species by the nature of the wall laminae as seen in longitudinal and transverse views, the complexity of the tabulated interspaces, the large length of the zooecia and the relatively large number of diaphragms. *P.* (*Pachydictya*) *robusta* is most similar to *P.* (*Pachydictya*) *everetti* Ulrich from the "Trenton Group," Dixon, Illinois (Ulrich 1890, p. 523) and *P.* (*Pachydictya*) *foliata* Ulrich from the "lower third of the Trenton shales" of Minnesota (Ulrich 1895,

p. 151). It differs from *P.* (*Pachydictya*) *everetti* in having monticules and solid areas at the zoarial surface. It is distinguished from *P.* (*Pachydictya*) *foliata* in having the tabulae in the tabulated interspaces continue to the zoarial surface, and in greater variability in position of diaphragm emplacement. *P. bromidenses* Loeblich, 1942 is considered a junior subjective synonym of *P.* (*Pachydictya*) *robusta* Ulrich, 1882 by the writer.

Types

Lectotype USNM No. 137608 designated by Phillips 1960, p. 14. Paralectotypes USNM Nos. 137609-137611, 137623-137625, and USNM No. 43701. These specimens are from the "lower beds of the Trenton Group, near Knoxville, Tennessee" (Ulrich 1882). The exact location is not known. Figured specimens USNM Nos. 162143-162153.

Occurrence and Relative Abundance

Abundant in the Bromide Formation, zones F, G, H, O, and Q, common in zones M, X_1, X_3, X_5, X_7, X_{13}, and X_{15}, rare in zones L, X_9, and X_{11}, Spring Creek USNM locality 2132. Rare in the Bromide Formation, zones C, D, and H, U. S. Highway 77 USNM locality 2116. Rare in the Bromide Formation, zone H, at the west branch of Sycamore Creek USNM locality 2127.

TABLE 17

Pachydictya robusta Ulrich

Zone 2132-E

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	8-13	10	10.25	1.236	16	6
Maximum zooecial void dimension	0.21-0.26	0.27	0.278	0.0109	78	6
Minimum zooecial void dimension	0.11-0.23	0.15	0.17	0.0277	77	6
Number of longitudinal ranges in 1 mm	3-6	5	4.63	0.8944	19	6
Number of diagonal ranges in 1 mm	3-5	4	4.05	0.6212	19	6

TABLE 18

Pachydictya robusta Ulrich

Zone 2132-F

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	7-16	12	11.9	1.931	50	10
Maximum zooecial void dimension	0.17-0.34	0.23	0.246	0.1608	220	10
Minimum zooecial void dimension	0.1-0.28	0.15	0.16	0.0519	220	10
Number of longitudinal ranges in 1 mm	3-7	4	4.5	0.9022	44	9
Number of diagonal ranges in 1 mm	3-4	4	3.5	-	44	9

TABLE 19

Pachydictya robusta Ulrich

Zone 2132-G

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	9-14	10,11	10.9	1.1704	35	7
Maximum zooecial void dimension	0.19-0.32	0.25	0.25	0.0333	154	7
Minimum zooecial void dimension	0.11-0.21	0.16	0.157	0.0264	154	7
Number of longitudinal ranges in 1 mm	3-5	4	4.03	0.4902	30	6
Number of diagonal ranges in 1 mm	3-4	3	3.3	0.4806	30	6

TABLE 20

Pachydictya robusta Ulrich

Zone 2132-0

Quantitative Data

Character	Range	Mode	Arithmetic Mean	Standard Deviation	Number of Measurements	Zoaria Measured
Number of whole zooecia in 1 mm sq.	8-15	9	10.7	1.8027	30	6
Maximum zooecial void dimension	0.25-0.33	0.28	0.29	0.01897	132	6
Minimum zooecial void dimension	0.16-0.28	0.18	0.19	0.01974	132	6
Number of longitudinal ranges in 1 mm	4-6	4	4.57	0.626	30	6
Number of diagonal ranges in 1 mm	3-4	3	3.37	-	30	6

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EXPLANATION OF PLATE 1

Stictopora parvus, n. sp.

1a. Oblique tangential view of holotype USNM No. 162077, showing median plane and median tubuli in lower left of figure. (X30). McLish Formation, West Spring Creek, 2126-C. 1b. Longitudinal view of same. Note nature of diaphragms. (X30).

2a. Oblique tangential view of paratype USNM No. 162078, passing through median plane. Median plane and median tubuli are visible in the lower third of figure. (X30). Same locality and horizon as above. 2b. Longitudinal view of same specimen which split along median plane during preparation. Note sigmoidal zooecial shape, irregular zooecial boundary, and position and nature of diaphragms. (X30).

3. Longitudinal view of paratype USNM No. 162079, showing zooecial shape from median plane to surface. Note irregular, jagged nature of zooecial boundary and presence of one or two diaphragms per zooecium. (X30). Same locality and horizon as above.

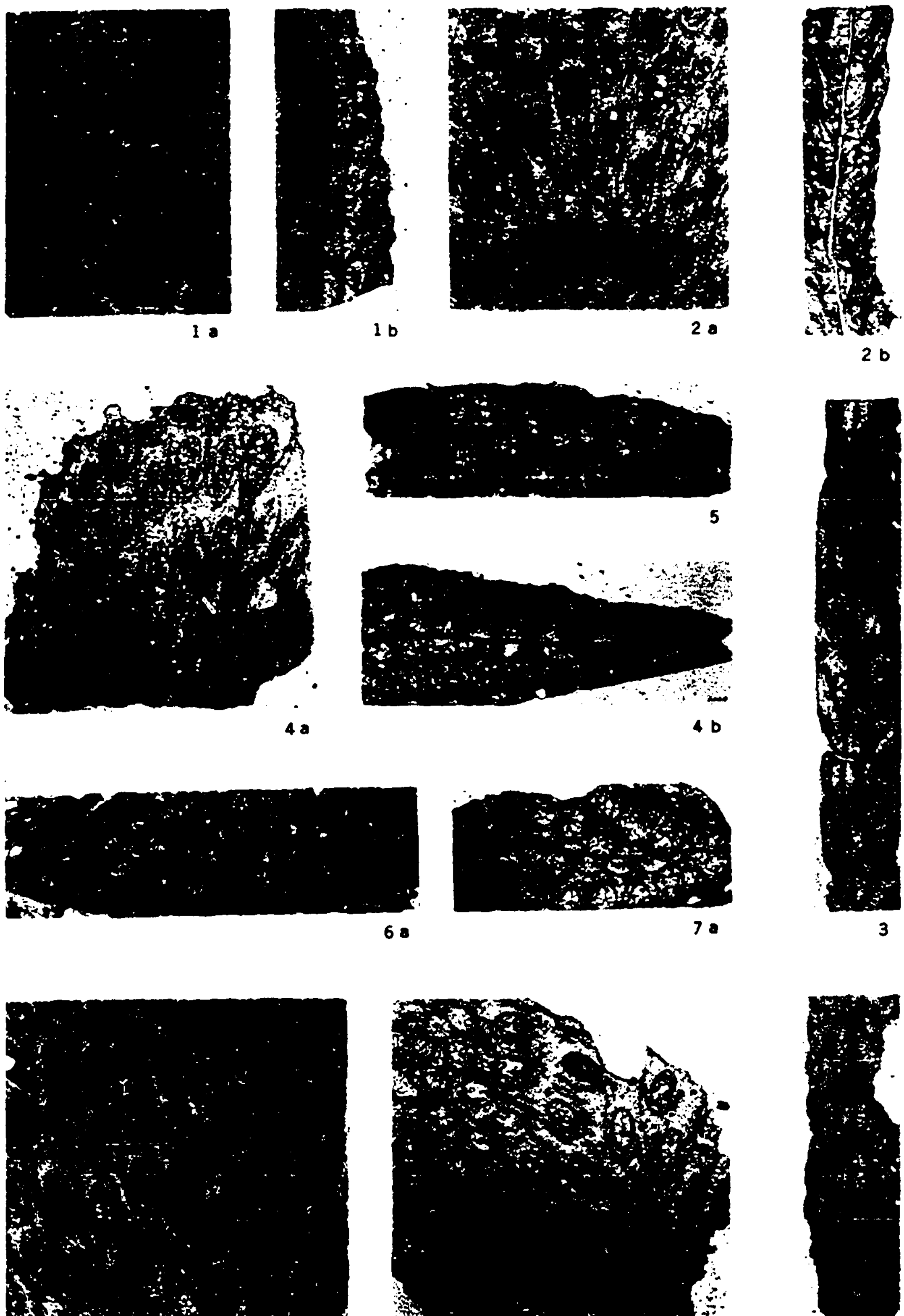
4a. Slightly oblique tangential view of paratype USNM No. 162080. (X30). Same locality and horizon as above.

5. Transverse view of paratype USNM No. 162981. (X30). Same locality and horizon as above.

6a. Transverse view of paratype USNM No. 162082, showing width of colony, median tubuli, and zooecial boundaries. (X30). Same locality and horizon as above. 6b. Shallow tangential view of same showing zooecial shape near zoarial surface, boundary lines, and zooecial lining. (X30).

7a. Transverse view of paratype USNM No. 162083. Note median tubuli, lack of sharp distinction between endozone and exozone. (X30). Same locality and horizon as above. 7b. Oblique tangential view of same showing pustules, zooecial shape, and zooecial lining. Median plane and median tubuli visible in upper left of figure. (X30). 7c. Slightly oblique longitudinal view of same. Note median tubuli in median plane. (X30).

PLATE 1



1 a 1 b 2 a 2 b

5

4 a 4 b

6 a 7 a 3

6 b 7 b 7 c

EXPLANATION OF PLATE 2

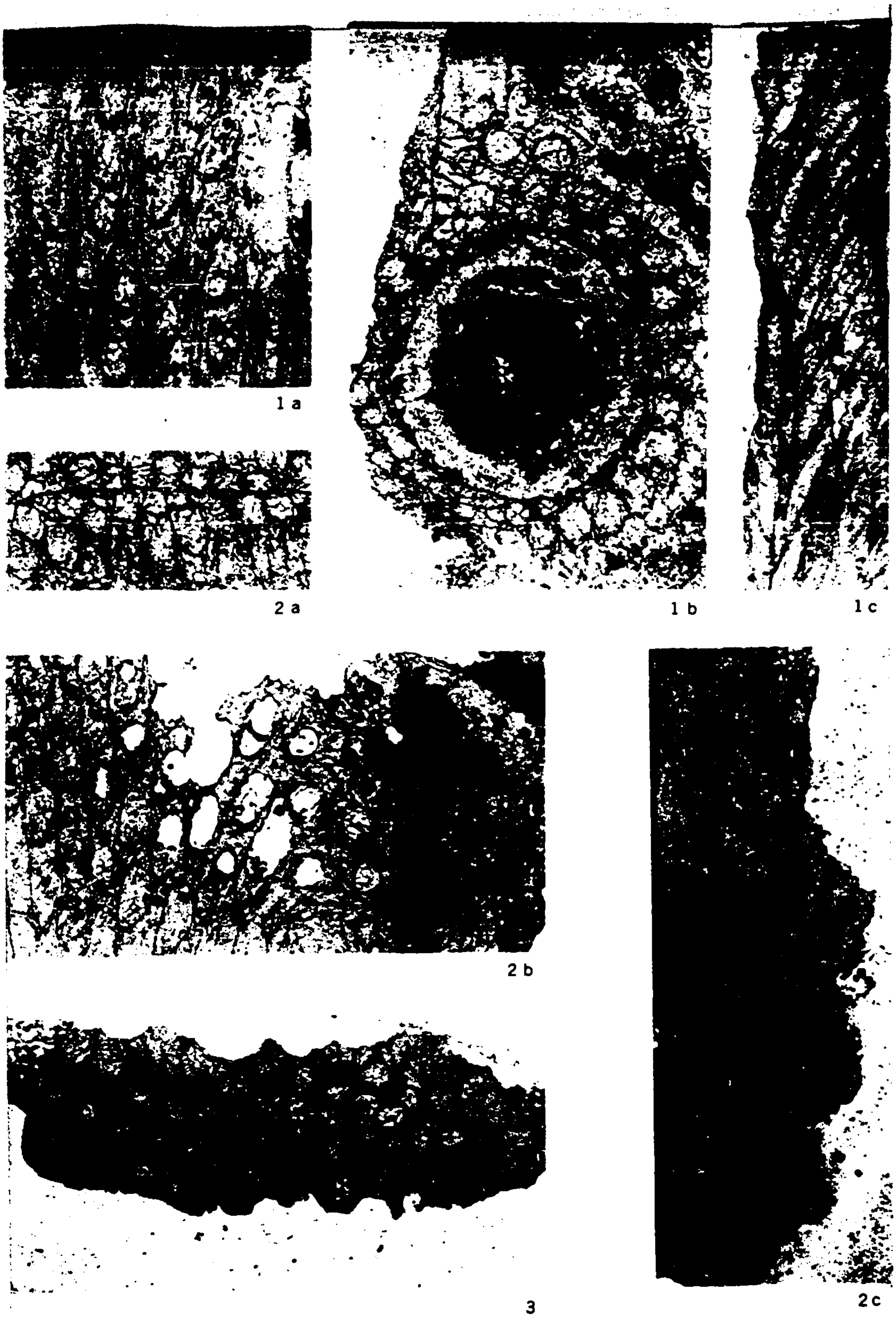
Stictopora dissitus, n. sp.

