Mississippian Rugose Corals, Peratrovich Formation, West Coast, Prince of Wales Island, Southeastern Alaska

GEOLOGICAL SURVEY PROFESSIONAL PAPER 534

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By AUGUSTUS K. ARMSTRONG

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Systematic descriptions of the rugose corals and paleoecologic studies of the marine carbonate sediments

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1970

UNITED STATES DEPARTMENT OF THE INTERIOR

WALTER J. HICKEL, *Secretary*

GEOLOGICAL SURVEY

William T. Pecora, *Director*

Library of Congress catalog card No. 72-606744

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Washington, D.C. 20402 - Price $1 (paper cover)

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MISSISSIPPIAN RUGOSE CORALS, PERATROVICH FORMATION, WEST COAST PRINCE OF WALES ISLAND, SOUTHEASTERN ALASKA

By AUGUSTUS K. ARMSTRONG

ABSTRACT

The Mississippian Peratrovich Formation, northwestern coastal regions of the Prince of Wales Island, Alaska, contains three members that represent continuous marine sedimentation from Osage into Chester time. The chert member, about 200 feet thick, rests disconforably on strata of Devonian age and is composed of dark-gray radiolarian cherts, lime mudstones, and thin shale beds that were deposited in an euxinic environment. The limestone and chert member, about 400 feet thick, is composed of gray chert and of bryozoan, echinoderm, foraminiferal wackestones and packstones. *Ekvasophyllum* cf. *E. inclinatum* Parks and *Faberophyllum williamsi* n. sp. are found in the middle through the top of the member. The upper 100–120 feet of the member contains *Faberophyllum girtyi* n. sp., *Lithostrotion* (*Siphonodendron*) sp., *Lithostrotion* (*Siphonodendron*) *warreni* Nelson, *Diphyphyllum venosum* n. sp., *Diphyphyllum klawockensis* n. sp., *Lithostrotionella banffensis* (Warren), *L. pennsylvanica* (Shimer), *L. birdi* n. sp., *Thysanophyllum astraeiforme* (Warren), and *Sciophyllum alaskaensis* n. sp. This fauna is of Meramec age and suggestive of a correlation with the Mount Head Formation of Alberta, Canada.

The limestone member, about 400 feet thick, is gray to light-gray echinoderm, bryozoan, foraminifera wackestones to echinoderm, foraminifera oolitic grainstones. The lower part of the member contains *Faberophyllum girtyi* n. sp., *Lithostrotionella banffensis* (Warren), and *Lithostrotionella peratrovichensis* n. sp. and is of late Meramec age. The upper part of the member contains *Lithostrotion* (*Siphonodendron*) *succinctus* n. sp. The limestone member represents late Meramec through late Chester carbonate sedimentation.

The Mississippian strata are overlain by marine sediments of Early Pennsylvanian age.

PREVIOUS WORK AND INTRODUCTION

Collections of Mississippian fossils were made from the northwest side of the Prince of Wales Island (figs. 1, 2), in the Craig-Klawock region by U.S. Geological Survey geologists, Theodore Chapin in 1916, G. H. Girty in 1918, and J. S. Williams in 1940. Girty (in Buddington and Chapin, 1929) published a faunal list of the material he and Chapin collected. He noted the fauna was Late Mississippian and somewhat similar to the fauna of the Lisburne Limestone of Arctic Alaska.

More recent geologic mapping of the northwest side of the Prince of Wales Island by the U.S. Geological Survey has resulted in more detailed stratigraphic studies and paleontologic collections. These investigations were conducted by G. D. Eberlein and Michael Churkin, Jr. during the field seasons of 1964–66. I joined them in the Craig region for 4 weeks in the summer of 1966 and examined most of the known Mississippian outcrops, measuring stratigraphic sections, collecting megafossils, and obtaining rock samples at 10-foot intervals for detailed micropaleontologic and petrographic carbonate studies.

The Mississippian strata in the Craig region may exceed 800 feet in thickness and are a series of dark-gray marine cherts and shales which grade upwards into light-colored oolitic and enchinodermal limestones (fig. 3). Eberlein and Churkin (1970) have designated this strata a new formation—the Peratrovich Formation. The formation has three members which are in ascending order a chert member, about 200 feet thick; a limestone and chert member, about 400 feet thick; and a limestone member, 400+ feet thick (fig. 3). The chert member rests with a disconformity on volcanics of Devonian age, and the limestone member is overlain by marine sedimentary rocks of Early Pennsylvanian age. The type locality is about 1 mile north of the village of Klawak on the south end of Peratrovich Island.

The stratigraphic collections of corals made by me in 1966 have been supplemented by the random collections made in the area by Theodore Chapin in 1916, G. H. Girty and W. C. Waters in 1918, and J. S. Williams in 1940. Examination of their field notebooks left little doubt as to the geographic locations of their specimens. Microscopic examination of the matrix which enclosed the corals generally revealed an endothyrid fauna which positioned most of the specimens within the stratigraphic succession. The collections of corals made by G. H. Girty and his field assistant, W. C. Waters, are

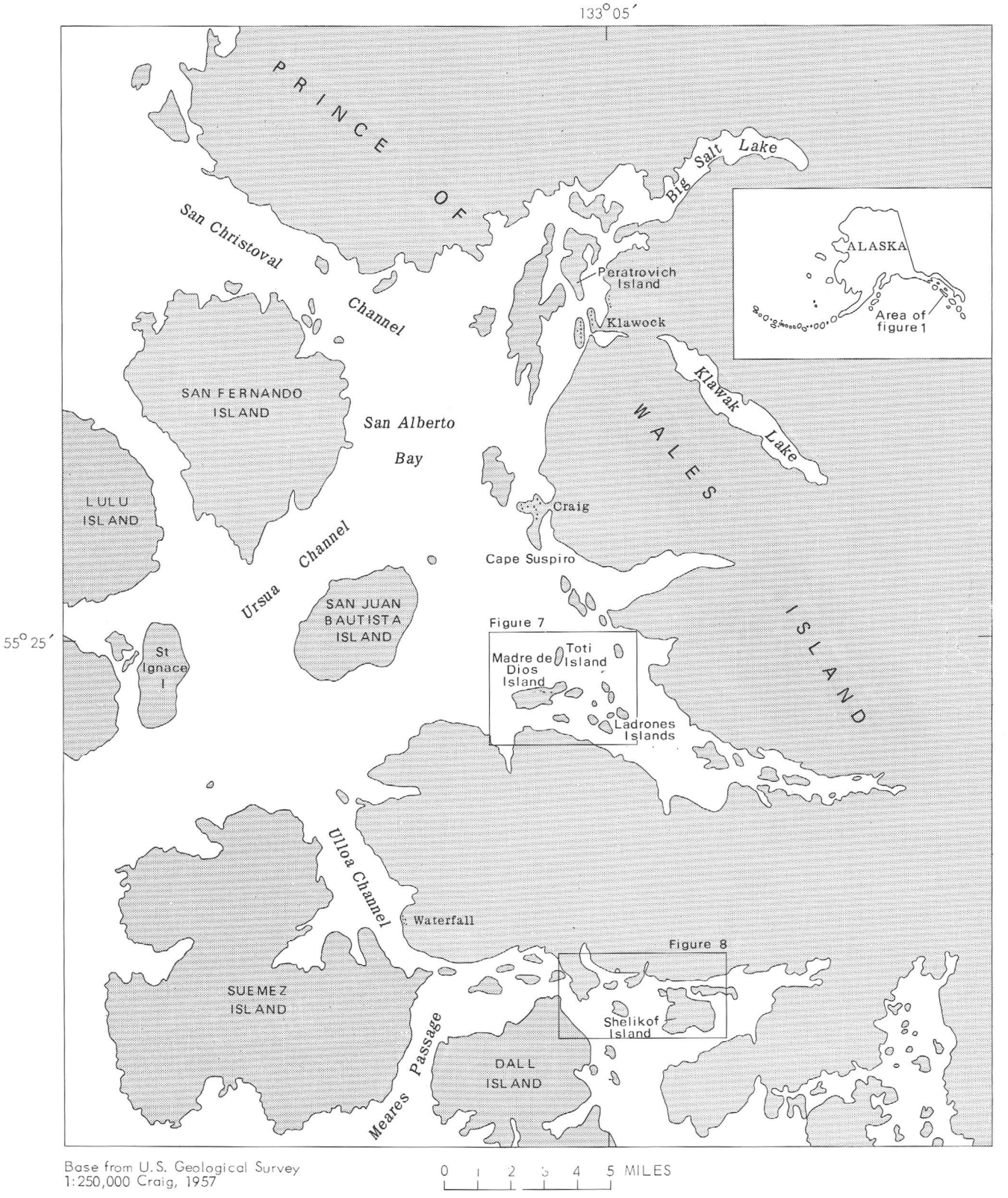

FIGURE 1.—Location of Peratrovich, Madre de Dios, Ladrones, and Shelikof Islands, on the northwest side of Prince of Wales Island.

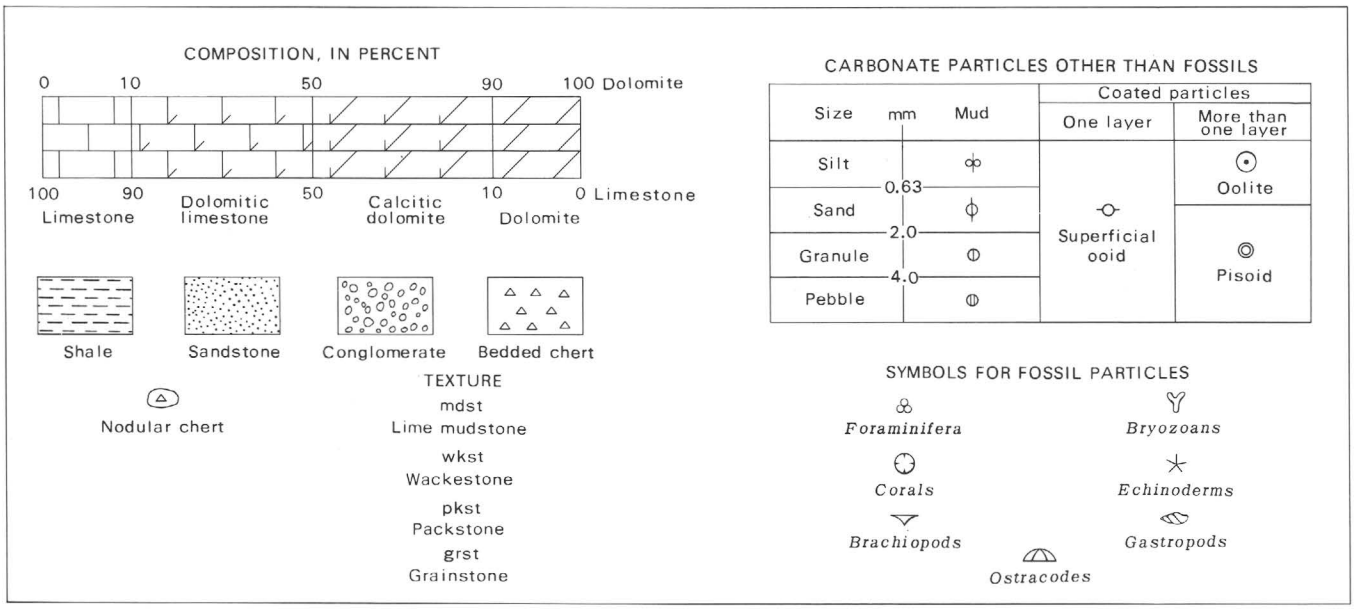

FIGURE 2.—Lithologic and paleontologic symbols used in this report.

large in numbers of specimens and in diversity of faunas and were of considerable value in the systematic studies.

In this report, Dunham's (1962) carbonate rock classification is used (table 1). The terminology of this system is based on particle kind and texture (fig. 2).

TABLE 1.—*Classification of carbonate rocks according to depositional texture*

[From Dunham (1962, p. 117)]

Depositional texture recognizable					Depsoitional texture not recognizable
Original components not bound together during deposition				Original components were bound together during deposition as shown by intergrown skeletal matter, lamination contrary to gravity, or sediment-floored cavities that are roofed over by organic or questionably organic matter and are too large to be interstices.	Crystalline carbonate (Subdivide according to classifications designed to bear on physical texture or diagenesis.)
Contains mud (particles of clay and fine silt)		Lacks mud			
Mud-supported		Grain-supported			
Less than 10 percent grains	More than 10 percent grains				
Mudstone	Wackestone	Packstone	Grainstone	Boundstone	

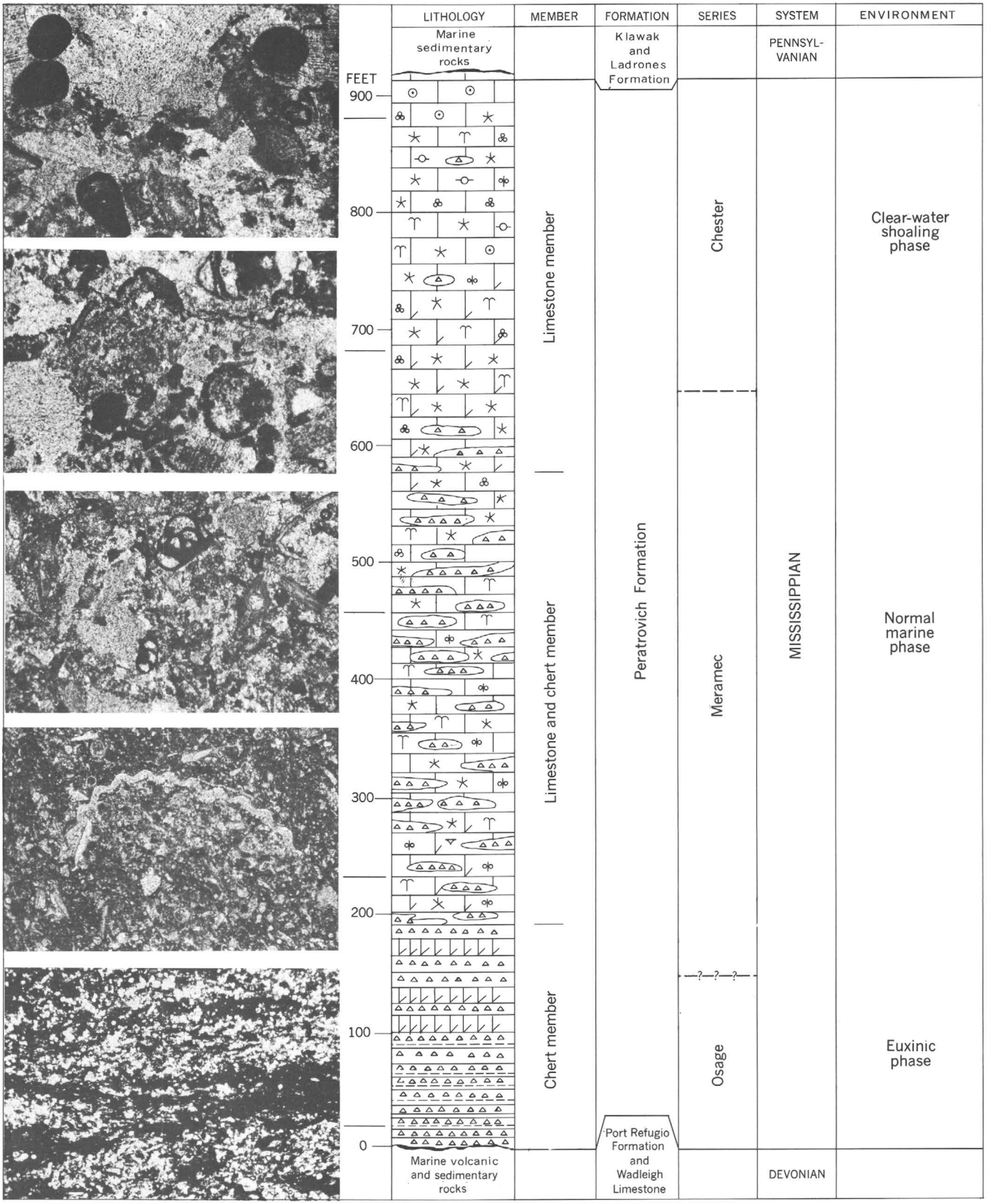

FIGURE 3.—Explanation on opposite page.

ACKNOWLEDGMENTS

I am grateful to G. D. Eberlein and Michael Churkin, Jr., for their guidance and cooperation in the field in July 1966 and for their subsequent help and discussion during the preparation of this report.

Also I thank Kenneth C. Crowther for assisting in the field, for helping to collect the fossils, and for measuring the sections. The thin sections were prepared by Robert Shely, and the photographs were made by Kenji Sakamoto.

I owe special thanks to J. T. Dutro for suggesting this study. My survey colleagues, W. J. Sando, W. A. Oliver, and J. T. Dutro, technically reviewed the manuscript and E. W. Bamber, of the Geological Survey of Canada, also reviewed the manuscript.

PERATROVICH FORMATION

STRATIGRAPHY, PALEOECOLOGY, AND DISTRIBUTION OF RUGOSE CORALS

The concepts of Wilson (1967a, b, c), as to the interpretation of sedimentary fabric and structures in understanding the environments of deposition, were applied to the study of the Mississippian sedimentary deposits on the west coast of the Prince of Wales Island. At the base of the Peratrovich Formation is the chert member (fig. 4), about 200 feet thick that rests on submarine volcanic rocks. This member is an alternating series of thin-bedded lime mudstones, dark-gray cherts, and shales rich in sponge spicules and radiolarians. The microfacies includes homogeneous lime mudstone, millimeter-laminated lime mudstones, and micropelletoid lime grainstones. There are some thin beds of gray siliceous lime mudstone and dolomite with dolomite rhombs in the 30- to 60-micron size. The chert originally may have contained a high percentage of argillaceous and calcareous micropelletoid material which has subsequently been silicified.

The chert member represents sedimentation which began in a euxinic environment downslope from a prograding carbonate shelf. The youngest bed of the chert member contains gray limestone and dolomite with fossil fragments of corals, echinoderms, and bryozoans which represent the transition to a normal marine phase of carbonate sedimentation. Most of the chert member was deposited in an euxinic environment which was unfavorable for coral growth. It has a gradational contact with the overlying limestone and chert member, and in outcrops the boundary between the two is placed at the horizons at which carbonates form 25 percent or more of the rock type.

The limestone and chert member is composed of gray crinoidal bryozoan wackestones and packstones. Nodular to lenticular bands of dark-gray chert (figs. 5, 6) form 20–50 percent of the limestone and chert member. The tubular shape of much of the chert suggests the selective silicification of the carbonate fillings of burrows of an infauna, such as arthropods and worms (Shinn, 1968, p. 890, fig. 15). Field observations and petrographic studies indicate the chert has selectively replaced the limestone, and the chert still retains silicified fossil fragments and the sedimentary fabric of the limestone. The limestone and chert member is believed to have been formed in a normal marine environment below normal wave base.

The rugose corals within the Peratrovich Formation are most abundant in the normal marine phase, which is represented by the limestone and chert member. The lower part of this member is predominantly lime mudstones and wackestones in which the colonial corals are generally absent, and solitary corals predominate (fig. 3). *Faberophyllum williamsi* n. sp., *Ekvasophyllum* cf. *E. inclinatum* Parks and indeterminate fragments of other genera of solitary corals are fairly common. The upper half of the limestone and chert member is predominantly echinodermal, foraminiferal wackestone and packstone which also contains *E.* cf. *E. inclinatum* Parks, *Faberophyllum girtyi* n. sp. and *F. williamsi* n. sp. and the colonial corals, *Lithostrotion* (*Siphonodendron*) *warreni* Nelson, *Lithostrotionella banffensis* (Warren), *L. pennsylvanica* (Shimer), *L. birdi* n. sp., *Thysanophyllum astraeiforme* (Warren), *Sciophyllum alaskaensis* n. sp., *Diphyphyllum venosum* n. sp., and *D. klawockensis* n. sp. The rock types associated with the corals are typically winnowed fragmental crinoidal, bryozoan, pelletoid packstones that suggest a transitional facies toward the shoaling-water carbonates of the overlying limestone member. The contact between the limestone and chert member and the limestone mem-

FIGURE 3.—Generalized stratigraphic column for the Peratrovich Formation in the Peratrovich–Ladrones Islands region. All photomicrographs (in descending order *A–E* are × 20. Clear-water shoaling phase: *A.* Consists of oolitic-bryozoan-echinoderm-foraminifer packstones and grainstones. The oolites frequently have two to six layers and are generally a minor constituent of the rock. *B.* Light-gray bryozoans, echinoderms, and foraminifers, pelletoid grainstones to wackestones. Fossil fragments are broken and worn; small rounded lithoclasts are common. Normal marine phase: *C.* Gray to medium-gray echinoderms, bryozoan, foraminifer packstones. Fossile fragments are broken and worn. *D.* Gray to medium-gray micropelletoid mudstones and wackestones with fragments of fossil echinoderms, bryozoans, and brachiopods. Euxinic phase: *E.* Sponge-spicule- and radiolarian-rich argillaceous millimeter-laminated lime mudstones and micropelletoid grainstones which have frequently been replaced by chert. Dark-gray shale partings are common.

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FIGURE 4.—The chert member at Cape Suspiro, 1.2 miles south of Craig, Alaska. The cherts are bedded and contain lesser amounts of thin-bedded siliceous lime mudstones, dolomites, and shales.

FIGURE 5.—Chert on the bedding surface in the lower part of the limestone and chert member, Toti Island. Photograph taken 15 feet above base of measured section 66X–6. Tubular shape of much of the chert suggests selective silicification of carbonates filling burrows of infauna such as arthropods and worms.

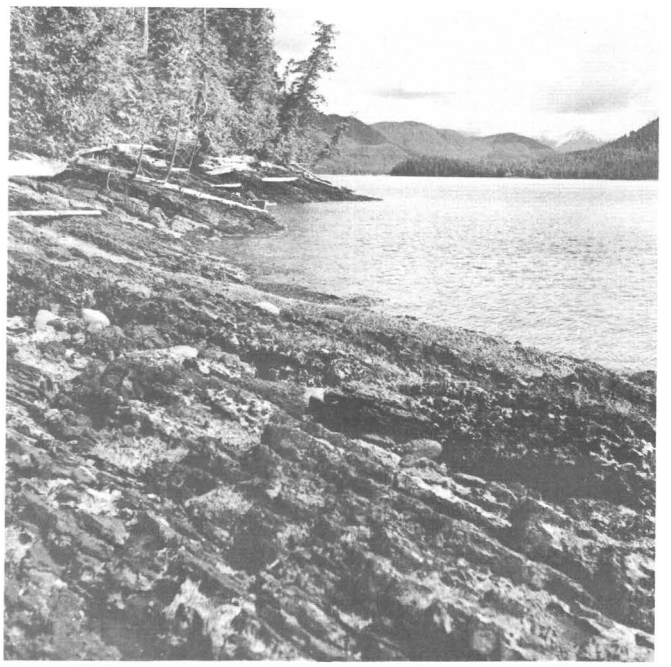


FIGURE 6.—Typical exposures of the lower part of the limestone and chert member, on the southeast side of Toti Island. View northward along the line of measured section 66X–6.

ber is a gradational zone 20–30 feet thick. The olive-gray to light-gray echinodermal wackestones and pelletoid, ooid, and oolitic packstones of the limestone member represent a clear-water shoaling phase of Mississippian sedimentation.

Although there were some environmental oscillations within the Peratrovich Formation, the overall trend was one in which sedimentation occurred in progressively more shallow water (fig. 3).

Shales and argillaceous material are common in the chert member, and some thin shale partings are present in the limestone and chert member. Insoluble residues of the limestones of these two members also contain varying amounts of argillaceous material, but the limestone member itself contains very little argillaceous material. Petrographic studies indicate that fragments of detrital sediments, such as quartz or chert derived from a terrigenous source, are very rare within the Mississippian section. In the limestone member rugose corals are present but are much less abundant than in the limestone and chert member. *Faberophyllum* sp. indet. and *Lithostrotionella banffensis* (Warren), *Lithostrotionella peratrovichensis* n. sp., and *Lithostrotion* (*Siphonodendron*) *succinctus* n. sp. are present in the limestone member at the type section on Peratrovich Island. No identifiable corals were found in this member on Madre de Dios Island or the Ladrones Islands.

In the area of Peratrovich Island the limestone member of the Peratrovich Formation is overlain with a possible disconformity by argillaceous and arenaceous carbonates of Early Pennsylvanian age. To the south on Madre de Dios, Ladrones, and Shelikof Islands, the limestone member is overlain by limestones also of Early Pennsylvanian age.

CORAL ZONES AND AGE

Identifiable corals have not been found in the chert member; its age is now based on a meager fauna of Foraminifera (*Archaediscus* sp. and *Globoendothyra* spp.) which has been found in the higher thin-bedded limestones of the member. The upper part of the chert unit is considered to be of Meramec (Late Mississippian) age. The lower part of the chert member is devoid of fossils and it conceivably may be as old as Kinderhook and (or) Osage (Early Mississippian).

On Toti and Shelikof Islands (figs. 7, 8, 9, 11), the lower 130–150 feet of the limestone and chert member has yielded a poorly preserved and unidentifiable fauna of small columella-bearing solitary corals.

At about the middle of the limestone and chert member, *Ekvasophyllum* cf. *E. inclinatum* Parks and *Faberophyllum williamsi* n. sp. first appear; they occur throughout 80–100 feet of section before the major colonial coral fauna appears. These two species are found with the colonial coral fauna which is present in the upper 100–200 feet of the member (figs. 9, 10, 11, 12). The fauna consists of the following species: *Faberophyllum girtyi* n. sp., *Lithostrotion* (*Siphonodendron*) *warreni* Nelson, *Diphyphyllum venosum* n. sp., *D. klawockensis* n. sp., *Lithostrotionella banffensis* (Warren), *L. pennsylvanica* (Shimer), *L. birdi* n. sp., *Thysanophyllum astraeiforme* (Warren), and *Sciophyllum alaskaensis* n. sp. Nelson (1960, 1961) reports

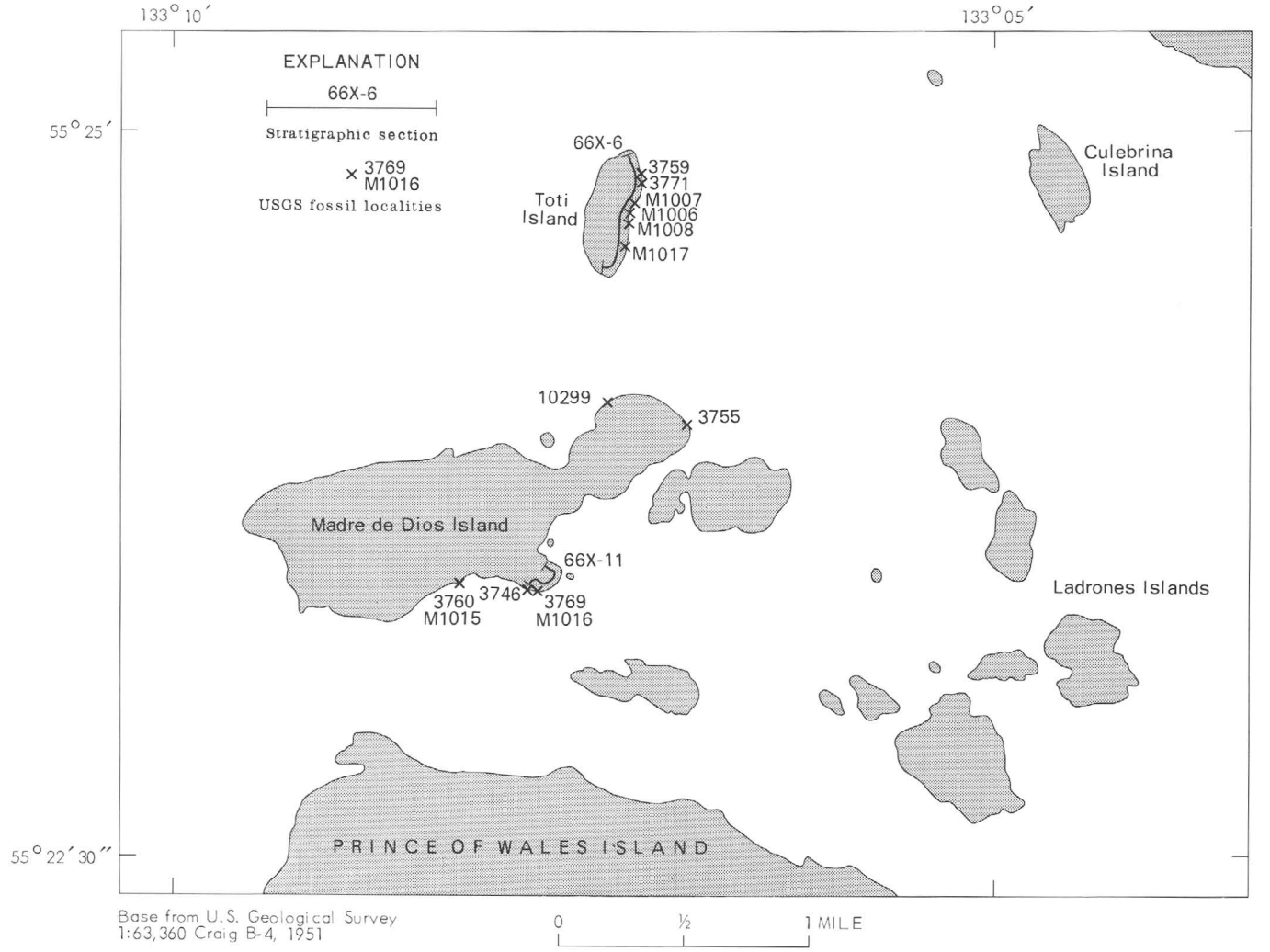


FIGURE 7.—Location of fossil localities and stratigraphic sections 66X–6, Toti Island, and 66X–11, Madre de Dios Island.

FIGURE 8.—Location of fossil localities and of stratigraphic section 66X–7 on Shelikof Island and stratigraphic section 66X–10 on unnamed island 1 mile west of Shelikof Island.

Faberophyllum and *Ekvasophyllum*, *T. astraeiforme*, *L. pennsylvanica*, and *L. banffensis* from the Mount Head Formation of western Canada. E. W. Bamber (oral commun., 1967) has found corals possibly belonging to *Diphyphyllum* spp. and various species of *Faberophyllum* and *Ekvasophyllum* to be also present in the Mount Head Formation.

From southeast Idaho, Dutro and Sando (1963a, p. 93–94, 1963b, p. 1974) reported *Diphyphyllum* sp., *Lithostrotionella* aff. *L. pennsylvanica* (Shimer), and *Ekvasophyllum* sp., 750–1,075 feet above the base of the Chesterfield Range Group in their faunal zone E which they believed to be of Meramec age. They found *Faberophyllum* sp. in their faunal zone F in the Chesterfield Range Group. They stated: "*Faberophyllum*-rich strata are common throughout the Great Basin region in the Great Blue Limestone and correlative stratigraphic units. They are present also in the upper Mount Head Formation of western Canada. Zone F is certainly of Meramec age in part, but it may include correlatives of the lower Chester as well".

The middle part of the limestone and chert member, which contains the coral genera *Ekvasophyllum* cf. *E. inclinatum* Parks and *Faberophyllum williamsi* n. sp., also contains a Foraminiferal fauna which is in the process of being studied and described. The corals and foraminifers both indicate a Meramec age. The lithostrotionid fauna in association with *Faberophyllum girtyi* n. sp., although containing some new species, is characteristic of late Meramec faunas in western Canada, particularly the upper half of the Mount Head Formation. A large and diversified foraminiferal fauna occurs with the lithostrotionid corals, and they also indicate a late Meramec age.

The limestone member in the Klawock–Ladrones Islands area contains a sparse fauna of rugose corals which alone would be inadequate to zone this part of the Mississippian section. *Lithostrotionella banffensis* (Warren) and fragments of *Faberophyllum* sp. indet. have been found in the lower part of the member. Associated Foraminifera indicate these beds are of late Meramec age. The youngest rugose coral found in the Peratrovich Formation comes from near the top of the limestone member and is a new species, *Lithostrotion* (*Siphonodendron*) *succinctus* n. sp. It is found associ-

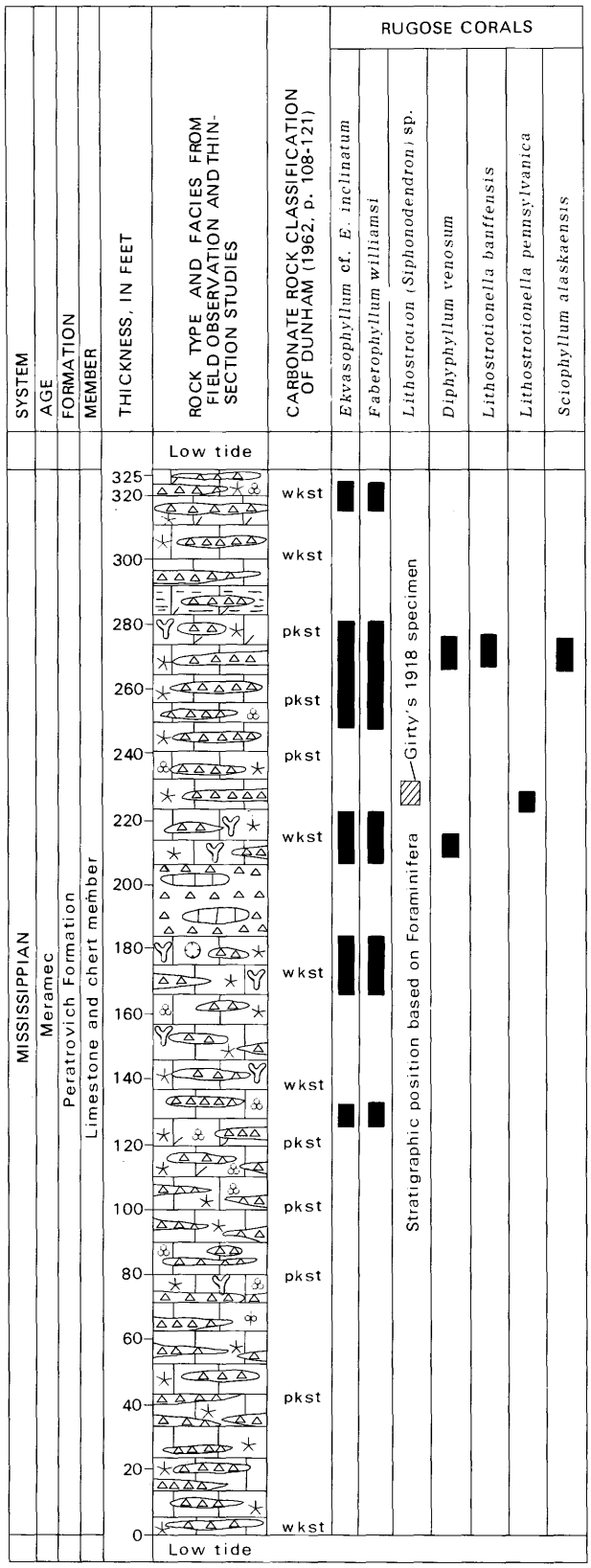


FIGURE 9.—Stratigraphic section 66X–6, Toti Island.

