

# Revision of Some Paleozoic Coral Species from the Western United States

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GEOLOGICAL SURVEY PROFESSIONAL PAPER 503-E





# Revision of Some Paleozoic Coral Species from the Western United States

By WILLIAM J. SANDO

CONTRIBUTIONS TO PALEONTOLOGY

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GEOLOGICAL SURVEY PROFESSIONAL PAPER 503-E

*Redescriptions of 12 species originally  
described by Hall, Meek, and White from  
material collected by the Stansbury, Hayden,  
Wheeler, King, and Powell expeditions*



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## CONTRIBUTIONS TO PALEONTOLOGY

### REVISION OF SOME PALEOZOIC CORAL SPECIES FROM THE WESTERN UNITED STATES

By WILLIAM J. SANDO

#### ABSTRACT

This paper presents the results of a restudy of the type specimens of coral species described as Carboniferous forms in the various reports of the Federal geological surveys of the Western United States made in the latter half of the 19th century. The specimens were collected from localities in Utah, Montana, Nevada, Idaho, Colorado, and New Mexico from strata of Ordovician or Silurian, Mississippian, Pennsylvanian, and possibly Permian age. The classification of corals has changed so profoundly in the last hundred years that only 2 of the 12 species considered retain the same generic names under which they were originally described. *Zaphrentis multilamellata* Hall is considered to be a junior subjective synonym of *Zaphrentis stansburyi* Hall, which is redescribed as a species of *Faberophyllum* Parks and regarded as a nomen dubium. *Faviphyllum? rugosum* Hall is an available name but has been referred to the International Commission on Zoological Nomenclature for suppression because retention of this binomen would not serve the best interests of stability in nomenclature. *Zaphrentis excentrica* Meek and *Cyathophyllum (Campophyllum?) nevadense* Meek are regarded as closely related species of *Caninia* Michelin. *Cyathophyllum subcaespitosum* Meek is redescribed as a species of *Dorlodotia* Salée. *Syringopora occidentalis* Meek is considered to be a nomen dubium. *Lithostrotion whitneyi* White (not Meek) is questionably placed in the genus *Orygmophyllum* Fomichev and considered as a nomen dubium. *Lophophyllum proliferum* var. *sauridens* White is elevated to species rank and allocated to the genus *Lophophylidium* Grabau. White's *Amplexus zaphrentiformis* is redescribed as a species of *Barytichisma* Moore and Jeffords. *Acervularia adjunctiva* White is referred to the genus *Sciophyllum* Harker and McLaren. White's *Leptopora winchelli* is probably a favositid coral of Ordovician or Silurian age, but the type material is so poorly preserved that the name is regarded as a nomen dubium.

#### INTRODUCTION

In the 15 years immediately following the Civil War, extensive geological exploration of the western territories was sponsored by the Federal Government. It was during this time that the Hayden, King, Wheeler, and Powell expeditions laid the foundations that led to the establishment in 1879 of the present U.S. Geological Survey. Among the fossils collected by these

expeditions were specimens that became the types of some of the first Paleozoic coral species to be described from the Western United States. This paper presents the results of a restudy of type specimens of species originally described as Carboniferous forms from the western territories by the distinguished paleontologists C. A. White and F. B. Meek. The study also includes three Carboniferous species described by James Hall in 1852 from material collected by the Stansbury expedition to the Great Salt Lake.

When these species were first described, paleontologists had just begun to appreciate the importance of internal morphology in the taxonomy of Paleozoic corals. Thin-section techniques were not used by these early American investigators, and observations of internal details were made on broken specimens or, rarely, on polished surfaces. The specimens were illustrated by means of sketches and line drawings. Because the studies were published before the advent of modern rules of zoological nomenclature, many decisions remained to be made concerning designation of type specimens. In spite of these difficulties, some of the species names have come into wide use, extending even into the literature of recent years. Meanwhile, the type specimens have laid virtually untouched in the collections of the U.S. National Museum, some for nearly a century, others longer. R. S. Bassler made a few thin sections from some of the type material, but these sections were never illustrated or described.

A dozen species are dealt with in this paper (table 1). Six of these are retained as useful taxonomic concepts, one is placed in the synonymy of another species, four are regarded as nomina dubia, and one is rejected (ICZN action pending). Thin sections of the type material are herein described and illustrated for the first time, and lectotypes are selected. Various specimens that were incorrectly assigned to the species under consideration are also discussed and illustrated. Synonymies compiled for each species hopefully include

TABLE 1.—Disposition of described coral taxa

Original designation	Recommended designation	Age	Type locality
<i>Acervularia adjunctiva</i> White, 1880-----	<i>Sciophyllum adjunctivum</i> (White)-----	Late Mississippian-----	Idaho.
<i>Amplexus zaphrentiformis</i> White, 1876---	<i>Barytichisma zaphrentiforme</i> (White)---	Middle Pennsylvanian-----	Colorado.
<i>Cyathophyllum subcaespitosum</i> Meek, 1873.	<i>Dorlototia subcaespitosa</i> (Meek)-----	Late Mississippian-----	Idaho.
<i>Cyathophyllum</i> ( <i>Campophyllum</i> ?) <i>nevadense</i> Meek, 1877.	<i>Caninia nevadensis</i> (Meek)-----	do-----	Utah.
<i>Faviphyllum?</i> <i>rugosum</i> Hall, 1852-----	" <i>Faviphyllum rugosum</i> " Hall (rejected name).	Early Mississippian-----	Do.
<i>Leptopora winchelli</i> White, 1879-----	" <i>Leptopora winchelli</i> " White (nomen dubium).	Ordovician or Silurian-----	Do.
<i>Lithostrotion whitneyi</i> White, 1875 (not Meek, 1877).	<i>Orygmophyllum?</i> <i>whitneyi</i> (White) (nomen dubium).	Pennsylvanian?-----	Nevada.
<i>Lophophyllum proliferum</i> var. <i>sauridens</i> White, 1875.	<i>Lophophyllidium sauridens</i> (White)---	Early Pennsylvanian-----	New Mexico.
<i>Syringopora occidentalis</i> Meek, 1877-----	<i>Syringopora occidentalis</i> Meek (nomen dubium).	Pennsylvanian or Permian----	Utah.
<i>Zaphrentis excentrica</i> Meek, 1873-----	<i>Caninia excentrica</i> (Meek)-----	Late Mississippian-----	Montana.
<i>Zaphrentis multilamellata</i> Hall, 1852-----	<i>Faberophyllum stansburyi</i> (Hall) (nomen dubium).	do-----	Utah.
<i>Zaphrentis stansburyi</i> Hall, 1852-----	<i>Faberophyllum stansburyi</i> (Hall) (nomen dubium).	do-----	Do.

every important usage of the species name and its synonyms through the year 1963. The geographic location, stratigraphic position, and geologic age of the type localities have been reevaluated in modern terms. The primary type specimens of all species described are in the collections of the U.S. National Museum, Washington, D.C. Morphologic terminology follows that of Hill (1956, p. 234–251), with the exception of the terms alar diameter and calicular angle, which are defined in another paper (Sando, 1961). The terminology of microstructural elements is that of Kato (1963).

Almost all the lectotypes were photographed before thin sections were cut from them. Plaster replicas of the primary types were also made before the thin-section operation, and the positions of thin sections are indicated on these replicas. Serial peels were made from some of the primary and secondary type material.

Inasmuch as supraspecific revisions are beyond the scope of this paper, a conventional treatment has been followed in the taxonomic hierarchy above the species level. The classification is generally that of Hill (1956), with the exception of minor changes in the composition of some of the genera. Generic synonymies are designed to show conventional usage and are intentionally abbreviated.

I am indebted to G. A. Cooper and R. S. Boardman of the U.S. National Museum for making the type specimens herein described available to me for study. I am also grateful to W. H. Easton, P. K. Sutherland, E. C. Wilson, and R. H. Hansman for the loan of specimens and for important information on the occurrences of some of the species. Mackenzie Gordon, Jr., Betty

Skipp, and L. G. Henbest identified some of the fossils associated with the types and contributed information on the ages of the collections. R. L. Langenheim, Jr., R. H. Olson, Walter Sadlick, A. H. Coogan, and C. B. Read provided various data pertaining to the occurrences of some of the species. The paper has benefited from the technical criticism of Helen Duncan and W. A. Oliver, Jr. Thin sections were prepared by W. C. Pinckney, Jr., and K. R. Moore. The photographs are the work of D. H. Massie (thin sections) and Jack Scott (exteriors).

#### SYSTEMATIC PALEONTOLOGY

##### Phylum COELENTERATA

##### Class ANTHOZOA

##### Order RUGOSA

##### Suborder STREPTELASMATINA

##### Superfamily CYATHAXONIIDAE

##### Family LOPHOPHYLLIDIIDAE

##### Genus LOPHOPHYLLIDIUM Grabau

1928. *Lophophyllidium* Grabau, p. 98–99.

1942. *Lophophyllidium* Grabau. Jeffords, p. 211–213.

1945. *Lophophyllidium* Grabau. Moore and Jeffords, p. 93.

1947. *Lophophyllidium* Grabau. Jeffords, p. 21–23.

1956. *Lophophyllidium* Grabau. Hill, p. 256.

*Type species.*—*Cyathaxonia prolifera* McChesney, (1860, p. 75). Pennsylvanian (Missouri), Illinois.

*Diagnosis.*—Straight or slightly curved conico-cylindrical solitary corals having a relatively large axial columella composed of a median plate which arises from the counter septum and radiating lamellae surrounded by dense deposits of stereoplasm. Major septa long and rhopaloid. Tabulae present. Dissepiments absent. (Summarized from Jeffords, 1947, p. 21.)

**Lophophyllidium sauridens (White)**

## Plate 1

1875. *Lophophyllum proliferum* McChesney, sp., var. *sauridens* White, p. 101, pl. 6, figs. 4a-d (preprint of White's 1877 report).
1877. *Lophophyllum proliferum* McChesney, sp., var. *sauridens* White, p. 101, pl. 6, figs. 4a-d.
1881. *Lophophyllum sauridens* White, p. xvi.
1898. *Lophophyllum profundum* var. *sauridens* White. Weller, p. 334 (bibliographic citation).
1905. *Lophophyllum proliferum sauridens* White. Schuchert, p. 369 (bibliographic citation).
1937. [not] *Lophophyllum profundum* var. *sauridens* White? Girty, in King, p. 82.
1942. *Lophophyllidium?* *proliferum* var. *sauridens* (White). Jeffords, p. 253.
1945. *Lophophyllum proliferum* var. *sauridens* White. Moore and Jeffords, p. 109.
1947. *Lophophyllum profundum sauridens* [= *Lophophyllidium sauridens*] White. Jeffords, p. 9.
1950. *Lophophyllidium profundum sauridens* (White). Bassler, p. 234 (bibliographic citation).

*Type material.*—The syntype lot consisted of five specimens cataloged under USNM 8499. Two of White's illustrated specimens were partly destroyed by him in order to show internal features by means of polished surfaces. One of these specimens, the original of White's figure 4c, is retained under USNM 8499. The other specimen, the original of White's figure 4b, has been given the new USNM number 144764. A third specimen that has a broken calice, illustrated by White as figure 4d, has been given the new USNM number 144765. These specimens are all regarded as paralectotypes.