1a. Tangential view of holotype USNM No. 162084, showing zooecial shape near the zoarial surface and zooecial alignment in longitudinal and diagonal ranges. Note horse-show-shape of zooecial boundaries which are not continuous around the top of zooecia. (X30). McLish Formation, West Spring Creek, 2126-F. 1b. View transverse to long axis of an echinoderm stem encrusted by the same specimen. Note median plane in upper left of view. (X30). 1c. Longitudinal view of same specimen showing zooecial shape, nature of the zooecial boundary, and diaphragms near the zoarial surface. (X30).

2a. Transverse view of paratype USNM No. 162085, showing median plane with median tubuli. (X30). Same locality and horizon as above. 2b. Deep tangential view of same specimen showing zooecial alignment and cystose encrustment in the right one-third of illustration. (X30). 2c. Longitudinal view of same specimen showing cystose interspaces. (X30).

3. Transverse view of weathered paratype USNM No. 162086, showing bends in the median plane, median tubuli and zooecial arrangement. (X30). Same locality and horizon as above.

PLATE 2



EXPLANATION OF PLATE 3

Stictopora dissitus, n. sp.

1a. Oblique tangential view of paratype USNM No. 162087, showing median plane with median tubuli appearing as nearly vertical rods. (X30). McLish Formation, West Spring Creek, 2126-F. 1b. Longitudinal view of same specimen, broken along zooecial boundaries. (X30).

2a. Oblique longitudinal view of paratype USNM No. 162088, showing nature of zooecial boundary. (X30). Same locality and horizon as above. 2b. Shallow tangential view of same specimen showing zooecial shape, alignment of zooecia, and horseshoe-shaped zooecial boundaries. Note beginning of dichotomous branching near top of illustration. (X30).

3a. Transverse view of paratype USNM No. 162089, showing nature of zooecial boundaries and median plane with median tubuli. Light areas normal to median plane are irregularities in the zooecial boundaries. (X30). Same locality and horizon as above. 3b. View of same specimen encrusting an echinoderm stem. Note development of cystose interspaces. (X30).

PLATE 3

EXPLANATION OF PLATE 4

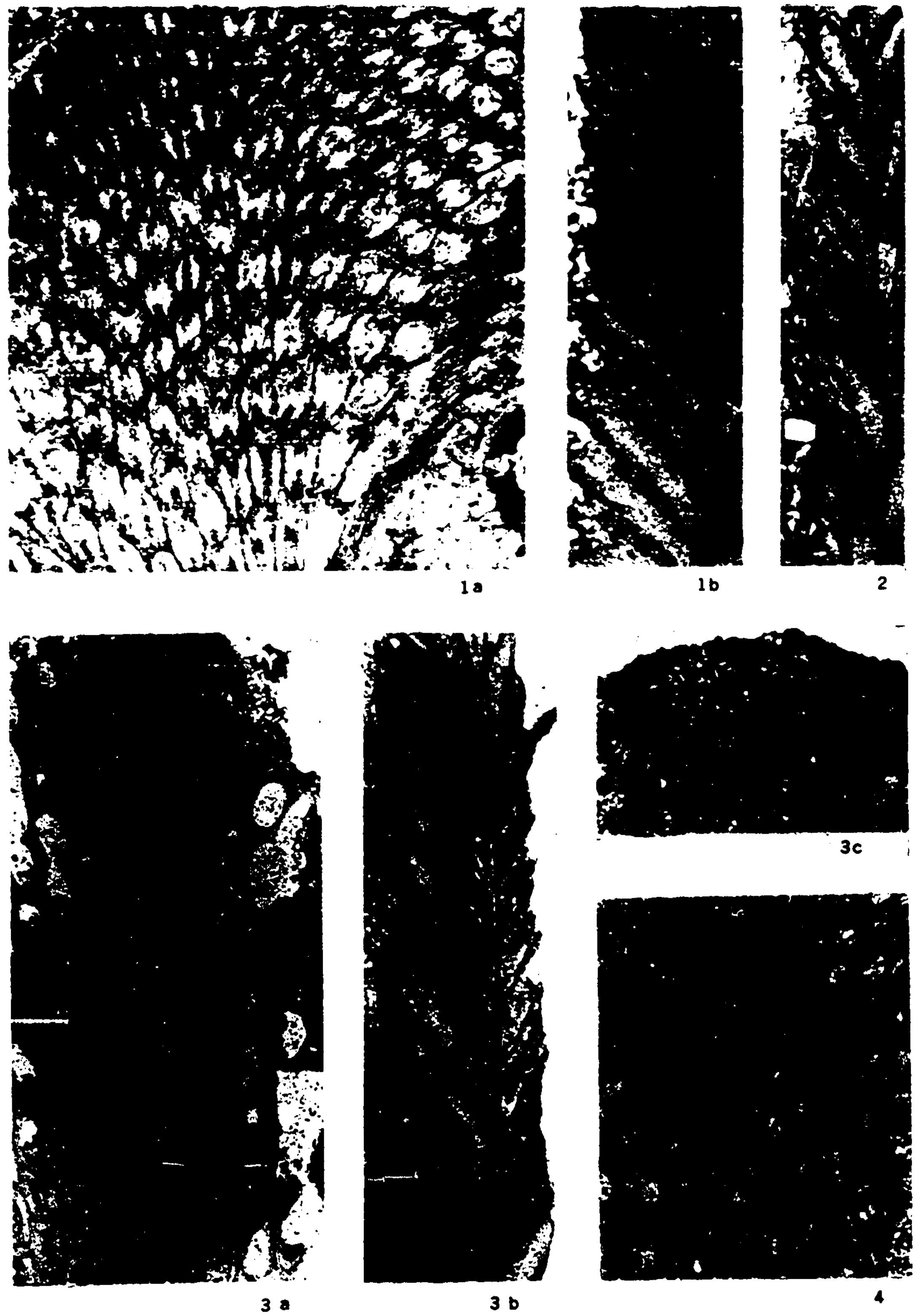
Stictopora praecox, n. sp.

1a. Tangential view of holotype USNM No. 162090, showing nature of the zooecial wall. Note gaps in the boundary zones resembling acanthopores. These are the result of inflections of laminae in the zooecial boundary. Also note the median tubuli in the lower right-hand portion of the illustration. Their orientation roughly parallels the zooecial ranges and at the edge of the zoarium they are almost normal to the zoarial edge. (X30). McLish Formation, West Spring Creek, 2126-6. 1b. Longitudinal view of the same specimen showing zooecial curvature, indistinct endozone and exozone, and inflections in the zooecial boundary. Note early thickening of the zooecial walls and the depth of diaphragms. (X30).

2. Longitudinal view of paratype USNM No. 162091, showing a tabulated interspace in the lower central part of the illustration. (X30). Same locality and horizon as above.

3a. Tangential view of paratype USNM No. 162092, showing zooecial shape, alignment of zooecia in longitudinal and diagonal ranges, and the horseshoe-shaped zooecial boundary. (X30). Tulip Creek Formation, West Spring Creek, 2146-float. 3b. Longitudinal view of the same specimen showing zooecial shape. (X30). 3c. Transverse view of the same specimen showing zooecial packing and median tubuli in the median plane. (X30).

4. Shallow tangential view of paratype USNM No. 162093, showing zooecial shape at the zoarial surface and the nature of the zooecial boundary. (X30). McLish Formation, West Spring Creek 2126-B.


1a
1b
2
3a
3b
3c
4

EXPLANATION OF PLATE 5

Stictopora miniacanthoporus, n. sp.

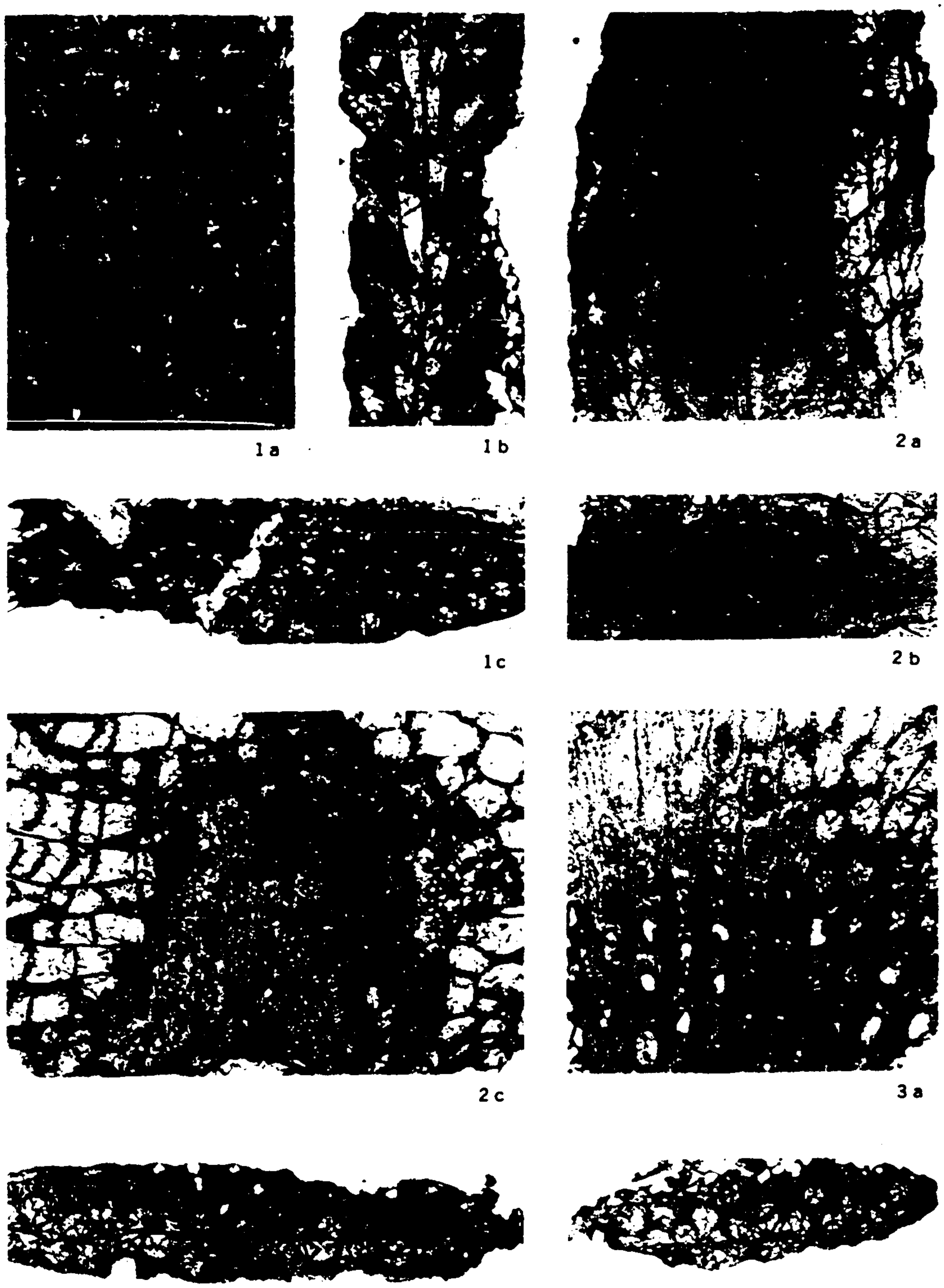
1a. Tangential view of holotype, USNM No. 162094, showing zooecial shape near zoarial surface, alignment of zooecia in both longitudinal and diagonal ranges, and horseshoe-shaped zooecial boundary. (X30). McLish Formation, West Spring Creek, 2126-M. 1b. Longitudinal view of same showing zooecial shape from the median plane, nature of zooecial boundary, and diaphragms. Light areas in the median plane represent intersections of the plane of the section with median tubuli. (X30). 1c. Transverse view of same showing large median tubuli, nature of zooecial packing, and zooecial walls. (X30).