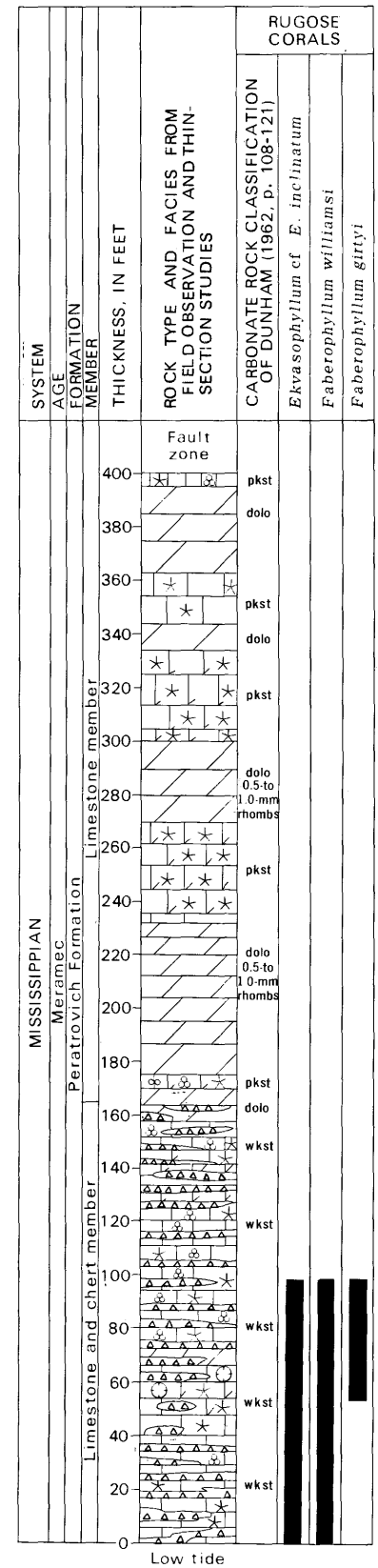


FIGURE 10.—Stratigraphic section 66X–11, Madre de Dias Island.

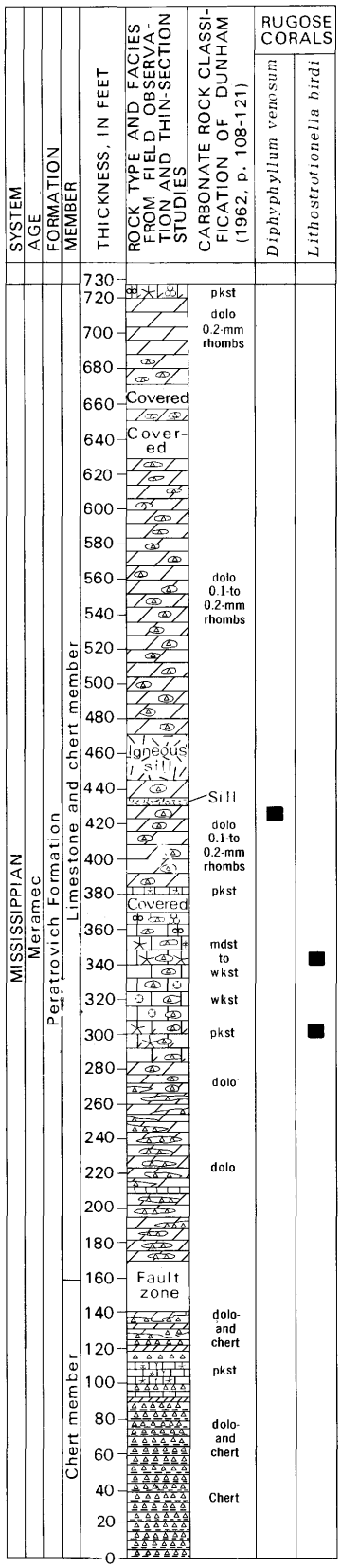


FIGURE 11.—Stratigraphic section 66X–7, Shelikof Island.

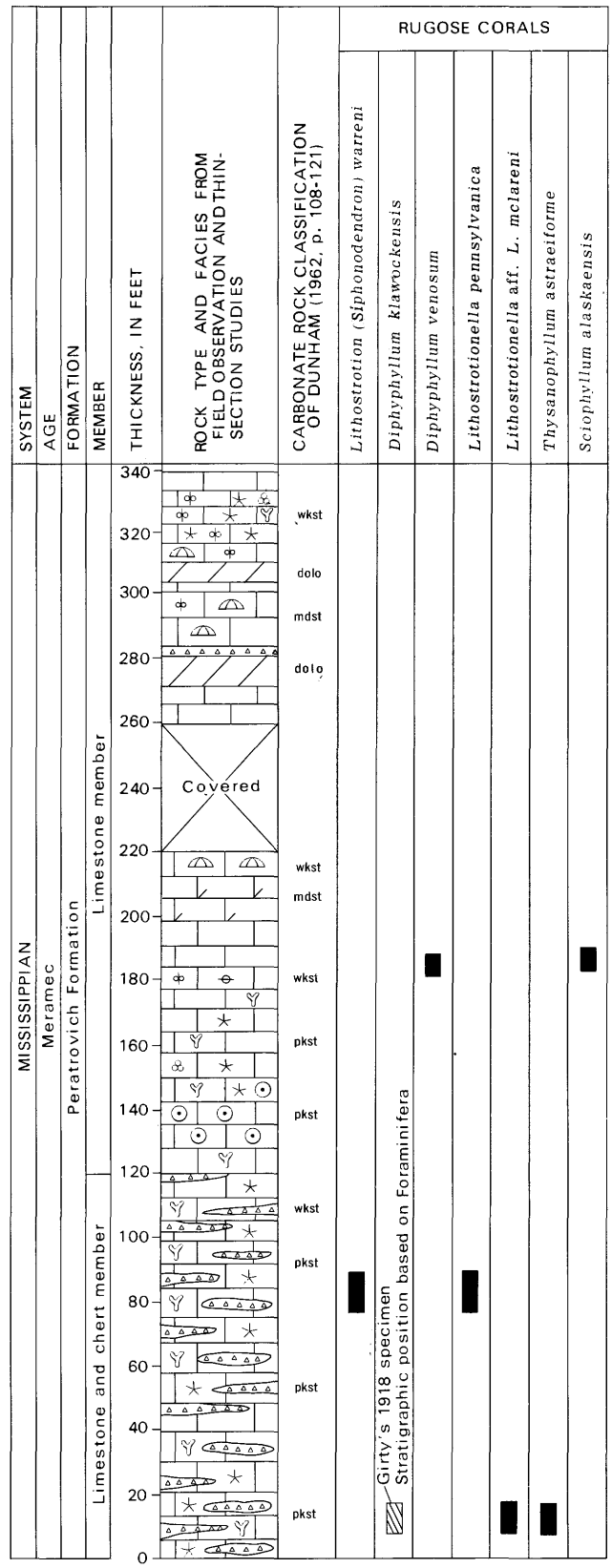


FIGURE 12.—Stratigraphic section 66X–10, on small unnamed island 1 mile west of Shelikof Island.

ated with a foraminiferal fauna of Chester age characterized by *Millerella* sp.

The highest 100 feet of the limestone member on the south end of Peratrovich Island contains foraminiferal ooid packstones with a large microfauna of *Pseudoendothyra* sp., *Neoarchaediscus* spp., *Bradyina* spp., and *Archaediscus* spp. which is of latest Chester age.

SYSTEMATIC PALEONTOLOGY

The morphological terminology followed is that of Hill (1956, p. 234–251) with the exception of the terms alar diameter and calicular angle, which are defined by Sando (1965).

Conventional treatment has been followed in the taxonomic hierarchy above the species level. The classification is generally that of Hill (1956) with some minor changes, and the terminology of the microstructure is that of Kato's (1963).

Phylum COELENTERATA
Class ANTHOZOA
Order RUGOSA Milne-Edwards and Haime 1850
Family AULOPHYLLIDAE Dybowski 1873
Subfamily AMYGDALOPHYLLINAE Grabau in Chi, 1935

Genus EKVASOPHYLLUM Parks, 1951

Ekvasophyllum Parks, 1951, Jour. Paleontology, v. 25, no. 2, p. 175.

Ekavasophyllum Parks, Sutherland, 1958, Canada Geol. Survey Mem. 295, p. 74–77.

Type species.—*Ekvasophyllum inclinatum* Parks 1951, p. 175, pl. 29, figs. 1a, b, 3). Meramec, Brazer Limestone, Leatham Hollow, northern Wasatch Mountains, Utah.

Diagnosis.—Solitary, slightly curved, trochoid, medium-sized corals, with numerous septa tending toward radial symmetry except near the prominent cardinal fossula where they are pinnately arranged; solid, slightly laterally compressed, rodlike columella; incomplete tabulae arch upward to join the columella; dissepiments present; cardinal fossula on convex side (Parks, 1951, p. 175).

Remarks.—The genus *Amygdalophyllum* was proposed by Dun and Benson (1920, p. 339–341) with *A. etheridge* Dun and Benson from the lower Carboniferous of Australia as the type species. Hill (1956, p. F291) considered *Ekvasophyllum* Parks to be a junior synonym of *Amygdalophyllum*. Sutherland (1958, p. 76) stated that the two genera are quite distinct. *Amygdalophyllum* is a turbinate to trochoid form with numerous long, radially arranged major septa, which extend to the axis and touch a thick elliptical solid columella. The cardinal fossula is absent and the minor septa are three-fourths the radius in length with a correspondingly wide dissepimentarium. Furthermore, in the late ephebic stage the outer ends of the septa die out in the dissepimentarium and do not reach the epitheca.

In contrast, the type species of *Ekvasophyllum*, *E. inclinatum* Parks, has a long, narrow fossula, pinnate septa near the fossula, short minor septa, and, in the ephebic stage, has septa that join the epitheca through a herringbone dissepimentarium.

Ekvasophyllum cf. E. inclinatum Parks

Plate 1, figures 1–14; plate 12, figures 3, 4–7

Ekvasophyllum inclinatum Parks, 1951, Jour. Paleontology, v. 25, p. 175, pl. 29, figs. 1a, 1b, 3a.

Amygdalophyllum (*Ekvasophyllum*) *inclinatum* (Parks), Nelson, 1961, Geol. Assoc. Canada Spec. Paper 2, pl. 13, figs. 1–3.

Material.—Specimen USNM 160502, which is described in detail, was chosen from a large collection of solitary corals made by Girty and Waters in 1918 from the eastern part of Madre de Dios Island (USGS loc. 3755). All the specimens were partially silicified and generally were fragments of incomplete coralla. From this collection seven individuals are either described or illustrated; one, USNM 160501, was etched free from the limestone matrix, and thin sections were made of six others, USNM 160503–160506, 160518, and 160519.

Description.—The specimen, USNM 160502, is a free trochoid corallum with a calicular angle of approximately 45°. The tip and earlier growth stages were broken off. The corallum is curved in the cardinal-counter plane, and the cardinal position is on the convex side. The calice rim is broken off, but the calice depth seems to have been 20–22 mm. The maximum diameter measured at the rim of the calice is 32 mm.

The earliest transverse thin section studied (pl. 1, fig. 3) has a diameter of 4 mm and was cut just above the broken tip. The epitheca is silicified, and chalcedony has penetrated and replaced some of the interior structure and has affected the septal and the axial region. The internal features have been obscured, but 15 pinnately arranged, dilated, and axially confluent septa appear to be present.

At a diameter of 8 mm, 25 major septa are present. The septa are pinnately arranged and are dilated and fused together. The cardinal fossula is long and narrow, and is formed by the fusion of five pairs of lateral septa. The cardinal fossula has been filled with stereoplasm which was deposited from the sides of the fossula to the center but the stereoplasm is not in optical continuity with the calcite of the septa which form the fossula. The cardinal septum is under 2 mm. long. The alar fossulae are open and marked by very short alar septa only 1 mm long. The counter septum is also short—1 mm. Except for the above-cited septa, the remaining major septa reach and join the columella, which is approxi-

mately 0.6 by 0.4 mm in size and has a well-developed medial plate.

A section cut at the base of the calice with a diameter of 22 mm has 44 radially arranged major septa. Variation in size of the alar diameter and in the number of major septa are graphed in figure 13. The nine septa in each of the counter quadrants are withdrawn from the columella, whereas those in the cardinal quadrants are fused with the columella. The long narrow cardinal fossula is formed by the ends of five pairs of major septa which are fused together. The cardinal septum is short, less than 2 mm. The alar septa are two-thirds as long as adjacent septa; the counter septum is not reduced. Minor septa are 2 mm long and are fused to major septa in a septal stereozone. There are two to four rows of regular dissepiments present adjacent to the septal stereozone. The columella has a medium plate in the cardinal—cardinal-counter plane; it is composed of septal lamellae and is 4.5 by 5 mm in size. The cardinal fossula makes an embayment 2.5 by 1 mm wide into the columella.

The original microstructure of the epitheca has been destroyed by silification. Parts of some septa have not been affected by silicification, and the microstructure has been preserved. In transverse section (pl. 1, fig. 14) the septa have a poorly defined central band of dark calcite 100–150 microns thick. Normal to both sides of this band are long fibers of dense calcite which comprise the bulk of the septa. The microstructure of the septa is diffuse trabeculae.

Specimen USNM 160518 is a free trochoid corallum with a calicular angle of approximately 45°. The earliest part of the apical end less than 2 mm in diameter, was broken off. The corallum is curved in the cardinal-counter plane, and the cardinal position is on the convex side. The calice was filled with chert.

The earliest transverse thin section studied (pl. 12, fig. 5) has a diameter of 3 mm. Chalcedony has replaced the calcite of the epitheca and has penetrated some of the interior structures. Thirteen pinnately arranged, dilated, and axially confluent septa are present.

At a diameter of 10 mm, 29 major septa are present. The septa are pinnately arranged and dilated. The cardinal fossula is long and narrow, formed by the fusion of four pairs of lateral septa. The cardinal septum is less than 1 mm long. The alar fossula are open, and the alar septa are 1 mm long. The counter septum is only slightly shorter than adjacent lateral septa. The columella is 2.2. mm long by 0.8 mm wide and consists of a medial plate in the counter-cardinal plane with thick stereome deposits. Most of the major septa make contact with the columella but do not appear to contribute to its development.

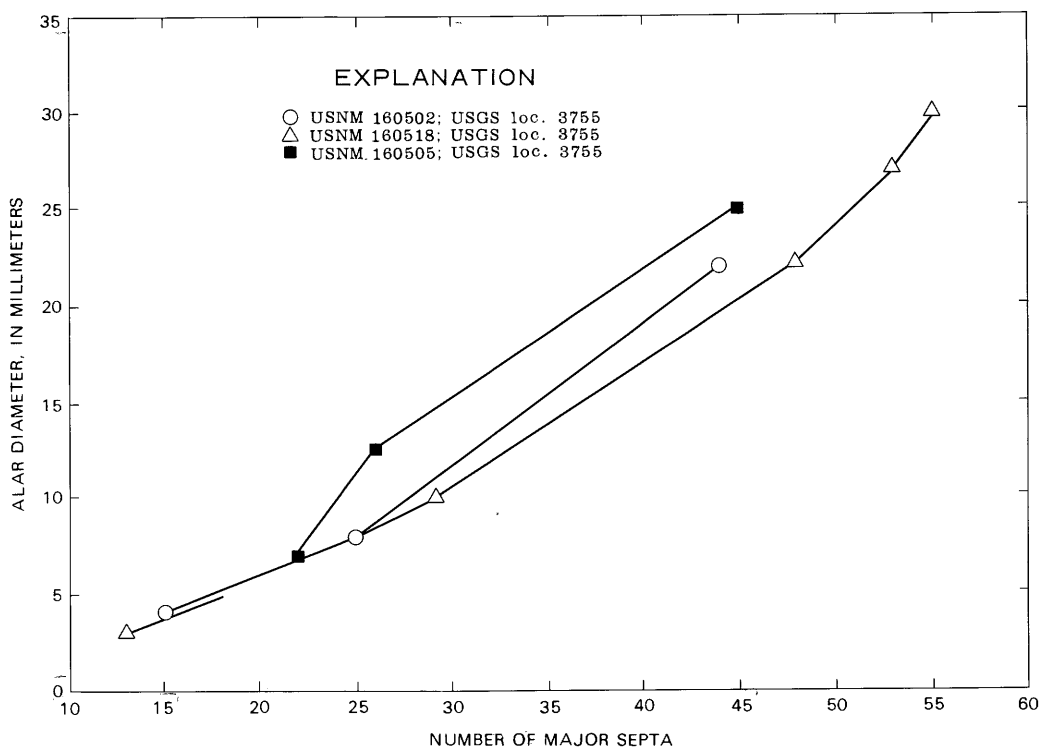


FIGURE 13.—Variations in alar diameter and number of major septa in *Ekvasophyllum* cf. *E. inclinatum* Parks.

At a diameter of 22 mm there are 48 dilated, radially arranged major septa of which there are 10 major septa in each counter quadrant and 12 major septa in each cardinal quadrant. The alar fossulae are open, and the alar septa are shorter than the adjacent septa. The cardinal fossula is closed and is formed by the fused ends of the two lateral septa. The cardinal septum is short, 1.5 mm. The minor septa are short (1–1.5 mm) and dilated, forming a septal stereozone with the major septa. There are two to three rows of regular dissepiments. The columella has a poorly defined sinuous medial plate which is in the counter-cardinal plane. Most of the major septa fuse with and contribute to the formation of the columella.

This specimen differs from specimen USMN 160502 and from other specimens of *E.* cf. *E. inclinatum* by having a columella in the ephebic stage which is not so strongly developed into a rodlike shape but is formed in part of sinuous axial ends of major septa.

Specimen USNM 160505 (pl. 1, figs. 10–12) is a free trochoid corallum, similar in shape to specimen USNM 160502; however, a large part of the tip and all the calice wall are broken off. A transverse section at a diameter of 7 mm shows that the corallum is extensively replaced by chalcedony; the replacement has obliterated much of the internal detail. Twenty-two major septa are pinnately arranged and axially confluent. The major septa are dilated and are fused by stereoplasm in the cardinal quadrants. The columella seems to be formed by septal lamellae. Minor septa are very poorly developed or absent.

At 12.5 mm diameter there are 26 pinnate major septa which join the well-developed columella. The major septa are dilated and are frequently fused together; the minor septa are short—0.4–0.6 mm. The cardinal fossula is weakly developed, and the cardinal septum is slightly shorter than the adjacent septa. The columella is an elongate lens shape, 1.8 by 2.5 mm, and is composed of an axial plate and septal lamella.

A transverse section cut just below the calice at a diameter of 25 mm has 45 major septa. The major septa in the cardinal quadrants fuse with the oval massive columella, whereas those in the counter quadrants tend to be withdrawn. The cardinal fossula is long and narrow, composed of the fused ends of six pairs of major septa. The fossula extends to the axis of the coral and makes an embayment in the columella. The cardinal septum is less than 1 mm long; the counter-septum is three-fourths as long as adjacent septa. The open alar fossulae contain short (3 mm long) alar septa. The minor septa (1.5 mm long) are fused to the adjacent major septa and form a septal stereozone.

Specimen USNM 160504 (pl. 1, fig. 8), lacks the apical end but otherwise is an almost complete trochoid corallum. It was cut in a longitudinal section in the cardinal-counter plane. At a level just below the calice floor, four to five elongate steeply inclined dissepiments are present; they are somewhat parallel to the epitheca of the corallum. One to two rows of dissepiments are present 8–10 mm below the calice floor, and at earlier stages dissepiments are absent. Below the calice and in the ephebic growth stage, the tabulae are incomplete and are composed of a series of dome-shaped tabella, 2–4 mm long. The tabellae are almost horizontal near their junction with the dissepiments, but within 2 mm of the columella they are sharply bent upward to an angle of 70°–80° to the horizontal before joining the columella. In earlier growth stages where dissepiments are absent, the tabulae are incomplete but nearly horizontal from the epitheca to the columella. The axial structure is formed by a complex of septal lamellae and tabulae.

Specimen USNM 160519 (pl. 1, fig. 9) was cut in a longitudinal section in the cardinal-counter plane. The dissepimentarium is obscured because the thin section was made in the plane of two opposing major septa. In the ephebic growth stage, just below the calice floor, the tabulae are incomplete and composed of a series of inflated, dome-shaped tabella from 2 to 6 mm long. From the point where the corallum diameter is 5 mm to the floor of the calice, the columella is formed by the axial ends of the major septa and the tabulae.

Stratigraphic range.—Specimen USNM 160502 and the seven other specimens, USNM 160501, 160503–160506, 160518, and 160519, were collected by G. H. Girty from USGS loc. 3755, which, according to his 1918 notebook, is on the east point of Madre de Dios Island in a dark-gray limestone with a great amount of chert. Examination of the limestone matrix associated with the corals in his collection reveals a foraminiferal fauna characteristic of the upper half of the limestone and chert member.

Analyzing collections made by me on Toti and Madre de Dios Islands (figs. 9, 10) I found that *E.* cf. *E. inclinatum* is the most abundant solitary coral in the upper half of the limestone and chert member. It occurs in association with *Faberophyllum williamsi* n. sp., *F. girtyi* n. sp., a large fauna of lithostrotionid corals, and foraminifers. All the fossils indicate a Meramec (Late Mississippian) age.

Remarks.—One of the most distinguishing ephebic features of *Ekvasophyllum* cf. *E. inclinatum* Parks is the very short minor septa, which are generally dilated and form a stereozone in conjunction with the major septa. Although the majority of specimens have this trait well developed, there are individuals which are

graditional with forms that have relatively nondilated minor septa and a well developed regular dissepimentarium. E. W. Bamber (written commun., Oct. 1968) reports a similar condition in *Ekvasophyllum inclinatum* Parks and *E. cascadense* (Warren) from the Mount Head Formation of Western Canada.

Parks' (1951, pl. 29, figs. 1a, 3) species *E. inclinatum* differs from my specimens of *E.* cf. *E. inclinatum* by having much longer minor septa, a wider dissepimentarium, a more weakly developed columella, and major septa which are withdrawn from the columella.

E. W. Bamber (written commun., Oct. 1968) states that *Ekvasophyllum* cf. *E. inclinatum* from the Peratrovich Formation "falls well within the limits of *E. inclinatum* Parks according to his observations on several hundred specimens of *E. inclinatum* from numerous localities in the Canadian Rockies".

Sutherland (1958) described three new species of *Ekvasophyllum* from rocks of Meramec age in northeastern British Columbia which are similar to but not conspecific with *E.* cf. *E. inclinatum* from southeastern Alaska. *Ekvasophyllum proteus* Sutherland differs by having a smaller diameter, better developed alar fossulae, and a weaker developed columella.

Ekvasophyllum enclinotabulatum Sutherland differs from *E.* cf. *E. inclinatum* by having a smaller ephebic corallum diameter of only 12–15 mm with 36–40 major septa, which are strongly dilated in the tabularium. There is a general absence of minor septa and dissepiments.

Ekvasophyllum? harkeri Sutherland has a complex axial plate, whereas *E.* cf. *E. inclinatum* Parks has a simple medium plate in its columella.

Genus FABEROPHYLLUM Parks, 1951

Faberophyllum Parks, 1951, Jour. Paleontology, v. 25, no. 2, p. 177.

Faberophyllum Parks. Sando, 1965, U.S. Geol. Survey Prof. Paper 503–E, p. E18.

Type species.—*Faberophyllum occultum* Parks (1951, p. 177–178, pl. 31, figs. 1a, b, 4a, b; pl. 32, figs. 3a, b). Upper Mississippian, Utah.

Diagnosis.—Solitary, large, moderately curved, trochoid to subcylindrical corals, with numerous septa tending toward radial symmetry except near the prominent closed cardinal fossula where they are pinnately arranged; dissepimentarium wide; tabulae incomplete; axial structure varying among species from a complex of one or more lamellae and tabellae to no axial structure and sagging tabulae (Parks, 1951, p. 177).

Faberophyllum williamsi new species

Plate 2, figures 1–15

Type material.—The holotype, USNM 160507, was chosen from a collection of corals made by Girty and Waters in 1918; the corals were collected on the south side of Madre de Dios Island at USGS loc. 3769. Seven individuals were chosen for paratypes, USNM 160508–160514.

All the specimens studied were partly silicified. The calcite of the epitheca is replaced by chalcedony to a depth of 0.5 mm. The internal structures of the coralla are replaced by calcite but much of the original microstructure is retained. The voids between the internal structures of the original coralla were subjected to two periods of sparry calcite filling during diagensis. The first was the deposition on the interior surfaces of 30- to 60-micron crystals of sparry calcite. Some of this sparry calcite penetrated into the calcite of the coralla. The second phase of calcite deposition filled most of the remaining voids with crystals of 0.5- to 1-mm sparry calcite. A third phase of silicification occurred when the calcite of the epitheca was replaced to a depth of 0.5 mm by 100- to 200-micron crystals of chalcedony.

Description of holotype.—The specimen, USNM 160507, is a free trochoid corallum that has a calicular angle of about 50°. The corallum is curved in the cardinal-counter plane with the cardinal fossula on the convex side. The diameter of the calice floor is about 23 mm; the maximum diameter measured at the top of the calice is about 42 mm.

A transverse section (pl. 2, fig. 1) cut above the tip has a diameter of 5.5 mm. Silicification of the corallum by chalcedony has replaced the epitheca and other structures, obscuring many internal details. The 22 pinnate major septa are strongly dilated. The cardinal fossula is open, long, and narrow and is formed by the fused axial ends of three pairs of major septa. Minor septa seem to be absent. The cardinal septum is short, less than 1 mm. The alar fossulae are well developed, and the alar septa are short. The counter and counter lateral septa are long and reach the axis as do the remaining major septa. The axial region has been replaced by chalcedony, but the vestigial pattern in the silica suggests the presence of a columella with a medium plate.

At a diameter of 13 mm (pl. 2, fig. 2) there are 38 major septa which are dilated in the tabularium and weakly dilated in the dissepimentarium. The septa are more strongly dilated in the cardinal quadrants than in the counter quadrants. The cardinal fossula is long and narrow, and is formed by the fusion of the ends of seven pairs of major septa. Major septa in the cardinal quadrants join in groups near the center to form one septum; that septum then joins the columella. The cardinal septum is dilated and short, 1 mm in length. The cardinal fossula is filled with calcite that is a stereoplasm deposit; this calcite is not in optical continuity with the calcite of the surrounding major septa. The alar fos-

sulae are long and narrow, and the alar septa are half as long as the adjacent major sept. The counter septum is only slightly withdrawn from the columella. The minor septa are 0.7–1.0 mm long. The columella is well developed, 2.2 by 1.7 mm, has a medium plate, and is composed of septal lamellae.

At a diameter of 21 mm (pl. 2, fig. 3), the 50 major septa show a strong tendency towards radial arrangement especially in the counter quadrants. The cardinal fossula is long and narrow and is formed by the fused ends of six pairs of major septa. The cardinal septum is very short, less than 0.5 mm. The solid columella of the previous thin section has become an axial complex of densely packed intertwined septal ends. The counter septum is two-thirds the length of the adjacent major septa. The alar fossulae are weakly developed, and the alar septa are two-thirds the length of the adjacent major septa. The minor septa are 1.5–2 mm long. The septa are moderately dilated in the dissepimentarium and are 0.2–0.3 mm thick; however, in the tabularium in the cardinal quadrants, they are strongly dilated and are 0.7–0.9 mm thick. The major septa are only 0.4–0.5 mm thick and are less dilated in the counter quadrants of the tabularium. The dissepimentarium has one to three rows of dissepiments.

A transverse section (pl. 2, fig. 4) cut about 4 mm above the preceding section and just below the floor of the calice has a diameter of 23 mm (fig. 14). The internal structures are similar to those found below in the coral, however, the major septa in the counter quadrants are less dilated and are only 0.3–0.4 mm thick. Also, the rows of dissepiments are more distinctly developed, and most of the major septa show a tendency to withdraw from the axial region. The axial complex is poorly developed and consists of septal lamellae.

In all the specimens studied, the calcite of the internal structures of the corallite is affected by extensive neomorphism (Folk, 1965, p. 20–23). The sparry calcite crystals, which filled the internal voids of the corallite, have penetrated and recrystallized the calcite of the corallite by the process of grain growth. Vestiges of the original microstructure can be seen; the corallite wall is fibrous; and the septa are trabecular and consists of fibrous calcite. The microstructure of the dissepiments and tabulae was destroyed by the grain growth of the sparry calcite.

Description of paratypes.—A longitudinal section was made from an almost complete corallum (pl. 2, fig. 6, USNM 160509). At a level just below the calice floor there are four to six rows of elongate dissepiments which are parallel with the epitheca. At 10 mm below the calice floor there are only one or two rows of elongate, flat-lying dissepiments; at an even earlier growth stage 12 mm below the calice floor, dissepiments are not

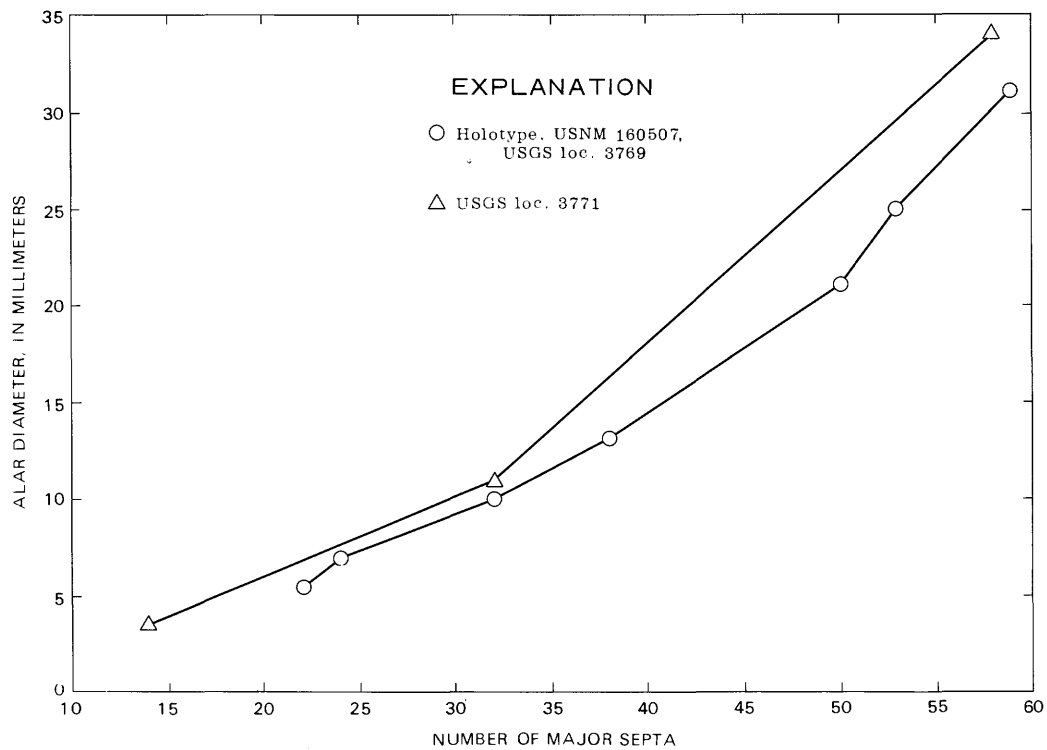


FIGURE 14.—Variations in alar diameter and number of major septa in *Faberophyllum williamsi*, n. sp.

developed. The tabulae are incomplete and have a gentle downward sag.

Three partially silicified paratypes were etched in HCl. The best specimen (pl. 2, figs. 9, 10, USNM 160511) is a corallum with the tip missing below a diameter of about 17 mm. The specimen is trochoid and has a calicular angle of about 40°. The corallum is curved in the cardinal-counter plane and the cardinal fossula is on the convex side. Some of the calice rim is missing, but the calice depth seems to be about 28 mm and the calice diameter about 42 mm. Within the calice the septa are radially arranged except near the weakly developed alar fossulae and the well-developed long narrow cardinal fossula. The axial complex is poorly developed and is composed of raised sinuous intertwined septal ends. The exterior of the corallum has weakly developed transverse striations and interseptal ridges.

Type locality and stratigraphic range.—The holotype, USNM 160507, and two paratypes, USNM 160508 and 160509, were collected by Girty and Waters in 1918 from the south side of the Madre de Dios Island (USGS loc. 3769). One of the HCl-etched paratypes, USNM 160511, was collected by Girty and Waters from the east point of Madre de Dios Island (USGS loc. 3755). One paratype, USNM 160512, was collected from measured section 66X–6, on Toti Island (USGS loc. M1006). Two paratypes, USNM 160510 and 160513, were collected from measured section 66X–11 on Madre de Dios Island (USGS loc. M1016).

Faberophyllum williamsi n. sp. is found in the upper half of the limestone and chert member in association with *Ekvasophyllum* cf. *E. inclinatum* Parks, *Faberophyllum girtyi* n. sp., a fauna of lithostrotionid corals characterized by *Lithostrotionella banffensis* (Warren), *L. pennsylvanica* (Shimer), and a Foraminifera fauna of Meramec age.

Remarks.—*Faberophyllum williamsi* n. sp. and *Faberophyllum girtyi* n. sp. occur together in the higher beds of the limestone and chert member. *F. williamsi* has a trochoid corallum. The late neanic and early ephebic growth stages are characterized by a well-developed columella composed of a median plate and septal lamellae, by strongly dilated major septa, and by poor development of or absence of dissepiments. Mature coralla have a cardinal length of between 55–65 mm and a calice diameter of 30–40 mm. By comparison, mature individuals of *F. girtyi* have a cardinal length of from 100–130 mm and a calice diameter of from 55–70 mm. The coralla are ceratoid. Late neanic growth stages have major septa which are not strongly dilated, somewhat withdrawn from the axis, and slightly sinuous. The dissepimentarium and minor septa are longer; the columella is more weakly developed and is a complex of septal ends. The ephebic stage of *F. girtyi* has a much larger diameter, more major septa, longer minor septa, a much wider dissepimentarium, and a very poorly developed to absent columella.

F. girtyi and *F. williamsi* are closely related species as shown by their similar neanic and ephebic growth stages of the coralla. Large collections of solitary corals were made by Girty and Waters in 1918, and the writer made similar collections in 1966 from the same beds. Examination of these collections reveals that the specimens assigned to the genus *Faberophyllum* fall into two distinct size groups without intermediate forms. The smaller trochoid *F. williamsi* is the more abundant form; the large form is the ceratoid *F. girtyi*, a minor element of the fauna.

Ekvasophyllum cf. *E. inclinatum* Parks also occurs in these same collections and is numerically the most abundant species. It has neanic and nearly ephebic growth stages which are similar to both *F. girtyi* and *F. williamsi*. This suggests all three species probably had a common ancestor at some point in earlier Mississippian time.

F. williamsi in the number of major septa and ephebic corallum diameter is similar to *Faberophyllum pisgahense* Parks (1951, pl. 32, figs. 1a–1b) from his Brazer Dolomite of Utah. *F. pisgahense* differs by having major septa which are not dilated in the ephebic growth stages, much longer minor septa, a wider dissepimentarium, a stronger tendency towards radial arrangement of major septa, and tabulae which are slightly arched upward.

The species is named in honor of James Steele Williams, paleontologist, U.S. Geological Survey, who collected Mississippian fossils from Prince of Wales Island in 1940.