Two nearly complete specimens were not figured by White. One of these, here designated lectotype for the species, has been given the new USNM number 144762. The other, a paralectotype, now bears USNM number 144763.

An additional suite of 21 uncataloged specimen of the species was found in the U.S. National Museum collections. The locality label reads: "Carboniferous, near Santa Fe, N.M., Wheeler Survey." Although these specimens, now cataloged under USNM 144767, may have been a part of the original collection, I cannot be certain that White included them in the type lot. Therefore, I regard these specimens as topotypes. One of the topotypes, figured in this paper, has been removed from the original lot and is now cataloged under USNM 144766.

*Description of lectotype.*—The corallum is a very slightly curved cone and has maximum curvature slightly to one side of the cardinal-counter plane. The cardinal septum is on the concave side of the corallum. The length of the corallum is 22 mm, and its maximum diameter is 10.6 mm, measured at the top of the calice. The calicular angle is approximately 25°. The calice

is at least 10 mm deep, but because the top of the specimen may be incomplete, the exact depth of the calice is uncertain. The columella projects about 9 mm into the calice. The exterior of the corallum is marked longitudinally with moderately coarse interseptal ridges and deep septal grooves. Transverse ornamentation consists of fine growth lines and a few low wrinkles.

Internal features were studied by means of four transverse thin sections. The earliest transverse section (pl. 1, fig. 7) was cut approximately 3 mm above the tip of the corallum at a corallum diameter of 3 mm. This section reveals 19 wedge-shaped major septa which, together with a poorly defined columella, occupy almost all the space within the corallum. The arrangement of septa is, in clockwise order, as follows: cardinal septum, two cardinal lateral septa, alar septum, five counter lateral septa, counter septum, six counter lateral septa, alar septum, two cardinal lateral septa. The cardinal septum is only slightly shorter than most of the septa of the counter quadrants, but it is longer than the two adjacent cardinal lateral septa. The columella appears as a dark mass of stereoplasm approximately half a mm in diameter and has obscure boundaries. Within this mass is a sinuous dark line which appears to be connected with the median line of the counter septum.

The next section (pl. 1, fig. 8) was cut approximately 4 mm above the tip of the corallum at a diameter of 5 mm. As in the previous section, the corallum is almost entirely filled by the major septa and the columella. The 21 major septa are all of approximately equal length and thickness so that the protosepta are not readily distinguishable. However, the alar septa can be identified by their positions on the cardinal sides of two slightly shorter septa, which represent the newest additions to the counter quadrants. The columella is now moderately well defined and appears in cross section as an ellipse 1.0 by 1.3 mm, oriented with its long axis parallel to the cardinal-counter plane. A sinuous dark line along the long axis of the ellipse marks the median lamella of the columella. The traces of six lateral lamellae can now be seen joining the median lamella of the columella. There is no longer any evidence of continuity between the counter septum and the columella.

The third section (pl. 1, fig. 9) was cut approximately 9 mm above the tip of the corallum at a diameter of 7.3 mm. There are 24 major septa at this stage. The cardinal septum is thinner and somewhat shorter than the other major septa, which are all rhopaloid and terminate against the columella. Cardinal and alar fossulae are poorly defined. The counter septum is slightly longer than its neighbors but is not connected to the

columella. The columella is well defined, elliptical in cross section (1.4 by 1.9 mm) and oriented as before with its median lamella in the cardinal-counter plane. Five lateral lamellae join the median lamella. Traces of tabulae can be seen between the attenuated peripheral segments of the major septa.

The fourth section (pl. 1, fig. 10) was cut through the calice approximately 16 mm above the tip of the corallum at a diameter of 9.5 mm. The 26 major septa have all withdrawn varying distances from the columella, and short minor septa appear for the first time. The cardinal septum is very short, represented by a low ridge on the interior of the corallum wall. The counter septum is also short, but not as short as the cardinal. The columella is a completely independent structure 2.4 by 3.0 mm in cross section. The median lamella and traces of five lateral lamellae are readily seen. Faint concentric layers of stereoplasm are also evident within the columella.

The septa consist of an inner part dominated by para-feather structure, which may be superimposed on a pseudo-trabecular structure, and an outer fibro-lamellar layer.

*Description of paralectotypes.*—The four paralectotypes are all incomplete coralla. The largest specimen (pl. 1, fig. 11) is 35 mm long and 12 mm in maximum diameter. The coralla are slightly curved cones, some showing more curvature than the lectotype in the lower 10 mm of their length. Maximum curvature of the corallum is mainly in the cardinal-counter plane, and the cardinal septum is on the concave side. The calicular angle is between 20° and 25°. Ornamentation is similar to that of the lectotype. In two specimens, the columella projects 5–7 mm into the calice, the depth of which cannot be determined.

A longitudinal section (pl. 1, fig. 12) of one of the paralectotypes, the original of White's (1875) figure 4b, reveals the structure of the columella and the nature of the tabulae. This section appears to be in or near the cardinal-counter plane. The columella is composed of a series of nested cones consisting of thin layers of fibro-lamellar stereoplasm. Vertical zigzag dark lines within the columella represent the traces of the medium lamella and lateral lamellae on the plane of section. Small irregular areas of sparry calcite, representing open spaces in the structure, are also evident. The tabulae are generally complete, slightly sigmoidal in cross section, and inclined from the columella at an angle of approximately 45° from the horizontal. Tabulae are regularly spaced at approximately 1-mm intervals. In vertical section each tabula appears to consist of a thin dark line overlain by a layer of seemingly amorphous stereoplasm. The dark lines terminate abruptly at the columella and the inner face of the

theca, but the layers of stereoplasm are continuous with the conical layers of the columella.

Two transverse sections cut from the other specimen not figured by White (USNM 144763) show interesting variations from the lectotype. The lower section (pl. 1, fig. 2) was cut about 6 mm above the tip of the corallum at a diameter of 5 mm. This section shows 22 major septa arranged in clockwise order, as follows: cardinal septum, 3 cardinal lateral septa, alar septum, 6 counter lateral septa, counter septum, 6 counter lateral septa, alar septum, and 3 cardinal lateral septa. The axial region is filled with stereoplasm, but a discrete columella is not evident. The counter septum and second cardinal lateral septum are very long and extend into the axial region.

The other transverse section (pl. 1, fig. 1), cut approximately 16 mm above the tip of the corallum at a diameter of about 9 mm, was broken during preparation and does not show all the internal features of the corallum. This section is of interest because it shows a complex columella with an irregular outline and open spaces within the columellar structure. Dark lines within the columella mark the traces of columellar lamellae which form an irregular network. One septum in the counter half of the corallum, presumably the counter septum, appears to be continuous with this network. Other features are similar to those seen in the third transverse section of the lectotype.

*Description of topotypes.*—The topotype suite includes coralla whose size and shape generally ranges within the same limits as those observed in the primary type specimens. The largest specimen in the topotype assemblage is a fragmentary corallum more than 35 mm long and 13 mm in maximum diameter, but most of the specimens are less than 25 mm long and attain a diameter of less than 12 mm. The calicular angle is 20°–25°. The coralla are slightly curved in the cardinal-counter plane and the cardinal side is invariably concave.

Subcalicular features were not studied on most of the topotypes. However, measurements of alar diameter, columellar diameter, and number of major septa were made on broken calices of mature topotype coralla. These data are presented, along with similar data obtained from the primary types and from hypotypes from the collections of P. K. Sutherland, in the variation diagrams (figs. 1 and 2). An ontogenetic series was made by means of cellulose acetate peels on one topotype and is presented on plate 1, figures 13–22.

*Type locality.*—Locality data given by White (1875, p. 103) are "strata of the Carboniferous period; near Santa Fé, New Mexico, and at Rock Creek, Lake County, Colorado." The same information appears on locality labels that accompany the primary type specimens. A penciled note by G. H. Girty found with the



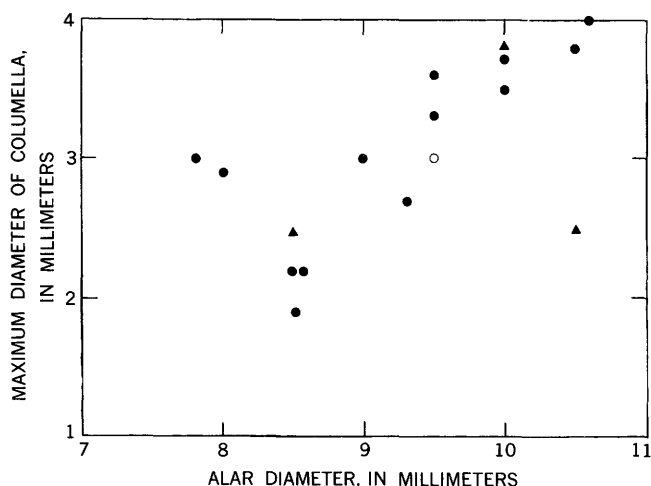


FIGURE 1.—Scatter diagram showing relation between alar diameter and maximum diameter of columella in mature stages of lectotype (open circle), 13 topotypes (solid circles), and 3 hypotypes (solid triangles) of *Lophophyllidium sauridens* (White).

specimens states: "It is my belief that all these specimens are from Santa Fe." Inasmuch as the specimens

are all very similar in preservation and closely resemble other specimens from Santa Fe in the U.S. National Museum collections, I agree with Girty's interpretation that the Colorado locality is not represented in the type material.

The type collection was probably made by the Wheeler Survey expedition of 1873, for which G. K. Gilbert was the geologist. Unfortunately, Gilbert (1875, p. 520) did not give a description of the geology around Santa Fe, although he mentioned a collection of "Coal-Measure fossils made by Mr. Keasbey, near Santa Fe" in his report. I have found no other information in the literature or with the type specimens that could aid in establishing the exact location and age of the type locality.