2a. Longitudinal view of paratype, USNM No. 162095, showing encrustation by a trepostomatous bryozoan. (X30). Same locality and horizon as above. 2b. Oblique transverse view of same showing the solid zoarial edge with continuous median plane bearing median tubuli. (X30). 2c. Tangential view of same showing zooecial shape and encrusting trepostome. (X30).

3a. Tangential view of paratype, USNM No. 162096, showing small acanthopores occurring mainly in the zooecial boundary. Note alignment of zooecia in longitudinal and diagonal ranges. In upper right hand corner of illustration the section passes into the endozone. (X30). Same locality and horizon as above. 3b. Transverse view of same showing median plane with median tubuli, zooecial packing, and nature of the zooecial walls. (X30).

4. Transverse section of paratype USNM No. 162097, showing large median tubuli in the median plane. Lower part of specimen is badly weathered. (X30). Same locality and horizon as above.

PLATE 5



EXPLANATION OF PLATE 6

Stictopora flabellatus, n. sp.

1a. Oblique transverse view of holotype USNM No. 162098, showing large acanthopores, nature of zooecial walls, and median tubuli in the median plane. (X30). McLish Formation, West Spring Creek, 2126-S. 1b. Longitudinal view of same, showing long, slightly curved zooecia and long, large, straight acanthopores in the zooecial wall oriented at right angles to the zoarial surface and to the plane of the median plane. (X30). 1c. Transverse view of same near one edge of the zoarium showing continuous median plane with median tubuli. Note median tubuli curving toward zoarial surface near the edge of the zoarium. (X30).

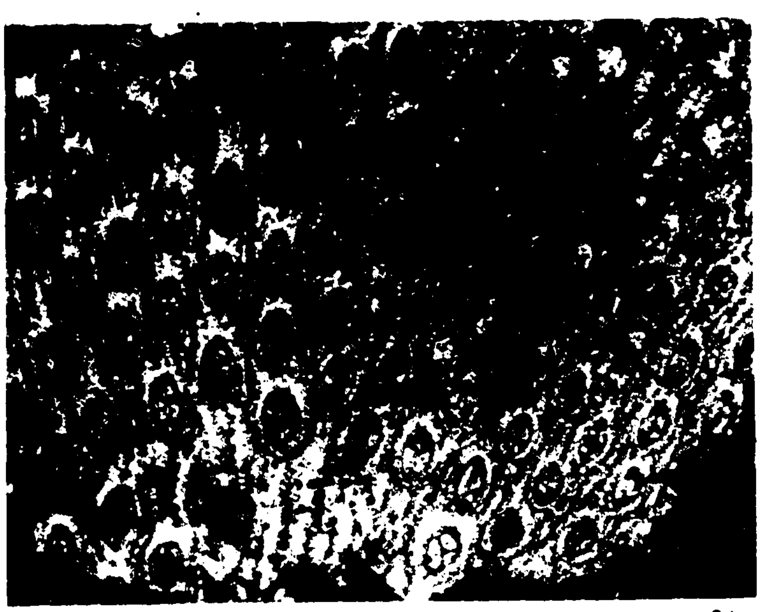
2a. Longitudinal view of paratype USNM No. 162099, showing zooecial curvature, diaphragms, and zooecial boundary. (X30). Same locality and horizon as above. 2b. Tangential view of same showing zooecial shape near the zoarial surface, nature of the zooecial walls, and acanthopores. (X30).

PLATE 6

1a

1b

2a



2b

1c

EXPLANATION OF PLATE 7

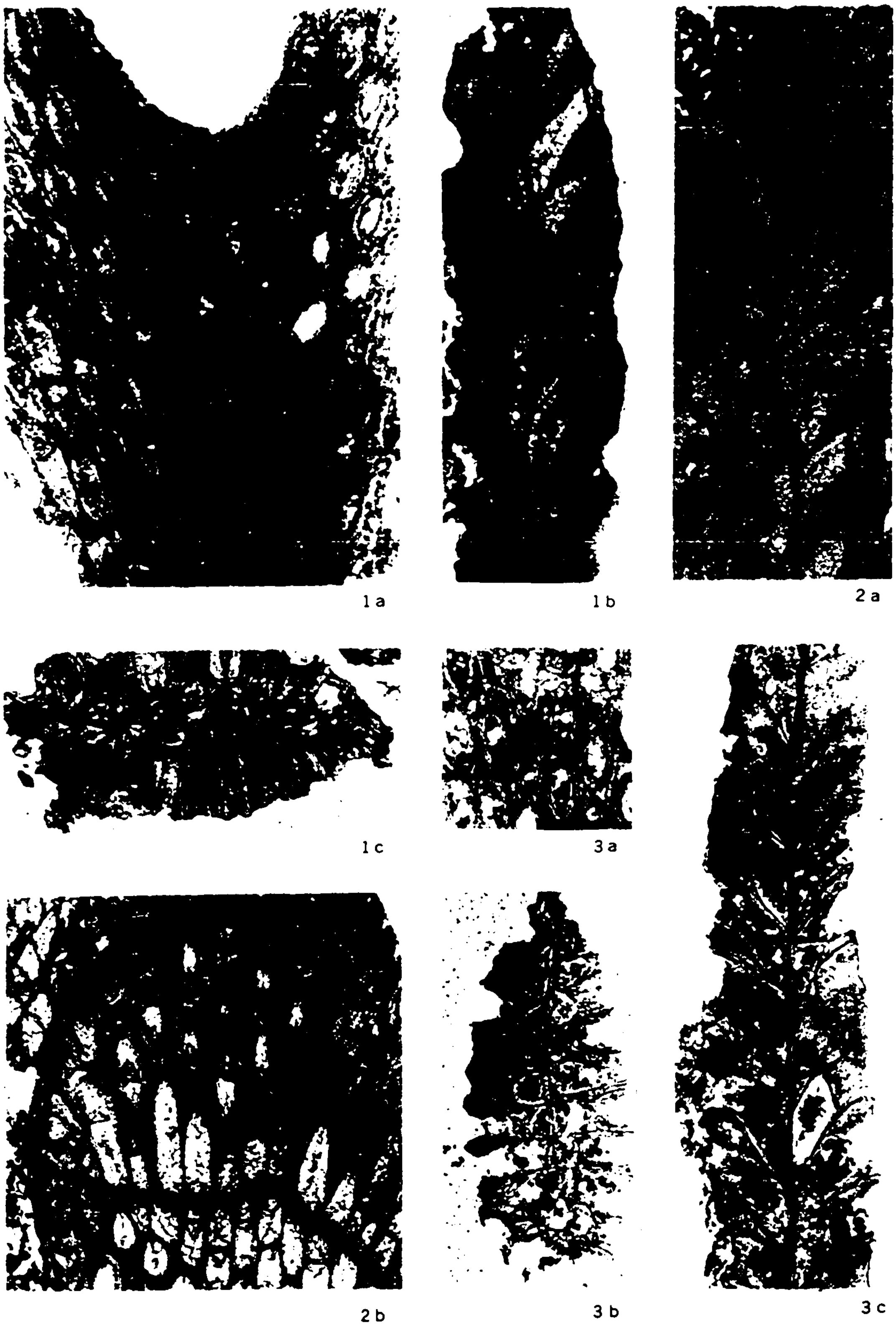
Stictopora intermedius, n. sp.

1a. Tangential view of holotype USNM No. 162100, near area of dichotomous branching showing zooecial shape near the zoarial surface and nature of the zooecial wall. Note discontinuous nature of the zooecial boundary in this view which gives the appearance of acanthopores (pseudo-acanthopores). (X30). Tulip Creek Formation, West Spring Creek, 2146-tank. 1b. Slightly oblique longitudinal view of same showing a sharp bend in the median plane, slight development of tabulated interspaces, and discontinuous nature of the zooecial boundary. Note the sharp bend in the first zooecium on the right-hand side of the illustration. (X30). 1c. Transverse view of same showing biconvex zoarial shape, nature of zooecial packing, and continuous median plane with evenly spaced, small median tubuli. Note nature of the zooecial wall in the exozone. (X30).

2a. Oblique longitudinal view of paratype USNM No. 162101, showing serrate nature of zooecial wall and slight development of tabulated interspaces. (X30). Same locality and horizon as above. 2b. Oblique transverse view of same showing median plane with median tubuli and discontinuous nature of the zooecial boundary. (X30).

3a. Tangential view of paratype USNM No. 162102, showing zooecial shape near the zoarial surface and the horseshoe-shaped zooecial boundary. (X30). Same locality and horizon as above. 3b. Transverse view of same showing zooecial packing and median plane with small, evenly-spaced median tubuli. (X30). 3c. Longitudinal view of same showing zooecial shape from the median plane to the zoarial surface, gradual thickening of the zooecial wall and very short endozone. (X30).

PLATE 7



EXPLANATION OF PLATE 8

Amalgamoporus typicus, n. sp.

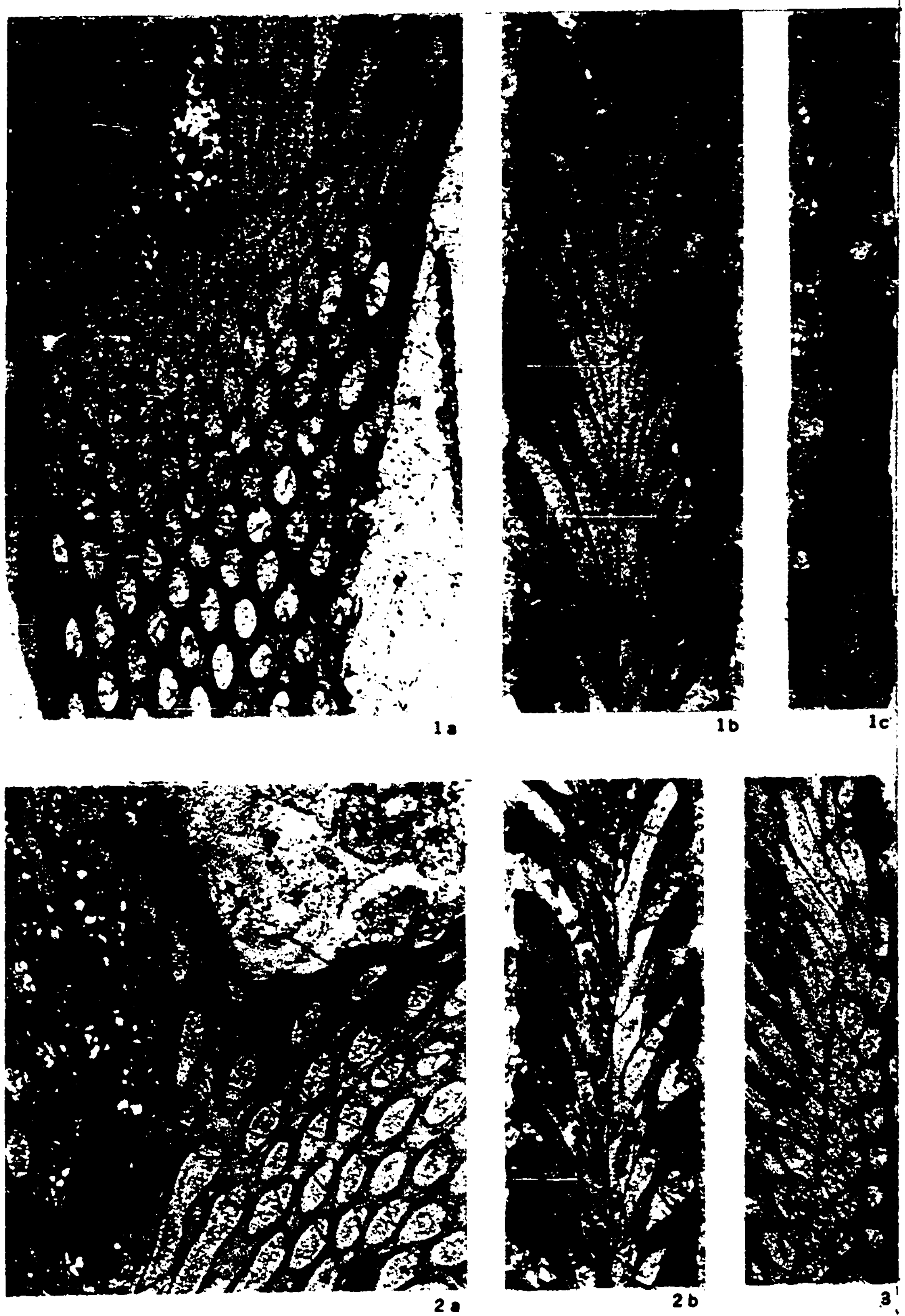
1a. Oblique tangential view of holotype USNM No. 162103, cutting the median plane in the upper left-hand portion of the illustration. Note median tubuli in the median plane, amalgamate appearance of the zooecial walls, and dark patches in the zooecial walls. (X30). Tulip Creek Formation, West Spring Creek, 2146-K. 1b. Longitudinal view of same showing zooecial curvature, one diaphragm emplaced in the early exozone, and nature of the zooecial boundary. (X30). 1c. Transverse view of same showing one-half of the zoarium with the median plane bearing median tubuli in the lower right-hand corner of the illustration. (X30).