Faberophyllum girtyi new species

Plate 3, figures 1–6

Type material.—The holotype, USNM 160515 (USGS loc. 3769) was collected by G. H. Girty in 1918 from Madre de Dios Island; and the paratype, USNM 160516 (USGS loc. M1016), was collected in 1966 from the same locality. Supplemental material not designated type material includes two other incomplete corallites collected at loc. M1016, and eight fragments collected by G. H. Girty from USGS loc. 3746. G. H. Girty also collected two incomplete and exfoliated specimens from the northwest side of Klawak Island.

Description of holotype.—The specimen, USNM 160515, is a free ceratoid corallum that has a calicular angle of about 60°. The corallum is curved in the cardinal-counter plane with the cardinal fossula on the convex side. The specimen has been weathered and is incomplete and partly silicified. Younger parts of the corallum with a diameter less than 24 mm had been weathered off, along with most if not all of the calice

rim. The calice itself was obscured by a deposit of chert.

The youngest transverse section was cut at a diameter of 33 mm and has 56 long slightly sinuous major septa. Some of the major septa in the counter quadrants join the columella. Those in the cardinal quadrants are withdrawn from the axis and do not reach the columella, and the columella is formed by intertwined septal plates. The cardinal septum is short and is in a fossula bordered by fused adjacent lateral septa. The fossula is long and narrow and extends into the axial region. The counter septum is somewhat shorter than the adjacent septa. Alar fossulae are present and are occupied by short alar septa. The short minor septa are 3 mm. The dissepimentarium consists of six to eight rows of regular dissepiments, some of which extend beyond the minor septa.

At a diameter of 45 mm, there are 67 radially arranged major septa which are withdrawn from the axial region. The short cardinal septum is 4 mm and is located in a long narrow, closed fossula bordered by the adjacent lateral septa. Counter septum and alar septa are slightly shorter than the adjacent septa. The axial structure or columella is absent, but the axial region beyond the ends of the major septa has five to six concentric rings which are the traces of the sagging tabulae. Thin short 0.2–0.3 mm, ridges are present which are traces of septa on the tabulae. The minor septa are 5–6 mm. The dissepimentarium is about 7–8 mm wide, extends axially beyond the minor septa, and consists of 9 to 11 rows of regular dissepiments.

A longitudinal section (pl. 3, fig. 3) cut between the two transverse sections shows 9 to 12 rows of elongate dissepiments inclined parallel to the epitheca of the corallum. The tabulae are incomplete and horizontal at their junction with the dissepimentarium but sag downward in the central part of the corallum. The axial complex is composed of tabulae and septal lamellae.

All the calcite of the internal structures of the corallites is affected by neomorphism, and the corallite wall is extensively penetrated by chalcedony. The sparry calcite crystals which filled the internal voids of the corallites have penetrated and absorbed much of the calcite of the corallite by the process of grain growth. Thus the shape of the corallite structures under the petrographic microscope is seen in thin section as bans of inclusions within the sparry calcite. The corallite is or was fibrous and the septa (pl. 1, fig. 15) are trabecular. The original microstructure of the dissepiments and tabulae was destroyed by the grain growth of sparry calcite.

Description of paratype.—An incomplete, free trochoid corallum, USNM 160516, about 75 mm in length with a calicular angle of approximately 65°, was collected by the writer on the south side of Madre de Dios Island from measured stratigraphic section 66X–11.

A transverse section (pl. 3, fig. 5) cut just below the calice floor has a diameter of 62 mm and 96 major septa. The septa are radially arranged except near the long narrow cardinal fossula which is formed by the fused ends of six pairs of adjacent major septa. The cardinal septum is 2 mm long; the minor septa are 8–9 mm long. The counter septum is not in a fossula and is only slightly shorter than the adjacent septum. The major septa are dilated in the tabularium where they are 0.3–0.4 mm thick; in the dissepimentarium they are 0.2 mm thick. There are seven to nine rows of regular dissepiments in the dissepimentarium.

In longitudinal section (pl. 3, fig. 6), the ephebic growth stage below the calice is characterized by seven to nine rows of elongate dissepiments in the dissepimentarium. The tabulae are incomplete and sagging or slightly downturned adjacent to the dissepimentarium, but in the central part of the corallum they are clearly dome-shaped. The axial complex is made up of tabulae and septal lamellae.

Type locality and stratigraphic range.—The holotype, USNM 160515 (USGS loc. 3769), was selected from Girty and Waters' 1918 collection from the south side of Madre de Dios Island. The paratype, USNM 160516, was collected from the measured section, 66X–11 (USGS loc. M1016), on the south side of Madre de Dios Island and is believed to be at the same geographic and stratigraphic level as Girty and Waters' collection (USGS loc. 3769).

Faberophyllum girtyi n. sp. occurs in the upper part of the limestone and chert member from Toti and Madre de Dios Islands (figs. 9, 10), southeastern Alaska. It occurs in association with *Faberophyllum williamsi* n. sp., *Ekvasophyllum* cf. *E. inclinatum* Parks, a large fauna of lithostrotionid corals, and endothyrid foraminiferas, this assemblage indicates a Meramec age, Late Mississippian.

Remarks.—*Faberophyllum languidum* Parks (1951, p. 180, pl. 33, figs. la, b, 2a, b, c) differs from *F. girtyi* n. sp. by lacking an axial structure and by having longer minor septa and incomplete tabulae which sag conspicuously near the axis.

Faberophyllum leathamense Parks (1951, p. 178, 179, pl. 32, figs. 2a, b, 4) has 80–88 major septa, at a corallite diameter of 42–48 mm; however, *F. girtyi* has 65–68 major septa at a similar diameter. Also *F. leathamense* differs by having longer minor septa, better developed

axial structure, incomplete tabulae (shorter, more numerous and more steeply arched upwards), more swollen dissepiments, and a wider dissepimentarium.

For a comparison of *F. girtyi* with *Faberophyllum williamsi* n. sp., see the remarks in this text under the latter species.

Individual specimens assigned to *F. girtyi*, collected by Girty and Waters in 1918 and by me in 1966, did not have the earlier neanic growth stages of the corallum preserved; thus, the early development of the axial structure is unknown.

This species is named in honor of George H. Girty, paleontologist, U.S. Geological Survey, who in 1918 made extensive collections of Mississippian fossils from Prince of Wales Island.

Family LITHOSTROTIONIDAE d'Orbigny, 1851

Genus LITHOSTROTION Fleming, 1828

Lithostrotion Fleming, 1828, A history of British Animals, Edinburgh, p. 508.

Lithostrotion Fleming. Hill, 1956, *in* Moore, ed., Treatise on Invertebrate Paleontology, pt. F, Geol. Soc. America, p. F282.

Type species.—(Opinion 117, International Commission of Zoological Nomenclature) *Lithostrotion striatum* Fleming. Lower Carboniferous, British Isles.

For detailed synonymy of the genus, see Hill (1940, p. 165, 166; 1956, p. F282).

Diagnosis.—Phaceloid or cerioid; typically with columella, long major septa and large conical tabulae, generally supplemented by outer, smaller, nearly horizontal tabulae; dissepiments absent in very small forms, normal and well-developed in large forms; increase nonparricidal; diphymorphs common (Hill, 1956, p. F282).

Subgenus SIPHONODENDRON McCoy, 1849

Siphonodendron McCoy, 1849, Annals and Mag. Nat. History, p. 127.

Siphonodendron McCoy. Sando, 1963, Jour. Paleontology, v. 37, no. 5, p. 1075.

Type species.—*Lithostrotion pauciradialis* McCoy, Carboniferous, Ireland.

Diagnosis.—Same internal features as *Lithostrotion* except the growth form of the corallum is fasciculate.

Lithostrotion (Siphonodendron) warreni Nelson

Plate 4, figures 1–6

Lithostrotion (*Diphyphyllum*) sp. A Sutherland, 1958, Canada Geol. Survey Mem. 295, p. 98, pl. 32, figs. 4a-d.

Lithostrotion warreni Nelson, 1960, Jour. Paleontology, v. 34, p. 121, 122, pl. 24, figs. 11–14.

Lithostrotion warreni Nelson. Nelson, 1961, Geol. Assoc. Canada Spec. Paper 2, pl. 13, figs. 4–8.

Lithostrotion (*Siphonodendron*) *warreni* Nelson, Bamber, 1966, Canada Geol. Survey Bull. 135, pl. 1, fig. 2.

Material.—A fragment of a corallum 6 by 6 by 9 cm with some 35 corallites, USNM 160473 (USGS loc. M1014), was collected from stratigraphic section 66X–10 and was available for study. It is preserved in a pelletoid, crinoidal, foraminiferal wackestone. The internal structures are preserved as neomorphic calcite on which has been deposited 0.15–0.25 mm calcite crystals. The remaining voids within the corallum were subsequently filled with interlocking crystals of chalcedony 0.3–0.5 mm in size. Also available for study were fragments of two coralla, of which one specimen was collected by G. H. Girty in 1918, USNM 160474 (USGS loc. 3746) and the other specimen by J. S. Williams in 1940, USNM 160475 (USGS loc. 10299). Both samples were collected from the south side of Madre de Dios Island. Girty's sample consists of 16 large fragments of a single corallum. Fragments are from 12 by 12 by 12 cm to 4 by 4 by 4 cm in size with over 150 individual corallites available for study of which 35 were studied in thin section. Williams' specimen is a fragment of a corallum 15 by 7 by 7 cm in size with 65 corallites of which 38 were studied in thin section.

Description.—The specimen, USNM 160473, from the unnamed island west of Shelikof Island, has a corallum which is dendroid and offsets that rise by lateral increase. In transverse section corallites are generally circular and from 3–7 mm apart. Mature corallites are 5–7 mm in diameter and have 18–20 major septa which are thin, 0.07–0.1 mm, at their base (fig. 15). The major septa are somewhat sinuous and extend axially one-third to one-half the radius of the corallite. The minor septa are always present and are one-fourth the length of the major septa.

The columella is present in all the corallites studied and is a vertical axial plate 0.1–0.2 mm thick and 0.5–1.0 mm long in greatest transverse dimension. It is not connected to the major septa.

In longitudinal section the tabulae slope away from the columella at an angle of 15°–25°. Near the periphery of the tabularium, the tabulae are deflected downward at an angle of 30°–45° but at their pheripheral edges may show a slight reflex to a lower angle before contact with the dissepiments. A 6.0 mm-wide corallite has a tabularium 4.7 mm wide; in 5 mm there are from 6 to 11 tabulae and an equal number of dissepiments. The dissepimentarium is a single and infrequently double row of somewhat uniform globose dissepiments.

The epitheca and internal structures of the corallites of specimen USNM 160473 are replaced by 40–80 micron crystals of neomorphic calcite and these in turn are extensively replaced and penetrated by crystals of chalcedony. No vestiges remain of the original microstructure.

The specimen USNM 160474, collected by G. H. Girty from Madre de Dios Island, differs (fig. 15) from the above specimen by having a higher septal

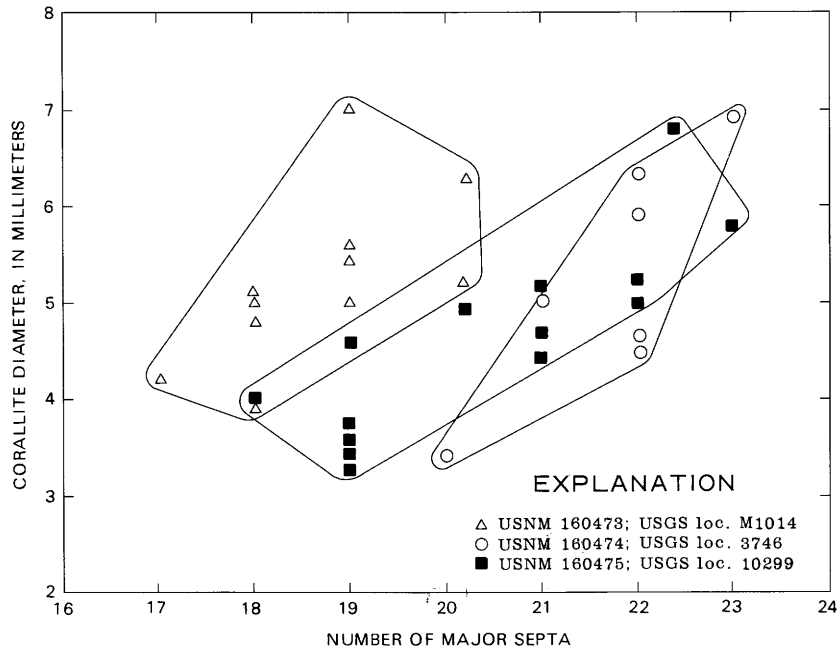


FIGURE 15.—Variations in corallite diameter and number of major septa in *Lithostrotion* (*Siphonodendron*) *warreni* Nelson.

count. Corallites with a diameter of 4.5–7 mm have 22–24 major septa. The major septa are 0.7–1.5 mm long, and the minor septa are 0.3–0.6 mm long. In longitudinal section the columella and dissepimentarium are discontinuous. There are seven to nine complete tabulae in a distance of 7–9 mm which are flat to gently sloping near the axis, deflected upward at the columella and strongly downward near the dissepimentarium. The microstructure of the corallites has been destroyed by the same processes as in specimen USNM 160473.

J. S. Williams' random specimen, USNM 160475 (USGS loc. 10299), is preserved as chalcedony (fig. 16).

Occurrence.—The specimen, USNM 160473, was found in the upper part of the chert and limestone member 80 feet above the base of measured section 66X–10 (fig. 12) which is on the west side of an unnamed island 1 mile due west of Shelikof Island, Alaska. It was found in the same bed associated with *Lithostrotionella birdi* n. sp., *Lithostrotionella pennsylvanica* (Shimer) and a foraminiferal fauna; the assemblage indicates a Meramec age.

Girty's random specimen, USNM 160474 (USGS loc. 3746), was collected on the south side of Madre de Dios Island (according to his 1918 notebook). A microfauna in the lime mudstone between the corallites contains a Meramec foraminiferal fauna characteristic of the upper part of the chert and limestone member.

J. S. Williams' specimen, USNM 160475 (USGS loc. 10299), was collected from the northwest side of Madre de Dios Island (according to his 1940 field notes). Microscopic examination of the limestone between the corallites reveals a sparse foraminiferal fauna characteristic of the upper half of the limestone and chert member.

Nelson (1960, p. 121) stated that *L.* (*S.*) *warreni* occurs in the lower Mount Head Formation, Alberta, ranging from the lower to upper *Lithostrotionella* beds.

I have collected *L.* (*S.*) *warreni* in arctic Alaska from the Lisburne Group, namely from the Nasorak Formation at Cape Thompson, in the upper two-thirds of the Kogruk Formation in the DeLong Mountains, Brooks Range, and the dark limestone member of the Alapah Limestone Lisburne Group at Shainin Lake,

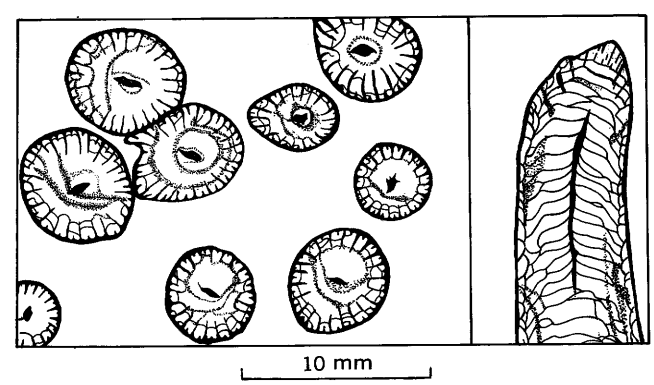


FIGURE 16.—Thin sections of *Lithostrotion* (*Siphonodendron*) *warreni* Nelson, USNM 160475.

Endicott Mountains, Brooks Range. In the Lisburne Group, *L.* (*S.*) *warreni* is found associated with a fauna of lithostrotionid corals and foraminifers of Meramec age.

Remarks.—The specimen *L.* (*S.*) *warreni* (USGS 160473), from the small unnamed island 1 mile west of Shelikof Island, differs from the redescription of the holotypes of *L.* (*S.*) *mutabile* (Kelly, 1942) and *L.* (*S.*) *warreni*, given by Bamber (1966, p. 4–6) in having two to four less major septa in corallites of equal size, shorter minor septa and discontinuous dissepiments. Sutherland's (1958, p. 9–7) specimen from British Columbia compares closely in number of septa to corallite diameter with the specimen from the island 1 mile west of Shelikof Island. Both Bamber's description of the holotype and Sutherland's description of his specimen state the columella may be absent in some corallites. The southeastern Alaskan specimens have columellae in all the corallites and well developed dissepiments.

Both samples, USNM 160474 collected by G. H. Girty and USNM 160475 collected by J. S. Williams from the south side of Madre de Dios Island, compare very closely to the holotype of *L.* (*S.*) *warreni*. *L.* (*S.*) *oculinum* Sando is distinguished by tabulae that are sharply deflected or depressed downward near the periphery of the tabularium and then reflexed to a nearly horizontal plane near their contact with the dissepiments (Sando, 1963, pl. 145, fig. 4).

Lithostrotion (Siphonodendron) succinctus new species

Plate 7, figures 5–8

Type material.—The holotype, USNM 160476 (USGS loc. M1005), is a fragment of a corallum 8 by 10 by 12 cm. A cut and polished surface of the specimen revealed 105 individual corallites of which 34 were studied in thin sections. In the field the corallum had a diameter of about a third of a meter. The corallum was preserved in a partially silicified oolitic foraminiferal packstone. The growth form is dendroid. The epitheca is thin and marked longitudinally by low but distinct interseptal ridges and shallow septal grooves. Transverse ornamentation was not observed.

Chalcedony has selectively replaced some of the oolites and lime mud between the fossil fragments in the limestone. The corallum has also been affected by silicification. Some corallites have had part of or all the calcite of their internal structures replaced by 0.1- to 0.2-mm crystals of chalcedony. The voids between the internal structures of the corallite are generally filled with sparry calcite. Fortunately a number of the corallites are unaffected by silicification, and the microstructures of the walls and septa are preserved (pl. 7, figs. 5, 6).

Description of holotype.—In transverse section (fig. 17), mature corallites range from 5 to 7 mm in diameter and have 17–22 major septa (fig. 18). The corallites are generally circular and may touch each other, but the normal spacing between corallites is 1–3 mm and often as much as 8 mm. The epitheca is 0.2–0.3 mm thick. Major septa are slightly sinuous, are 0.25–0.30 mm thick at their base, and taper toward the axis. Major septa sometimes join along their axial edges to form groups (pl. 7, fig. 7, second corallite from right, top). In a number of corallites the major septa join the columella. Random transverse sections show many of the corallites with all their major septa joining the columella. In these sections the septa run up the slope of the tabulae as ridges to join the columella. Other sections of corallites show the major septa withdrawn a short distance from the columella and the axial ends of the septa are bordered by intercepts of tabulae. These sections are interpreted as having been cut above the septal ridges on the tabulae and below the next tabulae. The columella is well developed and elongate in the cardinal-counter plane, typically 0.8–0.9 mm long and 0.3–0.4 mm thick. Short minor septa are always present and are 0.2–0.5 long. The dissepimentarium consists of dissepiments in a regular concentric pattern. Immature corallites, those less than 4 mm in diameter, have weakly developed columellae which are generally a continuation of the cardinal and counter septa; the major septa are withdrawn from the axis, and the minor septa are absent or weakly developed.

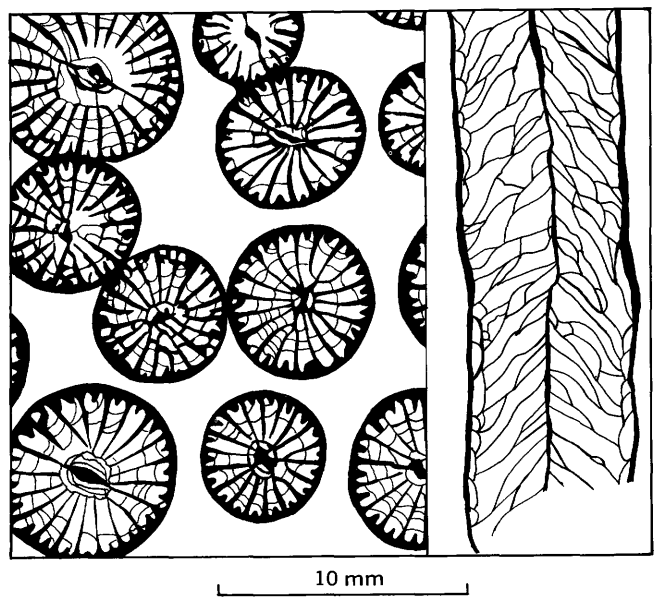


FIGURE 17.—Thin sections of *Lithostrotion* (*Siphonodendron*) *succinctus* n. sp., holotype, USNM 160476.

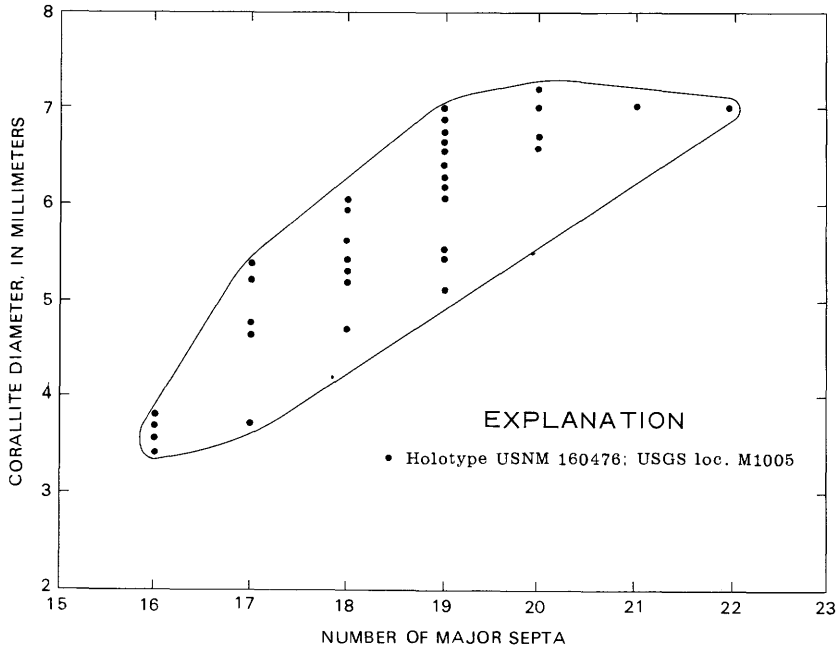


FIGURE 18.—Variations in corallite diameter and number of major septa in *Lithostrotion (Siphonodendron) succinctus* n. sp. Each mark represents a measurement taken from a transverse thin section.

In longitudinal section (pl. 7, fig. 8) the tabulae are generally incomplete and convex upward. They slope at an angle from 40° to 60° but are sharply deflected downward a short distance (1–1.5 mm) from the dissepiments. Occasionally the tabulae are reflexed to a horizontal plane near their junction with the dissepiments. The columella is strong, well developed, slightly sinuous, and persistent.

The dissepimentarium consists of a discontinuous single row and occasionally a double row of elongate, somewhat swollen dissepiments, of which four to six occupy an interval of 5 mm.

The corallites which have been replaced by calcite have maintained their microstructure. Transverse sections reveal the microstructure of the corallite wall is composed of long radiating fibers of calcite, which are at right angles to the exterior. A thin centrally located band of dark calcite extends the length of the septa from which, at right angles, long fibers of calcite extend to the face of the septa (pl. 7, figs. 5, 6).

Type locality and stratigraphic range.—Only one specimen was collected, and it was found on the south side of a small island in a small inlet on the northeastern side of Peratrovich Island, NE¼NW¼ sec. 35, R. 80 E., T. 72 S. The specimen was collected from near the top of the limestone member in oolitic packstones which contained *Lithostrotionella* sp. indet. and a foraminiferal fauna of *Endothyra* spp. and *Millerella* sp.; the assemblage is of Chester age.

Remarks.—This species can be distinguished from *Lithostrotion (Siphonodendron) oculinum* Sando by its short minor septa, longer and thicker major septa which frequently join the well developed columella. Also, in *L. (S.) succinctus*, the tabulae are steeper, have a distinctly different configuration and tend to be incomplete; the corallite diameter is somewhat larger.

Lithostrotion (Siphonodendron) mutabile (Kelly) and *Lithostrotion (Siphonodendron) warreni* Nelson also have much shorter major septa, weaker developed columella and tabulae which are more flat than those of *Lithostrotion (Siphonodendron) succinctus* n. sp.

Lithostrotion (Siphonodendron) genevievensis Easton (1957, p. 616–622), from the Upper Mississippian Ste. Genevieve Limestone of Kentucky, is similar in corallite diameter and number of major septa to *L. (S.) succinctus* n. sp. but differs from the latter species by having tabulae which tend to be complete and more flat lying, a weaker developed columella, major septa which are more sinuous and amplexoid and minor septa which are lacking.

Sloss (1945, p. 312–313, pl. 48, figs. 11–16) reported from Upper Mississippian rocks of Montana a specimen, *Lithostrotion* cf. *L. irregulare* (Phillips), which is similar in corallite diameter and number of septa to *L. (S.) succinctus*. The Montana specimen differs by having less steeply inclined tabulae, longer minor septa, and thinner major septa.

Nelson illustrates (1961, pl. 23, figs. 1, 2) but does not describe a specimen, *Lithostrotion* cf. *L. pauciradiale* (McCoy), from the lower Etherington Formation, Crowsnest Pass, British Columbia. The specimen differs from *L.* (*S.*) *succinctus* by having major septa which generally do not reach the columella, less steeply inclined tabulae, and a better developed dissepimentarium.

Yü's (1933, p. 96; 1937, p. 40) subspecies, *Lithostrotion irregulare jungtungense* from the lower Carboniferous of South China, closely resembles *Lithostrotion* (*Siphonodendron*) *succinctus* n. sp. in the development of the major septa, the columellae and the corallite diameter. Yü's subspecies differs however by having a single row of relatively wide and persistent dissepiments and minor septa which are very short or absent in some corallites.

Lithostrotion (Siphonodendron) species

Plate 5, figures 1, 4

Material.—The specimen collected in 1966, USNM 160497 (USGS loc. M1015), and G. H. Girty's 1918 specimen, USNM 160498 (USGS loc. 3760), may have been collected from the same large corallum exposed on the south shore of Madre de Dios Island (fig. 7). Specimen USNM 160497 is a fragment, 10 by 15 by 20 cm, of a large corallum about half a meter in diameter. The fragment has some 60 corallites of which 18 were studied in thin sections. A third specimen, USNM 160500, was available for study. It was collected by Girty in 1918 from Toti Island (USGS loc. 3759) and is a fragment of a corallum, 8 by 12 by 18 cm, with 36 corallites of which 12 were studied in thin sections.

Description.—The corallum, USNM 160497, is dendroid and corallites rise by offsets. In transverse section (pl. 5, fig. 4) the corallites are circular and 4–10 mm apart (fig. 19). Mature corallites are 8–11 mm in diameter and have 25–29 major septa (fig. 20). The corallite walls are 200–250 microns thick and are composed of fibrous calcite. The major septa are slightly sinuous and extend one-half the radius. The major septa are 60–80 microns thick in the dissepimentarium and 12–160 microns thick near the tabularium wall; they taper towards their distal ends. The cardinal septum is shorter than the other major septa but does not occupy a distinct fossula. The counter septum is generally long and is continuous with the axial plate of the columella. The minor septa are generally 1–1.5 mm long. Both orders of septa are continuous through the dissepimentarium and join the epitheca. The dissepimentarium is 1–1.5 mm wide and consists of one to three rows of regular to herringbone dissepiments. In most corallites, the columella seems to be the dilated axial end of the counter septum. In some corallites the columella is oblong in shape and is 0.4–1.0 mm thick and 1.0–2 mm long.

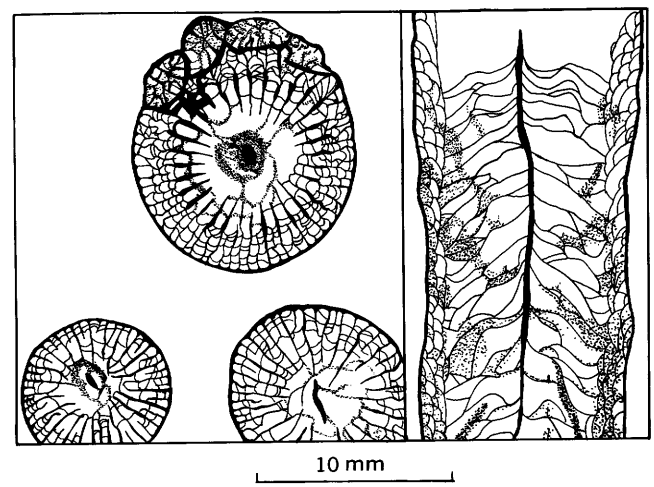


FIGURE 19.—Thin sections of *Lithostrotion* (*Siphonodendron*) sp., USNM 160497.

Longitudinal sections (pl. 5, fig. 1) reveal one to three rows of globose to elongate dissepiments of which five to eight occur in 5 mm. The tabulae may be either complete or incomplete. The tabulae within 1 mm of the columella are flexed upwards at an angle of 20°–30° before joining the columella; away from the columella they slope downward about 5°–10°. At a distance of 1–1.5 mm from the dissepimentarium, the tabulae are bent downward 30°–60° before joining the dissepiments. The columella is well developed, slightly sinuous, and persistent. Microscopic examination suggests that the tabulae abut and fuse to the columella, but do not contribute to the construction of the vertical axial structure. Calcite neomorphism has destroyed most of the original microstructure of the corallites.

G. H. Girty's specimen, USNM 160500 (USGS loc. 3759) from the north end of Toti Island, is similar to the above specimens except the columellae within the corallites are not so well developed, the major septa are weakly dilated in the tabularium, and the average corallite diameter is slightly larger. In transverse section the microstructure of the epitheca is fibrous with the long axis of the crystals at right angles to the exterior. The septal microstructure is trabecular with the fibers radiating from the center plane of the septa in convex arches towards the axis.

Occurrence.—All the material studied was collected as random samples not associated with measured stratigraphic sections. Girty's specimen, USNM 160498, and my specimen, USNM 160497, may have been collected from the same corallum exposed at the shore line on Madre de Dios Island. Girty's specimen, from the description in his field notebook (USGS loc. 3759), was collected from the north end of Toti Island. The limestone matrix surrounding the corallites of the two spec-

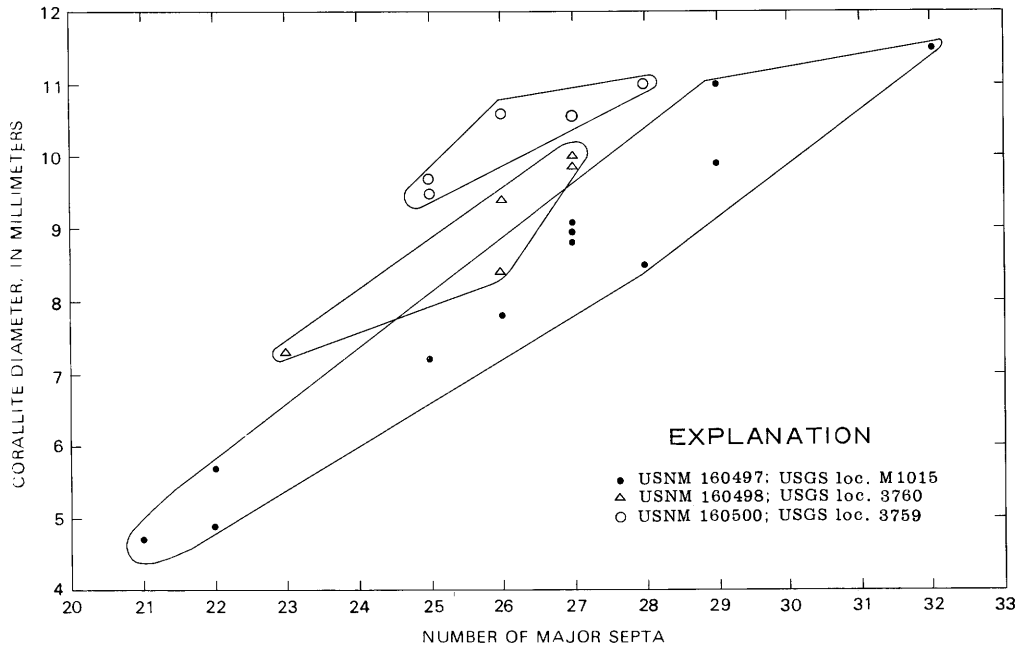


FIGURE 20.—Variations in corallite diameter and number of major septa in *Lithostrotion* (*Siphonodendron*) sp. Each mark represents the measurements of a single corallite.

imens contains a microfauna which is characteristic of the upper 100 feet of the limestone and chert member in the Toti and Madre de Dios Islands region.

The specimen, USNM 160497, although a random sample, was collected from the upper half of the limestone and chert member, on the central part of the south shore of Madre de Dios Island (USGS loc. M1015). Girty's specimen, USNM 160498, is believed to be from the same location (USGS loc. 3760), if not from the identical corallum. Girty's specimen, USNM 160500 was collected from the northeastern side of Toti Island (USGS loc. 3759). The limestone matrix surrounding the corallites contains a microfauna characteristic of the upper third of the limestone and chert member.

Remarks.—These three specimens are similar to some of the forms described by various authors as *Lithostrotion whitneyi* Meek. A detailed study of the type material of *L. whitneyi* by Sando (1965, p. E15–E18) revealed that White's preprint (1875) of Meek's (1877) name was based on different material than that described by Meek. White's species is a Lower Pennsylvanian form that probably belongs to the genus *Orygmophyllum* Fomichev. Sando (1965, p. E18) suggested that the specific name *whitneyi* be regarded as a *nomen dubium* and should not be used unless definitely established by supplementary material from the type area. Sando examined the specimens which formed the basis for Meek's (1877) usage of *Lithostrotion whitneyi* and found that they suggest reference to *Siphonodendron*, which he used as a subgenus of *Lithostrotion* Fleming. He stated that material referred to this species by various authors (see Sando, 1965, p. E15 for synonymy) includes a wide variety of Upper Mississippian forms actually referable to *Siphonodendron* McCoy, *Dorlodotia* Salée, and *Pseudodorlodotia* Minato (1955). Because of the present state of confusion surrounding these forms referred to by authors as *L. whitneyi*, no specific identification of the Prince of Wales Island specimen is given.

The Prince of Wales specimens do resemble closely in shape the tabulae, columella, and dissepiments of Sando's (1965, pl. 7, figs. 1–7) illustrations of Meek's (1877) specimen of *Lithostrotion* (*S.*) *whitneyi*. Nelson's (1960, p. 123, 124, pl. 25, figs. 1–4) specimens from the middle and upper parts of the Mount Head Formation of Alberta, which he considered with reservations to be *Lithostrotion whitneyi* (Meek), are similar to if not conspecific with *Lithostrotion* (*S.*) sp. from the Mississippian, of the Prince of Wales Island.