Inasmuch as direct evidence bearing on the type locality is lacking, I have attempted to arrive at a reasonable approximation by indirect means. The discovery of a suite of 21 uncataloged specimens considered to be topotypes of the species in the U.S. National Museum collections provided a key to the age of strata at the type locality. These specimens, identical with the types

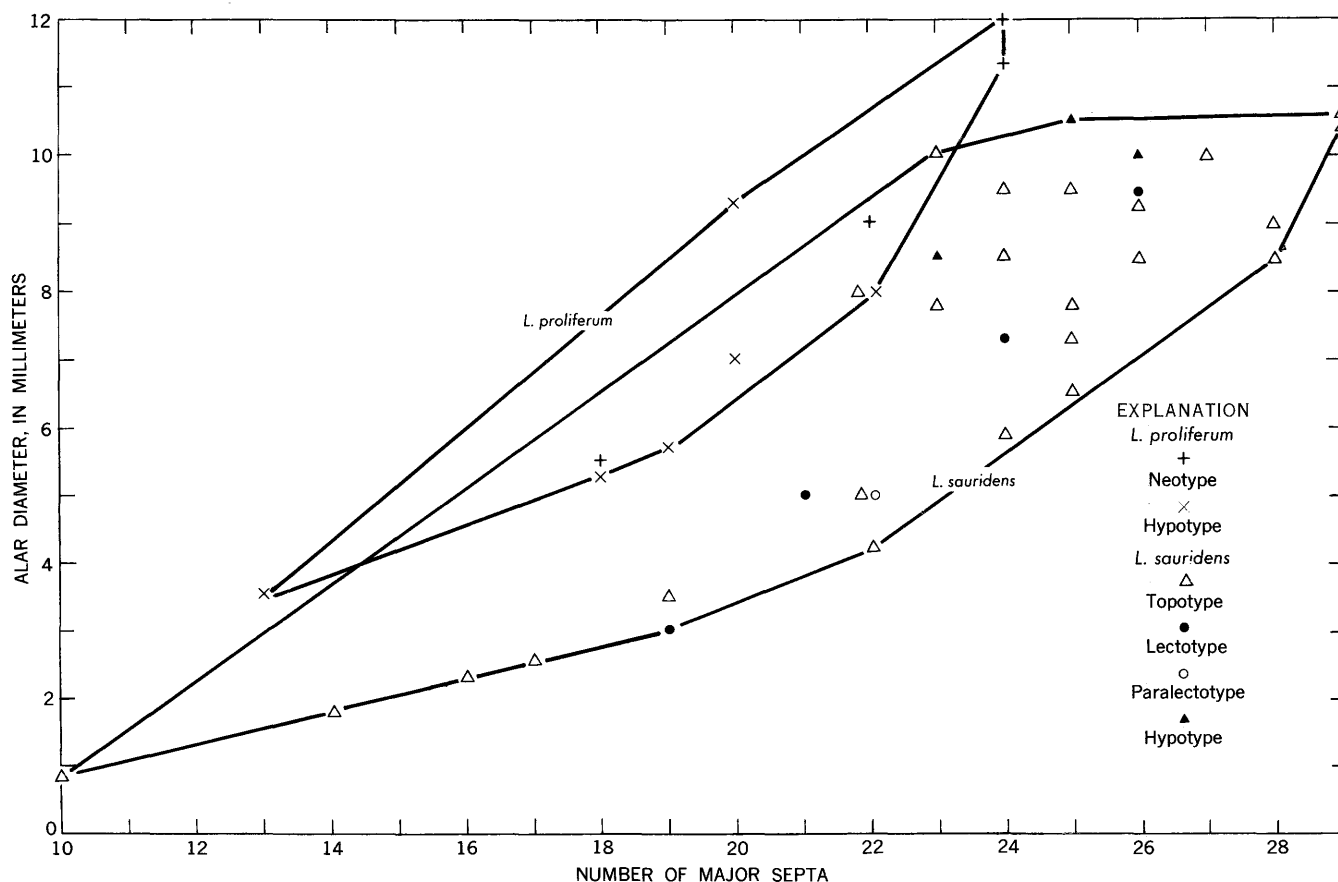


FIGURE 2.—Scatter diagram showing relation between alar diameter and number of major septa by means of 32 measurements on lectotype, paralectotype, 13 topotypes, and 3 hypotypes of *Lophophyllidium sauridens* (White). Similar data based on 10 measurements of neotype and 2 hypotypes of *L. proliferum* (McChesney) plotted for comparison (data from Jeffords, 1947, pl. 1).

in morphology, preservation, and general appearance, were accompanied by a label indicating that they were collected by the Wheeler Survey "near Santa Fe." In the same drawer, and bearing locality labels similar to that of the topotypes, the following brachiopods were found (identifications by Mackenzie Gordon, Jr.): *Schizophoria oklahomae* Dunbar and Condra, *Spirifer occiduus* Sadlick, *Linoproductus nodosus* (Newberry), *Juresania* sp., and an indeterminate dictyoclostid. According to Gordon (oral commun., 1963), these forms indicate an Early or Middle Pennsylvanian (Morrow or Atoka) age.

P. K. Sutherland, who has recently studied the Pennsylvanian strata in the vicinity of Santa Fe, provided me with the following information (written commun., 1963):

Most of the [Santa Fe] area is covered by gravels of the Cenozoic Santa Fe Group which rests directly on the Precambrian along most of the Sangre de Cristo Mountain front. However, there are a few windows in the gravels where limited thickness of Pennsylvanian rocks are exposed. The only such exposure "near Santa Fe" is on the northeast edge of the city at some long abandoned, shallow quarries. The sequence here exposes about 50 feet of Morrowan strata (base covered) which are faulted against about 175 feet of "Atokan" strata (top covered by Cenozoic). No corals occur in the "Atokan" interval but I have found corals uncommonly at two horizons in the Morrowan interval. Almost all of the other Pennsylvanian outcrops near Santa Fe, most of which are small and poorly exposed, are of Morrowan rocks.

Dr. Sutherland kindly allowed me to study the lophophyllid corals that he collected at two localities near the eastern edge of Santa Fe. I was able to identify the following material as *Lophophyllidium sauridens*: (1) Four specimens from Sutherland's unit 11 (Morrowan) of his section 61, La Pasada Formation of Sutherland (1963), 36–51 feet above the base of the section (covered interval at base), at the northeast edge of abandoned Sante Fe quarries, about two-tenths of a mile northeast of Gonzales Road and Cerro Gordo Road; (2) three specimens from Sutherland's unit 5 (Morrowan) of his section 90, La Pasada Formation near the base of the section (covered interval at base), in the east bank of an unnamed tributary of the Sante Fe River where the creek is crossed by Cerro Gordo Road, 1.2 miles east of the intersection with Gonzales Road. At the quarry locality, the corals are associated with *Schizophoria oklahomae* Dunbar and Condra, *Neospirifer? goreii* (Mather), and "*Productus*" *welleri* (Mather) and occur above beds that contain *Neospirifer? goreii* (Mather), *Schizophoria texana* Girty, *Linoproductus nodosus* (Newberry), and *Chonetes arkansanus* Mather (Sutherland, written commun., 1963). At the Sante Fe River valley locality, the corals occur in the same bed with *Schizophoria oklahomae* Dunbar

and Condra and *Neospirifer goreii* (Mather); brachiopod faunules collected above and below the coral horizon include *Neospirifer? goreii* (Mather), *Linoproductus nodosus* (Newberry), *Chonetes arkansanus* Mather, "*Productus*" *welleri* (Mather), *Krotovia globbosa* (Mather), and *Schizophoria texana* Girty (Sutherland, written commun., 1963). According to Sutherland, the two intervals from which fossils were collected correlate approximately with beds 50–125 feet above the base of the La Pasada Formation at Nambe Falls, where the Pennsylvanian rests unconformably on rocks of mid-Mississippian age.

Unfortunately, Sutherland's specimens of *Lophophyllidium sauridens* do not compare favorably in preservation and general appearance with the type material. The type specimens are almost entirely calcareous, whereas Sutherland's specimens are completely silicified, and the color of specimens and matrix is not the same in the two groups of specimens. Although the Sante Fe quarry locality has probably been accessible for the past one hundred years and is therefore a logical choice for the site of the type locality, differences in preservation and color of the specimens leave considerable doubt.

In summary, the available evidence does not reveal unambiguously the precise geographic location of the type locality. It does suggest, however, that the type material was collected from a horizon of Early Pennsylvanian (Morrow) age in the La Pasada Formation of Sutherland (1963) somewhere in the vicinity of Sante Fe.

*Discussion.*—White (1875, p. 101) originally proposed this taxon as a variety of *Lophophyllum proliferum* (McChesney), but later (White, 1881, p. xvi) regarded it as a distinct species. Subsequent authors (see synonymy) have treated it variously as a variety of *Lophophyllum proliferum* (McChesney) or *L. profundum* (Milne-Edwards and Haime) or as a separate species. When Jeffords (1942) revised *Lophophyllidium* Grabau and demonstrated that this name was applicable to many upper Paleozoic corals previously assigned to *Lophophyllum* Milne-Edwards and Haime, he correctly assigned White's species to *Lophophyllidium*.

A study of descriptions and illustrations of North American species of *Lophophyllidium* indicates that White's specimens are most similar to *Lophophyllidium proliferum*. I have examined the question of the exact relation of White's material to *Lophophyllidium proliferum* by comparing White's specimens with Jeffords' (1942, p. 213–219; pl. 1, figs. 1–3; pl. 8, fig. 2) descriptions and illustrations of the neotype and topotypes of *L. proliferum*. I conclude that White's specimens constitute a distinct species.

*Lophophyllidium sauridens* and *L. proliferum* include coralla of approximately the same size and shape, and in both species the cardinal septum is generally on the concave side of the corallum; however, the corallum of *L. sauridens* is generally straighter than that of *L. proliferum*. *L. sauridens* lacks the extreme curvature in the lower part of the corallum, which characterizes *L. proliferum*. The columella has approximately the same diameter in the two species, but it projects several millimeters farther into the calice of *L. sauridens*. Furthermore, continuity between the counter septum and the columella beyond the earliest stages seems to be less prevalent in *L. sauridens* than in *L. proliferum*, and the internal structure of the columella may be more complex in the former. *L. sauridens* has a larger number of major septa than *L. proliferum* at all corallum diameters (fig. 2). The tabulae of *L. sauridens* are spaced more regularly and slightly closer, and the minor septa are shorter than in *L. proliferum* which has a more distinct cardinal fossula.

In addition to the type material, my concept of *Lophophyllidium sauridens* includes two specimens (USNM 9459) listed by White (1881, p. xvi) from a locality near Taos, N. Mex., and four specimens (USNM 41242) from Santa Fe in the collections of E. O. Ulrich. Also included in the species are seven specimens from two localities on the outskirts of Santa Fe collected by P. K. Sutherland. Two specimens (USGS loc. 6923) from the Gaptank Formation of the Marathon region, Texas, referred to the species by Girty (in King, 1937, p. 82) appear to belong to an undescribed species of *Stereocorypha* Moore and Jeffords.

#### Family HAPSIPHYLLIDAE

##### Genus BARYTICHISMA Moore and Jeffords

1945. *Barytichisma* Moore and Jeffords, p. 131.

*Type species.*—*Barytichisma crassum* Moore and Jeffords (1945, p. 131–132, figs. 111–113, 123). Pennsylvanian (Morrow), Texas.

*Diagnosis.*—Slightly curved conico-cylindrical solitary corals that have a thick theca. Major septa are pinnately arranged and axially confluent in early stages but become radially arranged and amplexoid in mature stages. Tabulae generally flat but with downturned margins. Dissepiments absent.

##### *Barytichisma zaphrentiforme* (White)

Plates 2 and 3

1876. *Amplexus zaphrentiformis* White, p. 88, 107.

1880b. *Amplexus zaphrentiformis* White, p. 120, pl. 33, figs. 1a–d.

1889. *Amplexus zaphrentiformis* White. Miller, p. 172 (bibliographic citation).

1898. *Amplexus zaphrentiformis* White. Weller, p. 84 (bibliographic citation).

1903. *Amplexus zaphrentiformis*. Girty, p. 34.

1905. *Amplexus zaphrentiformis* White. Schuchert, p. 41 (bibliographic citation).

1950. *Amplexus zaphrentiformis* White. Bassler, p. 219 (bibliographic citation).