2a. Tangential view of paratype USNM No. 162104, showing a concentration of dark patches in the area of branching. Zooecia in lower part of illustration appear larger and elongate because section is passing parallel to the zooecial curvature. (X30). Same locality and horizon as above. 2b. Longitudinal view of same showing zooecial curvature, nature of zooecial walls, and diaphragms. A poorly developed tabulated interspace is seen in the lower right-hand portion of the illustration. (X30).

3. Oblique transverse view of paratype USNM No. 162105, showing curved median plane with median tubuli

and the nature of the zooecial wall. (X30). Same locality and horizon as above.

PLATE 8



EXPLANATION OF PLATE 9

Cystostictoporus distalis, n. sp.

1a. Deep tangential view of holotype USNM No. 162106, showing narrow zooecial walls, cystiphragms, and alignment of zooecia in longitudinal and diagonal ranges. Note horseshoe-shaped nature of zooecial boundary. (X30). McLish Formation, West Spring Creek, 2126-H. 1b. Longitudinal view of same showing indistinct endozone and exozone, early development of cystiphragms, overlapping nature of cystiphragms forming a narrow, distally cystose interspace. (X30). 1c. Transverse view of same showing gentle curvature of median plane with small, evenly spaced, round median tubuli. Note thin nature of the zooecial wall in the exozone. (X30).

2a. Shallow tangential view of paratype USNM No. 162107, showing small zooecial openings near the zoarial surface. Openings are larger in upper part of illustration because the section passes deeper into the zoarium. Note horseshoe-shaped nature of the zooecial boundary. (X30). Same locality and horizon as above. 2b. Longitudinal section of same, showing shape of zooecia from median plane to zoarial surface, sparce emplacement of diaphragms, and early development of cystiphragms. (X30).

3. Longitudinal view of paratype USNM No. 162108, showing nearly straight zooecia, gradual thickening of

zooecial walls, few diaphragms, and early development of cystiphragms. (X30). Same locality and horizon as above.

4. Transverse view of paratype USNM No. 162109, showing zooecial packing, continuous median plane with evenly spaced, distinct median tubuli. (X30). Same locality and horizon as above.

5. Oblique transverse view of paratype USNM No. 162110, showing overlapping nature of cystiphragms.

PLATE 9

1a

1b

1c

2a

2b

3

4

5

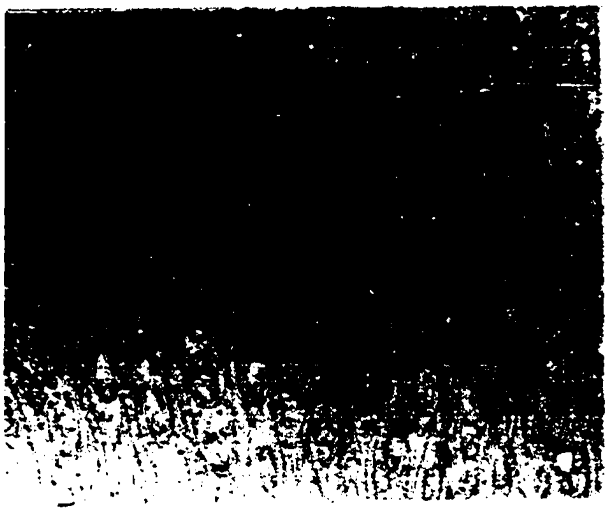
EXPLANATION OF PLATE 10

Cystostictoporus pachyphragmus, n. sp.

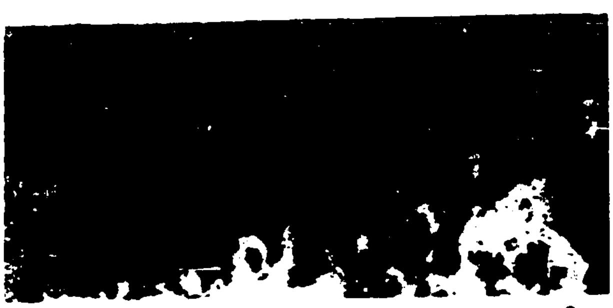
1a. Tangential view of holotype USNM No. 162111, showing small zooecial openings and wide longitudinal interspaces. Note horseshoe-shaped zooecial boundary. (X30). McLish Formation, West Spring Creek, 2126-M. 1b. Longitudinal view of same showing zooecial shape from median plane to zoarial surface, diaphragms, abrupt thickening of zooecial wall, and long exozone. Note inflections in the zooecial boundary. (X30).

2a. Tangential view of paratype USNM No. 162112. (X30). Same locality and horizon as above. 2b. Longitudinal section of same showing small zooecial voids, thick walls, and inflections in the zooecial boundary. (X30). 2c. Transverse view of same showing zooecial packing, slightly curved median plane with median tubuli, and nature of zooecial walls in exozone. (X30).

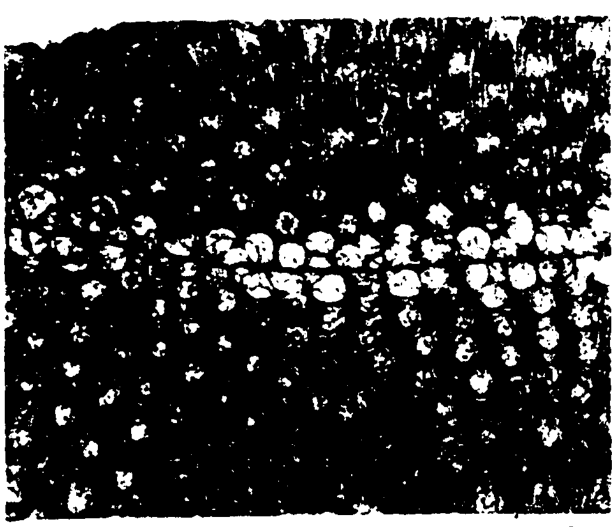
PLATE 10



1 a



2 a



2 c

1 b

2 b

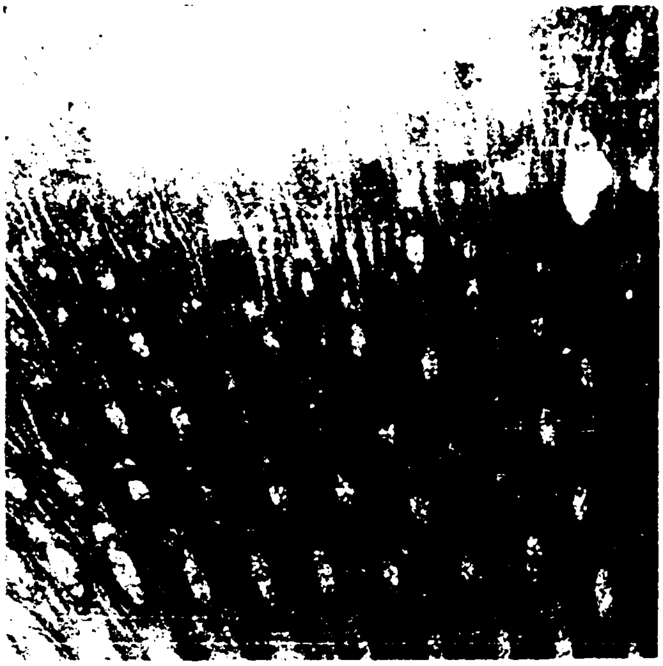
EXPLANATION OF PLATE 11

Cystostictoporus acanthoporus, n. sp.

1a. Tangential view of holotype USNM No. 162113, showing zooecial shape near zoarial surface, wide longitudinal and lateral interspaces, and acanthopores concentrated in the zooecial boundary. (X30). McLish Formation, West Spring Creek, 2126-O. 1b. Transverse view of same showing gently curved median plane with median tubuli, short endozone, long exozone, and nature of zooecial packing. Note development of interspaces near base of exozone. (X30). 1c. Oblique longitudinal view of same showing development of cystose interspaces near base of exozone. Note rapid thickening of zooecial walls. (X30).

2a. Longitudinal view of paratype USNM No. 162114, showing oblique intersection of zooecia with zoarial surface and nature of the zooecial wall. (X30). Same locality and horizon as above. 2b. Transverse section of same showing gently curved median plane with evenly spaced median tubuli, short endozone, long exozone. (X30).