Genus DIPHYPHYLLUM Lonsdale, 1845

Diphyphyllum Lonsdale, 1845, *in* Murchison and others, Geology of Russia and the Ural Mountains, v. 1, p. 622.

Diphyphyllum Lonsdale. Thomson, 1883, Royal Philos. Soc. Glasgow Proc. v. 10, p. 381.

Diphyphyllum Lonsdale. Thomson, 1887, Geol. Soc. London Quart. Jour., v. 43, p. 33.

Lithostrotion Fleming, genomorph [*Diphyphyllum* Lonsdale]. Smith and Lang, 1930, Annals and Mag. Nat. History, v. 5, p. 180.

Depasophyllum 1933, Yü, Paleontologica Sinica, v. 12, p. 86.

Lithostrotion Fleming, genomorph [*Diphyphyllum* Lonsdale]. Hill, 1940, Palaeontographical Soc., p. 180–182.
Diphyphyllum Lonsdale. Minato, 1955, Hokkaido Univ. Fac. Sci. Jour., v. 9, no. 2, p. 80–81.
Diphyphyllum Lonsdale. Hill, 1956, in Moore, ed., Treatise on invertebrate paleontology, pt. F, Geol. Soc. America, p. F283.
Depasophyllum Yü. Minato and Kato, 1957, Hokkaido Univ. Fac. Sci. Jour., ser. 4, v. 9, no. 4, p. 480.
Diphyphyllum Lonsdale. Dobroljubova, 1958, Akad. Nauk SSSR Paleont. Inst. Trudy, v. 70, p. 180–183.

Type species.—*Diphyphyllum concinnum* Lonsdale, 1845, Carboniferous, Ural Mountains, U.S.S.R. Smith and Lang (1930, p. 180) state the type of *D. concinnum* is lost, and they base *Diphyphyllum* on *D. lateseptatum* McCoy, which, if not conspecific, is certainly congeneric with *D. concinnum*.

Diagnosis.—Fasciculate corallum in which the columella failed to develop. Septa continuous in dissepimentarium and amplexoid in tabularium. Tabulae domed or flattened axially and downturned peripherally (modified after Hill, 1956, p. 283).

Remarks.—Smith (1928, p. 114) and later Hill (1940, p. 181) divided the species of *Diphyphyllum* into two groups based on the structure of the tabulae. The majority of the described species of *Diphyphyllum*, which includes the type species, have inner tabulae which are strongly arched and each arch rests upon the arch below. The smaller group of *Diphyphyllum* species have complete tabulae with broad flat tops and downturned edges that extend to the dissepimentarium without touching the lower tabulae. *Diphyphyllum venosum* n. sp. and *D. klawockensis* n. sp. from the Mississippian of the west coast of Prince of Wales Island both belong to the latter group of species.

Diphyphyllum venosum new species

Plate 6, figures 1–7; plate 9, figures 4, 5

Type material.—Fragments of five coralla were available for study. Four specimens were collected from measured stratigraphic sections in 1966; one specimen was collected from a random locality by T. Chapin in 1916. The holotype, USNM 160477, is a fragment, 8 by 11 by 12 cm, that was collected from a weathered corallum about one-third of a meter in diameter. From this material about 30 corallites were studied in polished sections and 13 were studied in thin sections. Paratype USNM 160479 was collected from a weathered and incomplete corallum; the fragment was 6 by 7 by 15 cm and had 10 corallites; four of which were studied in thin sections. A weathered corallum about one-third of a meter in diameter yielded a fragment, 10 by 10 by 15 cm, from which paratype USNM 160478 was taken. Polished sections of it showed some corallites; seven of which were studied in thin sections. A deeply weathered and incomplete corallite yielded paratype USNM 160516. It is composed of two fragments; each one is about 7 by 7 by 10 cm and each has a total of about 15 corallites. From this material thin sections were made from 4 corallites. T. Chapin's 1916 specimen, paratype USNM 160480, is composed of 10 fragments from one corallum. The smallest fragment is about 5 by 5 by 5 cm and the largest 8 by 10 by 15 cm. The largest fragment was cut and polished and continued about 40 corallites, some of which were crushed. Six corallites were studied in thin sections.

The holotype USNM 160477 was collected from a band of chert and was poorly preserved by silicification. The corallites and the surrounding lime mud matrix were replaced by chalcedony. The sequence of events in the silicification of the corallites began with the replacement of the calcite of the epitheca and internal structures and of the enclosing lime mud by 10- to 30-micron crystals of chalcedony. Traces of the original corallite and its internal structures are indicated by 10- to 20-micron crystals of calcite embedded within the crystals of chalcedony. The remaining internal voids of the corallum were then filled by two phases of silicification. The voids were first lined by 100- to 150-micron quartz crystals which have their long axis perpendicular to the surface on which they grew and then were subsequently filled by a mosaic of interlocking 200- to 300-micron crystals of chalcedony.

Description of holotype.—The holotype, USNM 160477 (pl. 6, figs. 6, 7), is dendroid and the corallites rise by budding. The corallum is preserved in chert and the exterior of the corallum and corallites were not seen. Normal spacing between coralliates is 3–5 mm.

Transverse thin sections near the top of the corallum show the typical corallite to be 10–12 mm in diameter and to have 27–29 major septa which are somewhat sinuous and extend one-third to one-half the distance to the axis (fig. 22). The septa are 120–150 microns thick at their base near the epitheca and they taper towards their distal ends. The major and minor septa in all the corallites examined extend through the dissepimentarium. Within the tabularium the septa may be slightly dilated. Minor septa are always present and are about half the length of the major septa. The cardinal septum is generally indistinct and may be slightly shorter than adjacent cardinal lateral septa which are not incurved towards the cardinal septum. The majority of the corallites are acolumellate (fig. 21). The dissepimentarium is between 1.5–2.0 mm wide and consists of two to three rows of regular dissepiments.

In longitudinal thin sections and polished sections, the majority of the corallites are acolumellate. The tabulae are generaly complete and flat in the central

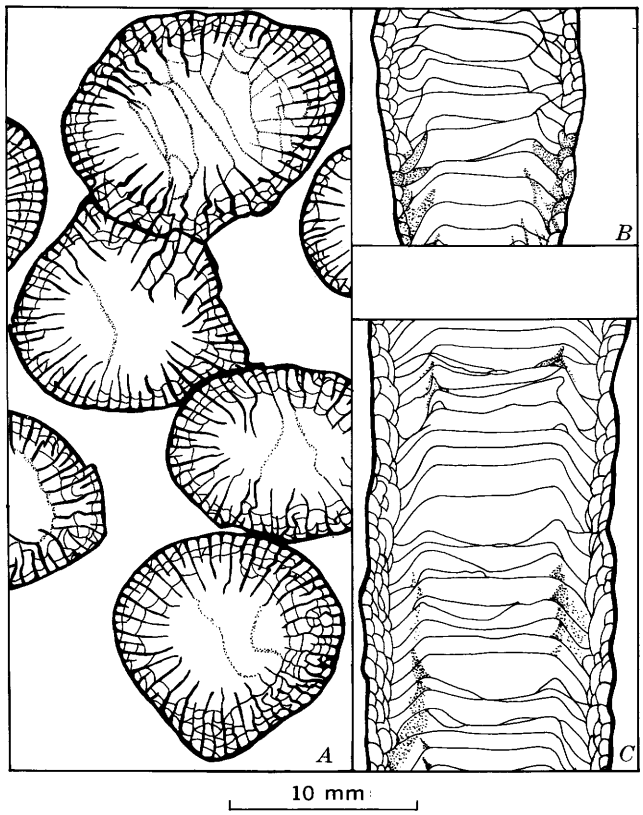


FIGURE 21.—Thin sections of *Diphyphyllum venosum* n. sp. A. Paratype, USNM 160478. *B*. Holotype, USNM 160477. C. Paratype, USNM 160480.

part of the corallite; however some are incomplete and sag so that they are slightly concave. The tabulae near the dissepimentarium have a sharp flexure downward with a slope of 40°–60°. The dissepimentarium consists of two or three rows of inclined, inflated to globose dissepiments of somewhat variable size; seven to nine dissepiments are 5 mm long.

Description of paratype.—The paratype USNM 160478 (pl. 6, figs. 3, 4), from measured section 66X–7 on Shelikof Island, is preserved in a matrix of 80–120-micron-size rhombs of dolomite. The calcite of the corallites and their internal structures were replaced by chalcedony crystals of 20–40 microns. The voids within the corallites were subsequently filled with 100-micron to 1.5-mm crystals of interlocking chalcedony. This specimen is similar to the holotype (fig. 22) except for a slightly higher septal count.

A second paratype, USNM 160479 (pl. 6, fig. 5), was collected from the Toti Island section, 66X–6, some 5 feet stratigraphically below the holotype. The corallum is preserved in a massive block of dolomitic line mudstone, and only fragments of the colony could be collected. The most important aspect of this colony is that the internal parts of the corallite are preserved as calcite. Most of the internal features are preserved as 10- to 15-micron crystals of calcite which are embedded within the larger 0.5- to 0.7-mm crystals of calcite that fill the original internal voids of the corallites. The epithecal wall is composed of radically fibrous calcite about 0.2- to 0.3-mm thick. The major septa are 70- to 100-microns thick at their base and they taper towards their distal ends. In transverse section the dissepiments are 30- to 40-microns thick, and the tabulae are 40- to 45-microns thick. In size of coralites, number of major septa, and other features, this specimen is very similar to the silicified holotype.

The third paratype, USNM 160516 (pl. 9, figs. 4, 5) (USGS loc. M1013), was found 180 feet from the base of measured section 66X–10 on the small unnamed island—1 mile west of Shelikof Island; it is preserved in a matrix of echinodermal wackestone. The corallites are preserved as calcite. The corallites are 8.5–10 mm in diameter and have 27–30 major septa. The septa are 80 microns thick at their base and 1.2–1.4 mm long; minor septa are 0.6–0.8 mm long. The septa are continuous through the dissepimentarium. The cardinal septum is about two-thirds as long as adjacent major septa and is in an open fossulae. Corallites are acolumellate.

The best longitudinal thin section available for study was from this specimen (pl. 9, fig. 5). The epitheca is about 200–225 microns thick. The dissepimentarium is 1.0–1.5 mm wide and consists of one to three rows of inclined inflated dissepiments of which 7 to 10 occur in 5 mm. The tabulae are about equally divided between complete and incomplete forms. The tabulae are flat or slightly concave in the axial region; within 1.5–2 mm of the dissepimentarium they are reflexed downward at an angle of 25°–35° before joining the dissepiments. Five to eight tabulae occur within 5 mm. Tabulae and dissepiments are 40–50 microns thick. This specimen is very similar to the holotype.

The microstructure of the corallites is extensively destroyed by 30- to 40-micron crystals of neomorphic calcite. Careful microscopic examination suggests the original microstructure of the epitheca was composed of fibrous calcite deposited normal to the exterior. The septa appear to be trabecular.

The fourth paratype is a random specimen, USNM 160480 (pl. 6, figs. 1, 2) (USGS loc. 975), collected by T. Chapin in 1916. The specimen was studied in thin section and on polished slabs. The corallum is dendroid, and the corallites rise by budding. Transverse sections show the corallites are typically 10–13 mm in diameter and have 30–33 major septa which extend one-half the distance to the axis. The septa are 100 microns thick at the base and taper towards their ends. The minor septa are 1–1.5 mm long. Both major and minor septa extend

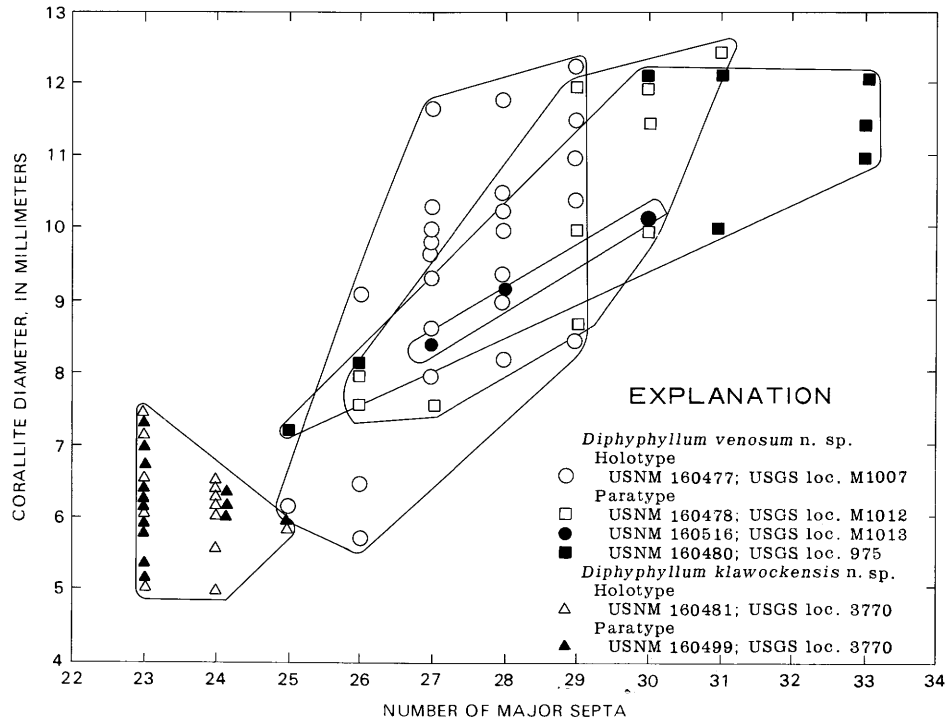


FIGURE 22.—Variations in corallite diameter and number of major septa in *Diphyphyllum venosum* n. sp. and *Diphyphyllum klawockensis* n. sp. Each mark represents a single corallite. Measurements for the holotype, USNM 160477, were taken from thin section and polished slabs. Measurements for the other specimens were taken from thin sections.

through the dissepimentarium to join the epitheca. Within the tabularium the major septa appear to be slightly thickened. The cardinal septum is about two-thirds as long as adjacent major septa, which are not incurved towards the cardinal septum. The tabulae floor is depressed around and immediately adjacent to the open cardinal fossulae. The corallites are acolumellate.

Longitudinal sections reveal that the corallites are acolumellate. The dissepimentarium is 1.2–1.7 mm wide and consists of two to three rows of inclined inflated dissepiments of variable size of which five to eight occur in 5 mm. The tabulae are frequently complete but may be incomplete. In the central part of the corallite, the tabulae are generally flat to slightly concave; at a distance of 2–2.5 mm from the dissepimentarium, they have a sharp downward flexure of 45°–70°. There are four to five tabulae in 5 mm. The thickness of the tabulae is 40–50 microns; the dissepiments vary from 40 to 70 microns; and the epitheca is about 0.2 mm. This colony differs from the holotype in having one to three more major septa in corallites of similar diameters.

The microstructure of the corallite is destroyed by 30- to 40-micron crystals of neomorphic calcite.

Type locality and stratigraphic range.—The holotype, USNM 160477, and paratype, USNM 160479, were collected from the upper part of the limestone and chert member, 275 and 270 feet respectively above the base of measured section 66X–6 (fig. 9), Toti Island, Alaska. The paratype, USNM 160478, was found on Shelikof Island in the limestone and chert member, 430 feet above the base of measured section 66X–7 (fig. 11). Another paratype, USNM 160516 (USGS loc. M1013), was found on the small unnamed island 1 mile west of Shelikof Island (fig. 8), 180 feet above the base of measured section 66X–10 in the limestone and chert member (fig. 12). The fourth paratype, USNM 160480 (USGS loc. 975), according to Chapin's 1917 field notebook, was collected from "the west coast of Soda Bay". His notes indicate that it was from the west shore of Shelikof Island and along the line of measured section 66X–7 (fig. 8). The corallum is enclosed by foraminifera-bearing dolomitic packstone. The lithology and microfossils indicate the specimen is from the limestone and chert member, at a stratigraphic zone equivalent to 300–350 feet above the base of section 66X–7.

The holotype and paratypes were found in beds associated with *Lithostrotionella pennsylvanica* (Shimer), *L. banffensis* (Warren), *L. birdi* n. sp., *Thysanophyllum astraeiforme* (Warren), and *Sciophyllum alaskaensis* n. sp. Associated foraminifera are species typical of Meramec age microfaunas.

Hill (1940, p. 180) states the genus *Diphyphyllum* "is first known in the S beds (Middle Viséan) of the British Isles, Russia, and Asia Minor and becomes very important at the top of the Upper Viséan throughout the British Isles, Northwest Africa, Russia, China, Japan, and Australia". Sando and Dutro (1960, p. 121) report finding the genus *Diphyphyllum* sp. in their Zone D of the Madison Group of western Wyoming and southwestern Montana. Dutro and Sando (1963d, p. 1974) report finding *Diphyphyllum* sp. in the upper part of the Chesterfield Range Group, southeastern Idaho. Sando (1967, p. 542) recognizes a *Diphyphyllum* sp. zone within the Sacajawea Member of the Madison Limestone (as used by Strickland, 1957) in west-central Wyoming, a unit he later renamed the Bull Ridge Member of the Madison Limestone (Sando, 1968). Sando (1967, p. 539, 543) provisionally regards the zone as early Meramec in age because it contains fasciculate lithostrotionid corals and brachiopods of Meramec aspect.

E. W. Bamber (oral commun., 1967) reports corals possibly belonging to *Diphyphyllum* spp. are abundant in the Mount Head Formation of Alberta and British Columbia.

Remarks.—Hill's (1940, p. 186) holotype of the species *Diphyphyllum ingens* from the lower Carboniferous of Scotland and Dobroljubova's (1958, p. 198) specimen which she assigned to *D. ingens* Hill from the lower Carboniferous of the Russian Platform are both similar to *D. venosum* n. sp. from the Prince of Wales Island, Alaska. Hill's holotype of *D. ingens* has a corallum which is phaceloid to partly cerioid with the corallites much more closely spaced than any known example of *D. venosum* n. sp. Dobroljubova's (1958, pl. 33, fig. 4) specimen has corallites of slightly larger size than the holotype, and her illustrations show a longitudinal section with a weakly developed columella formed from spines on successive tabulae.

Diphyphyllum equiseptatum Yabe and Hayasaka, as described by Minato (1955, p. 81–82) from the middle Carboniferous strata of Japan, is similar in corallite diameter and number of major septa to *D. venosum* but differs in having much shorter major septa and poorly developed to absent minor septa.

For a comparison of *D. venosum* n. sp. with *Diphyphyllum klawockensis* n. sp. see "Remarks" under the latter.

The possibility exists that *D. venosum*, which has a similar corallite diameter and similar numbers of septa, may be a diphymorph of *Lithostrotion* (*Siphonodendron*) sp. A. The holotype of *D. venosum* does have a few corallites which have weakly developed columella that suggest a relationship with *Lithostrotion* (*Siphonodendron*) sp. A.

Diphyphyllum klawockensis new species

Plate 5, figures 2, 3, 5, 6

Type material.—The material available for study were parts of two coralla collected by G. H. Girty in 1918 from the same locality, USGS loc. 3770. One corallum, USNM 160481, was 5 by 7 by 10 cm with about 35 corallites of which 21 were studied in thin sections. The other corallum, USNM 160499, consisted of two pieces, each about 10 by 10 by 20 cm with more than 110 corallites. Seventy-five corallites were studied in polished sections and 32 in thin sections.

Both coralla are preserved in a dark-gray crinoidal foraminiferal packstone. The corallites and their internal structures are mostly preserved by calcification, with only minor amounts of silicification. The voids within the corallites are filled with crystals of sparry calcite in the 100–300 micron size.

Description of holotype.—Specimen USNM 160481 (pl. 5, figs. 5, 6) is dendroid, and the corallites rise by budding. The corallite exteriors are poorly preserved. Normal spacing between corallites is about 5 mm but it may range from 1 to 8 mm.

In transverse section a typical corallite is 5–7 mm in diameter with 23–25 major septa (fig. 22, 23). The major septa are slightly sinuous, extend about one-third the distance to the axis, and are about 70–80 microns thick at their base. The minor septa are about 0.3 mm long. Both major and minor septa are continuous

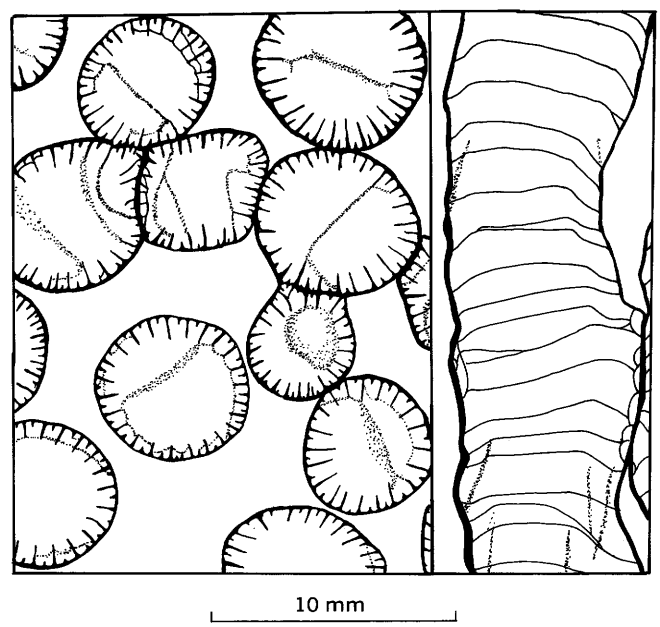


FIGURE 23.—Thin sections of *Diphyphyllum klawockensis* n. sp., holotype, USNM 160481.

through the dissepimentarium and join the epitheca. The epitheca is 60–70 microns thick. The cardinal septum is indistinct and may be somewhat shorter than the adjacent cardinal lateral septa which are not incurved toward the cardinal septum.

Longitudinal sections also show the corallites are acolumellate. The tabulae are almost always complete; they are flat to gently convex in the central part of the corallites. At a distance of 1–1.5 mm from the epitheca, the tabulae reflex downward at angles of from 35°–50°; at a distance of 0.2–0.3 mm, they resume a nearly horizontal position before joining the epitheca. Dissepiments are very weakly developed and on many corallites are absent. When they do occur, they are generally isolated, globose, 0.2–0.3 mm wide and 0.5–1.0 mm long with a wall about 50–60 microns thick. The tabulae are 40–50 microns thick. The microstructure of the corallites has been destroyed by calcite neomorphism.

Description of paratype.—The second specimen, USNM 160499 (pl. 5, figs. 2, 3), was collected by Girty from the same locality (USGS loc. 3770) as the holotype. The only significant difference between the paratype and the holotype is that most of the corallites have a persistent single row of elongate dissepiments. As in the holotype, calcite neomorphism has destroyed the original microstructure of the corallites.

Type locality and stratigraphic range.—According to G. H. Girty's field notebook, the specimens were collected on the west side of a small island (USGS loc. 3770) which, from his description, is the small unnamed island 1 mile west of Shelikof Island (fig. 8). The matrix between the corallites contains a foraminiferal fauna of Meramec age which indicates without question the specimens were collected in the upper 100–150 feet of the limestone and chert member.

Remarks.—*Diphyphyllum klawockensis* n. sp. differs from the holotype and paratypes of *D. venosum* n. sp. in the relative size of corallite diameter; the corallite diameter of *D. klawockensis* (5–7 mm) is considerably smaller than the corallite diameter of *D. venosum* (10–12 mm). *D. venosum* has three to four rows of well-developed dissepiments, whereas *D. klawockensis* has corallites that may or may not have a single row of dissepiments.

Hill's (1940, p. 185–186) description of *Diphyphyllum furcatum* Thomson from the Viséan of Scotland indicates it is similar to *D. klawockensis* n. sp. in corallite diameter and number and shape of minor and major septa. *D. furcatum* differs by having two to three rows of dissepiments and tabulae which are usually in two series—an inner series that consists of very broad flattened domes whose downturned edges abut on the lower dome; and an outer series that is narrow and consists of small concave plates. In contrast *D. klawockensis* n. sp. generally has complete tabulae with flat tops whose downturned edges extend to the dissepimentarium and do not touch the lower tabulae.

Dobroljubova (1958, p. 183–199, pls. 29–33) redescribed six species from the lower Carboniferous of the Russian Platform which she assigned to the genus *Diphyphyllum*. All her illustrations show the presence of collumella in some of the corallites, and most of the species have tabulae which are in two series. Thus, none of her specimens are similar to *D. klawockensis* n. sp.

Yü's (1933, p. 83) holotype of the species *Diphyphyllum multicystatum* from the lower Carboniferous of China has a corallite diameter of 5–7 mm with 22 major septa and has complete tabulae with flat tops, which are not in contact with the lower tabulae. In these respects it is similar to *D. klawockensis* n. sp. *D. multicystatum* Yü differs, however, in a number of significant ways: by having a dissepimentarium composed of four rows of dissepiments, minor septa which are much longer, and tabulae which are deflected near the tabularium downward at a steeper angle of 60°–75°.

Diphyphyllum hochangpingense Yü, as described from the upper Viséan of Manchuria by Yü (1933, p. 86, 87) and later by Minato and Kato (1957, p. 480, 481), has corallite diameters of 3.5–6.5 mm with 22–24 major septa and a single row of dissepiments. It differs from *D. klawockensis* n. sp. by having tabulae in two series that are formed by the tabulae near the dissepimentarium bending downward and contacting the preceding tabulae.

Family LONSDALEIIDAE Chapman, 1893

Genus LITHOSTROTIONELLA Yabe and Hayasaka, 1915

Lithostrotionella Yabe and Hayasaka, 1915, Geol. Soc. Tokyo Jour., v. 22, p. 94.

Lithostrotionella Yabe and Hayasaka. Hayasaka, 1936, Taihoku Imp. Univ., Formosa, v. 13, no. 5, p. 47–58.

Lithostrotionella Yabe and Hayasaka. Hill, 1956, *in* Moore, ed., Treatise on Invertebrate Paleontology, pt. F, Geol. Soc. America, p. F306–307.

Type species.—*Lithostrotionella unicum* Yabe and Hayasaka, 1915, Permian, Chihsia Limestone, Yun-nan, South China.

Diagnosis.—Cerioid corallum. Prismatic corallites. Columbella a presistent vertical lath frequently continuous with counter and cardinal septa. Lonsdaleoid dissepiments. Major septa generally confined to tabularium, although some may reach the epitheca. Minor septa short. Tabulae frequently complete, conical. (Summarized from Yabe and Hayasaka, 1915, p. 94.)

Lithostrotionella banffensis (Warren)

Plate 10, figures 1–8; plate 13, figures 1–7

Lithostrotion banffense Warren, 1927, Canada Geol. Survey Bull. 42, p. 46–47, pl. 3, figs. 6, 6, pl. 5.

Lithostrotionella floriformis Hayasaka, 1936, Taihoku Imp. Univ. Memoirs, Faculty of Science and Agriculture, v. 13, no. 5, p. 64, 65, pl. 17, figs. 1a, b.

Lithostrotionella vesicularis Hayasaka, 1936, Taihoku Imp. Univ. Memoirs, Faculty of Science and Agriculture, v. 13, no. 5, p. 68, 69, pl. 14, figs. 3a, b.

Lithostrotionella banffensis (Warren). Kelly, 1942, Jour. Paleontology, v. 16, p. 354–356.

Lithostrotionella banffense (Warren). Nelson, 1960, Jour. Paleontology, v. 34, p. 119, pl. 23, figs. 4, 5.

Lithostrotionella banffense (Warren). Nelson, 1961, Geol. Assoc. Canada Spec. Paper 2, pl. 17, figs. 1, 2.

Lithostrotionella banffensis (Warren). Bamber, 1966, Canada Geol. Survey Bull. 135, p. 17–19, pl. 3, fig. 5.

Material.—Only one specimen, USNM 160482 (USGS loc. M1007), was collected in 1966 from a measured stratigraphic section. It is from Toti Island and is a fragment of a corallum 10 by 10 by 15 cm from which 35 corallites were studied in thin sections. The internal structures of the corallite are preserved as neomorphic calcite which has obscured or destroyed the original microstructure of the corallum. Calcite crystals, 0.02–0.2 mm long, were deposited on all the internal surfaces; deposition of interlocking crystals of chalcedony filling the remaining voids in the corallum followed.

Two other fragments of undescribed coralla were available for study and were collected from random localities by G. H. Girty in 1918. The specimen, USNM 160483 (USGS loc. 3760), 10 by 10 by 12 cm, was collected from Madre de Dios Island and is preserved in a manner similar to the Toti Island specimen. The specimen from Klawak Island, USNM 160484 (USGS loc. 3706), 8 by 8 by 12 cm, is poorly preserved by neomorphic calcite, and the void spaces are filled with sparry calcite.

Hayasaka's (1936) type specimens for *Lithostrotionella floriformis*, USNM 120242, and *Lithostrotionella vesicularis*, USNM 120245, collected by G. H. Girty in 1918 from the Prince of Wales Island, were also studied.

Description.—The specimen from Toti Island, USNM 160482 (pl. 10, figs. 2, 5, 8), has a massive corallum, is cerioid and about a third of a meter in diameter. In transverse section the average mature corallites are 8.5–10.5 mm in diameter, and the dissepimentarium is 40–50 percent of the diameter. The dissepiments are large and lonsdaleoid. The corallites have 20–25 major septa which extend one-half to two-thirds the distance to the axis (fig. 24). In the tabularium the major septa are dilated and tapered to their ends; in the dissepimentarium they are very discontinuous and are primarily represented as ridges on the corallite walls and on the inner surfaces of the dissepiments. The counter septum approaches and occasionally joins the elongate lens-shaped columella. Very short ridges are present around the edges of the columella which are axial ends of major septa that are present on the surface of the sloping tabulae. The minor septa are short ridges on the inner surface of the corallite wall and infrequently are present on the inner surface of the dissepiments. The minor septa are common in the tabularium wall and are generally a fifth to a third the length of the major septa.

In longitudinal section the dissepimentarium consists of two to three rows of inflated dissepiments of which five to eight are present in 5 mm. The tabulae are frequently incomplete and are strongly arched upward. In the tabularium the half of the tabulae adjacent to the dissepimentarium has a slope of 50°–65°; the half nearest the columella has a flexure and slope of 25°–50°.

Specimen, USNM 160484 (pl. 10, figs. 6, 7), from Klawak Island has smaller corallites with diameters of 8–10 mm and 18–20 major septa, which are long and frequently join the columella. The columella is lens shaped and is joined with the counter-cardinal septum. Within the dissepimentarium, the dissepiments are abundant and lonsdaleoid, and they form small arches. In longitudinal section there are 10–12 dissepiments in 5 mm.

Specimen, USNM 160483 (pl. 10, figs. 1, 3, 4), from Madre de Dios Island has 22–24 major septa in a corallite diameter of 8.0–9.2 mm. The lens-shaped columella in the majority of the corallites is continuous with the counter-cardinal septum, but generally the major septa do not reach the columella. In longitudinal section there are six to eight dissepiments in 5 mm; they may be in single or double rows. In the larger diameter corallites, the dissepiments are commonly strongly swollen.

Occurrence.—In 1966, the specimen from Toti Island, USNM 160482 (USGS loc. M1007), was collected 275 feet above the base of measured section 66X–6 in the upper third of the limestone and chert member. The specimen is from beds that contain a fauna of Meramec corals and foraminifers.

G. H. Girty's notebook describes two random specimens of *L. banffensis* collected in 1918. One specimen, USNM 160484 (USGS loc. 3706), came from the northwest side of Klawak Island; the others, USNM 160483 and USNM 120242 (USGS loc. 3760), were collected on the south side of Madre de Dios Island and are believed to be from the upper part of the limestone and chert member. Hayasaka's (1936) type specimen for *L. floriformis*, specimen USNM 120242 (USGS loc. 3760), was collected by him from the limestone and chert member.

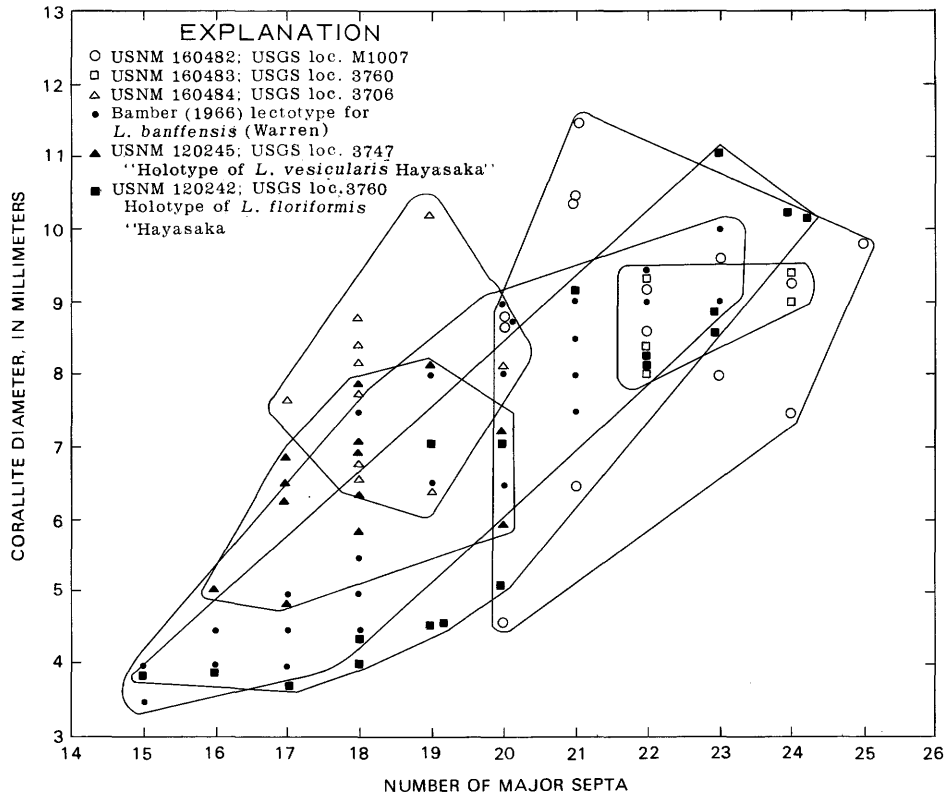


FIGURE 24.—Variations in corallite diameter and number of major septa in *Lithostrotionella banffensis* (Warren).

Warren (1927, p. 47) stated the type material came from Alberta, Canada, "near the top of the Rundle Limestone on Stoney Mountain." Nelson (1960, p. 119) is of the opinion that "the holotype was derived from the upper *Lithostrotionella* beds (lower Mount Head Formation)."

Remarks.—The exact stratigraphic position is known only for the specimen of *L. banffensis* collected from Toti Island in 1966. The two random samples of *L. banffensis* collected by G. H. Girty in 1918 are believed to have come from beds which are stratigraphically within 200 feet of the Toti Island specimen. As shown in figure 24, the variations in corallite diameter and septal count of the three specimens are similar to those of Bamber's (1966, p. 18, table 5) lectotype of *L. banffensis*. The relationship of the major septa to the columella varies in an individual corallum and between coralla. Bamber states (1966, p. 17) "a traversed section in the lectotype will show in some corallites, all of the major septa may reach the columella but in other corallites they may be withdrawn from the columella. Furthermore, transverse section in the lectotype at two levels in the corallum show that the degree of axial extension of major septa varies in an individual corallite."