*Type material.*—The syntype lot consisted of 102 specimens cataloged under USNM numbers 8064 and 35696. USNM 8064, cataloged in 1879, consisted of 41 specimens, including the 4 illustrated by White (1880b, pl. 33, figs. 1a–d). USNM 35696 included 61 specimens cataloged in 1906. White (1876, p. 108) stated that there were “nearly one hundred examples” in the original collection. Moreover, specimens cataloged under both USNM numbers bear old specimen numbers that are very similar, and both collections have old locality labels numbered 8064. For these reasons, I regard both lots as syntypes.

I have chosen White’s principal illustrated specimen (1880b, pl. 33, fig. 1a) as lectotype and given it the new USNM number 144776. Figured paralectotypes are now cataloged under USNM numbers 144777–144780. I have identified two of the unfigured specimens cataloged under USNM number 35696 as *Caninia* sp. and *Stereostylus* sp.; these have been assigned USNM 144781 and 144782, respectively. The remaining unfigured paralectotypes are retained under USNM numbers 8064 and 35696.

*Description of lectotype.*—The lectotype (pl. 2, fig. 3) is an almost perfect corallum 80 mm long and 32 mm in maximum diameter. The corallum is a moderately curved cone that expands rapidly in the lower 50 mm of its length but becomes nearly cylindrical in the upper 30 mm. Three periods of slight rejuvenation are evident in the subcylindrical part of the corallum. Although the lower 20 mm of the corallum is somewhat twisted, the plane in which maximum curvature occurs generally deviates approximately 20° from the cardinal-counter plane, and the cardinal septum is on the concave side. The calice is between 15 and 17 mm deep. The corallum is approximately circular in cross section throughout growth (alar diameter = cardinal-counter diameter).

The exterior of the corallum is marked by an unusual ornamentation pattern. Moderately coarse transverse rugae, some marking periods of slight rejuvenation, are spaced 1–3 mm apart. The longitudinal ornamentation is dominated by deep discontinuous grooves about 0.1 mm wide, spaced 1–3 mm apart. Between the grooves, the epitheca is marked by fine transverse striae (as many as 20 per mm) arranged in a lobate pattern. The lobes are convex upward, and their ends terminate in the grooves. In the lower third

of the corallum, this ornamentation pattern is superimposed on a pattern of shallow septal grooves and low rounded interseptal ridges, but the septal pattern is gradually obscured as the epitheca thickens in the upper part of the corallum.

Internal details were studied by means of five transverse thin sections and one longitudinal thin section. The earliest formed section that was studied (pl. 2, fig. 4), was cut 5 mm above the tip of the corallum and shows 22 major septa at an alar diameter of 4.5 mm. The septal complement (clockwise) is: cardinal, three cardinal laterals, alar, six counter laterals, counter, five counter laterals, alar, four cardinal laterals. The four protosepta (cardinal, alars, and counter) are longer than the metasepta and meet at the axis of the corallum. The cardinal septum is in a well-marked fossula. Alar fossulae are pronounced. A peripheral stereozone composed of epitheca five-tenths of a mm thick had developed at this level.

A thin section cut 15 mm above the tip of the corallum (pl. 2, fig. 5) shows 29 major septa at an alar diameter of 9.7 mm. The septal complement (clockwise) is: cardinal, five cardinal laterals, alar, seven counter laterals, counter, eight counter laterals, alar, five cardinal laterals. The cardinal septum is short and is in a pronounced axially expanded fossula. The counter septum is long and abuts against the axial termination of the cardinal fossula. Alar fossulae are reduced from the previous stage. The peripheral stereozone, now 1 mm thick, is composed almost entirely of septal deposits.

A thin section cut 28 mm above the tip of the corallum (pl. 2, fig. 6) shows 38 major septa at an alar diameter of approximately 17 mm. The septal complement (clockwise) is: cardinal, 6 cardinal laterals, alar, 11 counter laterals, counter, 11 counter laterals, alar, 6 cardinal laterals. This section marks the beginning of the amplexoid phase. All the septa have withdrawn from the axial region and most of them have become rhopaloid. The cardinal septum is short and thin and is in a pronounced fossula as before. The counter septum is slightly longer than adjacent metasepta. Alar fossulae are nearly obliterated. The peripheral stereozone is as much as 3 mm thick, of which the inner  $\frac{1}{2}$ – $\frac{2}{3}$  is septal deposits and the remainder is epithecal deposits.

A thin section cut 58 mm above the tip of the corallum (pl. 2, fig. 7) shows 43 major septa at an alar diameter of 25 mm. This section was cut just below the base of the calice. The septal complement (clockwise) is: cardinal, 8 cardinal laterals, alar, 12 counter laterals, counter, 11 counter laterals, alar, 8 cardinal laterals. As in the previous stage, the septa do not reach the axial region; each one extends about  $\frac{1}{2}$ – $\frac{2}{3}$  the radius of the corallum.

Most of the septa in the counter quadrants are rhopaloid, whereas those in the cardinal quadrants are axially attenuated. A conspicuous fossula marks the cardinal position, but the cardinal septum is buried in the peripheral stereozone. The counter septum is again slightly longer than adjacent metasepta. The alar positions are distinguished with difficulty. The peripheral stereozone ranges from about 4.5 to 7 mm thick (thickest in cardinal quadrants) and appears to consist almost entirely of septal deposits.

A thin section cut 65 mm above the tip of the corallum (pl. 2, fig. 8) illustrates calicular features. There are 45 major septa at an alar diameter of 25 mm in this section. Protosepta cannot be identified except by tracing their positions from subcalicular sections. The major septa are all very short, and the free axial extensions are thin. Minor septa appear for the first time; they are buried in the peripheral stereozone in the counter quadrants and project very slightly into the calice in the cardinal quadrants. The peripheral stereozone ranges from 2.5 to 3 mm in thickness and is composed principally of septal deposits.

A thin section cut in the cardinal-counter plane between 28 and 58 mm above the tip (pl. 2, fig. 9) illustrates internal features in longitudinal section. The tabulae are mostly incomplete, flat to slightly convex upward, have generally down-turned edges, and are inclined at an angle of about 45° from the horizontal into the cardinal fossula, where their edges are reflexed upward against the inner wall of the corallum. Many of the tabulae appear to be thickened by stereoplasmic deposits. Tabulae are irregularly spaced but generally occur at intervals of 1 mm. The traces of amplexoid septa appear as wedges resting on the tabulae; the septa decrease in height from the periphery toward the axis of the corallum.

In the earliest transverse section studied, some of the thinnest septa appear to have lamellar microstructure, whereas others are characterized by feather structure. Thicker septa in the same section have a second layer of oblique fibres whose direction is reversed from that of the feather structure layer so as to produce a zigzag structure. In later transverse sections, only the zigzag structure was observed. As the septa become thicker, the number of reversals of fibre directions becomes greater, until as many as three reversals may be present. Each reversal seems to represent a distinct layer of skeletal material.

*Description of paralectotypes.*—Observations on most of the paralectotypes were confined to features of the exterior and the calice. However, 2 specimens were studied by means of 20 serial transverse sections, and 19 transverse sections from various parts of 11

specimens were also examined. Longitudinal sections of 11 specimens, mostly fragmentary, were studied.

The overwhelming majority of coralla are slightly to moderately curved cones. Only 2 of 90 specimens complete enough for evaluation showed no curvature. Although some specimens are characterized by torsion through an angle of as much as  $180^\circ$  in neanic stages, the position of the plane containing maximum curvature with respect to the cardinal-counter plane is remarkably constant beyond the early growth stages. Of 61 neanic and ephebic specimens, 75 percent show an angular deviation between the 2 planes of  $10^\circ$  or less, whereas 18 percent show a deviation of  $10^\circ$ – $45^\circ$ , and only 10 percent show a deviation of  $45^\circ$ – $90^\circ$ . The cardinal septum is located uniformly on the concave half of the corallum.

In 40 specimens that have 31–39 major septa in the calice, the calicular angle ranges from less than  $10^\circ$  to  $33^\circ$ . Approximately 50 percent of the specimens have a calicular angle of  $25^\circ$ – $28^\circ$ . Specimens that have calicular angles less than  $18^\circ$  are characterized by cylindrical or subcylindrical coralla in the late ephebic stage and are commonly marked by rejuvenation. Evi-

dence of rejuvenation was observed in 24 of 74 specimens studied; this phenomenon appears to be restricted to the amplexoid phase of the corallum.

The length of the corallum was measured on 45 of the most complete specimens. Although imperfect apices and calices make these measurements inexact, they serve to illustrate the order of magnitude of size distribution in the sample. Measured length ranges from 22.2 mm (28 major septa in calice) to 65.0 mm (36 major septa in calice); the average length is 40.1 mm.

The ornamentation of the corallum is generally like that of the lectotype. Several specimens appear to be crudely pustulose, a feature not seen on the lectotype. Attachment scars were observed in the lower 5 mm of a few specimens that have perfectly preserved, un-abraded tips. The relatively small area of attachment as compared with the size and weight of the mature corallum suggests that attachment was a feature confined to the early life of the animal.

The relation between alar diameter and the number of major septa in the lectotype and paralectotypes is shown in figure 3. This scatter diagram illustrates