PLATE 11

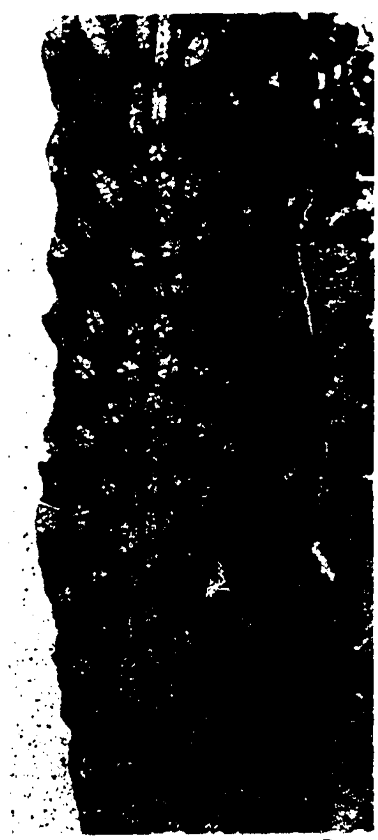


1a

1b

1c

2a



2b

EXPLANATION OF PLATE 12

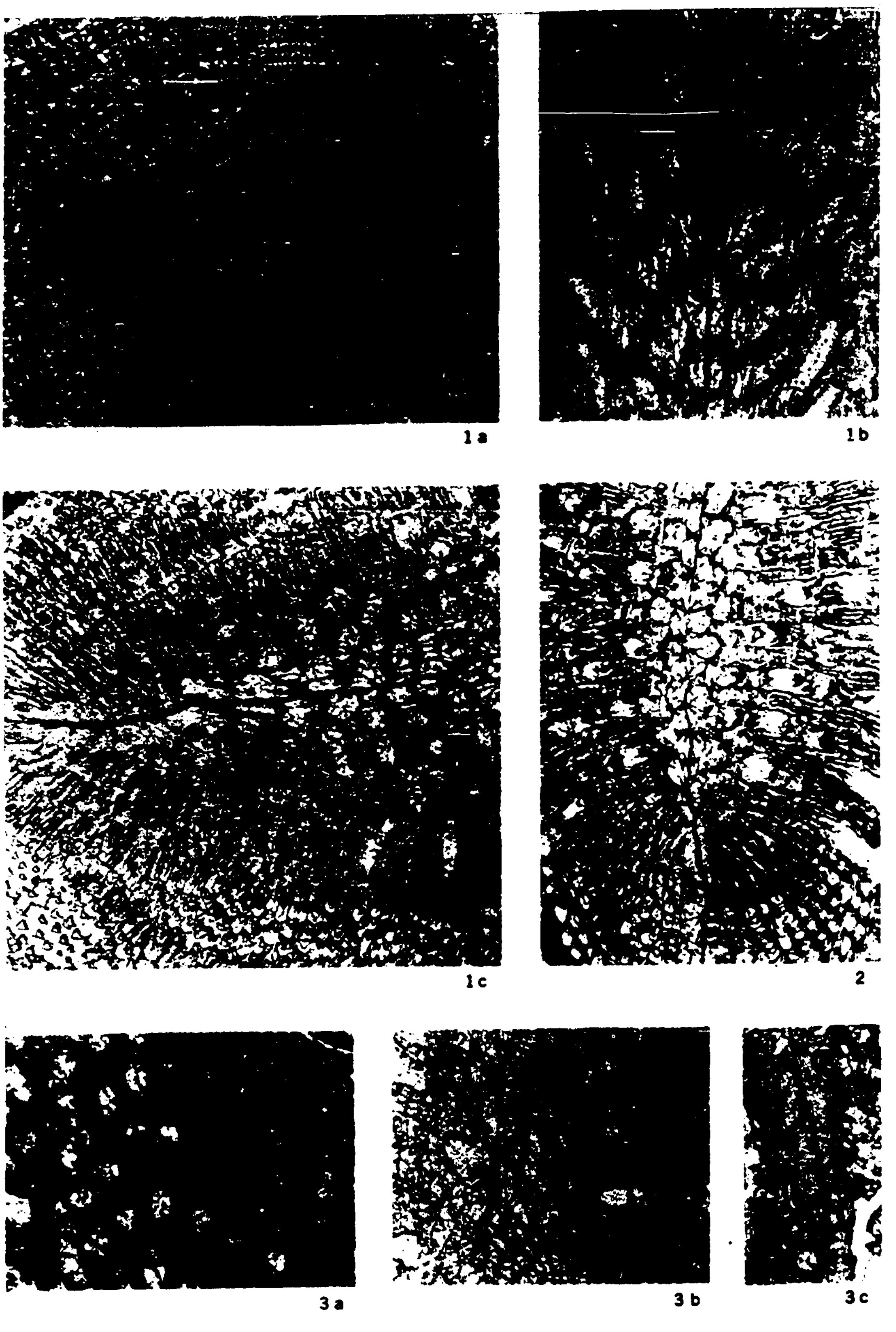
Cystostictoporus cryptophragmus, n. sp.

1a. Oblique tangential view of holotype USNM No. 162115, showing apparent overgrowths and massive structure. (X30). McLish Formation, West Spring Creek, 2126-W. 1b. Longitudinal view of same showing early development of cystose structure and massive nature of outer exozone. (X30). 1c. Transverse view of same near edge of zoarium showing median plane with median tubuli becoming bent toward zoarial surface near edge of zoarium. Note apparent overgrowths with predominant lack of third wall in exozone. (X30).

2. Transverse view of paratype USNM No. 162116, showing median plane becoming discontinuous in cystose outer portion of zoarium. Same locality and horizon as above. (X30).

3a. Oblique tangential view of paratype USNM No. 162117, showing median plane with median tubuli in left-hand portion of illustration. (X30). McLish Formation, West Spring Creek, 2126-T. 3b. Longitudinal view of same showing median plane and cystose outer portion of zoarium. (X30). 3c. Transverse view of same near zoarial edge showing median plane with median tubuli. (X30).

PLATE 12



EXPLANATION OF PLATE 13

Cystostictoporus cryptophragmus, n. sp.

1a. Longitudinal view of paratype USNM No. 162118, showing *Stictopora*-like wall structure in early exozone, later becoming predominantly or entirely cystose. Note appearance of overgrowths in cystose portion of exozone. (X30). McLish Formation, West Spring Creek, 2126-P.

1b. Oblique tangential view of same showing cystose nature of exozone and appearance of overgrowths. (X30).

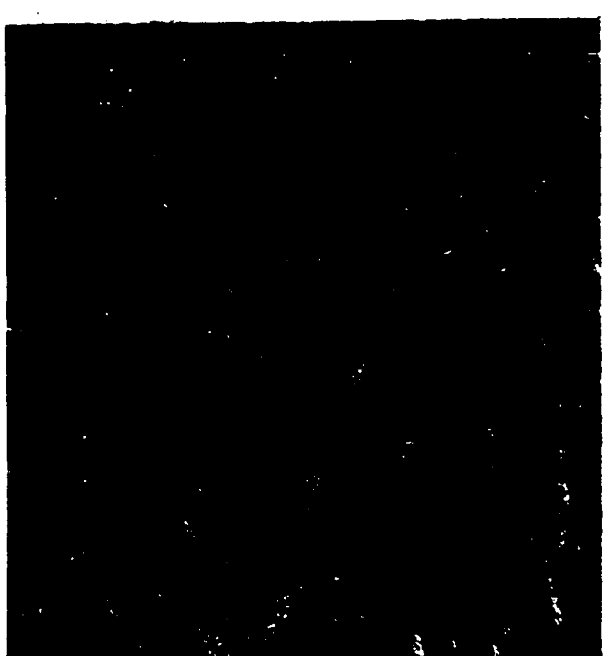
2. Longitudinal view of paratype USNM No. 162119, showing early development of outer cystose structure. (X30). McLish Formation, West Spring Creek, 2126-R.

3. Longitudinal view of paratype USNM No. 162120, showing indistinct basal zoarial growth, distinct median plane in upper one-half of illustration, and cystose nature of outer exozone. (X30). McLish Formation, West Spring Creek, 2126-S.

PLATE 13

1a

1b



2

3

EXPLANATION OF PLATE 14

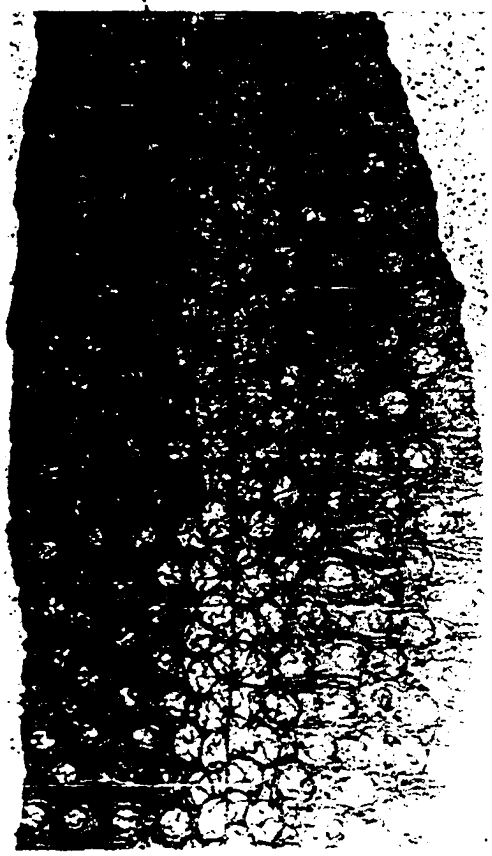
Cystostictoporus pregigantius, n. sp.

1a. Tangential view of holotype USNM No. 162121, showing wide longitudinal and lateral interspaces, shape of zooecia near zoarial surface, and alignment of zooecia in longitudinal and diagonal ranges. (X30). McLish Formation, West Spring Creek, 2126-P. 1b. Transverse view of same showing size and shape of zoarium, short endozone, long exozone, zooecial packing, straight median plane with small, evenly spaced median tubuli. (X30). 1c. Longitudinal view of same showing long, gently curved zooecia, emplacement of diaphragms, development of cystose interspaces, and development of an outer cystose portion of the exozone. (X30).

2. Longitudinal view of paratype USNM No. 162122, showing long, relatively straight zooecia, abundant cystiphragms beginning in early exozone and forming distally cystose interspaces. (X30). Same locality and horizon as above.

3. Transverse view of paratype USNM No. 162123, showing median plane with distinct, evenly spaced median tubuli. Note zooecial packing and development of cystose interspaces in early exozone. (X30). Same locality and horizon as above.

1a



1b

1c

3

2

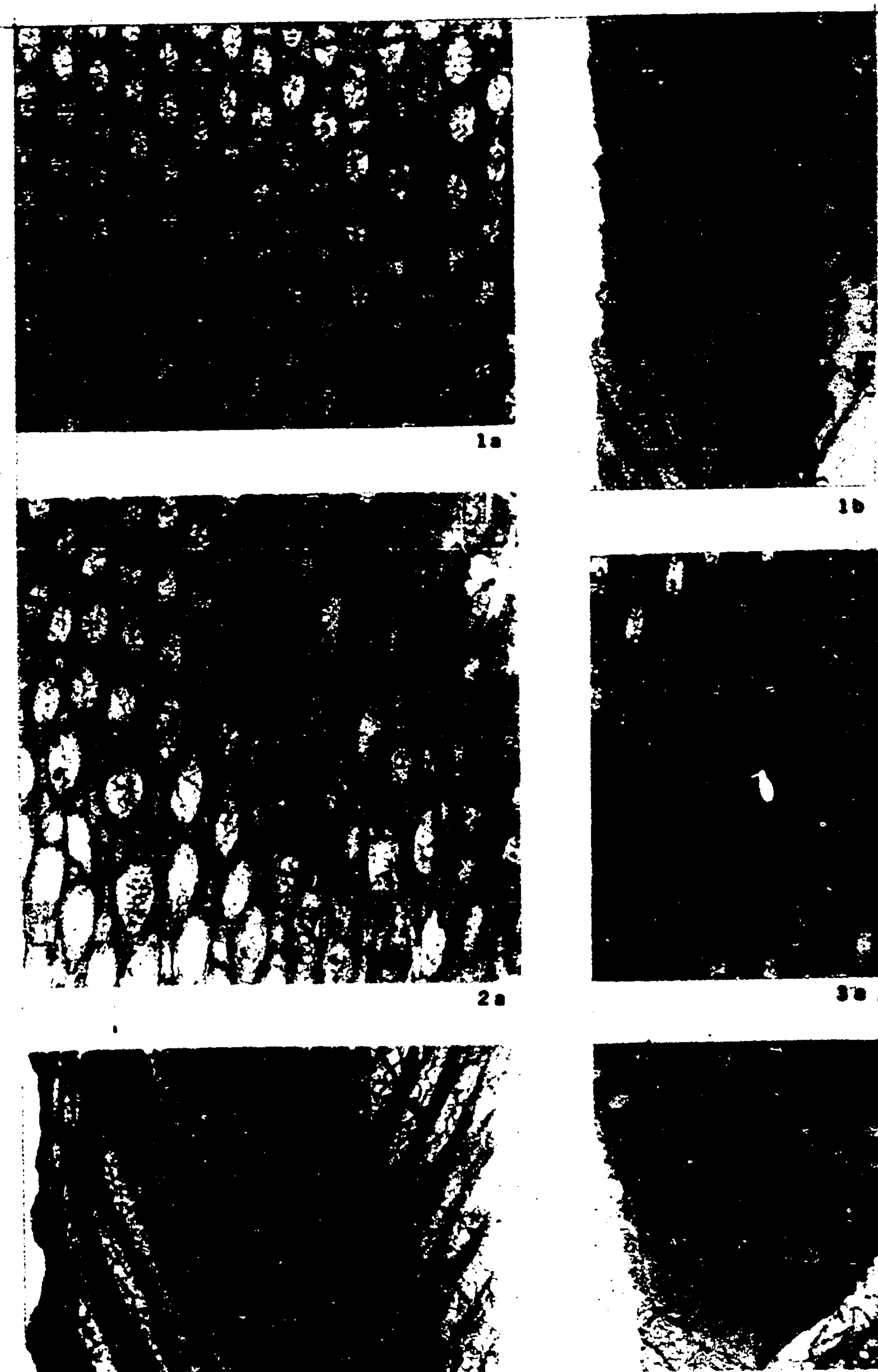
EXPLANATION OF PLATE 15

<u>Cystostictoporus</u> <u>pregigantius</u>, n. sp.

1a. Tangential view of paratype USNM No. 162124, showing alignment of zooecia in longitudinal and diagonal ranges, horseshoe-shaped nature of zooecial boundary. Dark lines within zooecial voids represent the intersection of the section with diaphragms. (X30). McLish Formation, West Spring Creek, 2126-P. 1b. Transverse view of same showing relatively straight zooecia, emplacement of diaphragms, early development of cystose interspaces, and nature of the zooecial wall. (X30).

2a. Deep tangential view of paratype USNM No. 162125, showing alignment of zooecia, relatively wide interspaces, and nature of zooecial wall. (X30). Same locality and horizon as above. 2b. Longitudinal view of same showing bends in the median plane, early development of cystose interspaces, and development of an outer cystose portion of the exozone. (X30).