The Toti Island specimen differs from Bamber's (1966, p. 17–19, pl. 3, fig. 5) lectotype of *L. banffensis* (Warren) by having its major septa somewhat more withdrawn from the axis, and they do not generally join the columella. Furthermore, the corallites generally have larger, more strongly developed lonsdaleoid dissepiments. The Toti Island specimen agrees closely with the lectotype in corallite diameter, number of major septa (fig. 24), and developments of the minor septa and the tabulae.

Hayasaka published in 1936 the result of his studies made in 1927 on the Carboniferous corals of North America. The corals are in the collections of the U.S. Geological Survey in Washington, D.C. His paper (1936) cites two coralla collected by G. H. Girty in 1918 from the Prince of Wales Island as holotypes for two new species.

The holotype of *Lithostrotionella floriformis* Hayasaka (USNM 120242, USGS loc. 3760) was described (1936, p. 64, 65, pl. 17, fig. 1) from one transverse thin section which shows only three incomplete corallites. (A rephotograph of this thin section is shown on pl. 13, fig. 3.) From the holotype, two transverse and one longitudinal thin sections were cut. Two of the new thin sections are illustrated (pl. 13, figs. 1, 2). These new thin sections show that the number of septa, the diameter

of the corallites (text fig. 24), and the development of the dissepimentarium, tabularium, and columella compare closely to Bamber's (1966) descriptions of the lectotype of *L. banffensis* (Warren).

L. vesicularis (USNM 120245, USGS loc. 3747) was described and illustrated by Hayasaka (1936, p. 68, 69, pl. 14, figs. 3a, b) from one transverse thin section, which shows two complete and eight incomplete corallites, and one longitudinal thin section. (These thin sections were rephotographed and are shown on pl. 13, figs. 4 and 5.) The writer cut from Hayasaka's holotypic corallum two transverse and two longitudinal thin sections. Studies of these thin sections reveal the specimen falls within the writer's morphological concepts of *L. banffensis* (Warren) (text fig. 24, and pl. 13, figs. 6 and 7).

L. pennsylvanica (Shimer), which occurs in the same zone, is easily distinguished from *L. banffensis* by its much larger corallite diameter, better developed minor septa, and more inclined tabulae.

L. banffensis is separated from *L. birdi* n. sp., which has corallite diameters of 4.5–6.5 mm with 17–25 major septa. The coralla of *L. birdi* are characterized by corallites with highly variable and inconsistent development of their internal structure as, for example, the dissepiments, major septa, and columella.

Lithostrotionella pennsylvanica (Shimer)

Plate 9, figures 1–3

Lithostrotion pennsylvanicum Shimer, 1926, Canada Geol. Survey Bull. 42, p. 27–29, pl. 5, figs. 3–5.

?*Lithostrotionella pennsylvanica* (Shimer). Kelly, 1942, Jour. Paleontology, v. 16, p. 352, pl. 50, figs. 1, 2, 5, 6, 8.

Lithostrotionella pennsylvanicum (Shimer). Nelson, 1960, Jour. Paleontology, v. 34, p. 117–118, pl. 22, figs. 4–6.

Lithostrotionella pennsylvanicum (Shimer). Nelson, 1961, Geol. Assoc. Canada Spec. Paper 2, pl. 17, figs. 3, 4.

?*Lithostrotionella shimeri* (Crickmay). Nations, 1963, Jour. Paleontology, v. 37, pl. 176, figs. 1, 2.

Lithostrotionella pennsylvanica (Shimer). Bamber, 1966, Canada Geol. Survey Bull. 135, p. 19–23, pl. 4, figs. 1, 2.

Material.—Two incompletely silicified fragments of coralla collected in 1966 from measured stratigraphic sections were available for study. One specimen is 3 by 4 by 7 cm and the other is 5 by 5 by 7 cm; both specimens are poorly preserved. The internal structures of the corallites are preserved as recrystallized, neomorphic calcite and secondary replacement dolomite. Some of the calcite and dolomite has been subsequently penetrated and replaced by chalcedony. The surface of the various internal structures, such as septa, dissepiments, and tabulae, frequently have a coating of 30- to 100-micron-size crystals of drusy calcite. The internal voids within the corallites are filled with interlocking 0.5- to 0.1-mm crystals of chalcedony and sparry calcite.

Description.—The specimen, USNM 160486 (pl. 9, figs. 1, 2) (USGS loc. M1014), is from the small island 1 mile west of Shelikof Island. In transverse section the corallites are from 7.6 mm in diameter with 17 major septa to 13 mm in diameter with 30 major septa. Typical corallites are 11–13 mm in diameter with 22 major septa (fig. 25). The tabularium is 6.5–8.0 mm in diameter. The major septa extend two-thirds to three-fourths the distance toward the axis and generally do not reach the columella. Within the tabularium the septa are dilated but taper towards the axis. Minor septa are generally absent in the tabularium but when they do occur are short and nonpersistent. The columella is lenseshaped and generally is attached to the counter septum. The columella frequently has projections, which are the ridges formed by the axial edges of the major septa on the upper surface of the arched tabulae.

Longitudinal section of a 19-mm-diameter corallite shows the dissepimentarium is 4–6 mm wide and is composed of one to three rows of convex, vertically short and horizontally elongated dissepiments of which three to five are present in a vertical distance of 5 mm. The tabularium is 7–8 mm wide. The majority of the tabulae are complete and are nearly flatlying or slightly concave; the most pronounced downward bending occurs near the dissepimentarium. Some tabulae joint the columella on a horizontal plane, but a majority of tabulae, within a distance of 0.4 mm of the columella, are reflexed upward, and they almost parallel the columella for 1–3 mm before joining it. The columella is a persistent solid rod of calcite 0.7–1 mm thick.

L. pennsylvanica from Toti Island, USNM 160485 (pl. 9, fig. 3), is similar to the above-described specimen, except the tabulae slope upward and across most of the tabularium at an angle of 30°–35°.

Occurrence.—Both specimens of *L. pennsylvanica* were collected from measured stratigraphic sections within the upper part of the limestone and chert member. Specimen USNM 160486 USGS loc. M1014), came from 80 feet above the base of section 66X–10 (fig. 12) on the west side of the unnamed island 1 mile west of Shelikof Island (fig. 11). Specimen USNM 160485 (USGS loc. M1008) came from 225 feet above the base of section 66X–6 on Toti Island (fig. 9). Both of these specimens of *L. pennsylvanica* occur in beds with a Meramec fauna of foraminifers and corals.

The lectotype, according to Bamber (1966, p. 19) and Shimer (1926, p. 22), comes from Shimer's section 3a on Mount Aylmer near Lake Minnewanka, Banff, Alberta. Bamber also reports that it was found in the middle and upper Mount Head Formation in the Rocky Mountains of southern British Columbia and Alberta

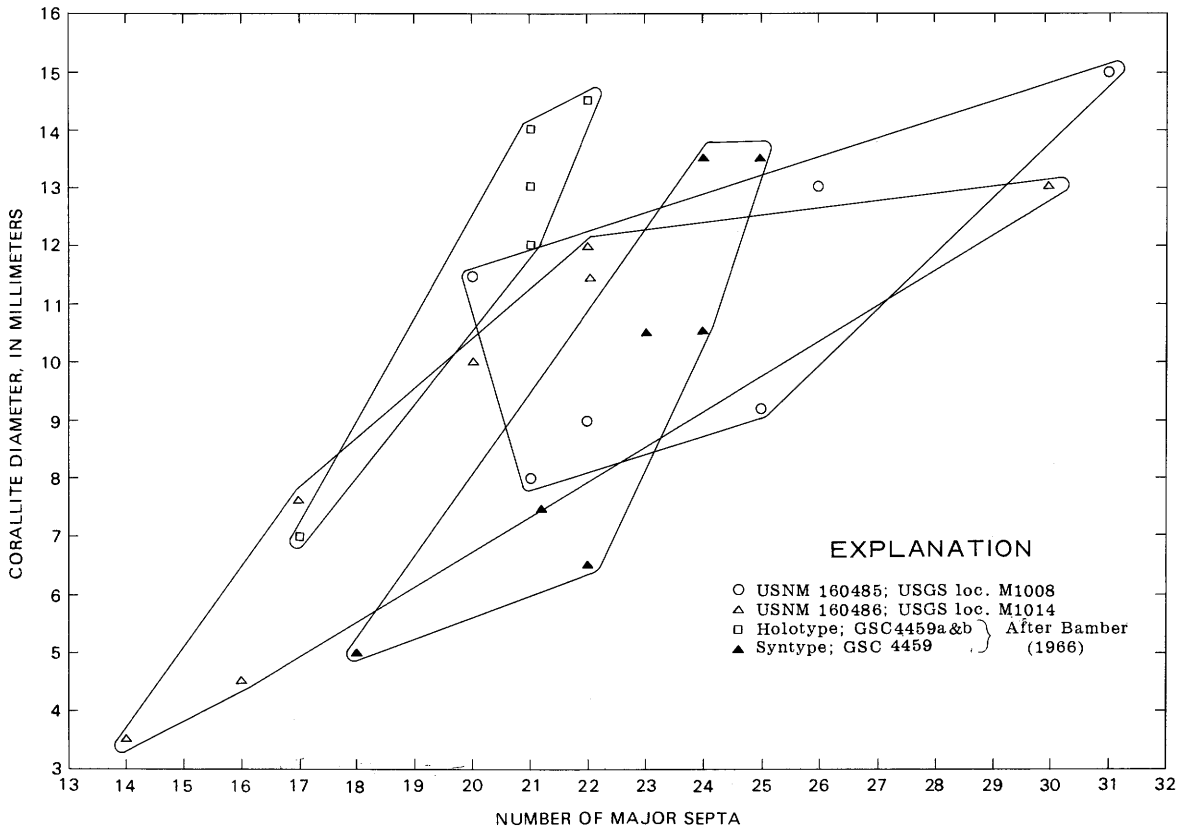


FIGURE 25.—Variations in corallite diameter and number of major septa in *Lithostrotionella pennsylvanica* (Shimer). Each mark represents one corallite. All measurements were taken from thin sections.

and 130 feet below the top of the Prophet Formation in northeastern British Columbia.

The corallum figured by Nations (1963, pl. 176, figs. 1, 2) is from Meramec cobbles of Escabrosa Limestone which had been reworked and were found in the base of Nations' Morrow (Pennsylvanian) Black Prince Limestone of southeastern Arizona.

Remarks.—The Toti and Shelikof Islands, Alaska, material differs from Bamber's (1966) lectotype of *Lithostrotionella pennsylvanica* (Shimer) by having corallites in which the dissepimentarium show greater variation in width and the minor septa are more poorly developed. A longitudinal section (pl. 9, fig. 1) of specimen USNM 160486, from the small unnamed island 1 mile west of Shelikof Island, is similar in the configuration of the tabulae and the columella to the syntype of *L. pennsylvanica* (Shimer) illustrated by Bamber (1966, pl. 4, figs. 2a, 2b).

Lithostrotionella birdi new species

Plate 7, figures 1–4; plate 8, figures 1–7

Type material.—The holotype, USNM 160487 (USGS loc. M1011), was collected from a bed of pelletoidal, crinoidal packstone on Shelikof Island. The specimen is a fragment of a corallum 10 by 10 by 5 cm. Some 70 corallites were studied in thin sections. The walls and internal structure of the corallites are preserved as calcite and retain much of their original microstructure. An overgrowth of 50- to 100-micron crystals of calcite was deposited on the internal structures of the corallites. The voids within the corallites were subsequently filled with interlocking 0.3- to 0.5-mm crystals of calcite and (or) 0.5- to 2-mm crystals of chalcedony (pl. 7, figs. 3, 4).

Five fragments of coralla, each 10 by 10 by 5 cm in size or larger, are designated paratypes and have similar modes of preservation. All paratypes were studied in thin sections. Three specimens, USNM 160488 and 160489 (USGS loc. M1011), and USNM 160490 (USGS loc. M1010), are from the same measured section on Shelikof Island as the holotype but from lower stratigraphic positions. The other paratype, USNM 160491 (USGS loc. M1013), is from a measured section on the small unnamed island 1 mile west of Shelikof Island.

Description of holotype.—Specimen 160487 is cerioid. In transverse section (pl. 7, figs. 3, 4; pl. 8, fig. 7) the mature corallites are 4.5–6.5 mm in diameter and have 17–20 slightly sinuous major septa (figs. 26–27). Corallites have a common wall which averages about 200 microns thick and is now composed of 10- to 20-micron

size crystals of calcite. The centers of the common walls are marked by a zone 40–50 microns thick or dark-gray calcite. The major septa may be dilated in the tabularium, and they extend from a third to a half the distance toward the axis. Major septa are nonpersistent in the dissepimentarium, but when they are present, they are 30–40 microns thick at their base. The major septa are slightly dilated in the tabularium, may be 60–80 microns thick at the tabularium wall, and taper towards their distal ends. The major and minor septa are composed of 10- to 30-micron-size calcite crystals. The minor septa may be absent in the tabularium of one corallite; however, in an adjacent corallite they may be well developed and about half the length of the major septa. The minor septa in the dissepimentarium are generally only short projections on the wall. The dissepiments in the dissepimentarium may have considerable variation in size and arranagement. The dissepiments in many corallites may have a herringbone pattern, but the majority of corallites have lonsdaleoid dissepiments.

The columella is lens shaped and elongated in the cardinal-counter plane and may be connected to the counter septum. The columella typically may be 0.5–1 mm long, 100–200 microns thick, and oblong in shape. The center of its long axis is marked by a dark band of calcite 20–30 microns thick; on both sides of the band are lens-shaped deposits of calcite crystals 10- to 20-microns in size.

In longitudinal section (pl. 8, figs. 4, 5), the dissepimentarium generally consists of a single row and occasionally of a nonpersistent double row of inflated and inclined dissepiments. There are six to eight dissepiments in 5 mm. The tabulae are frequently incomplete. They are convex and slope upwards at an angle of 30°–45° from their junction with the dissepiments to their apex where they join the columella. The columella is thin, persistent, and slightly sinuous.

Transverse sections of immature corallites, those 2–4 mm in diameter, are generally characterized by major and minor septa which are persistent throughout the dissepimentarium and join the epitheca. The major septa are amplexoid, extending only about half the distance to the axis; minor septa are about half the length of the major septa. The columella is generally absent or very weakly developed. The cardinal septum is slightly shorter than the adjacent major septa, and the tabulae floor is bent downward adjacent to the cardinal septa. Longitudinal thin sections reveal that new corallites bud from mature corallites at a diameter of 2–2.5 mm. At a distance of about 3 mm from their parent corallites, the buds have a diameter of about 4 mm and will frequently develop a columella. The immature stage of a corallite devoid of a columella will have complete

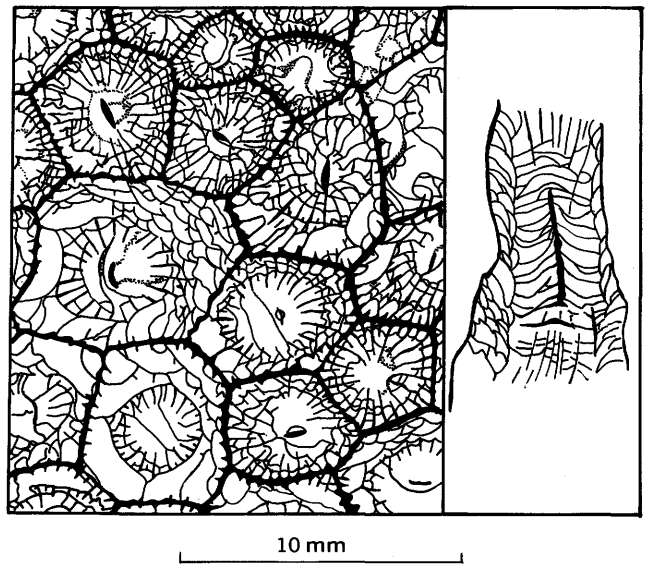


FIGURE 26.—Thin sections of *Lithostrotionella birdi* n. sp., holotype, USNM 160487.

tabulae which are horizontal or slightly concave in the axial region. The tabulae at a distance of 0.3–0.4 mm of the dissepimentarium are deflected downward at angles of about 40°–45° before joining the dissepiments. The dissepimentarium is a single row of arched globose dissepiments.

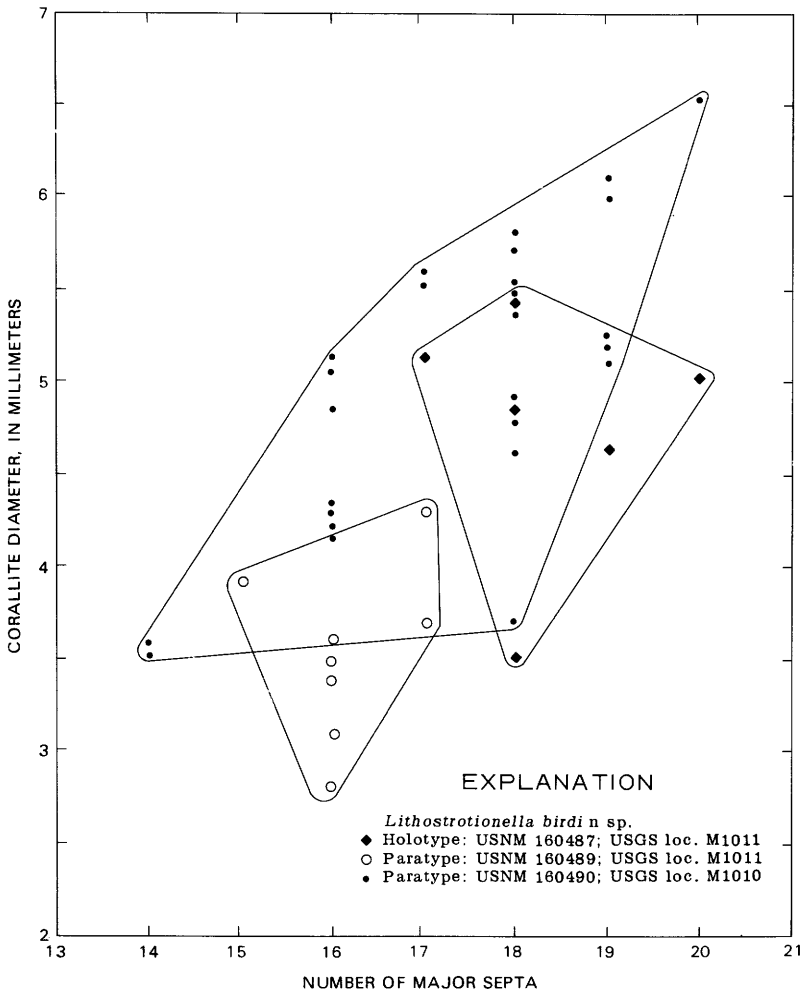
Description of paratypes.—The first paratype, USNM 160488, was collected from the same bedding surface a few feet from the holotype. It does not differ in any significant characteristic from the holotype.

The second paratype, USNM 160489 (pl. 7, figs. 1, 2), also from the same measured section, was collected from a bed 5 feet stratigraphically below the holotype. It differs from the holotype by having corallites which are about 1 mm smaller in diameter and by having two to three less major septa per corallite.

The third paratype, USNM 160490 (pl. 8, figs. 1, 2), collected 35 feet stratigraphically below the holotype and from the same measured section, differs from the holotype by having an average corallite diameter 1 mm larger than the holotype.

The fourth paratype, USNM 160491 (pl. 8, figs. 3, 6), is a specimen collected from the lower 10 feet of measured section 66X–10 on the small unnamed island 1 mile due west of Shelikof Island (figs. 8, 12). The corallites within the corallum typically have one to two fewer major septa but in other respects are similar to the holotype.

Type locality and stratigraphic range.—The holotype was found about 345 feet above the base of measured section 66X–7, in the limestone and chert member, west side of Shelikof Island (fig. 11). Three paratypes,



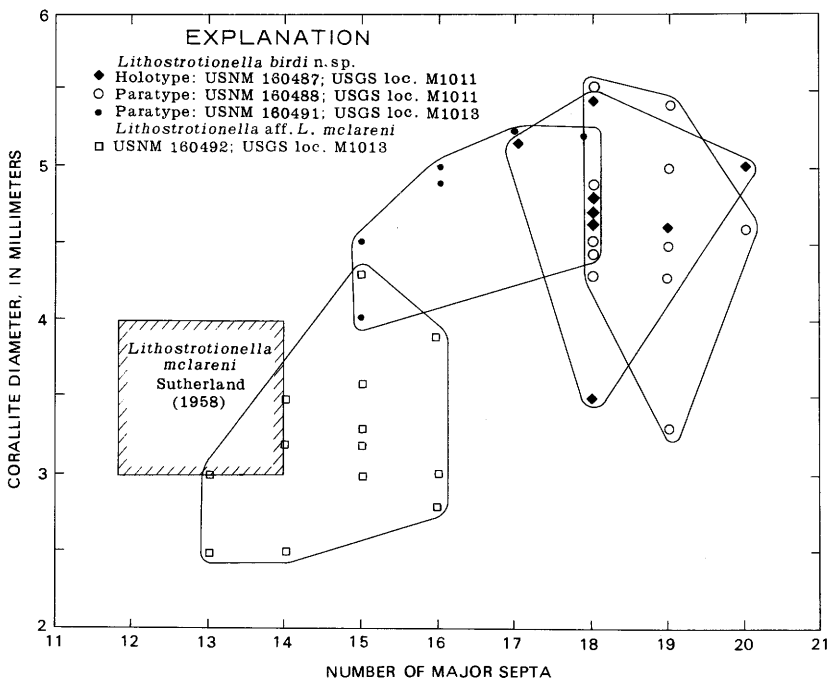


FIGURE 27.—Variations in corallite diameter and number of major septa in *Lithostrotionella birdi* n. sp. and *Lithostrotionella* aff. *L. mclareni* Sutherland. Each mark represents one coralite. The characteristics of the holotype of *Lithostrotionella mclareni* Sutherland fall within the shaded square. The data for diameter and number of major septa are from McLaren and Sutherland (1949, p. 631).

USNM 160488 to 160490, were found in the same section of the limestone and chert member at 345, 340, and 310 feet, respectively, above the base. A fourth paratype USNM 160491, was collected 0–10 feet above the base of section 66X–10 on the small unnamed island 1 mile due west of Shelikof Island (figs. 8, 12). *L. birdi* is one of the more abundant species of *Lithostrotionella* in the Meramec lithostrotionid zone of the Lisburne Group, Brooks Range, Arctic Alaska. (This species is named in honor of Dr. Kenneth J. Bird, my field associate in the Brooks Range in 1962.) In the Endicott Mountains, Brooks Range, at the Shainin Lake section, *Lithostrotionella birdi* n. sp. has been found in the dark limestone member of the Alapah Limestone, Lisburne Group. It is also common in the upper part of the Kogruk Formation, Lisburne Group, De Long Mountains, Brooks Range.

Remarks.—Within the coralla of specimens of *L. birdi* n. sp., the mature corallites generally have a consistent ratio of diameter size to number of septa, but there is considerable variation in the organization of their internal structures. This variation is particularly pronounced in the dissepimentarium, where the dissepiment and septa may vary widely in forms and shapes. Corallites which have herringbone dissepiments frequently have persistent major septa in the dissepimentarium. Those corallites which have discontinuous septa in the dissepimentarium frequently have large lonsdaleoid dissepiments. The majority of corallites within a corallum may have the characteristics of the genus *Lithostrotionella;* not infrequently some individual corallites may be acolumellate and have the traits of the genus *Thysanophyllum;* more rarely some corallites may have a columella and persistent major septa, which all join the epithecal wall and are typical examples of the genus *Lithostrotion.* The same type of corallite variation or plasticity exists in the closely related species of *Lithostrotionella mclareni* Sutherland. (See Sutherland, 1958; and McLaren and Sutherland, 1949.)

Lithostrotionella birdi n. sp. is distinguished from *L. mclareni* Sutherland by the latter's smaller corallites, which have a diameter of 3–4 mm, only 12–14 major septa, and typically a dissepimentarium in which lonsdaleoid dissepiments are not so well developed as in *L. birdi* n. sp.

In Alaska, *L. mclareni* Sutherland and *L. birdi* n. sp. overlap in stratigraphic range and occur together in the Lisburne Group of the Brooks Range, Arctic Alaska. The two species form two separate natural groupings with most of the specimens falling into two distinct groups. *L. mclareni* with a corallite diameter of 3–4 mm and 12–14 major septa, and *L. birdi* with a corallite diameter of 4.5–6.5 mm and 17–20 major septa. However, some specimens were found which seem to be transitional between the two species.

A specimen, USNM 160492 (USGS loc. M1013), which is in this category (pl. 8, figs. 8, 9) was collected (at 10 feet above the base of section 66X–10) from the Meramec part of the limestone and chert member on the small unnamed island 1 mile west of Shelikof Island. This specimen has corallites which are typically 3.0–4.3 mm in diameter and has 13–16 major septa.

As can be seen in figure 27, this specimen is intermediate between the specific characteristics of *L. mclareni* Sutherland and *L. birdi;* it is classified as *L.* aff. *L. mclareni* Sutherland.

Lithostrotionella peratrovichensis new species

Plate 12, figures 8–11

Type material.—The holotype, USNM 160493 (USGS loc. M1004), was collected from Peratrovich Island and is a fragment 4 by 7 by 9 cm of a weathered corallum about 25 cm in diameter. Polished sections revealed 164 corallites of which 95 were studied in thin sections. The corallite walls and internal structures are preserved as calcite and retain much of their original microstructure. The voids within the corallites were filled with 0.2- to 0.4-mm-size crystals of sparry calcite.

Description of holotype.—The corallum is cerioid. In transverse section the mature corallites are 4–5.5 mm in diameter. There are 15–19 long major septa which extend toward and may reach the columella (figs. 28, 29).

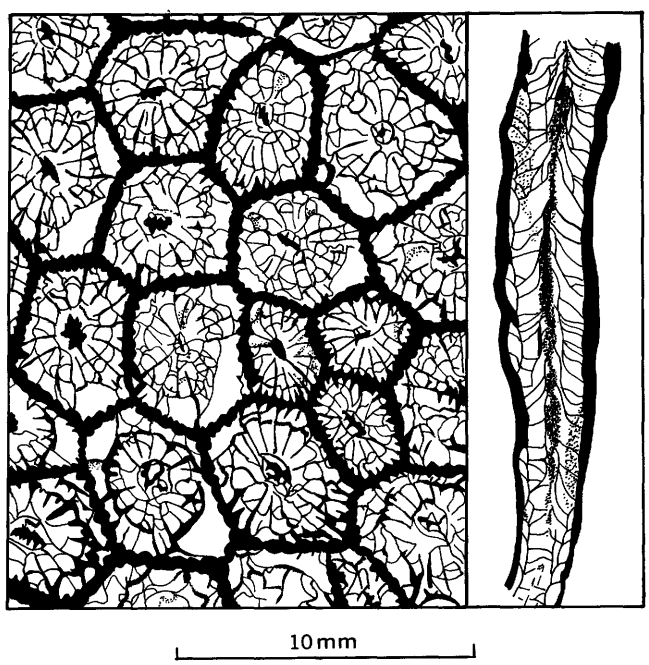


FIGURE 28.—This sections of *Lithostrotionella peratrovichensis* n. sp. holotype, USNM 160493.

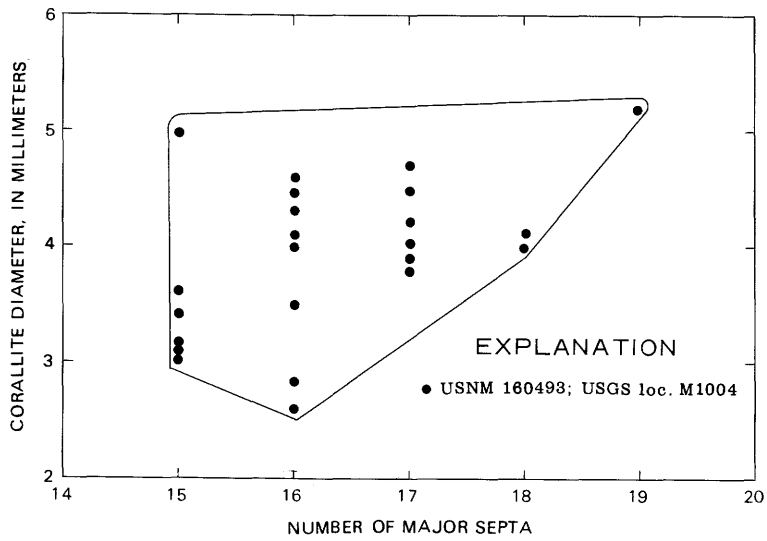


FIGURE 29.—Variations in corallite diameter and number of major septa in holotype of *Lithostrotionella peratrovichensis* n. sp.

The corallite walls are 0.7–1.0 mm thick. The center of the thick common walls are marked by a sinuous dark band of calcite about 50 microns wide. The remainder of the wall is composed of long fibrous calcite placed at right angles to the central band. The major septa extend from the thick epitheca and may be 70–100 microns thick at their base and taper towards their distal ends. The major septa may be nonpersistent in the dissepimentarium. The dissepimentarium, when present, is 0.5–1 mm wide and is composed of lonsdaleoid dissepiments. Septal stereozone frequently fills most of if not all the dissepimentarium and stereoplasm deposits 20–100 microns thick are found on the inner side of the tabularium wall. Minor septa are obscured by the septal stereozone but reappear as short spikes on the inner surfaces of the dissepiments and tabularium wall. The major septa extend toward the columella and join it as ridges on the upper surfaces of the tabulae. In many corallites the counter septum is better developed and joins the columella, which is oblong and about 0.5–1.0 mm in size. It has radiating projections which are formed by the axial ends of the major septa that are ridges on the upper surface of the arched tabulae. A median plate 30–40 microns thick of dark-gray calcite extends through the columella in the cardinal-counter plane and, in some corallites, is continuous with the cardinal and counter septa. Transverse sections of immature corallites, those under 4 mm in diameter, are characterized by the lack of a dissepimentarium, major and minor septa which join the epitheca, and thick septal stereozone development.

In longitudinal section the tabulae are about evenly divided between complete and incomplete forms. The tabulae are inclined 10°–45° upward near the dissepimentarium, but within 40–100 microns of the columella, they are sharply reflexed upward to an angle of 85°–88°. For a distance of 0.5–2 mm, they almost parallel the columella before fusing with it. Microscopic examinations indicate the tabulae are joined to the columella but are not an integral part of it. In immature corallites under 4 mm in diameter, dissepiments are poorly developed to absent. In larger corallites the dissepimentarium is generally one and occasionally two rows of elongate and swollen dissepiments of which five to eight occupy 5 mm.

Type locality and stratigraphic range.—The holotype was collected from measured stratigraphic section 66X–3 (not illustrated) from the northwestern side of Peratrovich Island on the south side of a small inlet, SW¼NW¼ sec. 35, T. 72 S., R. 80 E., Alaska (USGS loc. M1004). The holotype was found in the limestone member in association with large specimens of *Faberophyllum* sp. indet. and a foraminiferal fauna indicating a Meramec age. Fragments of coralla believed to be the same species, *L. peratrovichensis*, were found in adjacent beds. Thin sections were not made of these small fragments.

Remarks.—*Lithostrotionella peratrovichensis* n. sp. is distinguished from all other *Lithostrotionella* from the Peratrovich Formation by its thick corallite walls, strongly developed columella, septal stereozone, and tabulae which are sharply reflexed upward near the columlella and parallel to it for some distance.

L. peratrovichensis n. sp. in transverse section shows some affinities to *Lithostrotionella stelcki* Nelson from the upper Etherington Formation of western Canada.

The latter species differs in a number of significant ways—it has an average corallite diameter of 7 mm with 20–22 major septa, and the tabulae are nearly flat or gently concave upward in the tabularium with little or no marginal deflection.

The thick epitheca and strongly developed columella of *L. peratrovichensis* are similar to those of *Lithostrotionella occidentalis* Merriam (1942, pl. 56, fig. 7), found in the Permian Coyote Butte Formation of east-central Oregon. The latter species differs in having five to seven rows of steeply inclined dissepiments, and a narrow tabularium with horizontal or inclined tabulae.

Lithostrotionella spiniformis Yü (1933, p. 102) from the Viséan of China has in common with *L. peratrovichensis* n. sp. thick corallite walls and pronounced thick columellae. *L. spiniformis* Yü differs, however, by having corallites with 24–25 major septa in an average diameter of 10 mm and tabulae near the columella. That are not as strongly reflexed upward.

Lithostrotionella (*Hillia*) *santaemariae* deGroot (1963, p. 91–93, pl. 21, fig. 1), from the upper Viséan Santa Maria Limestone of northern Palencia, Spain, has thick epithecae, well-developed columellae, corallite diameters of 3.5–7 mm with 16–19 major septa. It differs from *L. peratrovichensis* n. sp. in its major septa which are less sinuous in the tabularium and more persistent in the dissepimentarium. In transverse section, the tabulae sag downward or are horizontal before reaching the columella.

Genus THYSANOPHYLLUM Nicholson and Thomson, 1876

Thysanophyllum Nicholson and Thomson, 1876, Royal Soc. Edinburgh Proc., v. 9, no. 95, p. 150.
Thysanophyllum Nicholson and Thomson. Thomson, 1880, Royal Philos. Soc. Glasgow Proc., v. 12, p. 255.
Thysanophyllum Nicholson and Thomson. Thomson, 1883, Royal Philos. Soc. Glasgow Proc., v. 14, p. 387.
Thysanophyllum Nicholson and Thomson. Thomson, 1926, Annals and Mag. Nat. History, v. 18, p. 148.
Lithostrotion Fleming, genomorph [*Diphystrotion* Smith and Lang], 1930, Annals and Mag. Nat. History, v. 5, p. 184.
Thysanophyllum Nicholson and Thomson. Hill, 1940, Palaeontographical Soc., p. 160–162.
Thysanophyllum Nicholson and Thomson. Hill, 1940, *in* Moore, ed., Treatise on invertebrate paleontology, pt. F, Geol. Soc. America, p. 306.

Type species.—*Thysanophyllum orientale* Nicholson and Thomson, 1876, lower Carboniferous, Viséan; Scotland.

Diagnosis.—Compound rugose corals with a lonsdaleoid dissepimentarium. The septa are withdrawn from the axis except for the counter septum, which may be very long, particularly in the young stages. The tabulae are complete; typically they are flat-topped domes but some are slightly sagging (Hill, 1940, p. 161).

Thysanophyllum astraeiforme (Warren)

Plate 11, figures 5–8

Diphyphyllum astraeiforme Warren, 1927, Canada Geol. Survey Mem. 153, p. 44–45, pl. 3, figs. 2, 3; pl. 6, fig. 1.
Lithostrotionella astraeiformis (Warren). Kelly, 1942, Jour. Paleontology, v. 16, p. 352, 354.
Lithostrotionella (*Thysanophyllum*) *astraeiformis* (Warren). Nelson, 1960, Jour. Paleontology, v. 34, p. 115–117, pl. 22, figs. 7–10.
Lithostrotionella astraeiformis (Warren). Nelson, 1961, Geol. Assoc. Canada Spec. Paper No. 2, pl. 18, figs. 1–3.
Thysanophyllum astraeiforme (Warren). Bamber, 1966, Canada Geol. Survey Bull. 135, p. 23–26, pl. 4, figs. 3–4.