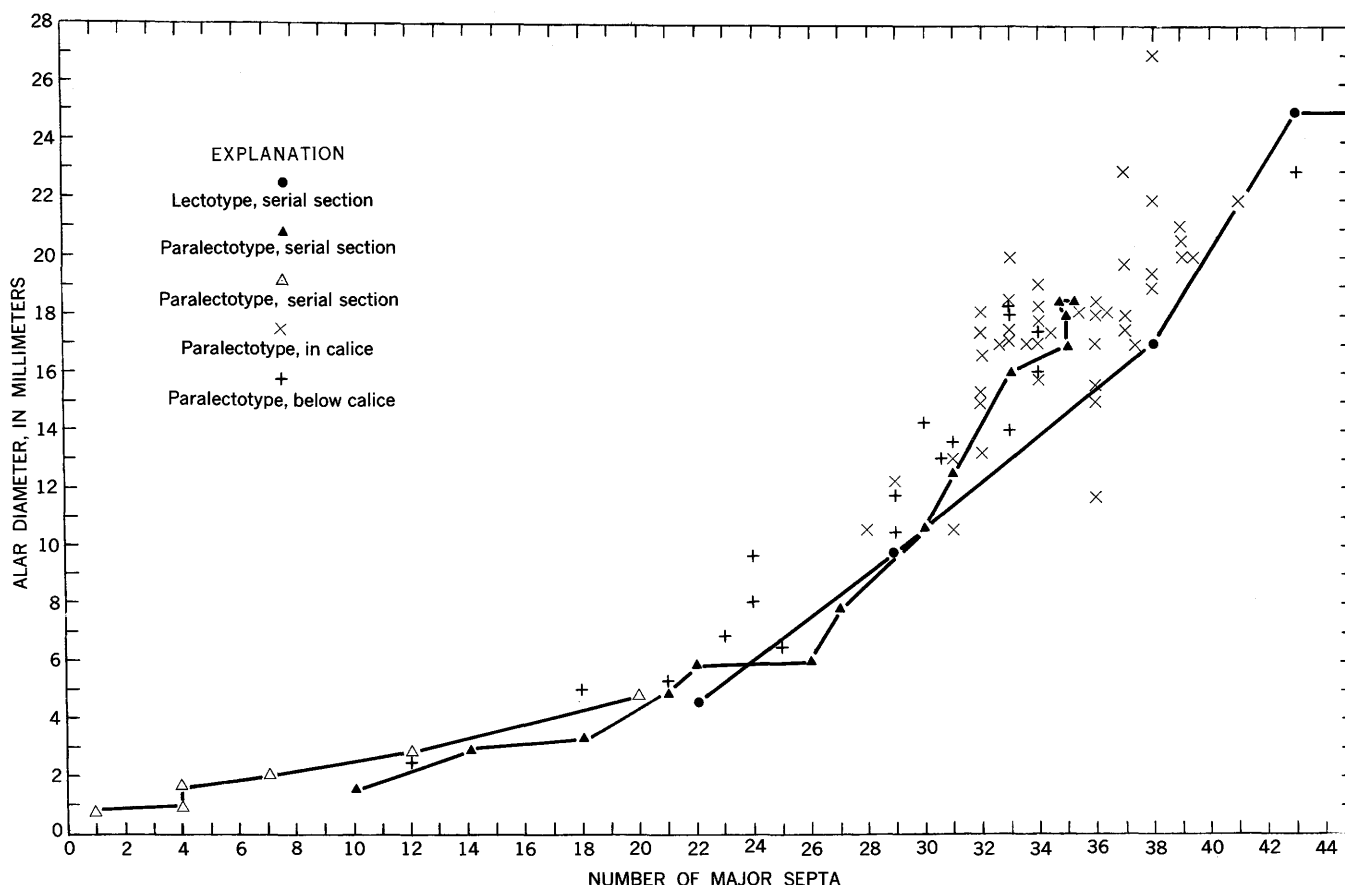


FIGURE 3.—Scatter diagram showing relation between alar diameter and number of major septa by means of 87 measurements on 56 specimens of *Barytichisma zaphrentiforme* (White). Straight lines connect measurements made from serial sections of lectotype and two paralectotypes.

both ontogenetic variation and individual variation at various ontogenetic stages. Other aspects of ontogenetic development, illustrated by serial sections of two paralectotypes (pl. 3, figs. 1-19), may be summarized as follows:

(1) Brephic stage: characterized by development of six protosepta (cardinal, counter, alars, and first counter laterals). Composes earliest 2 mm of the corallum length and includes alar diameters up to 2 mm.

(2) Neanic stage: characterized by addition of meta-septa up to a total septal complement of 29 or 30. Composes that part of the corallum from 2 mm to approximately 25 mm from the tip and includes alar diameters from 2 to about 10-12 mm. The septal plan is zaphrentoid except for a temporary amplexoid phase of short duration between insertion of 14 and 25 major septa in some specimens.

(3) Ephebic stage: characterized by about 30-44 amplexoid major septa; the principal amplexoid phase of the corallum. Composes that part of the corallum from approximately 25 mm above the tip to the calice (as much as 80 mm from tip) and includes alar diameters from about 10-12 mm to as much as 32 mm.

Evidence bearing on the order of insertion of the six protosepta was obtained with difficulty owing to poor definition of the septa in the earliest stages of the corallum even in the few specimens with perfect tips where preservation is good enough to permit observation of this feature. However, a successful determination of early septal development was accomplished in serial transverse peel sections of one of the paralectotypes (pl. 3, figs. 1-5). The tip of this specimen (not illustrated) consisted of the floor of the cup which was occupied by the polyp in its earliest developmental stage. This cup was aseptate to a distance of approximately 0.2-0.3 mm above the basal disk, where a partition separating the cup into two chambers appeared (pl. 3, fig. 1). A single septum appeared as a low ridge on one wall of the larger chamber at this stage. Judging from the orientation of this septum with respect to later septal development, the septum was one of the alar septa. Approximately six-tenths of a mm above the basal disk, three additional septa were seen as low ridges on the walls of the larger chamber (pl. 3, fig. 2). The four septa of this stage were identified as cardinal, counter, and two alars. The partition between the two chambers in the corallum disappeared a short distance above this level. A section about nine-tenths of a mm above the basal disk revealed an enlarged cup characterized by further growth of the four principal septa (pl. 3, fig. 3). Between 0.9 and 2.1 mm above the basal disk, the four principal septa joined at the axis of the corallum, and two counter lateral septa were

added. A section 2.1 mm above the basal disk revealed the six protosepta and an additional counter lateral septum (pl. 3, fig. 4).

*Type locality.*—The locality data given by White (1876, p. 108) are: "Lower Aubrey Group; Split Mountain Cañon, and near Echo Park, Utah." Inasmuch as old locality labels with the specimens read "near Echo Park," the Split Mountain locality does not seem to be represented in the type lot.

Echo Park is just south of the confluence of the Green and Yampa rivers in NE $\frac{1}{4}$  sec. 32, T. 3 S., R. 103 W., Moffat County, Colo. The bedrock in the immediate vicinity of Echo Park is mapped as Weber Sandstone by Untermann and Untermann (1954, pl. 2, fig. 5), but evidence bearing on the identity of the beds from which White's specimens were collected suggests that the material came from the Morgan Formation. Thus, the most probable location of the type locality is the area approximately 1 mile north of Echo Park, where a faulted belt of the Morgan Formation crosses the Green River.

Powell's report includes a stratigraphic section of the Paleozoic rocks in the Uinta Mountains by J. F. Steward (Powell, 1876, p. 57, fig. 10). Steward recorded abundant cup corals in a mottled dark drab and buff limestone 90 feet thick which composes unit 3 in the lower Aubrey Group of the Uinta Mountains section. A comparison of Steward's description of the lower Aubrey Group with a description of the Morgan Formation near Island Park by Untermann and Untermann (1954, p. 118-120) suggests that Steward's unit 3 corresponds to the lower part of the middle member (Atoka age) of the Morgan as mapped by Untermann and Untermann. The grayish-red siltstone and limestone matrix of White's specimens seemingly confirm this determination.

A collection of fossils made by Keyte and Heaton (USGS loc. 15050-PC) approximately 1,500 feet below the top of the Weber Sandstone in Split Mountain Canyon has an important bearing on the age and stratigraphic position of the species in the type area. The approximate stratigraphic position given for the collection indicates that the material is from either the lower part of the Des Moines or the upper part of the Atoka age equivalents of the Morgan Formation in the Split Mountain section of Untermann and Untermann (1954, p. 102-103). The collection contains specimens of *Amplexus zaphrentiformis* virtually identical with White's types in preservation and included matrix. Along with the corals are specimens of *Hystriaculina* aff. *H. wabashensis* (Norwood and Pratten) and *Inflatia?* sp., which indicate a Middle Pennsylvanian



(Atoka or Des Moines) age for the collection (M. Gordon, Jr., 1963, oral commun.).

I conclude that the available evidence clearly indicates a stratigraphic position near the middle of the Morgan Formation for the type material. The specimens are of Middle Pennsylvanian age, either Atoka or Des Moines, but most probably Atoka.

*Discussion.*—The abundant well-preserved specimens in the type collection provide an excellent foundation for the species concept. The geographic location and stratigraphic level of the type locality have been established within practicable limits.

*Barytichisma zaphrentiforme* is distinguished from other described species of *Barytichisma* by its large, robust corallum, extraordinarily thick peripheral stereozone, and unusual ornamentation. It appears to be most similar to *B. callosum* Moore and Jeffords (1945, p. 134–137, text figs. 115, 116, 120–122) but differs in the features mentioned above and also in having fewer major septa at the same corallum diameter in the ephelic stage. *B. zaphrentiforme* and *B. callosum* are distinguished from other species referred to the genus by Moore and Jeffords (1945, p. 131–134) by having the cardinal septum on the concave side of the corallum.

**Superfamily ZAPHRENTICAE**  
**Family LITHOSTROTIONIDAE**

**Genus DORLODOTIA Salée**

1920. *Dorlodotia* Salée, p. 145, 149–150.

*Type species.*—*Dorlodotia briarti* Salée (1920, p. 150–154, figs. 5, 6). Lower Carboniferous (Viséan), Belgium.

*Diagnosis.*—Fasciculate colonial corals that have an axial columella that consists of a medial plate which may be attached to the counter septum. Tabulae ordinarily complete, conical. Major septa mostly confined to the tabularium, although some reach the epitheca, and the counter septum may reach the axis. Minor septa short or absent. Dissepimentarium mostly lonsdaleoid.

***Dorlodotia subcaespitosa* (Meek)**

**Plate 4**

1873. *Cyathophyllum subcaespitosum* Meek, p. 470, footnote.  
1877. [not] *Diphyphyllum subcespitosum*. Hague in Hague and Emmons, p. 547.  
1877. [not] *Cyathophyllum subcaespitosum* Meek, p. 60, pl. 5, figs. 4, 4a, b.  
1878. [not] *Diphyphyllum subcespitosum*. King, p. 208.  
1881. [?] *Cyathophyllum subcaespitosum*. Miller, p. 308.  
1889. [part] *Cyathophyllum subcaespitosum* Meek. Miller, p. 182 (bibliographic citation).  
1898. [part] *Cyathophyllum subcaespitosum* Meek. Weller, p. 204 (bibliographic citation).  
1905. [not] *Cyathophyllum subcaespitosum* Meek. Schuchert, p. 191 (bibliographic citation).

1917. [not] *Cyathophyllum subcaespitosum*? Girty in Umpleby, 1917, p. 30.  
1925. [not] *Cyathophyllum subcaespitosum* Chapman, p. 112, pl. 13, figs. 15, 16a, b (junior homonym, Silurian of Australia).  
1931. [not] *Cyathophyllum subcaespitosum* Girty in Hewett, p. 24.  
1932. [not] *Cyathophyllum subcaespitosum*? Girty in Westgate and Knopf, p. 22.  
1935. [not] *Cyathophyllum subcaespitosum*? Girty in Nolan, p. 38.  
1942. [not?] *Cyathophyllum subcaespitosum*? Girty in Loughlin and Koschmann, 1942, p. 20.  
1950. [part] *Cyathophyllum subcaespitosum* Meek. Bassler, p. 220 (bibliographic citation).

*Type material.*—Although the type material was cataloged in 1875 or 1876, it apparently was misplaced or forgotten by the time Schuchert and his colleagues (1905) published their catalog of type specimens of fossil invertebrates in the U.S. National Museum. Schuchert (1905, p. 191) erroneously designated Meek's hypotype from the White Pine District, Nev., as holotype of the species. I am very fortunate to have rediscovered Meek's original collection from Idaho in a drawer of Hayden Survey fossils. The collection is unquestionably the one that Meek had before him when he described the species for the first time in 1873. The specimens agree with Meek's (1873, p. 470, footnote) brief diagnosis and are accompanied by a label written by Meek's hand. Other fossils in the same drawer can be identified with those in Meek's list for the Ross Fork-Lincoln Valley locality.

The syntype lot consisted of 11 specimens cataloged under USNM 7783. The specimens are all fragmentary; they include single, disassociated corallites and clusters of two to four corallites. I have chosen the largest specimen in the type lot as lectotype and given it the new USNM number 144783. The figured paralectotype is now cataloged under USNM number 144784. Unfigured paralectotypes retain the original catalog number USNM 7783. A large indeterminate horn coral found with the type lot has been removed and is now cataloged under USNM 144785.