3a. Tangential view of paratype USNM No. 162126, showing alignment of zooecia, wide interspaces, nature of zooecial walls, and horseshoe-shaped zooecial boundary. (X30). Same locality and horizon as above. 3b. Transverse view of same showing one edge of zoarium with large median tubuli. Note that median plane extends to edge of zoarium. (X30).


1a
1b
2a
3a
2b
3b

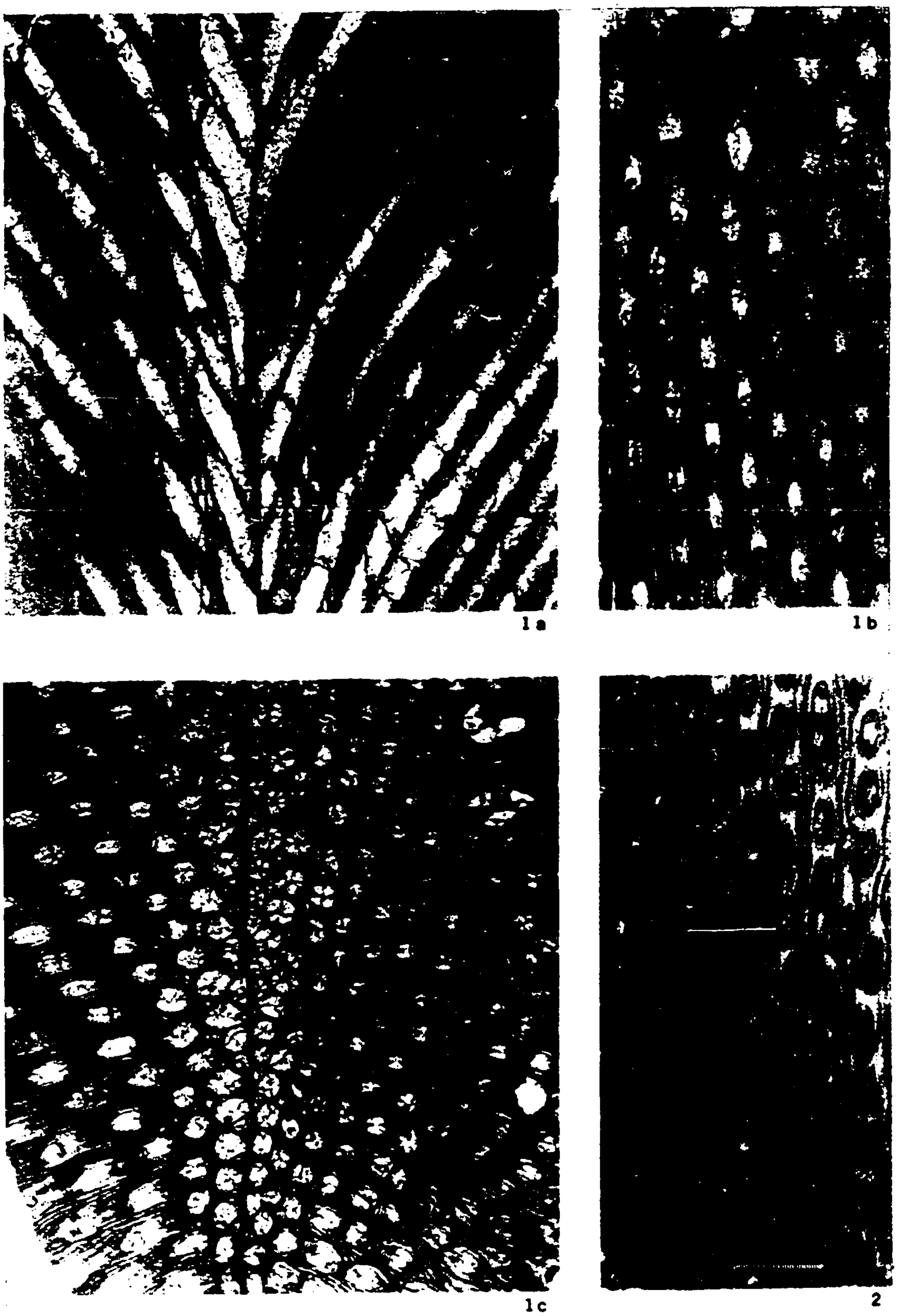
EXPLANATION OF PLATE 16

Cystostictoporus gigantius, n. sp.

1a. Longitudinal view of holotype USNM No. 162127, showing long, gently curved zooecia, evenly spaced diaphragms, and early development of cystiphragms which result in cystose interspaces. (X30). McLish Formation, West Spring Creek, 2126-Q. 1b. Tangential view of same showing small zooecial voids, wide interspaces, and alignment of zooecia in longitudinal and diagonal ranges. Note solid area in upper left of figure. (X30). 1c. Transverse view of same showing median plane with median tubuli, short endozone, long exozone, and development of cystose interspaces in early exozone. (X30).

2. Tangential view of paratype USNM No. 162128, showing small zooecial voids near the zoarial surface, wide interspaces and discontinuous alignment in longitudinal and diagonal ranges. (X30). Same locality and horizon as above.

PLATE 16

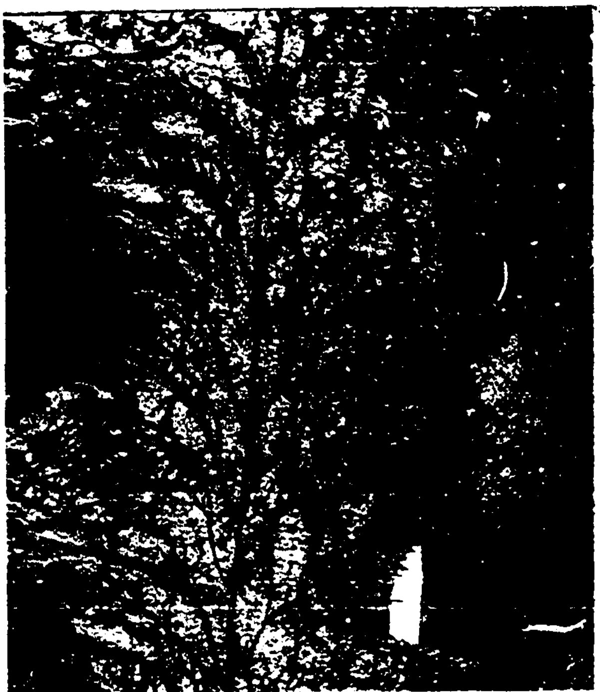


EXPLANATION OF PLATE 17

Cricodictyum ponderosum, n. sp.

1a. Longitudinal view of holotype USNM No. 162129, showing lateral branches of the median plane, median tubuli in the lateral branches, cystiphragm-like zooecial diaphragms, and the three basic types of interspaces. Two zooecial annuli are shown. (X30). McLish Formation, West Spring Creek, 2126-D. 1b. Tangential view of same specimen showing two annuli with branches of the median plane bearing median tubuli. Note inter-zooecial areas (interspaces) and the fact that zooecial walls are thinner near annuli and thicker between annuli due to the zooecial wall being elevated by the annuli and subtended at earlier growth stages by the plane of the section. (X30).

2. Transverse view of paratype USNM No. 162130, showing lack of keels and sinuses, zooecial packing, and the evenly spaced median tubuli of the median plane. (X30). Same locality and horizon as above.



1a

2

1b

1c

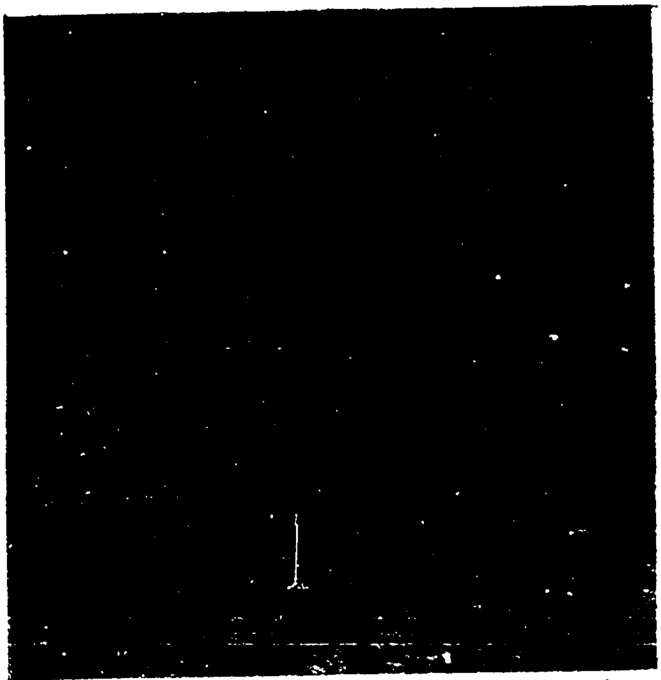
EXPLANATION OF PLATE 18

Cricodictyum ponderosum, n. sp.

1a. Oblique transverse view of paratype USNM No. 162131, showing median tubuli, zooecial diaphragms, and laterally cystose interspaces. (X30). McLish Formation, West Spring Creek, 2126-D. 1b. Longitudinal section of same specimen showing zooecial shape from median plane to zoarial surface, one annulus, laterally and distally cystose interspaces, and nature of zooecial diaphragms. (X30). 1c. Tangential view of same specimen showing two annuli with branches of the median plane with median tubuli, interspaces, and zooecial shape near the zoarial surface. (X30).

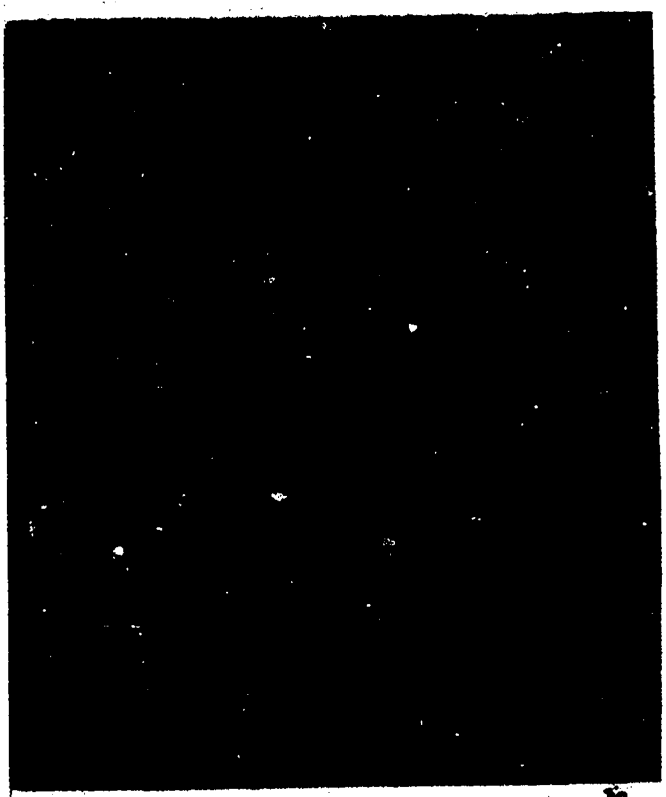
2. Longitudinal view of paratype USNM No. 162132, showing zooecial curvature from median plane to zoarial surface, one annulus, distally and laterally cystose interspaces. (X30). Same locality and horizon as above.

PLATE 18



1a

1b



1c

2

EXPLANATION OF PLATE 19

Cricodictyum ponderosum, n. sp.

1. Tangential view of paratype USNM No. 162133, obliquely cutting the median plane. Note median tubuli. (X30). McLish Formation, West Spring Creek, 2126-D.

2. External view of paratype USNM No. 162134, showing dichotomously branching zoarium with surface annuli and curved diagonal ranges. (X3). McLish Formation, West Spring Creek, 2126-E.

3. Transverse view of paratype USNM No. 162135, showing unilaminate encrustation of an echinoderm stem. (X30). McLish Formation, West Spring Creek, 2126-D.

4a. Tangential view of paratype USNM No. 162136, showing two annuli with branches of the median plane. Note longitudinal ranges in upper part of illustration where the section becomes a deep tangential. (X30). Same locality and horizon as 3. 4b. Longitudinal view of same specimen showing one annulus with median plane. Distally cystose and tabulated interspaces are shown. (X30).