Material.—Two specimens were available for study. One specimen, USNM 160494 (USGS loc. M1013), is a fragment 5 by 5 by 7 cm of a weathered and incomplete corallum and was collected in 1966 from stratigraphic section 66X–10 on a small unnamed island 1 mile due west of Shelikof Island. Some 140 corallites were examined on a polished surface, and 73 were studied in thin sections. The other specimen is a random sample, USNM 160495 (USGS loc. 1803), which was collected by Chapin in 1915 on an island at the entrance to Soda Bay. The island is believed to have been Shelikof Island. Chapin's sample consists of eight fragments of one corallum, typically 6 by 8 by 10 cm. Thirty-five corallites were studied in thin sections.

Description of specimens.—The corallum is cerioid. The internal features of the corallum, USNM 160494, are preserved by calcite. The voids within the corallites are generally filled with sparry calcite and minor amounts of chalcedony.

In transverse section (pl. 11, fig. 6) the average mature corallite is 5–6.2 mm in diameter, and the dissepimentarium occupies 30–35 percent of the corallite diameter.

The corallite wall is 80–100 microns thick. This common wall is divided in the center by a band of dark-gray calcite about 30–40 microns thick. The corallite wall is composed of 10- to 30-microns crystals of calcite which have their long axis perpendicular to the central band of gray calcite. Within the dissepimentarium there are generally two to five traces of thin-walled, 20–30 microns thick, lonsdaleoid dissepiments. The corallites contain 16–17 major septa which extend half the distance from the inner edge of the tabularium wall to the axis.

The major septa are 80–100 microns thick at their base on the inner side of the tabularium wall, and they taper towards their distal ends. The major septa are poorly developed in the dissepimentarium, where they occasionally occur as short discontinuous ridges on the corallite wall and on top of the dissepiments. Minor septa are very poorly developed or absent. A lens-shaped columella is generally present and is occasionally con-

tinuous with the cardinal and counter septa in the tabularium.

In longitudinal section (pl. 11, fig. 5) the dissepimentarium consists of a single row of large, strongly convex, moderately to steeply inclined dissepiments. There are ordinarily six to eight dissepiments in 5 mm. The tabulae are domeshaped, strongly reflexed upwards near their junction with the columella, and sharply bent downward near their junction with the dissepimentarium. In corallites that have a well-developed columella, the tabulae are frequently incomplete. There are six to eight tabulae in 5 mm.

The specimen, USNM 160495 (pl. 11, figs. 7, 8) (USGS loc. 1803), collected by Chapin in 1915, was preserved similar to the above example. In the dissepimentarium the corallum has short but persistent major and minor septa which are 0.2–0.6 mm long and are ridges on the epithecal wall. The 14–18 major septa reappear on the inner wall of the tabularium and extend towards, but do not generally reach the axial region and the long narrow columella. The columella is generally well developed and may be continuous with the cardinal and counter septa. In longitudinal section the dissepimentarium is generally a single but occasionally a double row of swollen, convex, and inclined dissepiments, of which six to eight occur in 5 mm. The tabulae bend convexly upward but with their steepest angle near the dissepiments and with an abrupt upward reflex near the columella.

Occurrence.—One specimen, USNM 160494 (USGS loc. M1013), which was collected 10 feet above the base of measured section 66X–10 on the west side of the small unnamed island 1 mile west of Shelikof Island, Alaska, is from the upper one-third of the limestone and chert member. The beds also contain a large fauna of Meramec age, including lithostrotionid corals and foraminifera (figs. 8, 12).

According to Chapin's 1915 notebook, his random sample USNM 160495, USGS loc. 1803) was collected on an island at the entrance to Soda Bay. The writer believes the sample was taken from the limestone and chert member on the southwest side of Shelikof Island.

Bamber (1966) reports finding *T. astraeiforme* (Warren) in the Rundle Group near Banff, Alberta, and in the upper Mount Head Formation of the Rocky Mountains of southern British Columbia and Alberta. The writer has found the species in the upper half of the Krogruk Formation, De Long Mountains, Brooks Range, Alaska.

Remarks.—The lectotype of *T. astraeiforme* (Warren) from near the top of the Rundle group on Tunnel Mountain, Banff, Alberta, has been described in detail by Bamber (1966, p. 23–26). The two specimens from Shelikof Island differ from the lectotype in that corallites of equal diameter have three to four more major septa. These specimens also differ in that longitudinal sections show the tabulae may be incomplete, and the dissepiments are frequently swollen.

Jull (1967), in a recent study of a number of topotype specimens of the type species of *Thysanophyllum*, *T. orientale* Thomson, states only a few corallites have developed axial structures in adult corallites. Hill's (1938–40, pl. 8, figs. 26, 27) illustration of lectotypes of *T. orientale* also shows some corallites without axial structures.

Bamber's (1966, pl. 4, fig. 3a–b) photographs of the lectotype of *Thysanophyllum astraeiforme* (Warren) show a number of corallites which are diphymorphic. His illustrations of his hypotype (pl. 4, fig. 4a–b) show axial structures in most of the corallites. This latter specimen closely resembles specimen USNM 160494 collected from the limestone and chert member of the Peratovich Formation. Chapin's specimen, USNM 160495, is characterized by even better developed columellae in most corallites than the columellae of either Bamber's hypotype or of the specimen from the limestone and chert member.

Bamber (1966, p. 26), who examined the holotype of *Lithostrotionella simplex* Hayasaka, USNM 120249, states it differs from *T. astraeiforme* by having a thicker lens-shaped columella, minor septa that extend into the tabularium, and septa which are more strongly tapered.

Genus SCIOPHYLLUM Harker and McLaren, 1950

Sciophyllum Harker and McLaren, 1950, Canada Geol. Survey Bull. 15, p. 31.

Sciophyllum Harker and McLaren. Hill, 1956, *in* Moore, ed., Treatise on invertebrate paleontology, pt. F, Geol. Soc. America, p. F307.

Sciophyllum Harker and McLaren. Sando, 1965, U.S. Geol. Survey Prof. Paper 503–E, p. E29.

Type species.—*Sciophyllum lambarti* Harker and McLaren (1950, p. 31–33, pl. 4), Mississippian, Canada.

Diagnosis.—Cerioid rugose corals of basaltiform habit, without columella; complete corallum unknown; dissepimentarium of one or more series of dissepiments, the inner margin forming a well-marked inner wall; tabulae strong, well spaced and regular, flat or slightly arched; septa absent or reduced to fine vertical striations on the inner side of the epitheca or inside the inner wall; gemmation lateral (Harker and McLaren, 1950, p. 31).

Sciophyllum alaskaensis new species

Plate 11, figures 1–4; plate 12, figures 1, 2

Type material.—The holotype, USNM 160496, consists of 15 fragments, typically 6 by 6 by 12 cm, collected from an incomplete and eroded corallum preserved in a large chert nodule. The internal structures of the coral-

lum are preserved as calcite and retain some of the original microstructure (pl. 11, fig. 4). One hundred and fifty corallites were studied in polished section and of these 60 were studied also in thin sections. The internal voids of the corallites were filled in two stages. Crystals of calcite 50–100 microns long were deposited on the surface of the internal structures, then the remaining voids were filled with 0.3- to 0.6-mm crystals of interlocking chalcedony. The paratype, USNM 160517, consists of seven fragments (average size 6 by 6 by 8 cm) collected from an eroded corallum preserved in limestone. Of the material collected, about half the corallites had been fractured and crushed before lithification.

Description of holotype.—The corallum is cerioid. In transverse section (pl. 11, fig. 3) the average mature corallite is 6.5–8.5 mm in diameter (fig. 30). The dissepimentarium occupies 20–25 percent of the corallite diameter and consists of lonsdaleoid dissepiments. The corallite walls are 130–200 microns thick and are composed of an interlocking mosaic of 20-micron-size calcite crystals. From the epithecal wall projects 18–19 short spikelike major septa and an equal number of shorter minor septa. The major septa are 0.2–0.4 mm long, the minor septa are 0.1–0.2 mm. The discontinuous and vestigial major septa reappear on the inner wall of the tabularium as short spikes 0.2–0.4 mm long; the minor septa are absent. In the corallum studied, most corallites had a full complement of major septa on the tabularium wall, and both major and minor septa were present on the epithecal wall.

In longitudinal section (pl. 11, figs. 1, 2), the dissepimentarium is a double row of large inflated and steeply inclined dissepiments which are 40–70 microns thick. There are ordinarily six to seven dissepiments in 5 mm. Tabulae are complete, flat to slightly convex with their greatest convexity near their junction with the dissepiments. Tabulae are 40–50 microns thick.

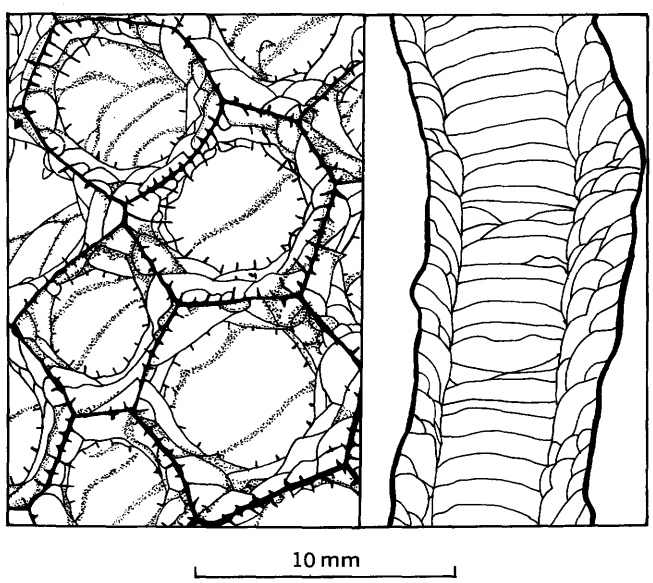


FIGURE 30—Thin sections of *Sciophyllum alaskaensis* n. sp., holotype, USNM 160496.

Description of paratype.—The paratype (pl. 12, figs. 1, 2), USNM 160517 (USGS loc. M1006), was collected 5 feet stratigraphically below the holotype and was preserved in the same way as the holotype. The paratype is similar in internal organization to the holotype. The average corallite of the paratype has a diameter of 5.5–6.0 mm with 18 major septa compared to the average corallite diameter of the holtype which has 7.5 mm and 20 major septa per corallite.

Type locality and stratigraphic range.—The holotype was collected 275 feet (USGS loc. M1007) and the paratype 270 feet (USGS loc. M1006) above the base of measured section 66X–6, in the upper third of the limestone and chert member, Toti Island, Alaska (fig. 9). The specimens were found in a bed which contained a large fauna of Meramec lithostrotionid corals and Foraminifera. A fragment of a corallum, *S. alaskaensis*, was collected from USGS loc. M1013, on the small unnamed island 1 mile west of Shelikof Island. This specimen was found with *Lithostrotionella pennsylvanica* (Shimer) and a microfauna of Meramec age. *S. alaskaensis* is also present in the upper half of the Kogruk Formation, De Long Mountains, Brooks Range, Alaska.

Remarks.—*Sciophyllum alaskaensis* n. sp. has a double row of dissepiments and differs from *S. adjunctivum* (White) as redescribed by Sando (1965, p. E29–E31) and from the holotype of *S. lambarti* as described by Harker and McLaren (1950, p. 31–33), both of which have only a single row of dissepiments. Furthermore, *S. adjunctivum* has tabulae which are concave and septa which are inconsistently present on the inner side of the tabularium wall and absent on the corallite wall. *S. lambarti* is distinguished from *S. alaskaensis* by the former's smaller corallite diameter of only 4.6–5.0 mm and more weakly developed septa.

S. alaskaensis n. sp., which occurs with *Thysanophyllum astraeiforme* (Warren) in the upper part of the limestone and chert member, may be derived from or conceivably is a diphymorph of the latter. Trends towards the reduction of the length of the major septa in the tabularium and the elimination of the columellae in some of the corallites of *T. astraeiforme* are typically developed in all the corallites of *S. alaskaensis*. The two species do have corallites of similar diameter with similar numbers of major septa. Longitudinal sections of acolumellate corallites of *T. astraeiformis* are almost identical to longitudinal sections of corallites of *S. alaskaensis*.

FOSSIL LOCALITIES

U.S. Geological Survey locality numbers: those with an M prefix refer to Menlo Park office locality numbers; all others are Washington, D.C., office numbers.

T. Chapin, 1915 fossil localities:

975. West coast of Soda Bay. The examination of T. Chapin's 1915 field notebook 1, p. 70, clearly indicates the specimen was collected at about 300–350 ft above the base of the 1966 measured section 66X–7.

1803. Soda Bay Island, Notebook 3 (p. 23).

G. H. Girty and W. C. Waters, 1918 fossil localities:

3706. North end of Klawak Island, p. 3.

3746. Just beyond point, south side of Madre de Dios Island, p. 8.

3747. South Shore of the Island at the entrance of Soda Bay, p. 3.

3755. East end of Madre de Dios Island. Black cherty series, p. 12.

3759. North end Robber Island (ss), p. 8. This is interpreted as being Toti Island. Orth (1967, p. 979) states that prior to 1922 Toti Island was named Robber Island. The latter was discontinued because of the confusion with Ladrones Island.

3760. South Side, Madre de Dios Island, p. 9.

3769. Southwest shore, Madre de Dios Island, west of point, p. 8.

3770. Islet west of Soda Bay, western shore, p. 5.

3771. From Girty's field notebook. His description clearly indicates he was in the lithostrotionid zone of the limestone and chert unit on the east shore of Toti Island.

J. S. Williams, 1940 fossil locality:

10299. Madre de Dios Island, at entrance to Trocadero Bay, northwest side of island at small niche in coast line about 500 ft northwest of most easterly point on island.

A. K. Armstrong, 1966 fossil localities:

M1004 West side of Peratrovich Island, along south side of small inlet, beside small "tidal waterfalls". SW¼NW¼ sec. 35, T. 72 S., R. 80 E.

M1005. East side of Peratrovich Island, SW¼NE¼NW¼ sec. 35, T. 72 S., R. 80 E.

M1006. Shore line, east side, central part of Toti Island; 270 ft above the base of section 66X–6.

M1007. Shore line, east side, central part of Toti Island; 275 ft above the base of section 66X–6.

M1008. Shore line, east side, central part of Toti Island; 225 ft above the base of section 66X–6.

M1009. West side of Shelikof Island, at 55°15′ lat, 133°03′ long; 200–250 ft above the base of measured section 66X–7; specimens were found as float on surface, believed to have been derived from higher in the section.

M1010. West side of Shelikof Island, at about 55°15′20″ lat, and 133°03′ long; 310 ft above the base of section 66X–7.

M1011. West side of Shelikof Island at about 55°15′20″ lat, and 133°03′ long; 340–345 ft above the base of section 66X–7.

Armstrong, 1966 fossil localities—Continued

M1012. West side of Shelikof Island at about 55°15′20″ lat, and 133°03′ long; 430 ft above the base of section 66X–7.

M1013. and M1014. West side, on shore of unnamed island 1 mile west of Shelikof Island; 55°15′21″ lat, 133°05′ long; 0–180 ft above the base of section 66X–10.

M1015. South shore of Madre de Dios Island, at about 55°23′ lat, 133°08′ long; random sample.

M1016. Most southern point on south-central shore of Madre de Dios Island, 0–100 ft above the base of section 66X–11.

M1017. Southeast side, on shore, Toti Island, 140–220 ft above the base of measured section 66X–6.

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[Italic page numbers indicate both major references and descriptions]

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PLATES 1–13

PLATE 1

[All specimens are from the limestone and chert member. Collected by G. H. Girty, 1918, from Madre de Dios Island]

FIGURES 1–14. *Ekvasophyllum* cf. *E. inclinatum* Parks (p. 11).

1, 2. Alar and calicular view respectively (× 1); paratype, USNM 160501.

3–6. Serial transverse thin section; holotype, USNM 160502. 3, 4 (× 4), 5, 6 (× 2).

7. Transverse thin section (× 2), below calice floor; paratype, USNM 160503.

8. Longitudinal section (× 2); paratype, USNM 160504.

9. Longitudinal section (× 2); paratype, USNM 160519. Exterior alar view of this thin section is shown on pl. 12, fig. 3.

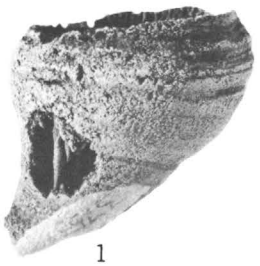
10–12. Serial transverse thin section; 10, 11 (× 3), 12 (× 2); paratype, USNM 160505.

13. Transverse thin section (× 2); paratype, USNM 160506.

14. Transverse thin section (× 20); holotype, USNM 160502. Major septa illustrating microstructure, central band of dark calcite is clearly seen with fibrous calcite at right angles.

15. *Faberophyllum girtyi* n. sp. (p. 16).

Transverse thin section (× 20); holotype, USNM 160515. Microstructure of major septa, axial region toward top of photomicrograph, central band within septa and fibrous dark calcite at right angles can be seen.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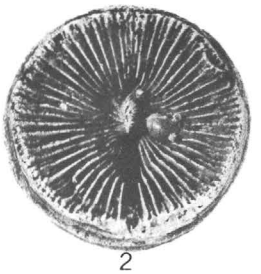
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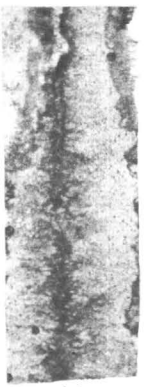
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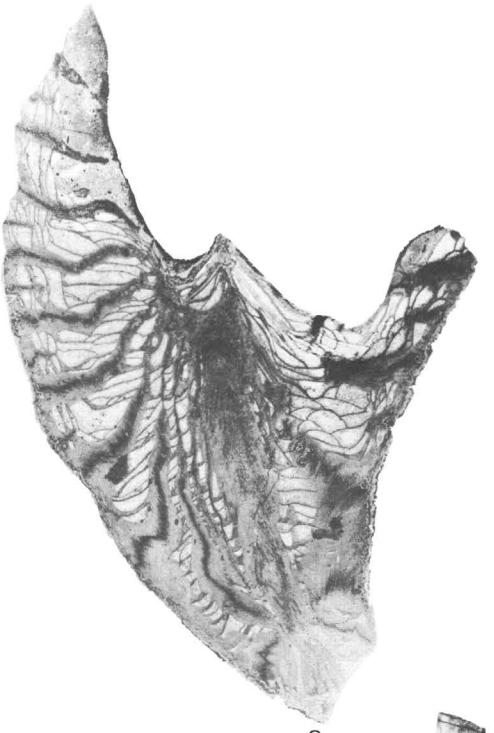
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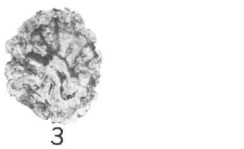
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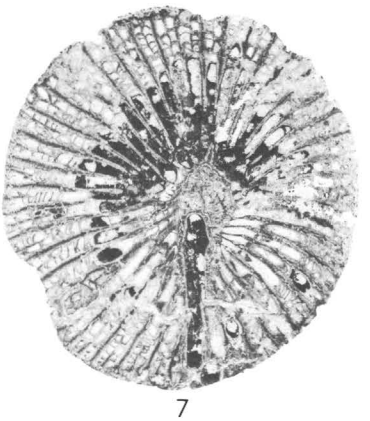
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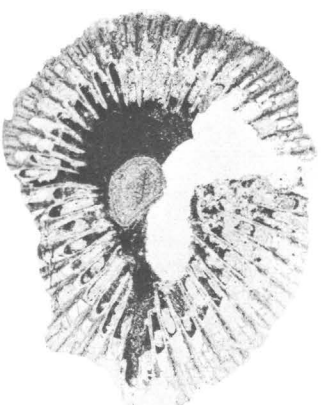
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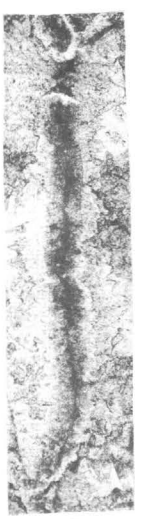
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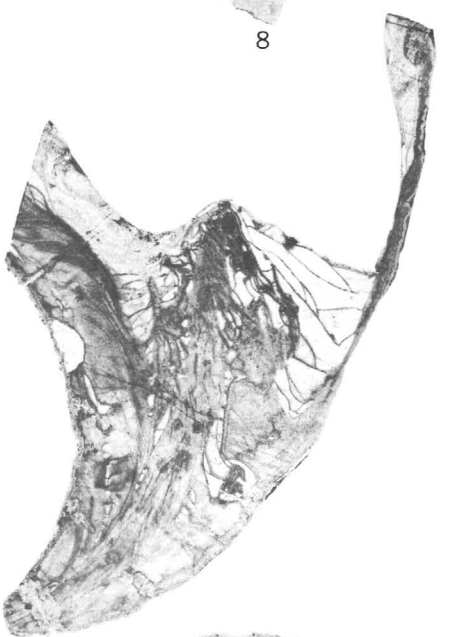
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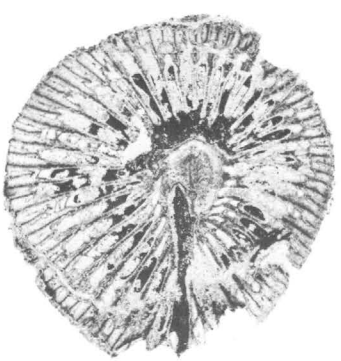
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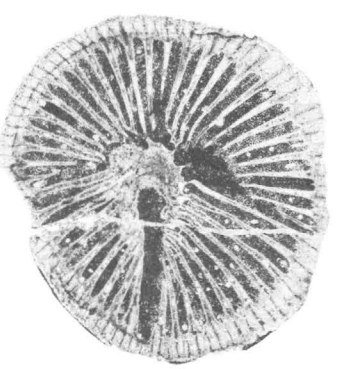
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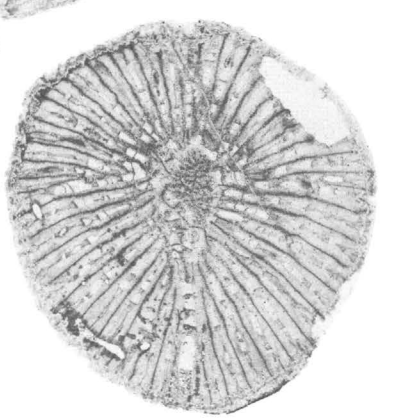

13

EKVASOPHYLLUM cf. *E. INCLINATUM* Parks and *FABEROPHYLLUM GIRTYI* n. sp.

PLATE 2

[Specimens are from the limestone and chert member]

FIGURES 1–15. *Faberophyllum williamsi* n. sp. (p. 14).

1–4. Serial transverse thin sections; holotype, USNM 160507; 1 (× 4), 2 (× 3), 3, 4 (× 2). Collected by G. H. Girty, 1918, south shore Madre de Dios Island.

5, 8. Serial transverse sections (× 2); paratype, USNM 160508. Collected by G. H. Girty, 1918, south shore Madre de Dios Islands.

6. Longitudinal thin section (× 2); paratype, USNM 160509. Collected by G. H. Girty, 1918, south shore Madre de Dios Island.

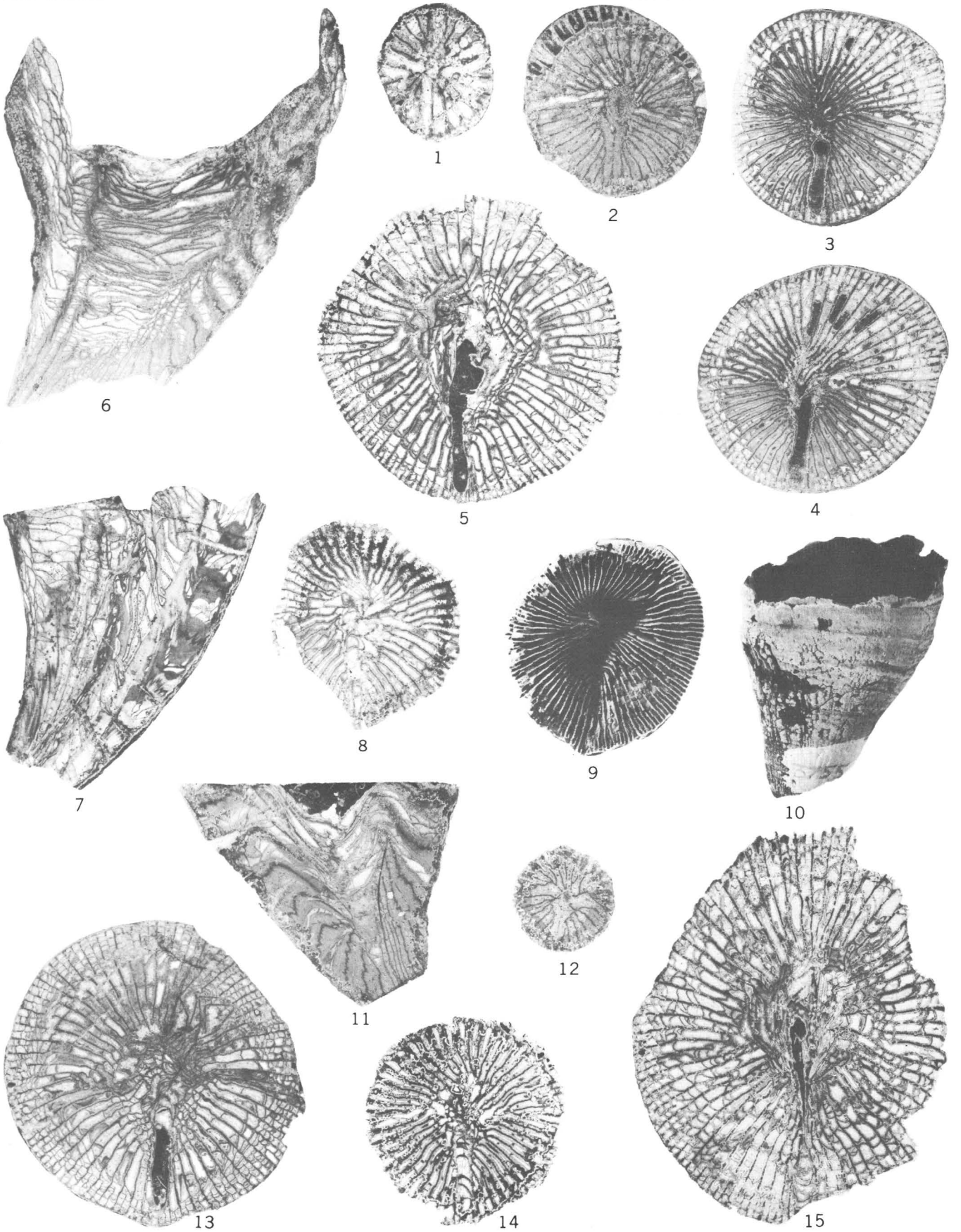
7. Longitudinal thin section (× 2); paratype, USNM 160510. Collected on south shore of Madre de Dios Island, 90–100 ft. above base of section 66X–10.

9, 10. Calicular and alar views, respectively (× 1); paratype, USNM 160511. Collected by G. H. Girty, 1918, south shore of Madre de Dios Island.

11, 12. Longitudinal thin section 11 (× 2); transverse thin section 12 (× 3); paratype, USNM 160512. Toti Island, 250 feet above base of section 66X–6.

13. Transverse thin section (× 2); paratype, USNM 160513. South shore of Madre de Dios Island, 90–100 ft. above section 66X–10.

14, 15. Transverse serial thin sections; 14 (× 3), 15 (× 2); paratype, USNM 160514. Toti Island, 270 ft. above the base of section 66X–6.



FABEROPHYLLUM WILLIAMSI n. sp.

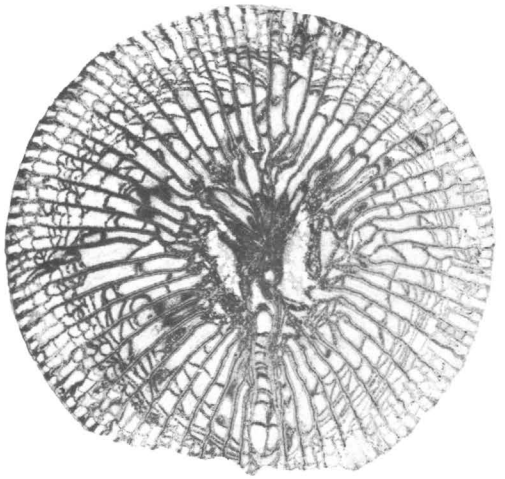
PLATE 3

[Specimens are from the limestone and chert member, Madre de Dios Island]

FIGURES 1–6. *Faberophyllum girtyi* n. sp. (p. 16).

1–3. Transverse serial thin sections, 1, 2; longitudinal thin section, 3 (× 2); holotype, USNM 160515. Collected by G. H. Girty, 1918.

4–6. Transverse serial thin sections, 4 (× 3), 5 (× 2), longitudinal thin section, 6 (× 2); paratype, USNM 160516. About 20–50 ft. above base of section 66X–11.



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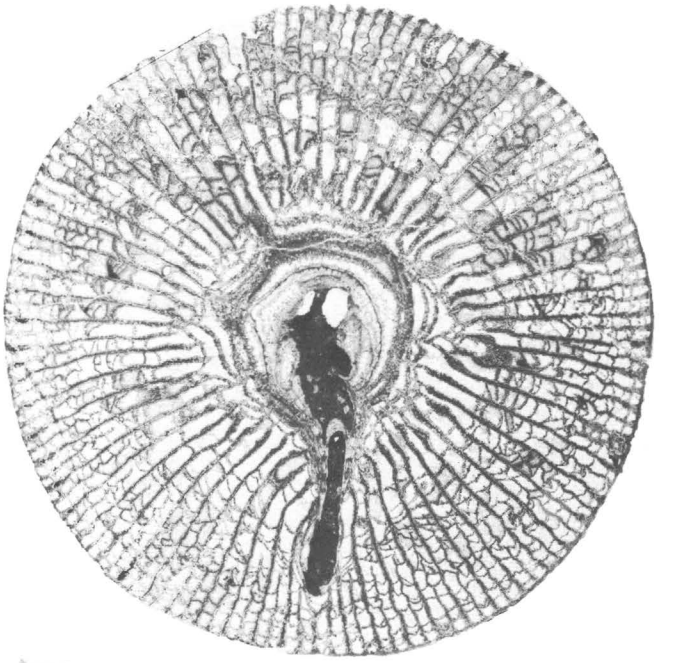

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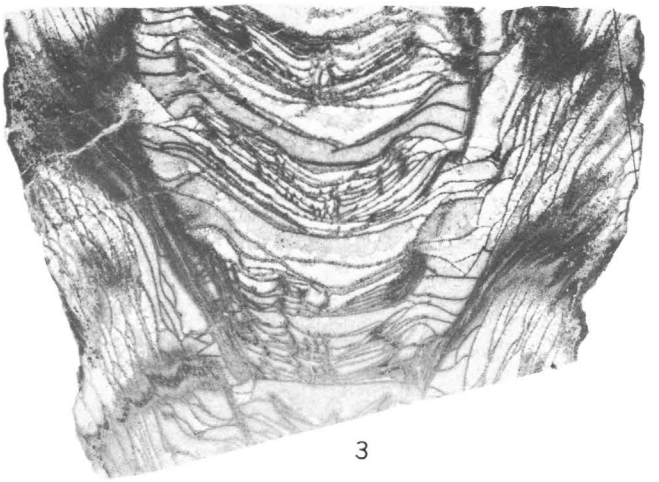

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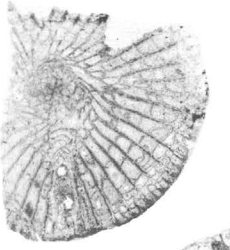

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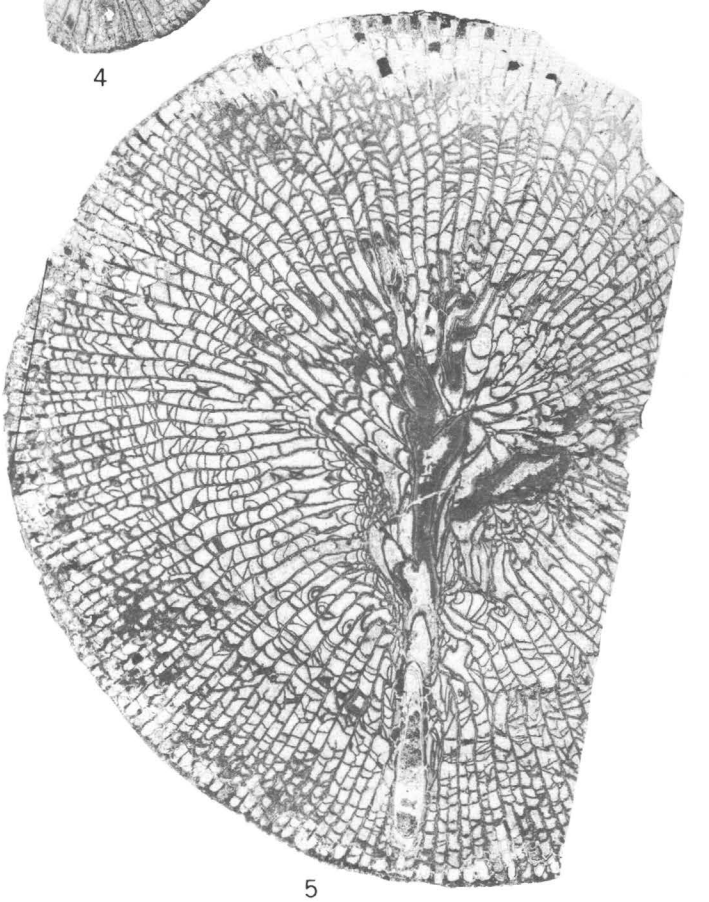

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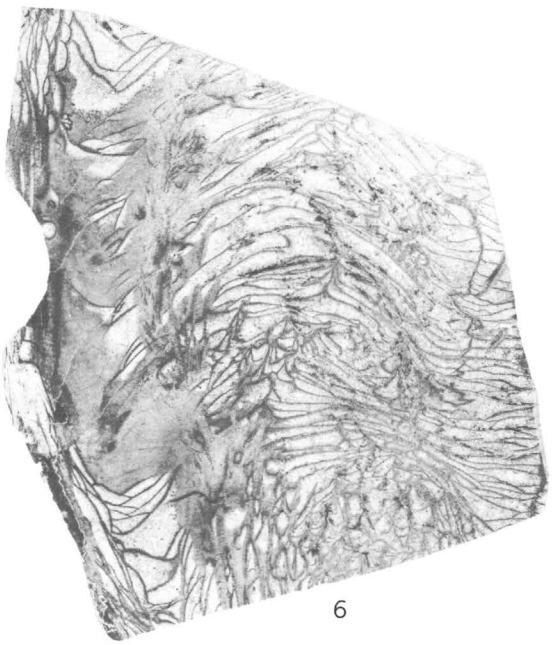


6

FABEROPHYLLUM GIRTYI n. sp.