*Description of lectotype.*—The lectotype (pl. 4, fig. 4) consists of a mature corallite which has given rise to about eight offsets. The specimen and the limestone matrix in which it is imbedded form an approximately tabular slab 6.5 by 11 by 2 cm. The growth form of the colony appears to be dendroid.

Budding is verticillate. Serial transverse thin sections (pl. 4, figs. 7–9) show the origin of at least eight offsets but only three of these are preserved in the upper part of the specimen.

The epitheca is thin and longitudinally marked by low rounded interseptal ridges and shallow septal

grooves. Transverse ornamentation consists of fine growth lines, as many as 10 per millimeter. Alternate expansion and contraction of the corallites at intervals of 5–10 mm is due to variation in the width of the dissepimentarium.

The parent corallite expands from a diameter of 14.5 mm to 19.5 mm in a longitudinal distance of 65 mm but maintains a constant major septal number of 30 throughout its preserved length (fig. 4).

A thin section cut near the top of the principal corallite (pl. 4, fig. 5) illustrates the ideal features seen in transverse section. The major septa are thin (0.05–0.1 mm) and slightly sinuous; many of them extend continuously from the periphery toward the axis for a distance of half the radius, whereas others are interrupted by lonsdaleoid dissepiments in the outer half of the dissepimentarium. The major septa are slightly dilated in the tabularium. The cardinal septum is about half as long as adjacent major septa and is in a moderately well marked fossula defined by incurved adjacent cardinal lateral septa and tabular intercepts. The counter septum is slightly shorter than adjacent major septa. Minor septa are thin and variably developed; they may be absent or extend to a length of as much as one-fifth the length of the major septa. The columella appears in transverse section as a discrete plate 3.5 by 0.1 mm, elongated in the cardinal-counter plane. The plate is surrounded by concentric tabular and tabellar traces. The dissepimentarium is between 4 and 5 mm wide and consists of an inner half composed of regular and herringbone dissepiments and a variable outer half of regular, herringbone, and lonsdaleoid dissepiments.

In two of the thin sections cut lower in the corallite (pl. 4, figs. 7 and 8), no trace of a columella appears in transverse section. However, the lowest transverse section studied (pl. 4, fig. 9) shows a columella 0.8 by 0.1 mm. These observations, supported by study of a longitudinal section (see below), indicate that the columella is vertically discontinuous. Other features observed in the uppermost transverse section are constant in underlying sections, with the exception of the length of the major septa and nature and width of the dissepimentarium in the section where offsets originated (pl. 4, fig. 9).

A longitudinal thin section cut between the level of the uppermost transverse section and the next underlying transverse section and in the cardinal-counter plane (pl. 4, fig. 6) illustrates vertical discontinuity of the columella. The columella is represented by a very sinuous plate that is present only in the upper 7 mm of the section. In the acolumellate part of the corallite, the tabulae are complete or incomplete and flat or gently

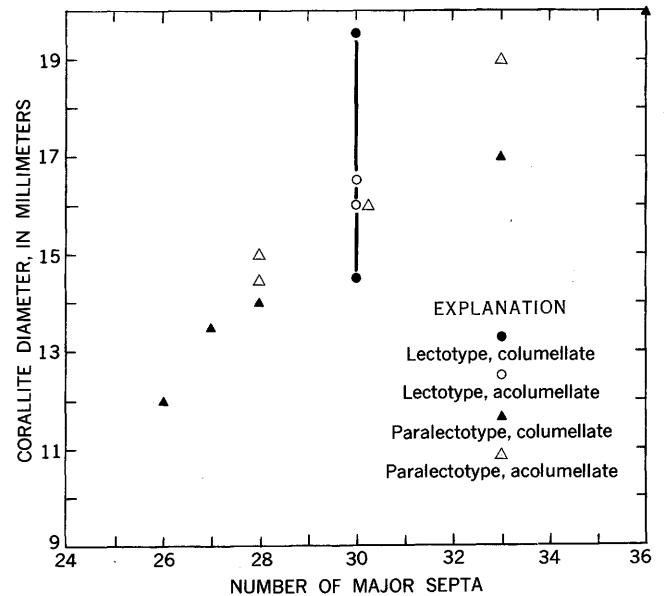


FIGURE 4.—Scatter diagram showing relation between corallite diameter and number of major septa in transverse sections of two lectotype corallites and nine paralectotype corallites of *Dordodotia subcaespitosa* (Meek). Straight line connects measurements made on the principal lectotype corallite.

convex in the axial region. On the left-hand side of the section, the tabulae slope into the cardinal fossula at an angle of about 30° from the horizontal. On the right-hand side of the section, the tabulae slope more steeply, on the order of 45° from the horizontal. Tabular shoulders adjacent to the cardinal fossula are broadly rounded, whereas those on the opposite side of the corallite are relatively abrupt. In the columellate part of the corallite, the tabulae are complete and broadly tent shaped; they may be augmented by incomplete tabulae or tabellae at the axis of the corallite. Globose tabellae occur sparsely on the flanks of some of the tabulae. Tabular spacing ranges from 0.5 to 2.0 mm but averages about 1 mm. The dissepimentarium ranges from 4 to 5 mm in width and consists of two to four rows of steeply inclined globose to elongate dissepiments of variable size.

The septal microstructure has been altered by recrystallization. Several patterns illustrated by Kato (1963, text fig. 16 a, c, f) can be identified, but none of these are primary structures.

*Description of paralectotypes.*—The paralectotypes consist of disassociated single cylindrical corallites and clusters of two to four cylindrical corallites. Although they are all similarly preserved and contain similar rock matrix, I cannot certainly determine whether they are fragments of the same corallum as the lectotype or represent more than one corallum. Most of the observations on the paralectotypes were made by means of

polished transverse sections (1 section on each of 10 corallites). These observations were supplemented by study of one longitudinal thin section (pl. 4, fig. 1) and one transverse thin section (pl. 4, fig. 2) made from the largest and best preserved corallite in the paralectotype lot.

The scatter diagram (fig. 4) shows the variation in corallite diameter in relation to number of major septa in measurable paralectotypes as compared to the same parameters measured in the lectotype. These data indicate a maximum corallite diameter of 20 mm corresponding to a maximum major septal number of 36 in the type material. Columellate and acolumellate sections are also indicated on the diagram, illustrating the incidence of these features in random transverse sections.

The paralectotypes show virtually the same internal features that are observed in the lectotype, with a few notable exceptions. In six of the transverse sections, no lonsdaleoid dissepiments were observed; lonsdaleoid dissepiments are also absent in the two daughter corallites of the lectotype (pl. 4, fig. 7). Nonlonsdaleoid corallites range from 9.2 to 17 mm in diameter and possess 24–33 major septa; all but 2 corallites in this group are 15 mm or less in diameter and have no more than 28 major septa. These data suggest that absence of lonsdaleoid dissepiments is either a pre-adult feature or is associated with the periodic constriction of the corallite.

Two corallites in a cluster of three that make up one of the paralectotypes show a feature not observed in any of the other type specimens. In each of these corallites, one of the major septa in the counter quadrants is flanked by two unusually long minor septa. Symmetry considerations indicate that in each one, the major septa in question are merely counter lateral septa, not the counter septum.

The longitudinal thin section of one of the paralectotypes (pl. 4, fig. 1) shows a thin discontinuous sinuous axial plate through most of the corallite. The tabulae are tented where the columella is present but flat where this structure is absent. Tabulae are somewhat more closely spaced than in the lectotype.

*Type locality.*—The type material was collected by the Hayden Survey at a locality described by Meek (1873, p. 470) as the “divide between Ross Fork and Lincoln Valley, Montana.” Actually, the area referred to is in Idaho, not Montana as stated in Meek’s report. The geology of the Ross Fork-Lincoln Valley divide is described in detail by Bradley (1873, p. 206–207). Meek (1873, p. 433–434) compared the associated fauna from the type locality with the well-known Spergen

fauna of Indiana, which was at that time included in the St. Louis Limestone.

Unfortunately the exact geographic location of the type locality is cloaked in mystery. Although Mansfield’s (1920, pl. 3) geologic map of the Fort Hall Indian Reservation includes the Ross Fork-Lincoln Valley divide, Mansfield’s mapping does not concur with many of Bradley’s (1873, p. 206–207) statements on geographic distribution of the various stratigraphic units in this area. Meek’s Spergen fauna unquestionably came from beds that Mansfield (1920, p. 35–36) included in the Brazer Limestone. Girty (in Mansfield, 1927, p. 69–71) discussed this fauna at great length in his evaluation of the Brazer faunas of southeastern Idaho. According to Mansfield’s map (1920, pl. 3), the Brazer crops out in two small areas on the Ross Fork-Lincoln Valley divide: on a hill in sec. 6, T. 4 S., R. 37 E., and on an east-facing slope in sec. 31, T. 4 S., R. 37 E., and sec. 6, T. 5 S., R. 37 E. However, Mansfield (1920, p. 36) stated that Girty attempted to rediscover Meek’s locality but found “that the descriptions of the locality were inadequate and that the locality probably lay outside of the Ross Fork drainage basin and outside the limits of the [Fort Hall] reservation.”

Although the exact geographic location of the type locality is in doubt, the stratigraphic level is determinable within reasonable limits. Inasmuch as the term Brazer Limestone is no longer considered appropriate for the Upper Mississippian strata of southeastern Idaho (Sando and others, 1959, p. 2768), a new nomenclature has been proposed for those beds in the Chesterfield Range (Dutro and Sando, 1963b), approximately 25 miles southeast of the Ross Fork-Lincoln Valley divide area. Meek’s (1873, p. 470) faunal list includes *Zaphrentis stansburyi* Hall, a coral which is now referred to the genus *Faberoephyllum*. *Faberoephyllum* is restricted to a zone that spans approximately the lower half of the Monroe Canyon Limestone of the Chesterfield Range Group. Large fasciculate lithostrotionoid corals similar to *Dorlodotia subcaespitosa* but apparently not conspecific and possibly not congeneric are abundant in beds immediately above and below the top of the massive limestone member of the Monroe Canyon Limestone. These beds are regarded as Late Mississippian (Meramec) in age.

Foraminifera in the lectotype slides are indicative of a late Meramec age and support correlation with the Monroe Canyon Limestone (Betty Skipp, written commun., 1963). According to Skipp, the foraminiferal assemblage includes *Endothyra* cf. *E. pseudoglobulus*, *E.* cf. *E. disca*, *E. scitula*?, and undetermined species of *Tetrataxis*, *Earlandia*, *Forschia*? and *Tournayella* or *Septatournayella*. Several elements of this

assemblage occur in the Monroe Canyon Limestone of the Bancroft quadrangle, southeast Idaho.

*Discussion.*—The name *Cyathophyllum subcaespitosum* first appeared in a faunal list (Meek, 1873, p. 470). Meek gave a superficial description of the species in a footnote on the same page, contrasting it with *C. caespitosum* Goldfuss and referring to his unpublished description and illustration of the species, which appeared in 1877 in a report on the survey of the 40th parallel. The type material was never illustrated or described in detail, and subsequent concepts of the species were based on Meek's (1877, p. 60, pl. 5, figs. 4, 4a, b) description and illustrations of a specimen from the White Pine District, Nev. Schuchert (1905, p. 191) erroneously listed the Nevada specimen (USNM 24545) as the holotype of *Cyathophyllum subcaespitosum* Meek.