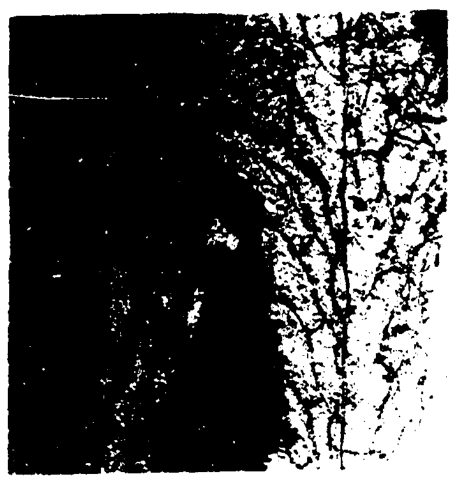
PLATE 19

1

2

3

4a



4b

EXPLANATION OF PLATE 20

P. (*Eopachydictya*) *segregata*, n. sp.

1a. Tangential view of holotype USNM No. 162137, showing small zooecial openings and alignment of zooecia in alternating longitudinal and diagonal ranges. (X30). Tulip Creek Formation, West Spring Creek, 2146-float. 1b. Oblique transverse view of same showing median plane with median tubuli, relatively simple wall structure, and slight development of tabulated interspaces. (X30).

2. Oblique longitudinal view of paratype USNM No. 162138, showing tabulated interspaces and median plane with median tubuli. (X30). Same locality and horizon as above.

3. Oblique tangential view of paratype USNM No. 162139, showing median plane with median tubuli, tabulated interspaces, and simple nature of zooecial wall in this view. (X30). Tulip Creek Formation, West Spring Creek, 2146-L.

4. Oblique longitudinal view of paratype USNM No. 162140, showing very narrow, simple tabulated interspaces. (X30). Same locality and horizon as 1 above.

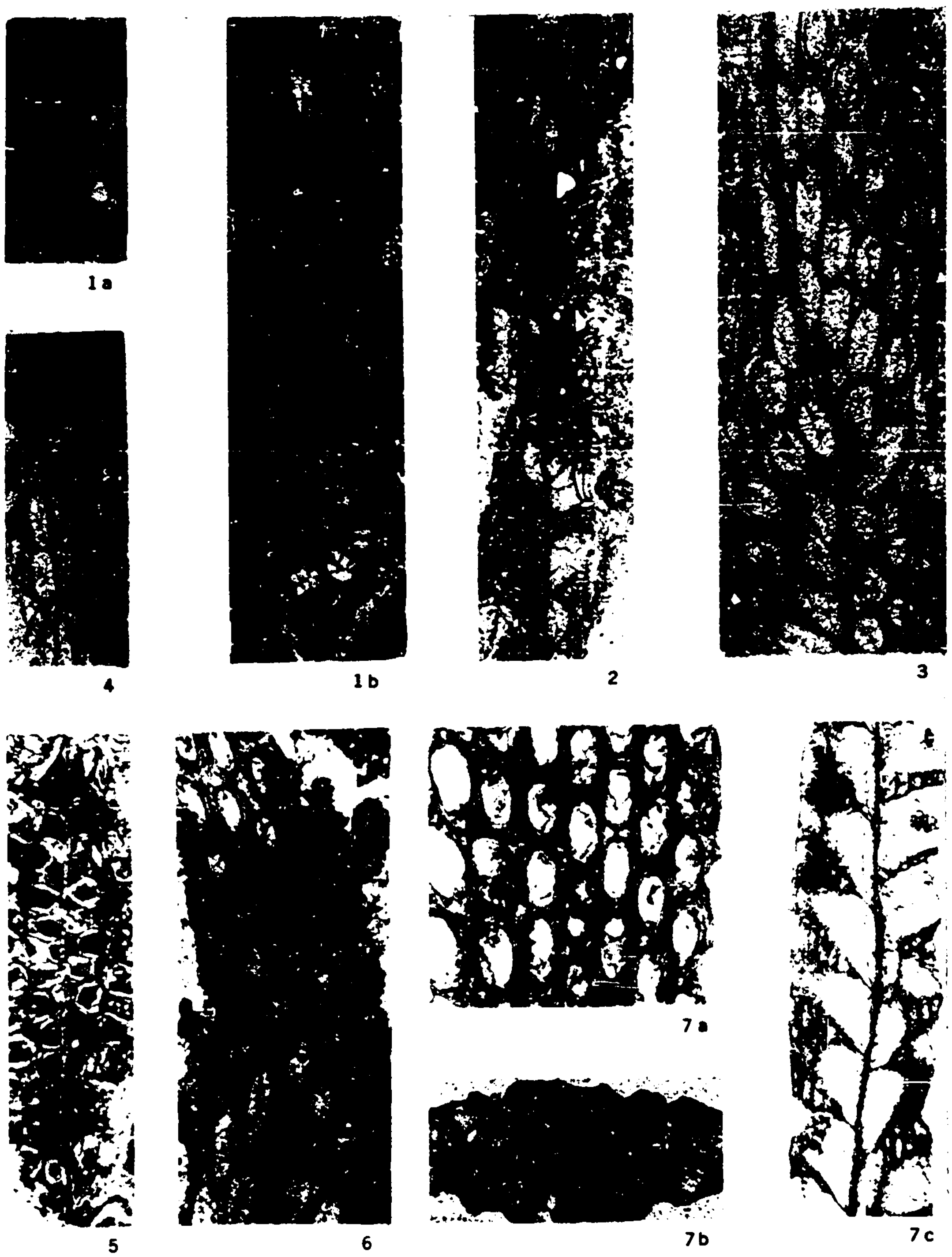
5. Transverse view of paratype USNM No. 162141, showing continuous median plane with median tubuli. Note that median tubuli extend to zoarial edge. (X30). Tulip Creek Formation, West Spring Creek, 2146-B.

6. Tangential view of paratype USNM No. 162142, showing nature of openings at a shallow zoarial level and simple nature of the zooecial walls. (X30). Same locality and horizon as 1 above.

Pachydictya robusta Ulrich

7a. Tangential view of an immature zoarium, USNM No. 162143, showing simple nature of zooecial walls, alignment of zooecia, and narrow interspaces. (X30). Bromide Formation, West Spring Creek, 2132-E. 7b. Transverse view of same showing alternating zooecial voids and tabulated interspaces. Note median plane with median tubuli. (X30). 7c. Longitudinal section of same showing alternating zooecial voids and tabulated interspaces. Note consistent high angle of budding. (X30).

PLATE 20



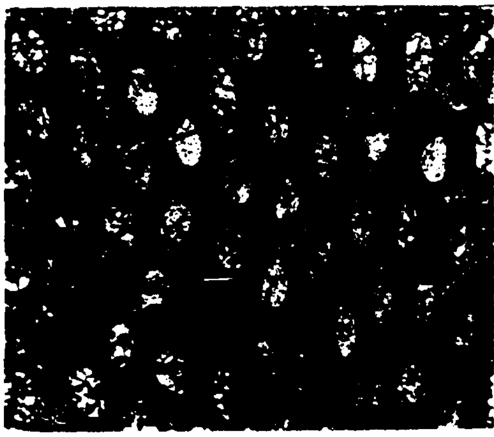
EXPLANATION OF PLATE 21

Pachydictya robusta Ulrich

1a. Tangential view USNM No. 162143, showing zooecial alignment near an area of dichotomous branching. Note acanthopores surrounding zooecia. (X30). Bromide Formation, Spring Creek, 2132-F. 1b. Transverse view of same showing zooecia and tabulated interspaces, median plane with median tubuli, and diaphragms. (X30). 1c. Longitudinal view of same showing alternating zooecia and tabulated interspaces. (X30).

2a. Longitudinal view USNM No. 162144, showing young zoarium encrusted with a conspecific overgrowth which reached maturity. Note irregular nature of diaphragms. (X30). Same locality and horizon as above. 2b. Transverse view of same showing distinctly bilaminate median plane with evenly spaced median tubuli. (X30). - -

PLATE 21



1a

1b

1c

2a

2b

EXPLANATION OF PLATE 22

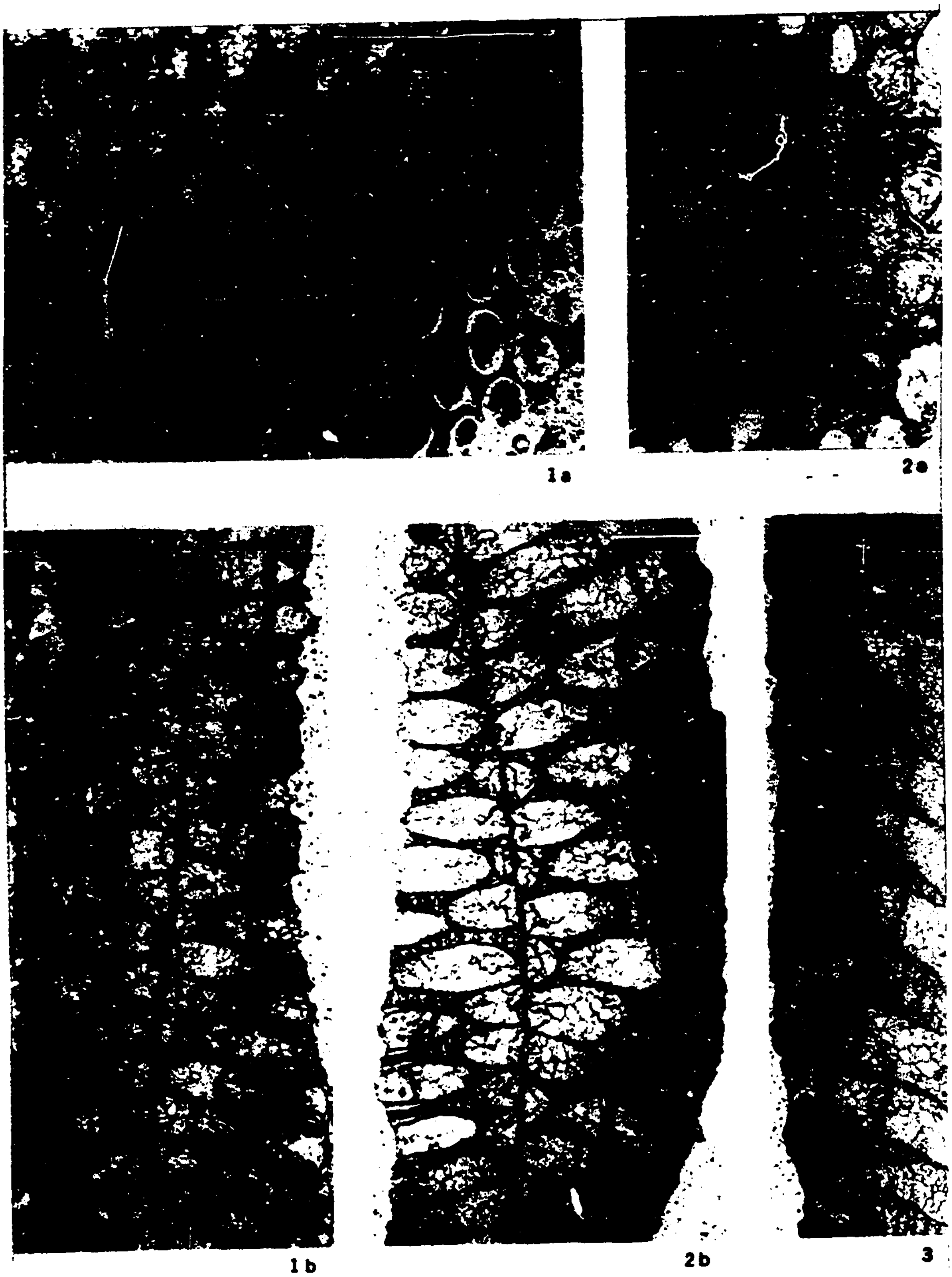
Pachydictya robusta Ulrich

1a. Tangential view of USNM No. 162145, showing zooecial shape near zoarial surface and wide interspaces in outer exozone. Section is deeper in upper part of illustration. (X30). Bromide Formation, Spring Creek 2132-G. 1b. Transverse view of same showing zooecial packing, tabulated interspaces beginning at base of exozone, and median tubuli. (X30).