PLATE 4

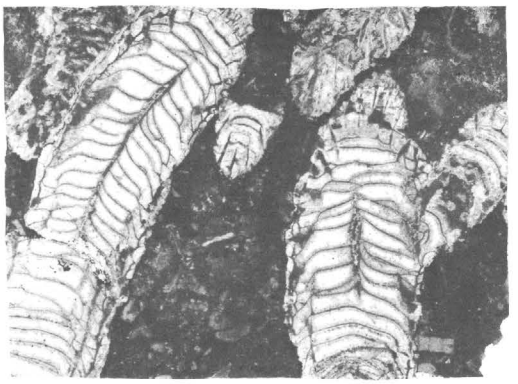
[All specimens are from the limestone and chert member]

FIGURES 1–6. *Lithostrotion (Siphonodendron) warreni* Nelson (p. 18).

1, 2. Longitudinal and transverse thin sections, respectively; USNM 160475. Collected by J. S. Williams, 1940, from Madre de Dios Island.

3, 4. Longitudinal and transverse thin sections, respectively; USNM 160474. Collected by G. H. Girty, 1918, Madre de Dios Island.

5, 6. Longitudinal and transverse thin sections, respectively; USNM 160473. From small unnamed island 1 mile west of Shelikof Island.



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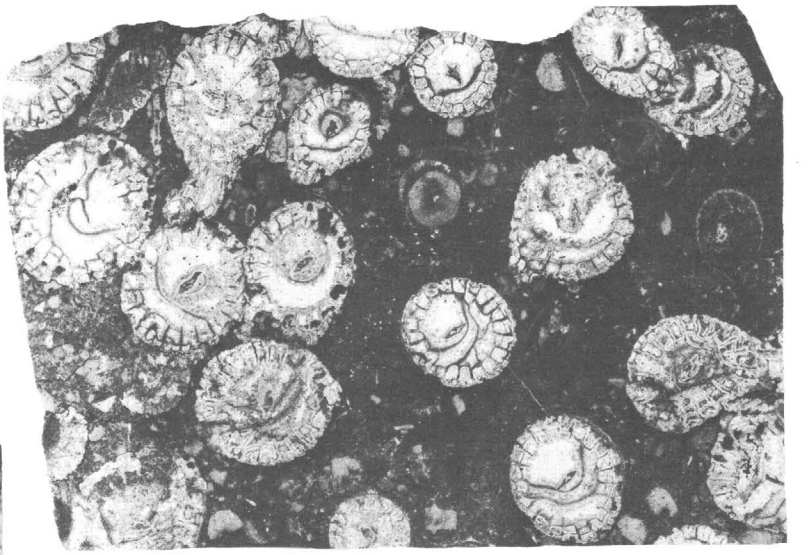

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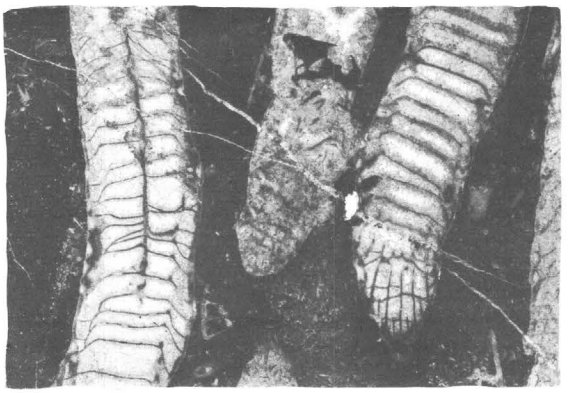

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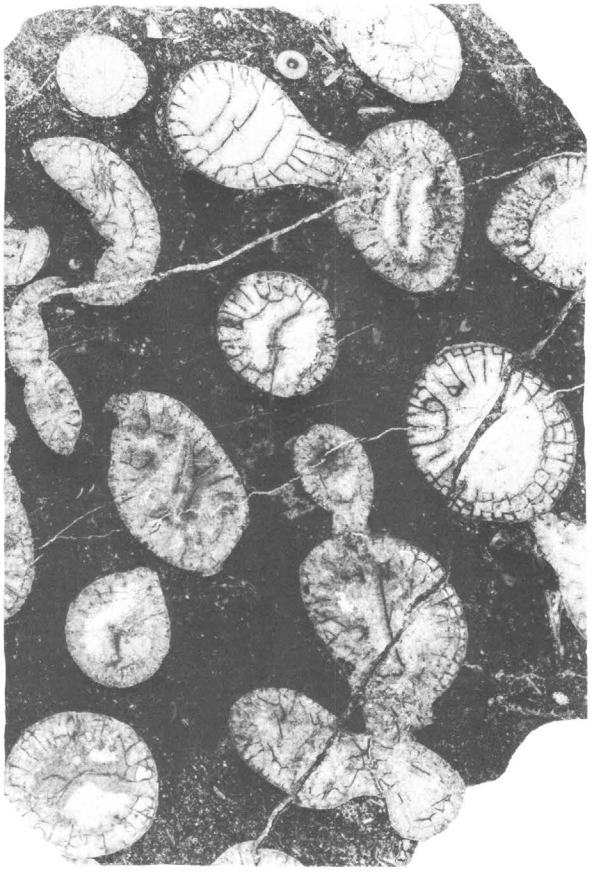

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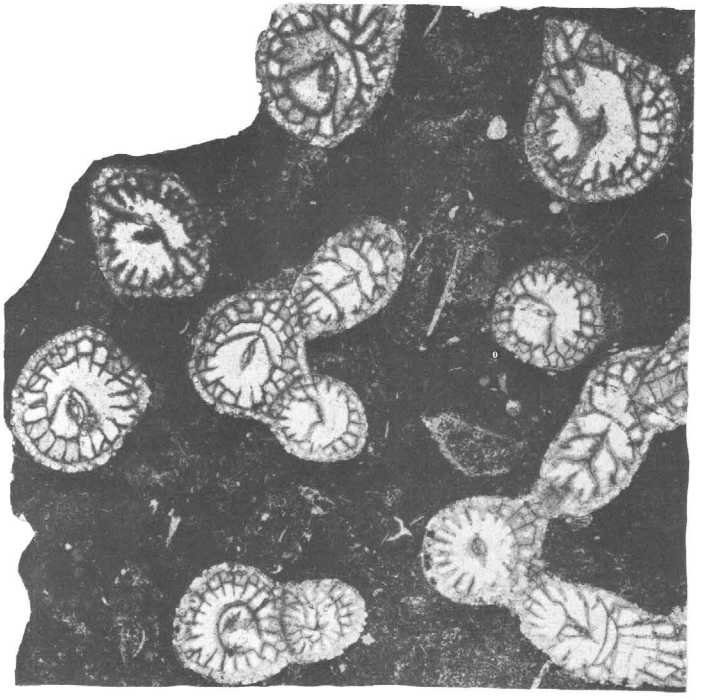


6

LITHOSTROTION (SIPHONODENDRON) WARRENI Nelson

PLATE 5

[Specimens were collected from the limestone and chert member. All figures × 3]

FIGURES 1, 4. *Lithostrotion* (*Siphonodendron*) sp. (p. 22).

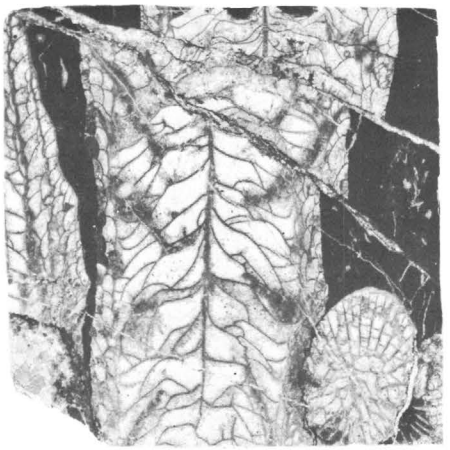
Longitudinal and transverse thin sections, respectively; USNM 160497. South side Madre de Dios Island.

2, 3, *Diphyphyllum klawockensis* n. sp. (p. 27).

5, 6. Collected by G. H. Girty, 1918, unnamed island 1 mile west of Shelikof Island.

2, 3. Longitudinal and transverse thin sections, respectively; paratype, USNM 160499.

5, 6. Transverse and longitudinal thin sections, respectively; holotype, USNM 160481.



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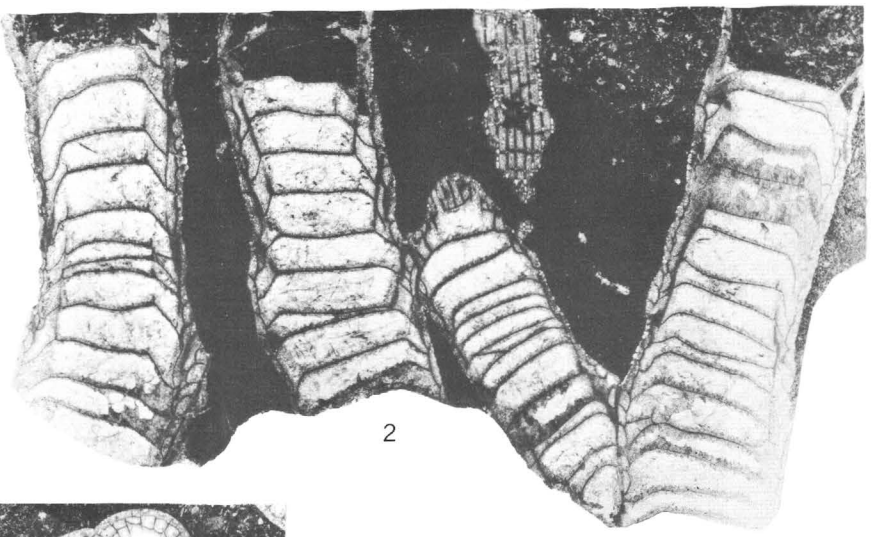

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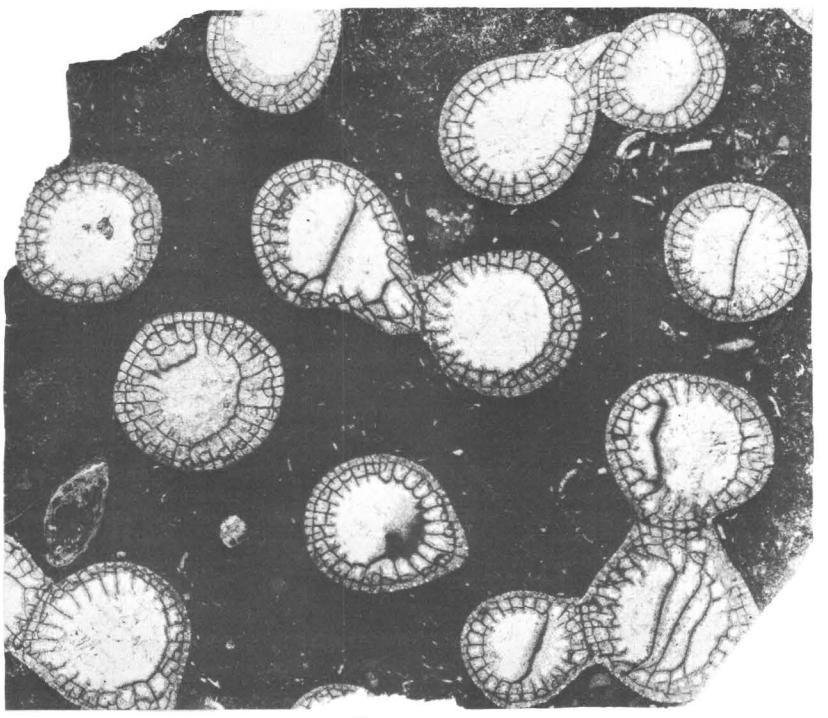

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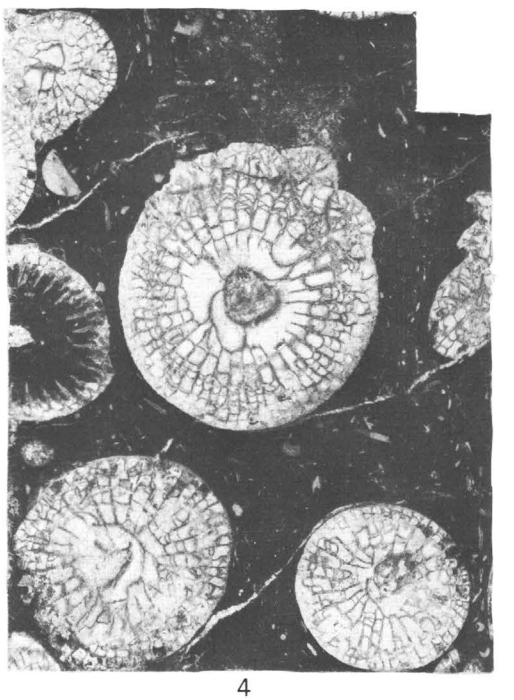

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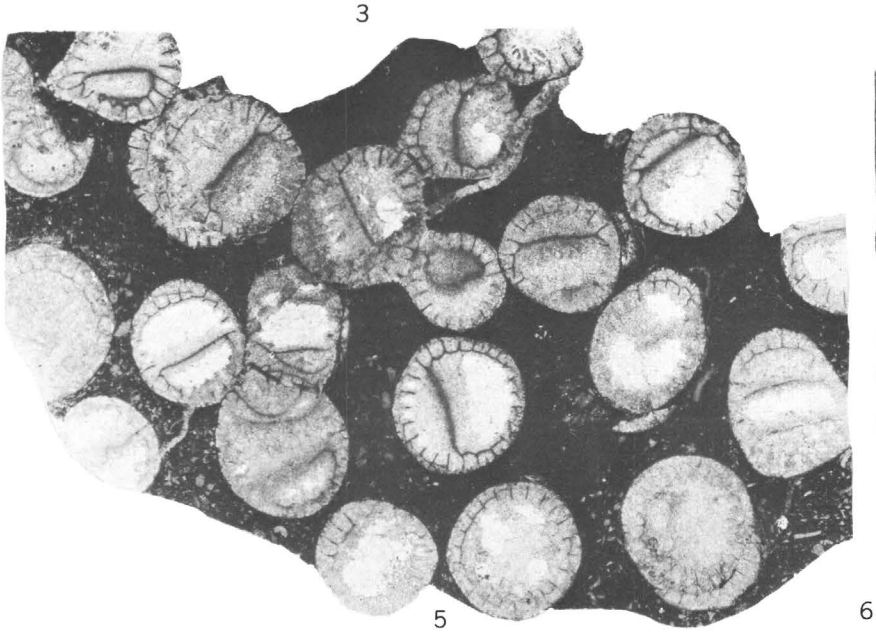

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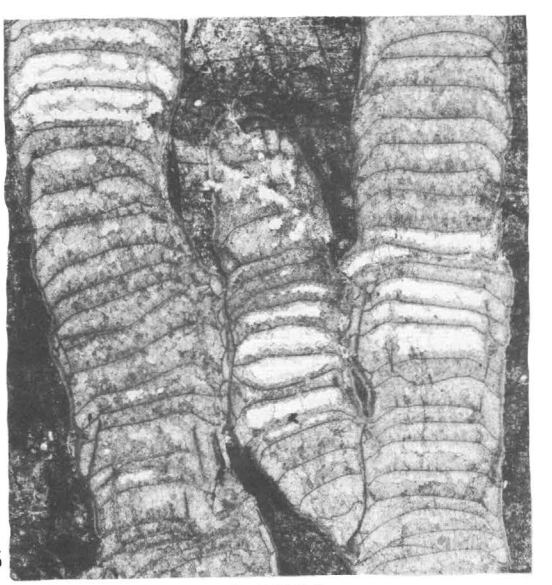


6

LITHOSTROTION (SIPHONODENDRON) sp.; *DIPHYPHYLLUM KLAWOCKENSIS* n. sp.

PLATE 6

[All specimens are from the limestone and chert member. All figures × 3]

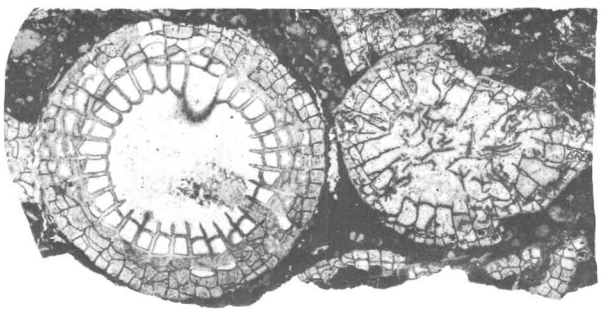
FIGURES 1–7. *Diphyphyllum venosum* n. sp. (p. 24).

1, 2. Transverse and longitudinal thin sections, respectively; third paratype, USNM 160480. Collected by T. Chapin, 1916, Shelikof Island.

3, 4. Longitudinal and transverse thin sections, respectively; paratype, USNM 160478. From Shelikof Island, 430 ft. above the base of stratigraphic section 66X–7.

5. Longitudinal thin section; paratype, USNM 160479. From Toti Island, 270 ft. above the base of stratigraphic section 66X–6.

6, 7. Longitudinal and transverse thin sections; holotype, USNM 160477. From Toti Island, 275 ft. above the base of stratigraphic section 66X–6.



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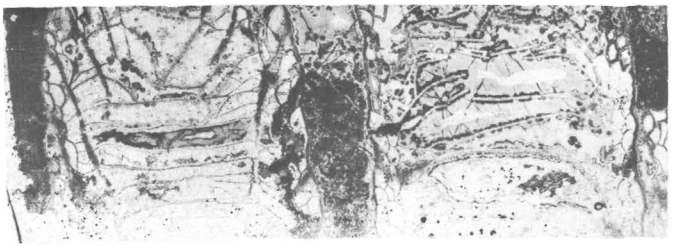

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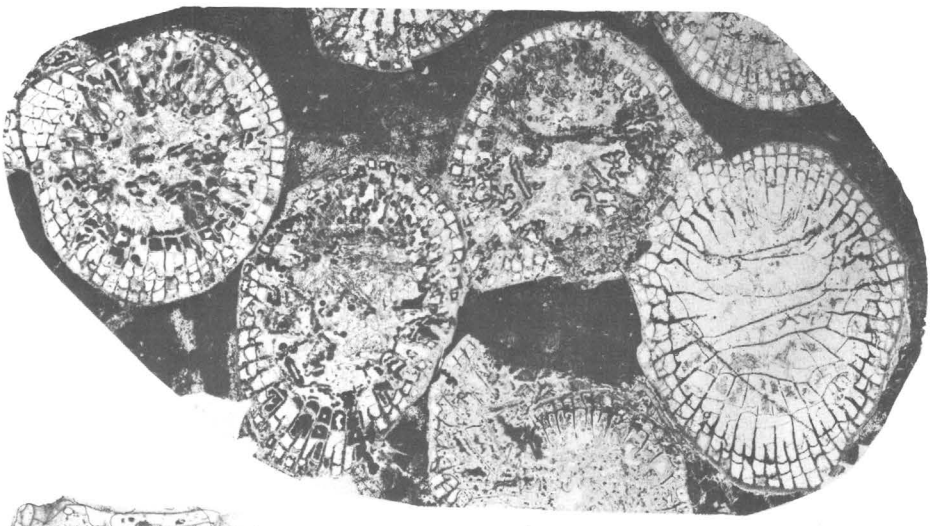

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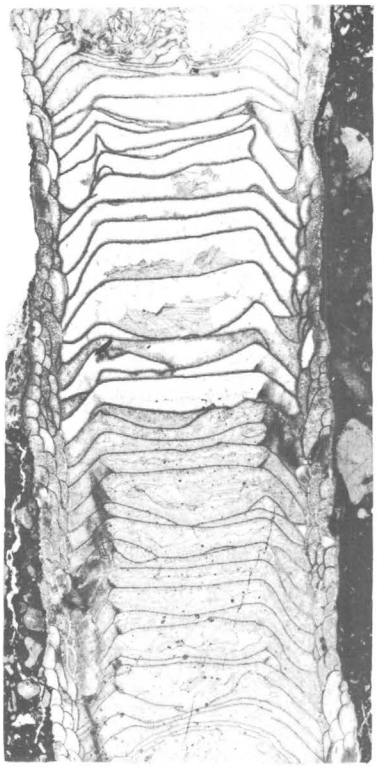

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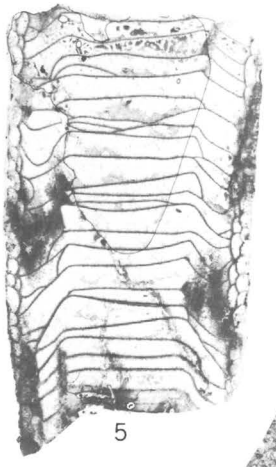

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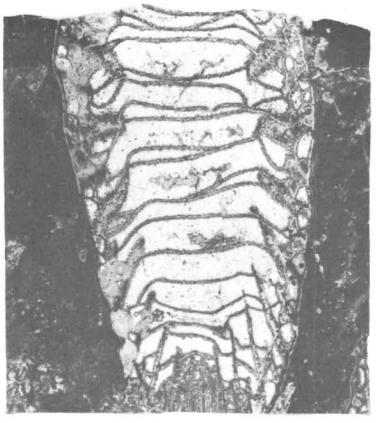

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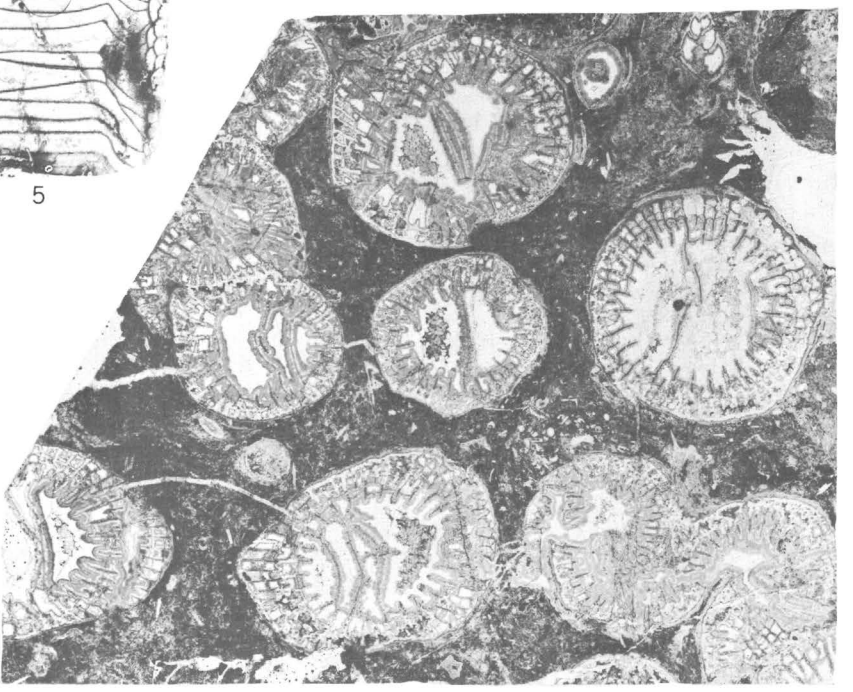


7

DIPHYPHYLLUM VENOSUM n. sp.

PLATE 7

FIGURES 1–4. *Lithostrotionella birdi* n. sp. (p. 32).

1, 2. Transverse and longitudinal thin sections, respectively (× 3); paratype, USNM 160489. From Shelikof Island, 340 ft. above stratigraphic section 66X–7, limestone and chert member.

3, 4. Transverse thin section of holotype (× 20), USNM 160487. 3, Details of preservation of columella, septa, and tabulae; 4, details of preservation of corallite wall, dissepiments, and septa. The walls and internal structure are preserved as calcite on which there is a secondary overgrowth of 50- to 100-micron crystals of sparry calcite. Remaining voids within corallites are filled with 0.3–0.5-mm crystals of calcite and/or 0.5–2 mm crystals of chalcedony.

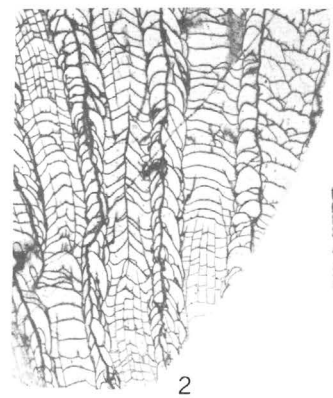
5–8. *Lithostrotion* (*Siphonodendron*) *succinctus* n. sp. (p. 20).

Holotype, USNM 160476. Peratrovich Island, limestone member.

5, 6. Two views (× 20) of a corallite showing microstructure preserved in calcite. The septa and columella are composed of fibrous calcite at right angles to their exterior surfaces. The septa are composed of dark-colored fibrous calcite and the epitheca is light-colored fibrous calcite.

7, 8. Transverse and longitudinal thin sections, respectively (× 3).

1



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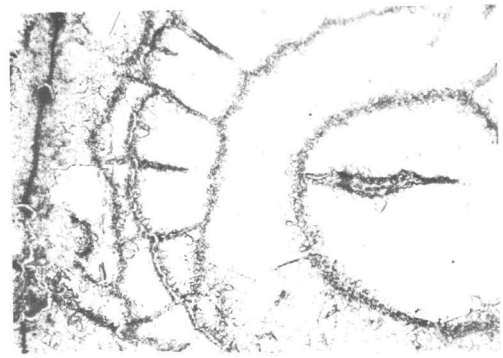

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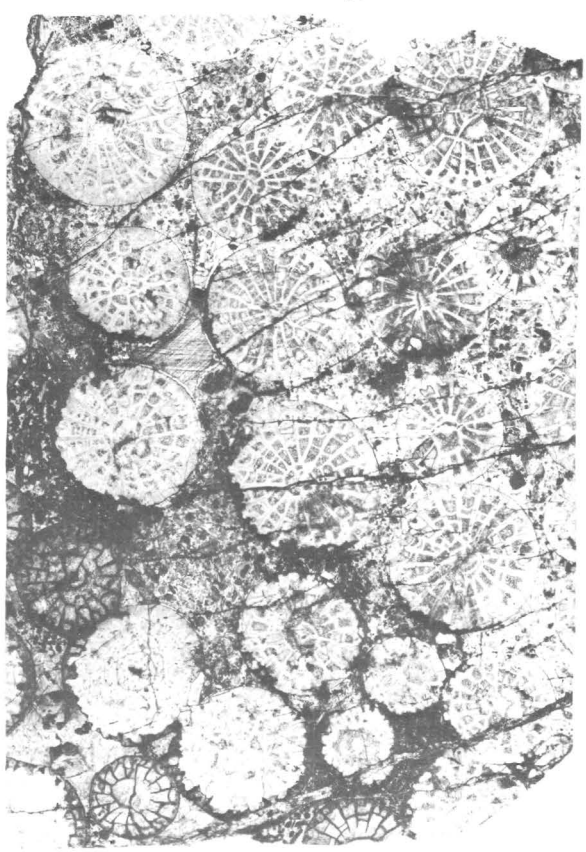

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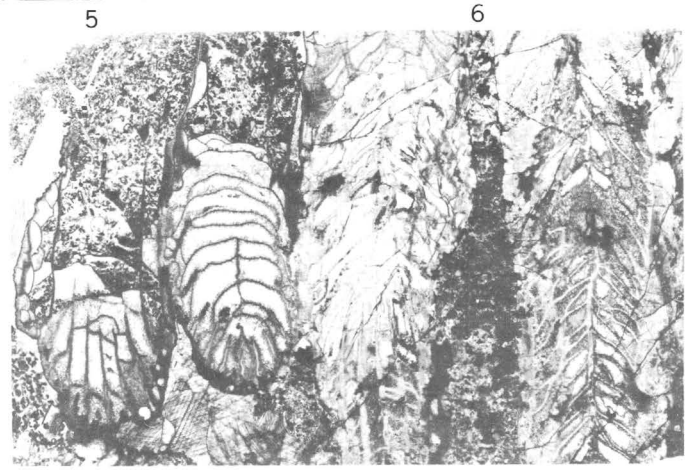

8

LITHOSTROTIONELLA BIRDI n. sp.; *LITHOSTROTION (SIPHONODENDRON) SUCCINCTUS* n. sp.

PLATE 8

[Specimens are from the limestone and chert member. All figures are × 3]

FIGURES 1–7. *Lithostrotionella birdi* n. sp. (p. 32).

1, 2. Transverse and longitudinal thin sections, respectively; paratype, USNM 160490. From Shelikof Island, 310 ft. above the base of stratigraphic section 66X–7.

3, 6. Longitudinal and transverse thin sections, respectively; paratype, USNM 160491. Small unnamed island 1 mile west of Shelikof Island; lower 10 ft. of stratigraphic section 66X–10.

4, 5, 7. Longitudinal, 4, 5; transverse, 7, thin sections; holotype, USNM 160487. Shelikof Island, 345 ft. above the base of stratigraphic section 66X–7.

8, 9. *Lithostrotionella* aff. *L. mclareni* Sutherland (p. 35).

Transverse and longitudinal thin sections, respectively; USNM 160492. Small unnamed island 1 mile west of Shelikof Island; lower 10 ft. of stratigraphic section 66X–10.

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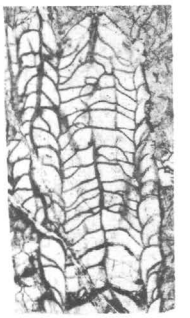

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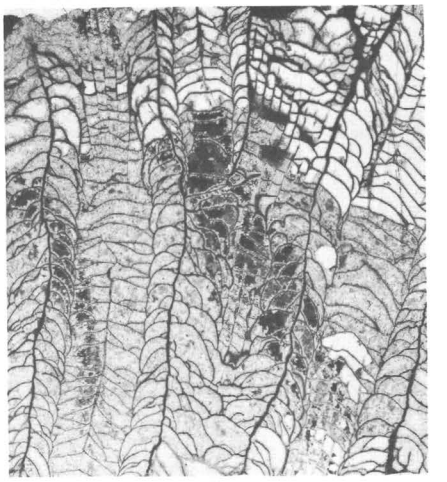

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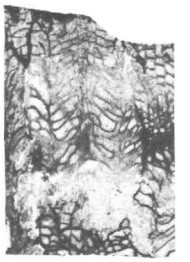

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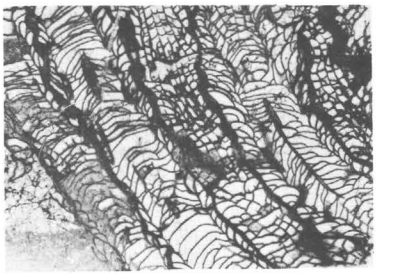

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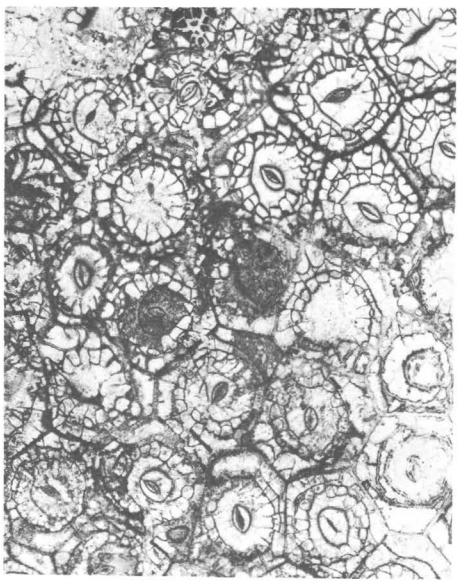

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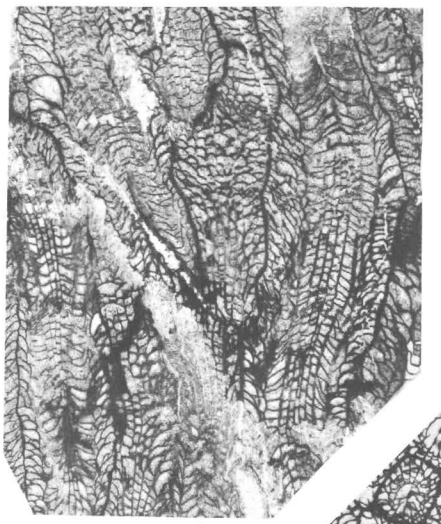

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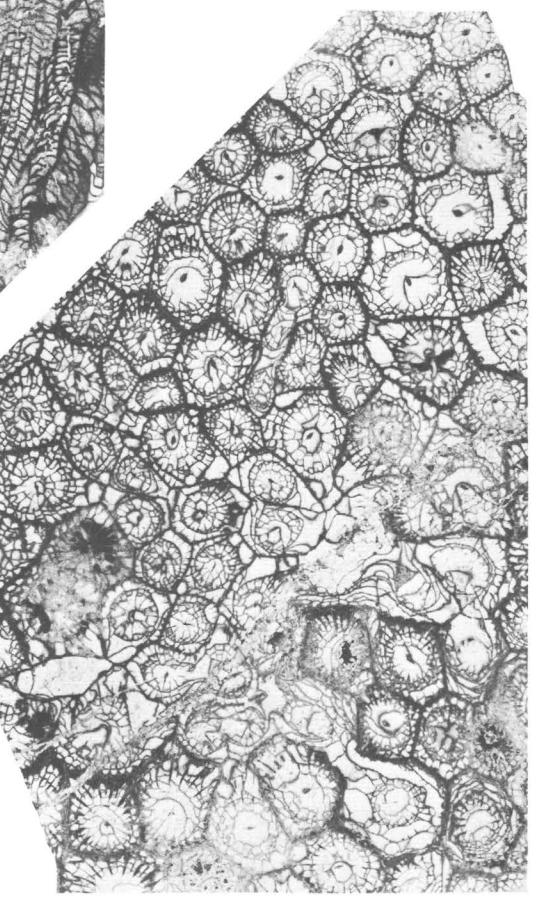

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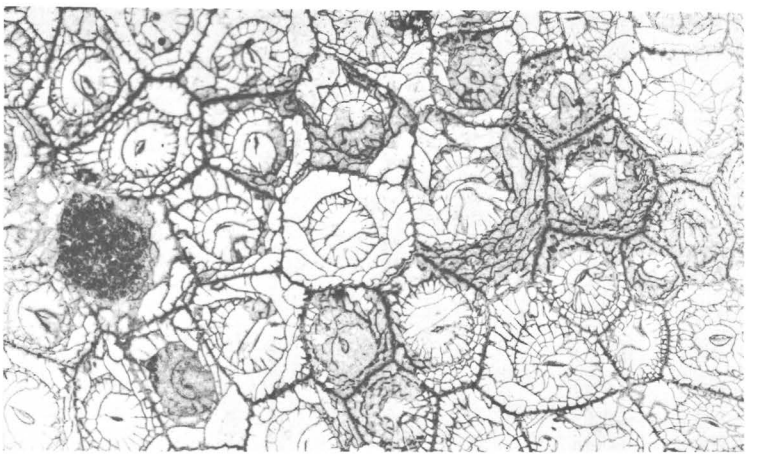


7

LITHOSTROTIONELLA BIRDI n. sp.; *LITHOSTROTIONELLA* aff. *L. MCLARENI* Sutherland

PLATE 9

[Specimens are from the limestone and chert member. All figures are × 3]

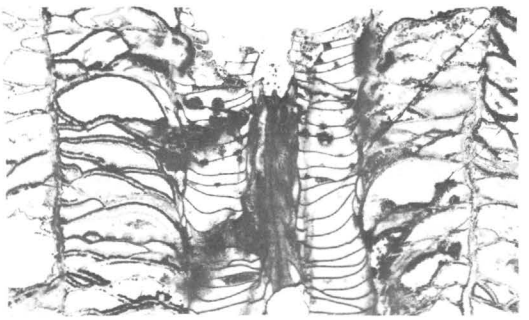
FIGURES 1–3. *Lithostrotionella pennsylvanica* (Shimer) (p. 31).