Meek's original material is clearly of Late Mississippian age and belongs to the genus *Dorlodotia* Salée. The White Pine specimen, on the other hand, is from the Ely Limestone of Early and Middle Pennsylvanian age and represents a species apparently related to the Pennsylvanian species of the Russian genus *Orygmophyllum* Fomichev. This specimen, identified herein as *Orygmophyllum? whitneyi*, is illustrated on plate 6, figures 6–11, in order that the reader can compare it with the type material of *Dorlodotia subcaespitosa*.

G. H. Girty used the name *Cyathophyllum subcaespitosum* in various faunal lists from the Mississippian and Pennsylvanian of Idaho, Nevada, Utah, and New Mexico. I have studied most of the material upon which Girty's identifications were based and conclude that none of the specimens belong in Meek's species. My findings are summarized as follows:

1. *Cyathophyllum subcaespitosum?* Girty (in Umlpleby, 1917, p. 30) is based on one specimen (USGS loc. 1141a) from the Mississippian of the Mackay region, Idaho. This specimen has fewer major septa and smaller corallites than the types of *D. subcaespitosa*. Moreover, the absence of a columella in all parts of all corallites in the colony indicates that the specimen represents a species of *Pseudodorlodotia* Minato.
2. *Cyathophyllum subcaespitosum* Girty (in Hewett, 1931, p. 24) is based on specimens (USGS locs. 4218, 4219, 4220a, 4226) from the Bird Spring Formation, Goodsprings quadrangle, Nev. The material is Upper Mississippian not Pennsylvanian as listed. The specimens are all very poorly preserved. Most of them have smaller corallite diameters than the types of *D. subcaespitosa* and all specimens are acolumellate, indicating that they belong to *Pseudodorlodotia* Minato.
3. *Cyathophyllum subcaespitosum?* Girty (in Westgate and Knopf, 1932, p. 22) is based on specimens (USGS locs. 5478, 5479, 5481) from the Bailey Spring Limestone (Mississippian and Pennsylvanian) of the Pioche District, Nev. The material consists of poorly preserved horn corals, most of which appear to belong to *Vesiculophyllum* Easton.
4. *Cyathophyllum subcaespitosum?* Girty (in Nolan, 1935, p. 22) is based on specimens (USGS locs. 6344, 6364) from the Oquirrh Formation, Gold Hill District, Utah. The material may be Mississippian rather than Pennsylvanian as listed, and appears to belong to a species of *Lithostrotion* (*Siphonodendron*).
5. *Cyathophyllum subcaespitosum?* Girty (in Loughlin and Koschmann, 1942, p. 20) is cited in a faunal list for the Madera Limestone (Pennsylvanian), Magdalena District, N. Mex. The identification is probably incorrect but it was not checked because I was unable to locate the specimens.

*Dorlodotia subcaespitosa* is similar to *D. arizelum* (Crickmay) (Crickmay, 1955, p. 11, pl. 1, figs. 5, 7; see also Nelson, 1960, p. 124, pl. 25, figs. 5–10), from the Mount Head Formation (Upper Mississippian) of Alberta, Canada. The two species have similar corallite diameters, numbers of major septa, cardinal fossulae, dissepimentaria, and major and minor septa. Meek's species is distinguished from the Canadian species by its short counter septum which is not continuous with the columella, vertically discontinuous columella, and generally flatter tabulae.

*Dorlodotia subcaespitosa* differs from *D. inconstans* (Easton and Gutschick) (Easton and Gutschick, 1953, p. 20, 21, pl. 2, figs. 10–12), from Upper Mississippian beds in the Redwall Limestone of northern Arizona, by its larger corallites and larger maximum number of major septa. *D. inconstans* also has a narrower dissepimentarium with fewer and larger dissepiments and poorly differentiated cardinal and counter septa.

*D. subcaespitosa* is undoubtedly related to some of the forms from the Upper Mississippian of Utah and Canada that have been erroneously referred to *Lithostrotion whitneyi* by various authors. Meek's (1877, p. 58, pl. 6, figs. 1, 1a–c) specimens from Utah, upon which the erroneous concept of *L. whitneyi* was founded, are illustrated on plate 7. These specimens are readily differentiated from the types of *D. subcaespitosa* by their thick continuous columella that is commonly connected to the counter septum, dissepimentarium composed of only one or two rows of nonlonsdaleoid dissepiments, smaller maximum number of major septa (31), and smaller maximum corallite diameter (8.5

mm). Sutherland's (1958, p. 93, pl. 31, fig. 3) specimens from British Columbia and Nelson's (1960, p. 123, pl. 25, figs. 1-4) specimens from Alberta are very similar to Meek's Utah material. On the other hand, specimens from Utah illustrated by Kelly (1942, p. 359, pl. 51, figs. 2, 5) and Parks (1951, p. 180, pl. 33, figs. 3-5) under the name of *L. whitneyi* Meek may belong to a different species, which differs only slightly from *D. subcaespitosa*. These specimens have a maximum major septal number of 31-33 and a maximum corallite diameter of 12 or 13 mm, which is only slightly less than the types of *D. subcaespitosa*. The columella is thin and discontinuous and not connected to the counter septum. The dissepimentarium is weakly lonsdaleoid and consists of two to four rows of dissepiments.

#### Genus *ORYGMOPHYLLUM* Fomichev

1953. *Orygmophyllum* Fomichev, p. 304-306.

*Type species.*—*Orygmophyllum convexum* Fomichev (1953, p. 312-314, pl. 18, figs. 11a-d, 12a, b, 13). Upper Carboniferous (C<sub>3</sub>), U.S.S.R.

*Diagnosis.*—Solitary (?) and fasciculate colonial corals with an impersistent weakly developed variable axial structure composed of an axial plate, septal lamellae, and tabellae. Tabulae flat to vesicular. Dissepiments abundant, ordinarily of the regular and herringbone type.

#### *Orygmophyllum? whitneyi* (White)

Plate 5; plate 6, figures 6-11

1875. *Lithostrotion whitneyi* Meek. White, p. 103, pl. 6, figs. 1a-c (preprint of White's 1877 report).  
 1877. [not] *Lithostrotion whitneyi* Meek, p. 58, pl. 6, figs. 1, 1a-c.  
 1877. *Lithostrotion whitneyi* Meek. White, p. 103, pl. 6, figs. 1a-c.  
 1877. [not] *Lithostrotion whitneyi*. Hague in Hague and Emmons, p. 405.  
 1877. *Diphyphyllum subcaespitosum*. Hague in Hague and Emmons, p. 547.  
 1877. *Cyathophyllum subcaespitosum* Meek, p. 60, pl. 5, figs. 4, 4a, b.  
 1878. *Diphyphyllum subcaespitosum*. King, p. 208.  
 1878. [part] *Lithostrotion whitneyi* Meek. King, p. 181, 239, 242, 245.  
 1886. [not] *Lithostrotion whitneyi*. Walcott in Diller, p. 11.  
 1889. *Lithostrotion whitneyi* Meek. Miller, p. 194 (bibliographic citation).  
 1898. [part] *Lithostrotion whitneyi* Meek. Weller, p. 330 (bibliographic citation).  
 1900. [not] *Lithostrotion whitneyi*. Lindgren, p. 2.  
 1905. [part] *Lithostrotion whitneyi* Meek. Schuchert, p. 369.  
 1917. [not] *Lithostrotion whitneyi*. Girty in Umpleby, p. 29, 30.  
 1920. [not] *Lithostrotion whitneyi* Meek. Girty p. 650, pl. 52, fig. 5.  
 1926. [not] *Lithostrotion whitneyi* Meek. Shimer, p. 26.  
 1942. [not] *Lithostrotion whitneyi* Meek. Kelly, p. 359, pl. 51, figs. 2, 5.

1943. [not] *Lithostrotion whitneyi* Meek. Williams, p. 596.  
 1944. [not] "*Lithostrotion*" *whitneyi* Meek. Shimer and Shrock, p. 89, pl. 26, figs. 4, 5.  
 1945. [not] *Lithostrotion whitneyi* Meek. Williams and Yolton, p. 1146, 1148.  
 1950. [part] *Lithostrotion* [*Lithostrotionella*] *whitneyi* (Meek). Bassler, p. 220 (bibliographic citation).  
 1951. [not] *Lithostrotion whitneyi* Meek. Parks, p. 180, pl. 33, figs. 3-5.  
 1956. [not] *Lithostrotion whitneyi* Meek. Davis, p. 32, pl. 2, figs. 7, 8.  
 1958. [not] *Lithostrotion* cf. *whitneyi* Meek, Sutherland, p. 93, pl. 31, fig. 3.  
 1959. [not] *Lithostrotion whitneyi* Meek. Nelson, p. 21-25, fig. 1.  
 1960. [not] *Lithostrotion whitneyi* Meek. Nelson, p. 123, pl. 25, figs. 1-4.  
 1960. [not] *Lithostrotion* cf. *L. whitneyi* Meek. Langenheim and Tischler, p. 115, figs. 10a-c.  
 1961. [not] *Lithostrotion whitneyi* Meek. Nelson, p. 25, 26, 33; pl. 16, figs. 6, 7; pl. 20, figs. 3, 4.  
 1961. [not] *Lithostrotion* (*Siphonodendron*) *whitneyi* Meek. Sando in Ross, p. 224.

*Type material.*—The syntype lot consisted of two specimens cataloged under USNM number 8480.

The specimen figured by White (1875, pl. 6, fig. 1a) is here designated lectotype and given the new USNM number 144774. White polished one side of this specimen in order to study longitudinal sections. Two corallites on the polished face are the sources of White's figures 1b and 1c.

The other syntype, not figured by White, is regarded as a paralectotype and is given the new USNM number 144775. Bassler made one transverse and two longitudinal thin sections, mounted on a single slide, from this specimen.

*Description of lectotype.*—This specimen (pl. 5, figs. 1 and 2) is a fragment of a dendroid corallum approximately 6 by 4.5 by 7.5 cm. The size and shape of the complete corallum are unknown. Budding by lateral increase is common (pl. 5, fig. 8). Spacing between corallites is extremely variable, ranging from less than 1 mm to 16 mm.