2a. Tangential section of USNM No. 162146, in a deformed area of the zoarium showing distorted zooecial openings and a portion of the median plane with median tubuli in the upper right one-quarter of illustration. (X30). Same locality and horizon as above. 2b. Transverse view of same showing zooecial packing, tabulated interspaces, nature of zooecial wall, and median plane with offset median tubuli. (X30).

3. Longitudinal view of USNM No. 162147, showing different types of diaphragms. (X30). Same locality and horizon as above.

PLATE 22



EXPLANATION OF PLATE 23

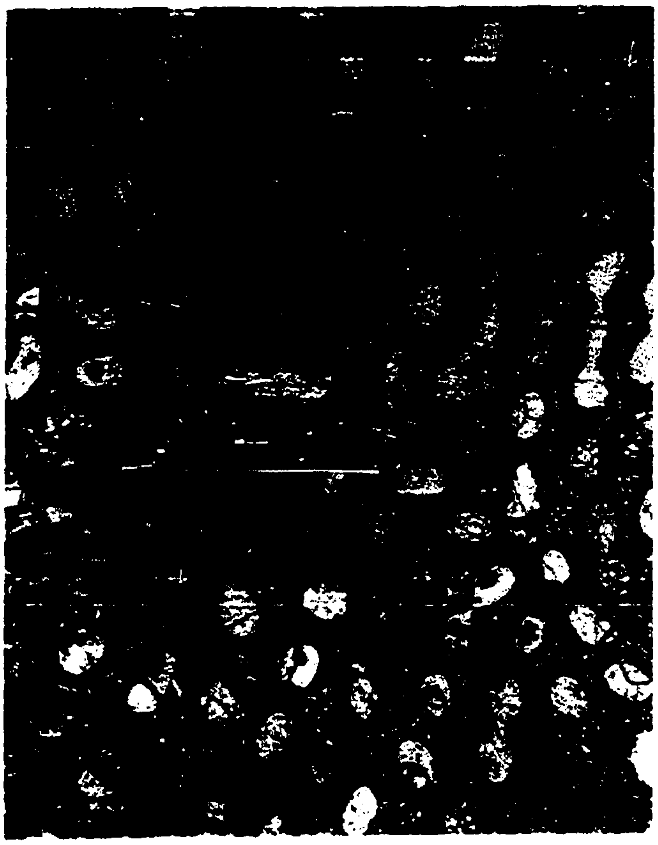
Pachydictya robusta Ulrich

1a. Tangential view of USNM No. 162154, showing concentration of acanthopores and shape of zooecia near a monticule. Note that irregular constricted zooecia are concentrically arranged with respect to the monticule. (X30). Bromide Formation, Spring Creek, 2132-G. 1b. Oblique transverse view of same showing short endozone, long exozone, median plane with median tubuli, and acanthopores in the exozone. (X30).

2. Longitudinal view of USNM No. 162155, showing a conspecific overgrowth with an opposite growth direction. (X30). Same locality and horizon as above.

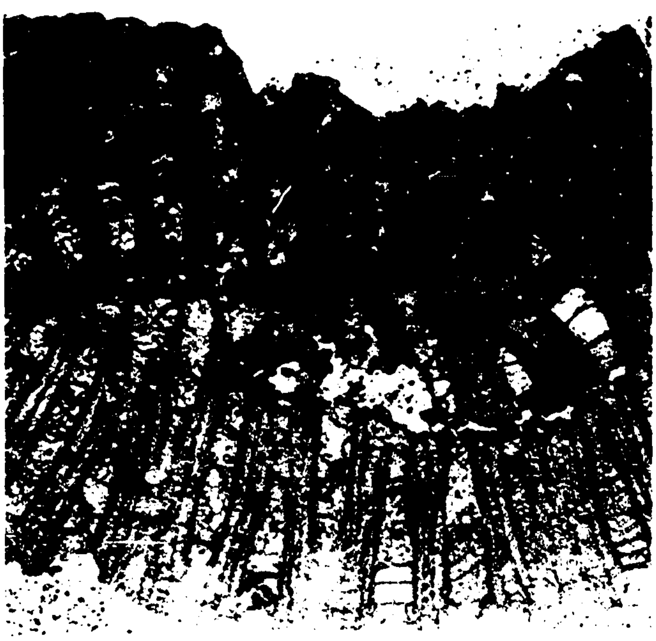
3. Longitudinal view of USNM No. 162156, showing nature of zooecial walls, diaphragms, and tabulated interspaces. (X30). Same locality and horizon as above.

PLATE 23



1a

2



1b

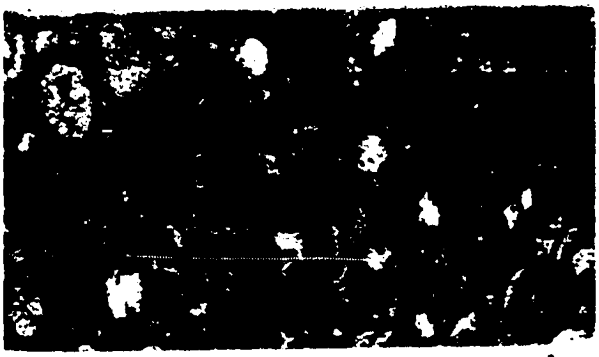
3

EXPLANATION OF PLATE 24

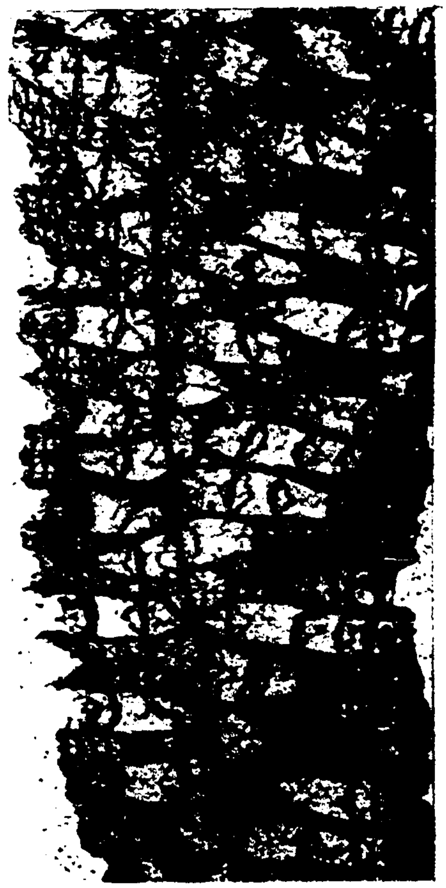
Pachydictya robusta Ulrich

1a. Tangential view of USNM No. 162148, showing wide interspaces and predominant alignment of zooecia in diagonal ranges. (X30). Bromide Formation, Spring Creek, 2132-0. 1b. Transverse view of same showing curved median plane with offset, evenly spaced median tubuli. (X30). 1c. Longitudinal view of same showing long zooecia, alternating zooecia and tabulated interspaces, and number and nature of diaphragms. (X30).

2a. Longitudinal view of USNM No. 162149, cutting zooecia and interspaces obliquely giving the appearance of doubly tabulated interspaces. (X30). Same locality and horizon as above. 2b. Deep tangential view of same showing thin zooecial walls and wide interspaces. (X30).



1 a



1 b

1 c

2 a

2 b

EXPLANATION OF PLATE 25

Pachydictya robusta Ulrich

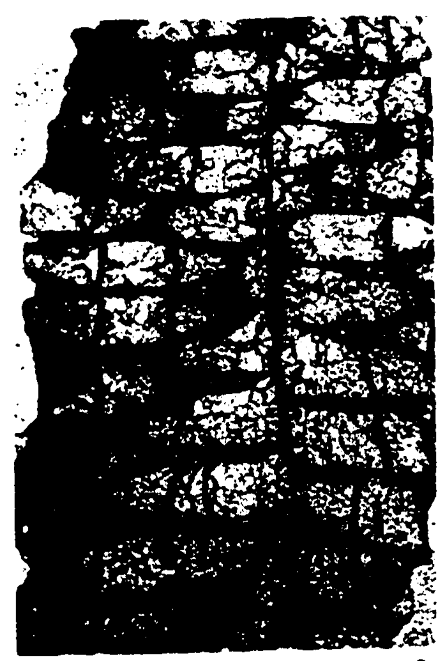
1a. Tangential view of USNM No. 162150, showing zooecial shape near zoarial surface, apparent random zooecial packing, and wide interspaces. (X30). Bromide Formation, Spring Creek, 2132-O. 1b. Longitudinal view of same showing early development of tabulated interspaces, tendency of diaphragms to become cystiphragm-like, and overlapping cystiphragms in one zooecium. (X30). 1c. Transverse view of same near zoarial margin showing nature of walls and median plane with offset median tubuli. (X30).

2. Transverse view of USNM No. 162151, showing early development of tabulated interspaces, and median plane with offset median tubuli. (X30). Same locality and horizon as above.

1a

1b

1c



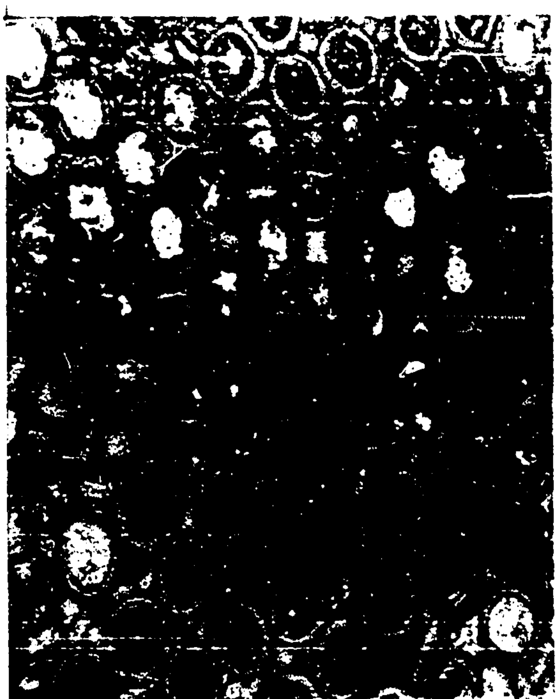
2

EXPLANATION OF PLATE 26

Pachydictya robusta Ulrich

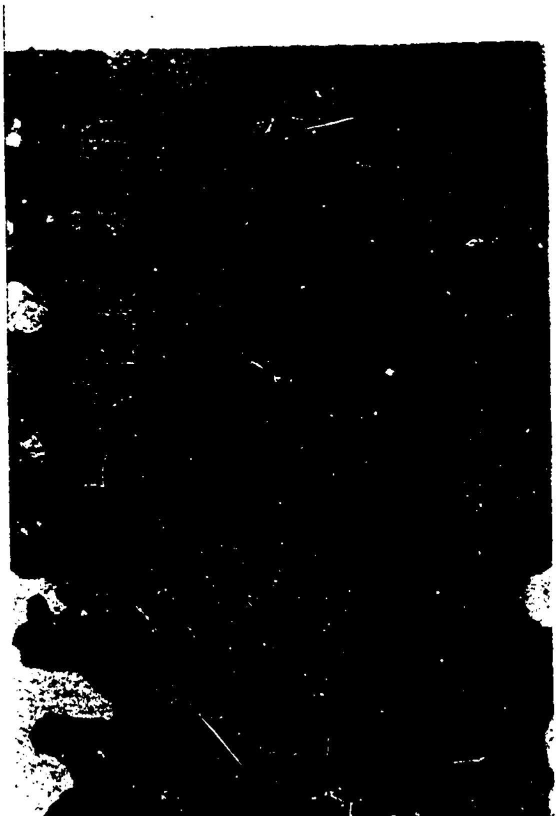
1a. Tangential view of USNM No. 162152, showing nearly indistinct alignment of zooecia in diagonal ranges, wide interspaces, and relatively thick zooecial walls in outer exozone. (X30). Bromide Formation, Spring Creek, 2132-Q. 1b. Longitudinal section of same showing wide zooecia, short endozone, rapid thickening of zooecial wall in exozone, and a conspecific overgrowth with growth direction opposite that of bifoliate zoarium. Note irregular nature of diaphragms. 1c. Transverse view of same showing zooecial packing, bilaminate median plane with median tubuli, and thick zooecial walls in the exozone. (X30).

2. Longitudinal view of paratype USNM No. 162153, showing long zooecia, high angle of budding, early development of tabulated interspaces, nature of diaphragms, and thick walls in the exozone. (X30). Same locality and horizon as above.



1a

1b



2

1c