1, 2. Longitudinal and transverse thin sections, respectively; USNM 160486. Small unnamed island 1 mile west of Shelikof Island, 80 ft. above base of measured section 66X–10.

3. Transverse thin section; USNM 160485. Toti Island, 225 ft. above the base of measured section 66X–6.

4, 5. *Diphyphyllum venosum* n. sp. (p. 24); paratype, USNM 160516.

Transverse and longitudinal thin sections, respectively. Specimen is from the small unnamed island 1 mile west of Shelikof Island, 180 ft. above the base of measured section 66X–10.



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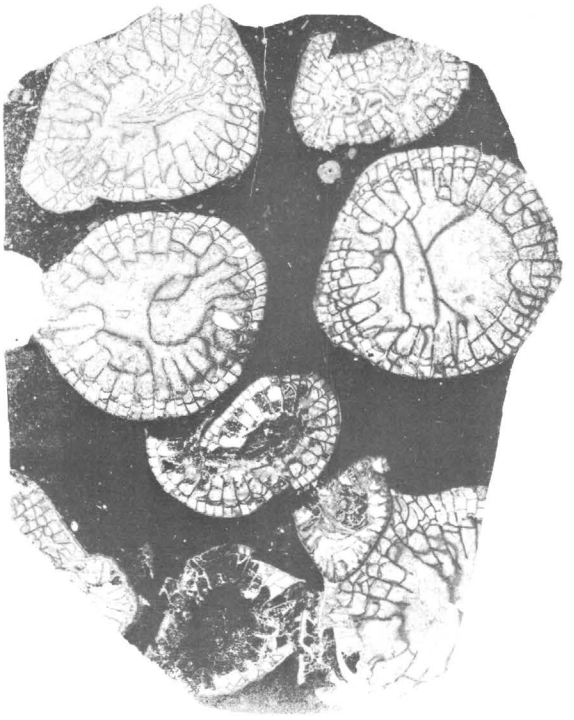

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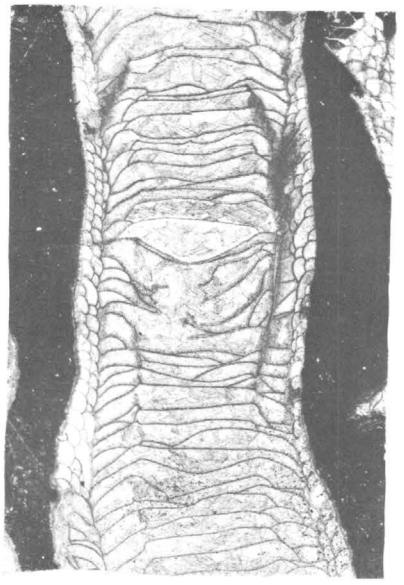

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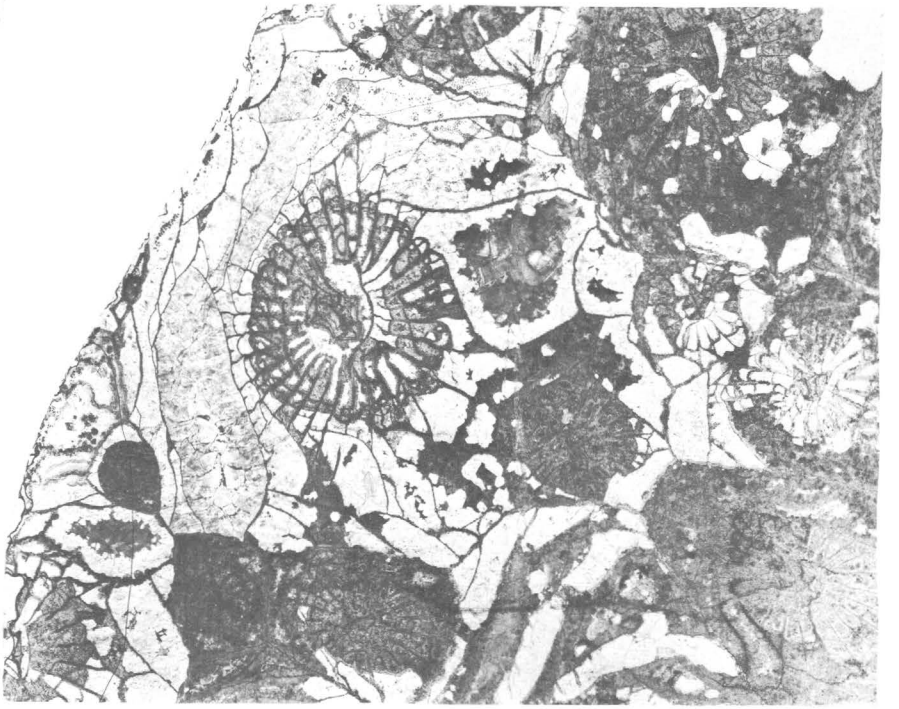


3

LITHOSTROTIONELLA PENNSYLVANICA (Shimer); *DIPHYPHYLLUM VENOSUM* n. sp.

PLATE 10

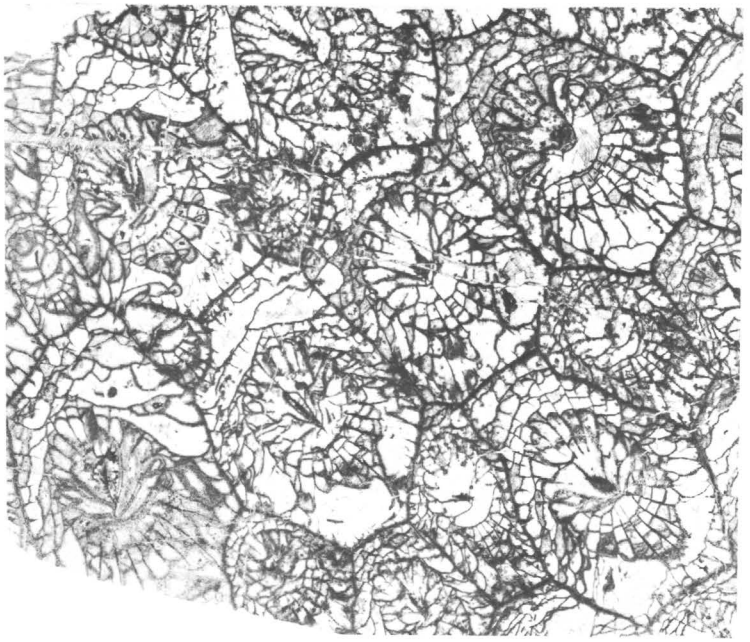
[All figures are × 3]

FIGURES 1–8. *Lithostrotionella banffensis* (Warren) (p. 29).

1, 3, 4. Transverse thin section, 1; longitudinal thin sections, 3, 4; USNM 160483. Collected by G. H. Girty, 1918. Limestone and chert member, south shore of Madre de Dios Island.

2, 5, 8. Transverse thin section, 8; longitudinal thin sections, 2, 5; USNM 160482. Toti Island, 275 ft. above the base of stratigraphic section 66X–6; limestone and chert member.

6, 7. Longitudinal and transverse thin sections, respectively; USNM 160484. Collected by G. H. Girty, 1918. Limestone member, northwest side, Klawak Island.



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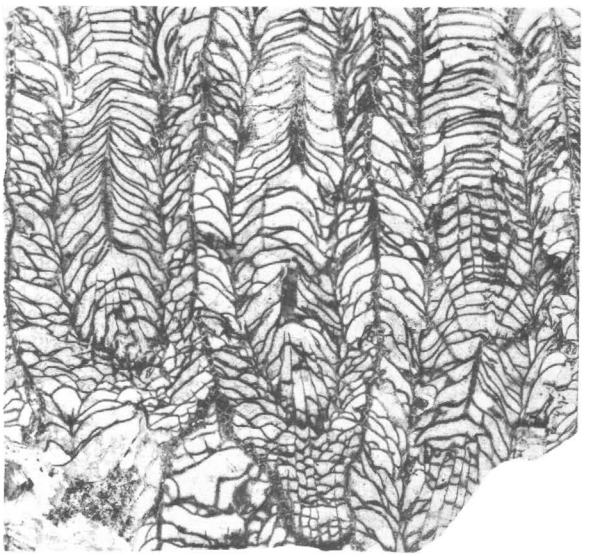

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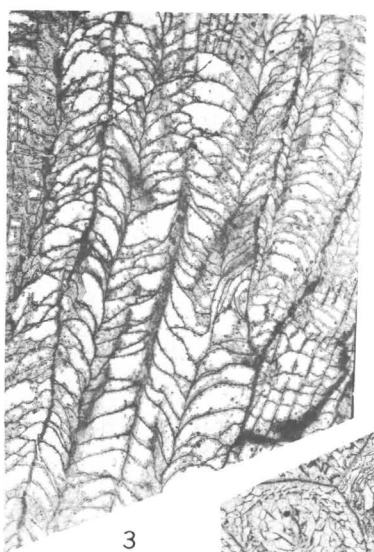

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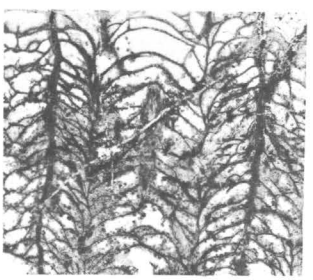

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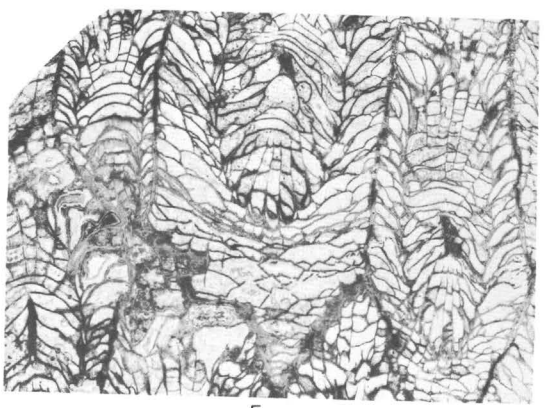

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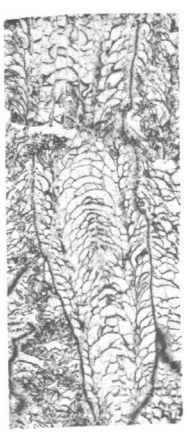

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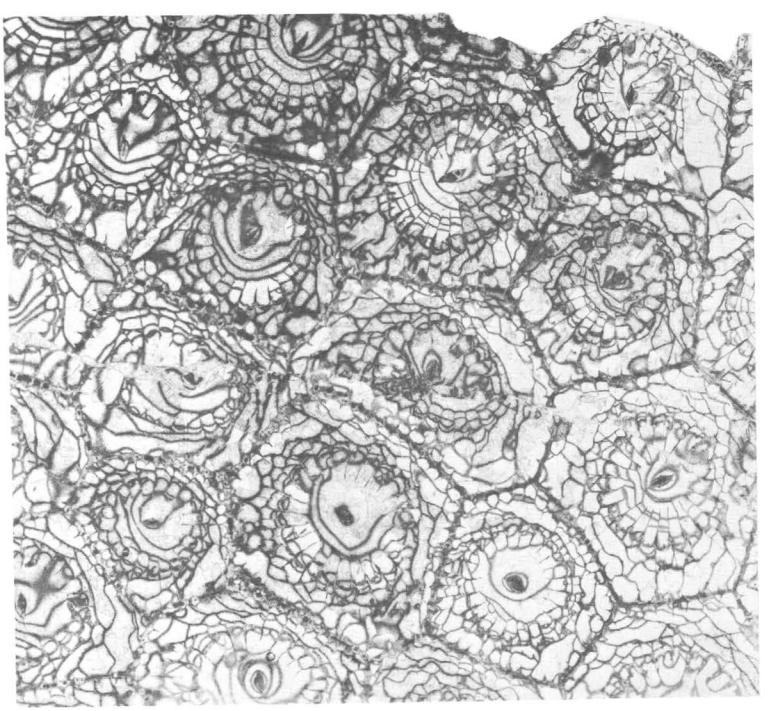


8

LITHOSTROTIONELLA BANFFENSIS (Warren)

PLATE 11

[Specimens from the limestone and chert member]

FIGURES 1–4. *Sciophyllum alaskaensis* n. sp. (p. 38).

Holotype, USNM 160496. Toti Island, 275 ft. above the base of stratigraphic section 66X–6.

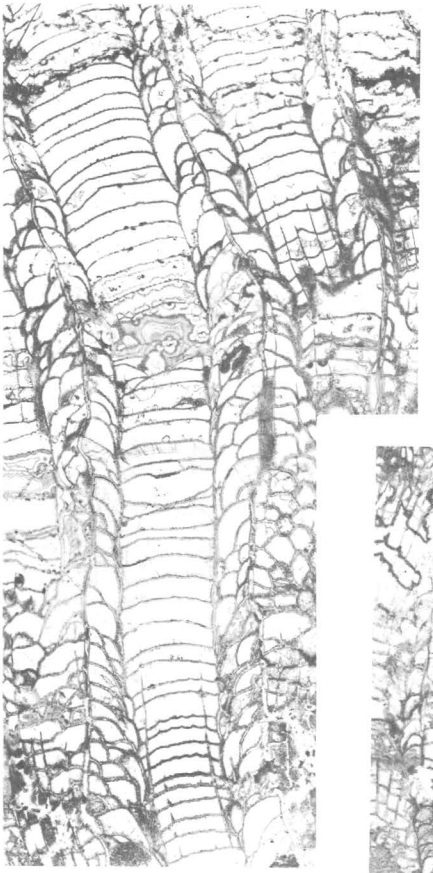
1–3. Longitudinal thin sections, 1, 2; transverse thin section, 3 (× 3).

4. Transverse thin section (× 30), illustrating microstructure of the wall and septa. The coral is preserved as calcite but the internal voids were filled with chalcedony.

5–8. *Thysanophyllum astraeiforme* (Warren) (p. 37).

5, 6. Longitudinal and transverse thin sections, respectively (× 3); USNM 160494. Small unnamed island 1 mile west of Shelikof, lower 10 ft. of stratigraphic section 66X–10.

7, 8. Transverse and longitudinal thin sections (× 3); USNM 160495. Collected by T. Chapin, 1915, Shelikof Island.



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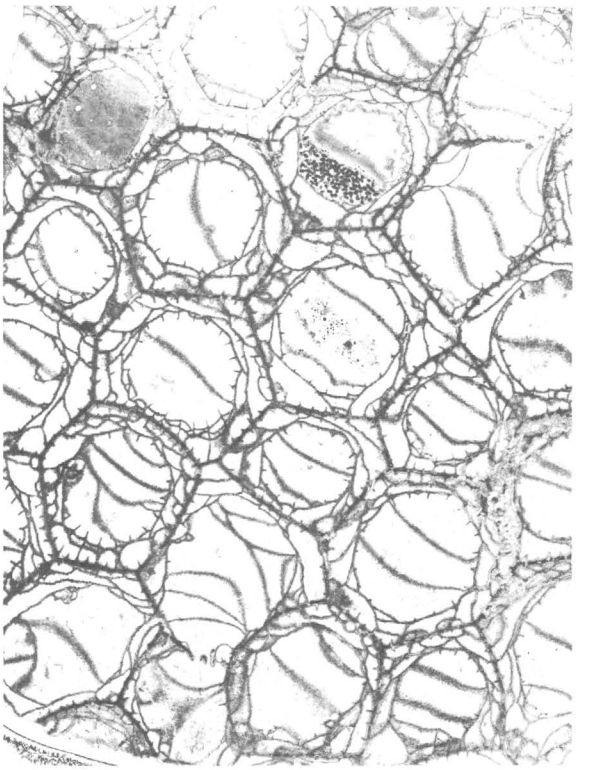

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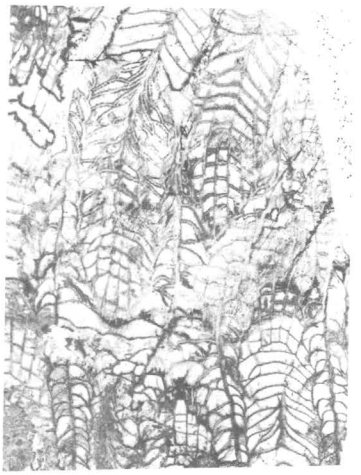

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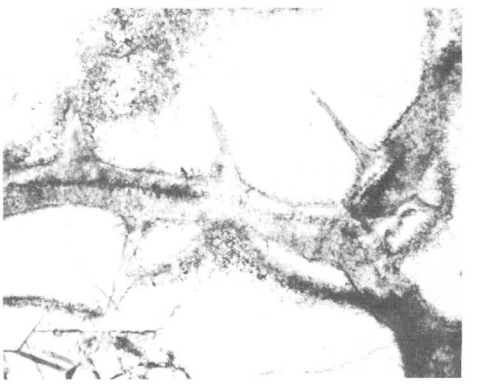

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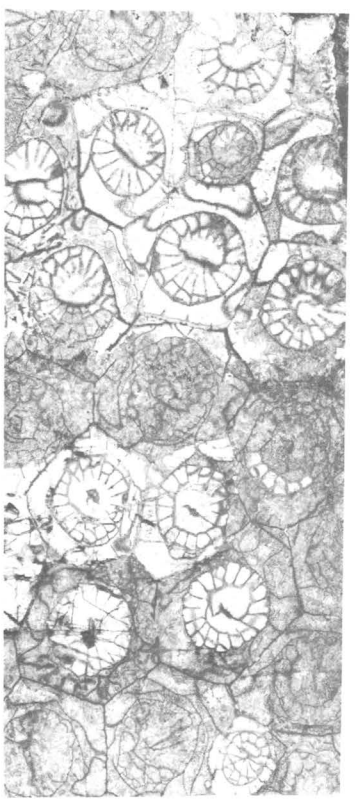

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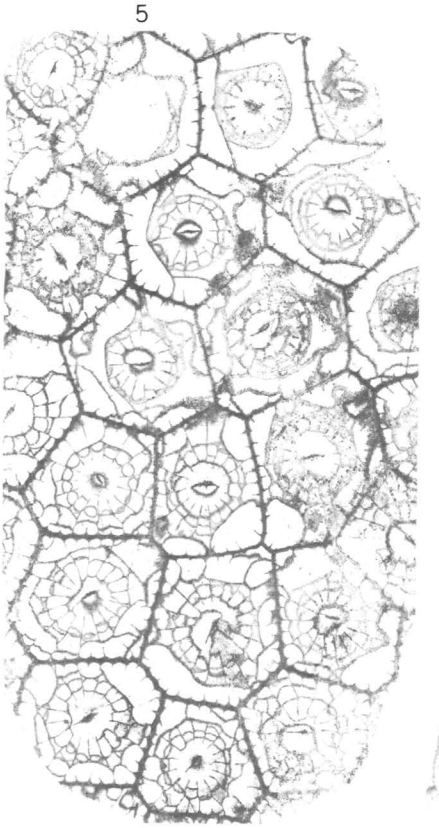

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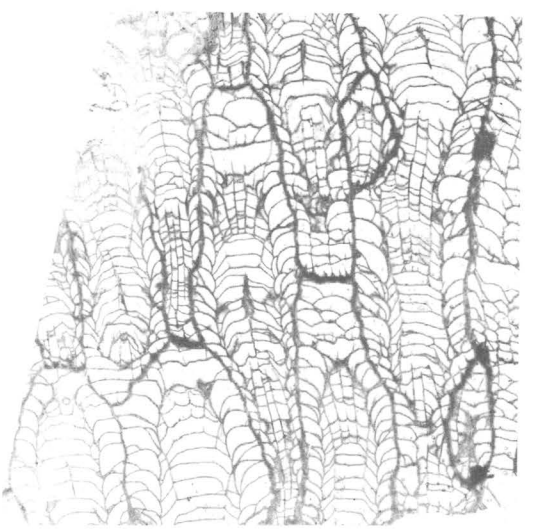


8

SCIOPHYLLUM ALASKAENSIS n. sp.; *THYSANOPHYLLUM ASTRAEIFORME* (Warren)

PLATE 12

FIGURES 1, 2. *Sciophyllum alaskaensis* n. sp. (p. 38).

Transverse and longitudinal thin sections, respectively (× 3); paratype, USNM 160517. Toti Island, limestone and chert member, 270 ft. above base of stratigraphic section 66X–6.

3, 4–7. *Ekvasophyllum* cf. *E. inclinatum* Parks (p. 11).

Limestone and chert member. Collected by G. H. Girty, 1918, from Madre de Dios Island.

3. Alar view (× 1); paratype, USNM 160519. Longitudinal thin section, pl. 1, fig. 9, is from the same individual.

4. Alar view (× 1); paratype, USNM 160518.

5–7. Serial transverse thin sections, 5 (× 6), 6, 7 (× 2); paratype, USNM 160518. Thin sections from individual shown in fig. 4.

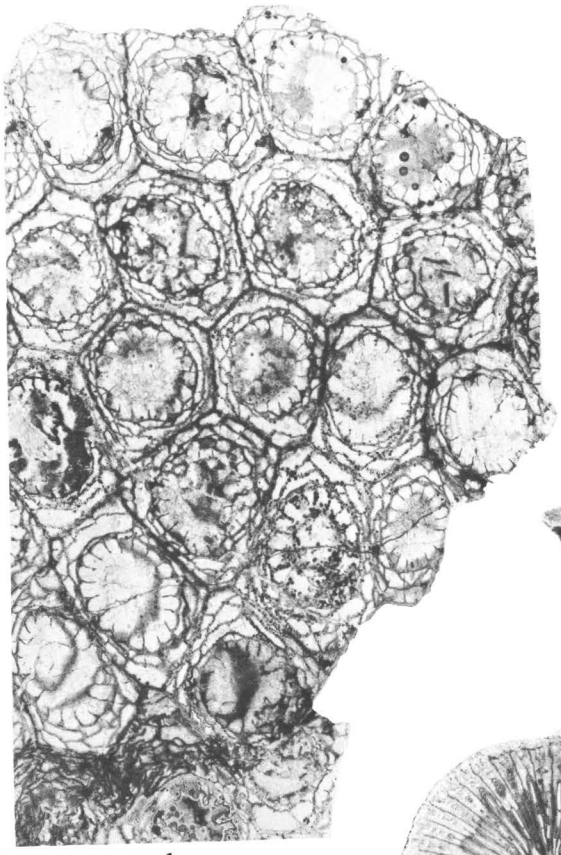
8–11. *Lithostrotionella peratrovichensis* n. sp. (p. 35).

Holotype, USNM 160493. Limestone member from Peratrovich Island.

8–9. Transverse and longitudinal thin sections, respectively (× 3).

10. Longitudinal thin section (× 20) showing the sharp upward reflex of the tabulae near the columella.

11. Transverse thin section (× 20) showing the thick wall and microstructure of the corallite walls.



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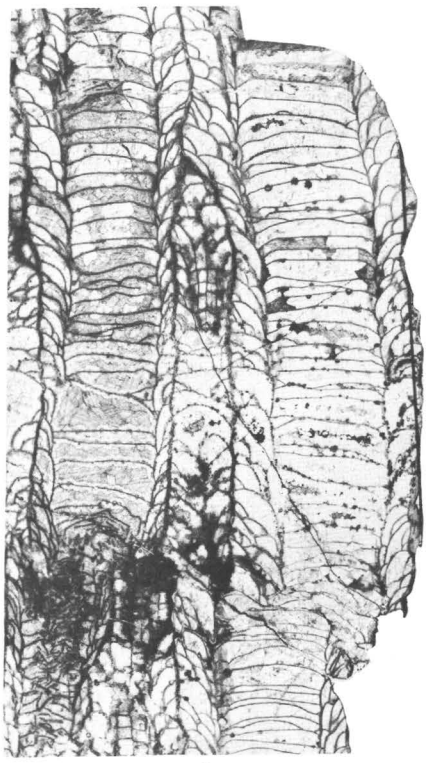

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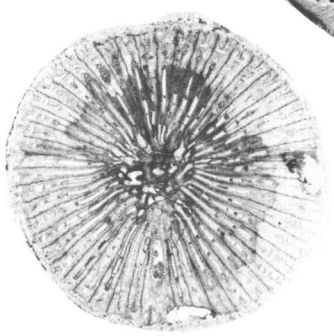

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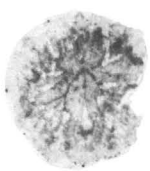

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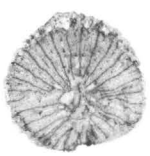

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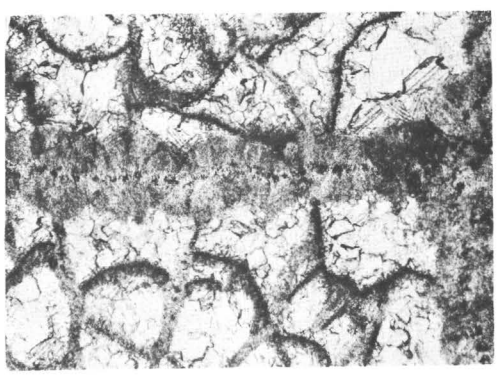

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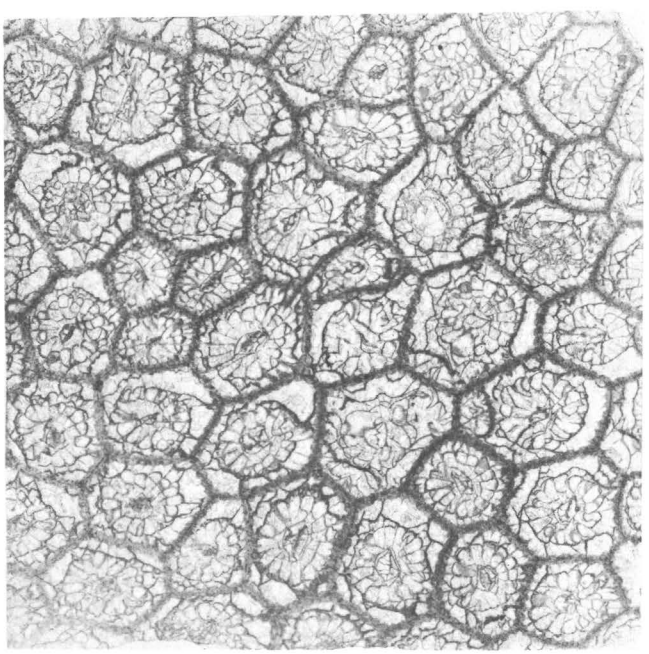

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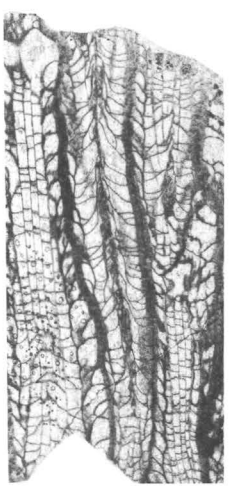

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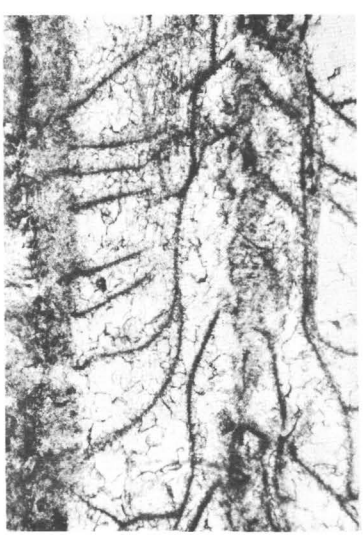

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SCIOPHYLLUM ALASKAENSIS n. sp.; *EKVASOPHYLLUM* cf. *E. INCLINATUM* Parks; *LITHOSTROTIONELLA PERATROVICHENSIS* n. sp.

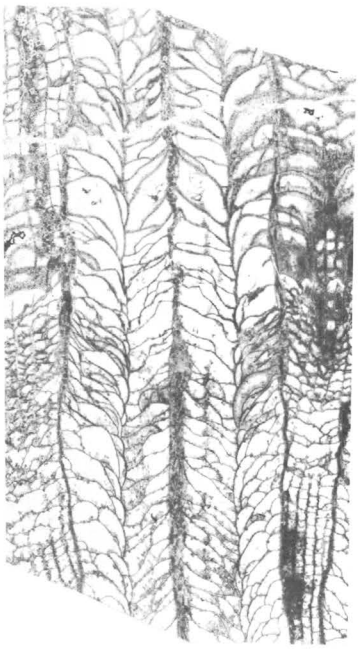
PLATE 13

[All figures are × 3]

FIGURES 1–7. *Lithostrotionella banffensis* (Warren) (p. 29).

1, 2, 3. Longitudinal thin section, 1; transverse thin sections, 2, 3; USNM 120242. Collected by G. H. Girty, 1918. Limestone and chert member, south shore Madre de Dios Island.

4–7. Transverse thin sections, 4, 6; longitudinal thin sections, 5, 7; USNM 120245. Collected by G. H. Girty, 1918. Limestone and chert member, south side Shelikof Island.



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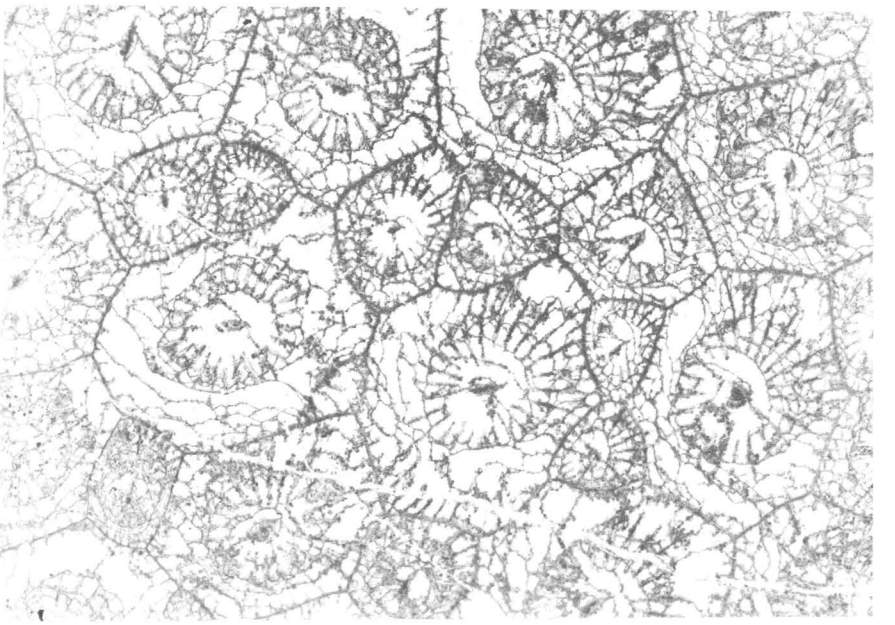

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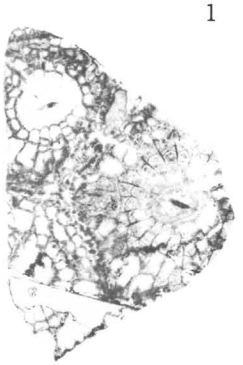

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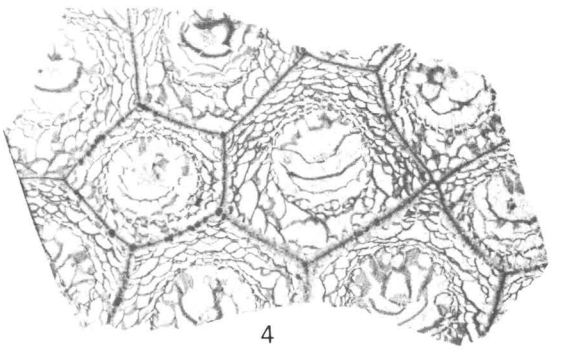

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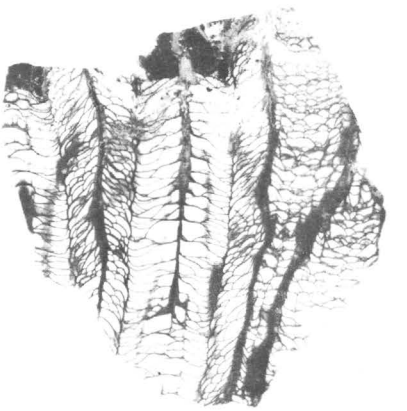

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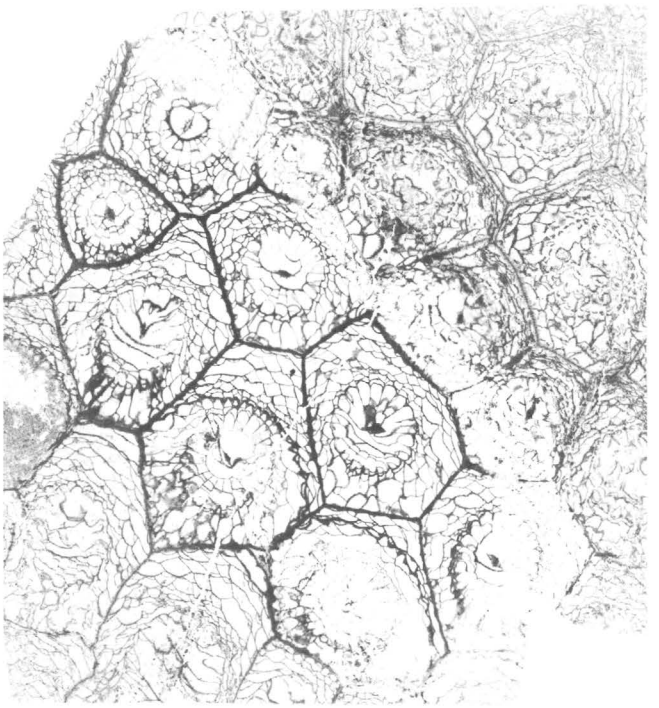

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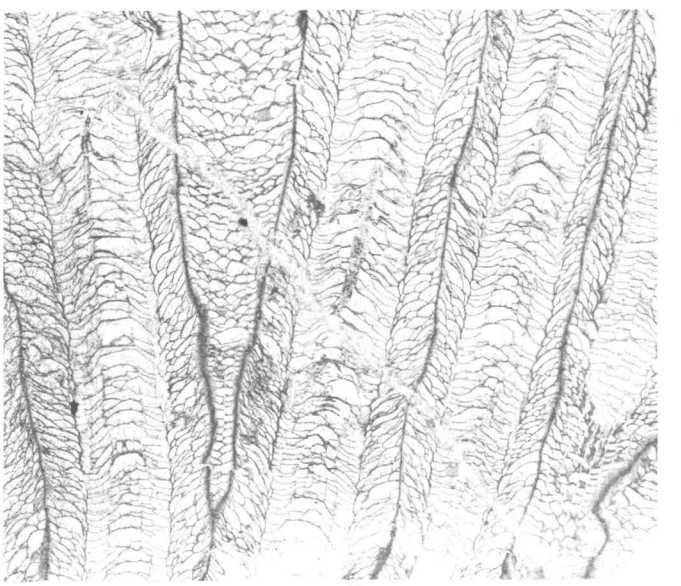

7

LITHOSTROTIONELLA BANFFENSIS (Warren)