Internal features were studied by means of two transverse and four longitudinal thin sections (pl. 5, figs. 3-9). The corallites range from 5.5 to 14.0 mm in diameter and contain 16-27 major septa in 12 corallites in the transverse sections studied (fig. 5); this variation in diameter and septal number is principally ontogenetic, the smaller corallites having the fewer septa. The major septa are generally thin and slightly sinuous and occupy  $\frac{1}{2}$ - $\frac{2}{3}$  of the radius of the corallum. They are slightly dilated in the tabularium. An off-center longitudinal section of one of the corallites (pl. 5, fig. 3) indicates that the major septa are vertically discontinuous (amplexoid) in the tabularium. Minor septa are thin and sinuous and as much as half as long as the

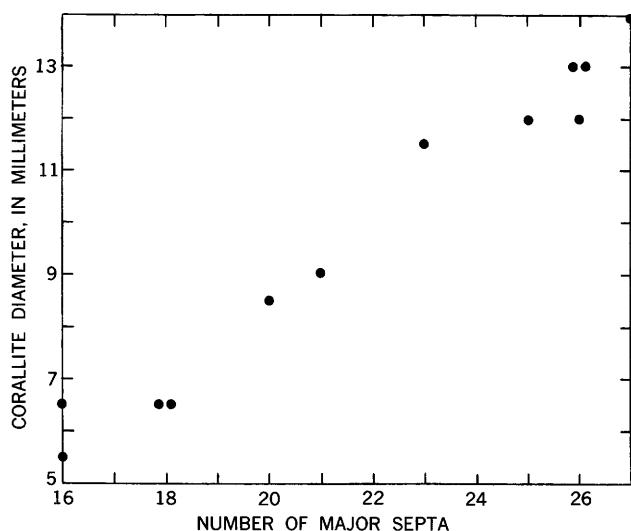


FIGURE 5.—Scatter diagram showing relation between corallite diameter and number of major septa in 12 corallites of the lectotype of *Orygmophyllum? whitneyi* (White).

major septa. Both major and minor septa are rarely interrupted by lonsdaleoid dissepiments in the peripheral region of the corallite. The cardinal septum is slightly shorter than the other major septa but does not occupy a distinct fossula. The counter septum is invariably long and is continuous with the axial plate of the columella when the latter is present. One or both of the minor septa on either side of the counter septum are commonly longer than neighboring minor septa.

The dissepimentarium may be absent locally or as much as 3 mm in width (ordinarily a little less than half the radius) and, where present, consists of one to five (ordinarily four) rows of globose to elongate dissepiments (as seen in longitudinal section). The dissepiments are mostly regular or herringbone types; lonsdaleoid dissepiments are scarce and may be associated with budding.

The structure of the tabularium is extremely variable. Where the columella is absent or weakly developed, the tabulae are flat or slightly convex upward and have nearly straight to down-turned margins. The marginal shoulders in these forms are ordinarily rounded, and the tabulae commonly rest on underlying tabulae. Where a strong columella is present, the tabulae may be complete and tent shaped or the entire tabularium may be composed of incomplete tabulae and axial tabellae. Tabulae are most commonly spaced about 1 mm apart.

The columella is impersistent and extremely variable within individual corallites. In some parts of the corallite there may be no columella. Elsewhere, a thin sinuous axial plate connected to the counter septum is

developed. In some corallites, the axial plate appears to be simply the axial end of an amplexoid counter septum developed discontinuously on successive tabulae. A more complex axial structure is commonly produced by the introduction of steeply inclined axial tabellae. The most complex axial structure consists of two to four septal lamellae in addition to the axial plate and tabellae.

Transverse thin sections show an interesting and unusual septal microstructure in parts of the corallum where silicification has not obliterated fine details. In many septa the medial plane is marked by a series of dark horseshoe-shaped or hairpin-shaped structures whose closed ends are directed toward the axis of the corallum. In other septa the medial plane is characterized by two parallel dark dashed lines, possibly the result of destruction of the closed ends of the horseshoes. In both types, most of the calcite that makes up the septum is fibrous and the fibres are arranged more or less normal to the axial plane. Although this phenomenon deserves further study, I am inclined to regard it as a function of recrystallization. Such patterns might be produced by the development of centers of recrystallization along the dark medial septal line that characterizes many rugose corals. This interpretation is supported by the presence of a solid dark medial line in some septa near their junction with the wall of the corallum.

*Type locality.*—According to White (1875, p. 103), the type material was collected from “strata of the Carboniferous period; Fossil Hill and Ice Creek, Steptoe Valley, White Pine County, Nevada.”

Ice Creek is shown on sheet 49 of the topographic atlas published by the Wheeler Survey (Wheeler, 1876). The creek flows eastward down the east flank of the Egan Range and enters Steptoe Valley at a point about 15 miles south of Mineral City (now called Ely). I have not found the name Ice Creek on recent maps of the area, but comparison of Wheeler’s map with the U.S. Geological Survey Ely quadrangle map (1:125,000 series, 1952 edition) indicates that Wheeler’s Ice Creek is probably the stream now called Willow Creek. The bedrock within the drainage area of Willow Creek is of Pennsylvanian and Permian age, assigned to the Ely and Arcturus Limestones and to the Rib Hill Formation of Pennebaker (1932) by Langenheim and others (1960, fig. 2). Wilson and Langenheim’s (1962, text fig. 3) Charcoal Ovens section illustrates the Pennsylvanian and Permian sequence in the Willow Creek area.

A thorough search of the maps and reports published by the Wheeler Survey failed to reveal the location of the Fossil Hill locality referred to by White. However, the name appears on Spencer’s (1917, pl. 2)



geologic map of the Ely quadrangle and on the Ely quadrangle topographic map, 1952 edition. On these maps, the name is used for a hill located in SW $\frac{1}{4}$ , sec. 14, T. 16 N., R. 62 E., about a mile southeast of Ruth, Nev. Inasmuch as this locality is very close to the route taken by several parties of the Wheeler Survey, it seems reasonable to assume that it is the one referred to by White. Fossil Hill is made up of complexly faulted Pennsylvanian and Permian rocks, including outcrops of the Ely, Rib Hill, and Arcturus Formations (Langenheim and others, 1960, fig. 2).

White's two syntypes are not separately identified as to locality. The paralectotype is a specimen of *Durhamina cordillerensis* (Easton) which is very similar to the small corallite forms that are abundant at the base of the Arcturus Limestone (Zone 2 of Easton, 1960, p. 573) in the Ely district. A stratigraphic position at the base of the Arcturus is also indicated by the presence of *Schubertella kingi* (identification by L. G. Henbest) in a thin section of the paralectotype. *Schubertella kingi* was reported from the basal Arcturus in the Ely area by Wilson and Langenheim (1962, p. 501. Other foraminifers found in the matrix of the paralectotype are *Spandelinoides* sp., *Endothyra* sp., and *Globivalvulina* sp. Henbest interprets the foraminiferal assemblage as definite Early Permian.

The lectotype probably was collected from the Ely Limestone, inasmuch as similar corals have not been found in other formations in the Ely area. The rock matrix of the lectotype contains a foraminiferal assemblage consisting of *Earlandia* aff. *E. perparva* Plummer, sedentary cornuspirids, and *Bradyina* sp. (identifications by L. G. Henbest). According to Henbest, these forms range from Mississippian to Early Permian and, consequently, neither confirm nor deny identification of the rock as Ely Limestone.

Thus, the available evidence suggests that the lectotype was derived from the Ely Limestone of Pennsylvanian age but does not indicate whether the specimen was collected at Fossil Hill or the Ice Creek locality.

**Discussion.**—In 1875, C. A. White published a preprint of a report on invertebrate fossils collected by the Wheeler Survey which was later combined with Cope's report on the vertebrates and published in 1877 as Volume IV of the Wheeler Survey Reports. Among the specimens studied by White were colonial corals from the Carboniferous of White Pine County, Nev., which he described and illustrated under the heading of *Lithostrotion whitneyi* Meek, citing a manuscript by Meek as reference for the name. Because Meek's manuscript was not published until 1877, the original usage of the specific name must be credited to White's 1875

preprint, and the concept of *Lithostrotion whitneyi* must be based on White's Nevada material. *Lithostrotion whitneyi* White pertains to a coral of probable Pennsylvanian age whose affinities are with the Russian genus *Orygmophyllum* Fomichev, whereas *Lithostrotion whitneyi* Meek, based on material from the Upper Mississippian of Utah, belongs with the group of corals now referred to *Siphonodendron* McCoy. Unfortunately Meek's usage of the name was perpetuated by all subsequent authors.

The paralectotype of White's species (pl. 6, figs. 1–5) is actually a characteristic example of *Durhamina cordillerensis* (Easton). Although available evidence does not indicate which of the two possible geographic localities was the source of this specimen, its Early Permian age and occurrence in the lower part of the Arcturus Limestone are confidently established (see discussion on type locality above). On the other hand, the age and stratigraphic level of the lectotype, as well as the geographic location of its source, cannot be established with certainty. Attempts to find comparable corals from eastern Nevada have met with limited success. I have seen only three specimens that may be conspecific with the lectotype: (1) Meek's (1877, p. 60, pl. 5, figs. 4, 4a, b) *Cyathophyllum subcaespitosum* was collected near the old mining camp of Swansea in the White Pine District, Nev. Hague's (1870, pl. 14) geologic map of the White Pine District shows a small outlier of Carboniferous limestone just north of Swansea. Hague's Carboniferous limestone is now included in the Ely Limestone of Pennsylvanian age. The specimen (USNM 24545) described and illustrated by Meek from this locality is shown herein on plate 6, figures 6–11, for comparison with the lectotype of *Orygmophyllum? whitneyi*. (2) The coral that Coogan,<sup>1</sup> (p. 22) listed as *Caninostrotion* sp. A appears to belong with the *Orygmophyllum? whitneyi* group, judging from photographs that Coogan sent me. Coogan's specimens are from his *Millerella marblensis-Stafella expansa-Caninostrotion* sp. A faunizone in the Bird Spring Formation at Kane Springs Wash, sec. 33, T. 9 S., R. 64 E., Lincoln County, Nev. The specimens are from units 66 and 67 of Coogan's stratigraphic section. According to Coogan, the coral horizon is of Early Pennsylvanian (Morrow) age. Coogan (p. 56, 57) also recorded these corals in units 57, 79, and 81 in the Bird Spring Formation of his Arrow Canyon section, sec. 12, T. 13 S., R. 64 E., Clark County, Nev. Coogan identified this faunizone in the lower and middle parts of the Ely Limestone in the Ely Basin. (3) A specimen col-

<sup>1</sup> Coogan, A. H., 1962, Early Pennsylvanian stratigraphy, biostratigraphy, and sedimentation of the Ely Basin, Nevada: Illinois Univ. unpub. Ph. D. thesis, 88 p., 2 pls., 26 figs.

lected by Arnold Brokaw in 1960 is the only fasciculate colonial coral that he had found in the Ely Limestone of the Ely district at the time. The material is from USGS loc. 20938-PC in sec. 8, T. 14 N., R. 63 E., White Pine County, Nev.

*Orygmophyllum? whitneyi* is evidently an uncommon element in the Pennsylvanian faunas of eastern Nevada. The exact geographic locality of the lectotype is unknown. The probable age and stratigraphic position of the lectotype have been established only by comparison with a few specimens of similar forms. The fragmentary specimen upon which the species is based does not permit an adequate characterization of the species nor a decisive determination of its taxonomic affinities. In view of the widespread incorrect usage of the name *whitneyi* for a different concept, it might be wise to simply allow the name to lapse. Consequently, I recommend that the species name be regarded as a nomen dubium that should not be used unless the species is soundly established on supplementary material from the area of the type locality.

The specimens (USNM 144799 and 144800, formerly USNM 24546) that formed the basis for Meek's (1877) usage of *Lithostrotion whitneyi* are herein illustrated on plate 7 so that the reader may compare them with White's specimen. The morphology of Meek's specimens suggests reference to *Siphonodendron* McCoy, which I am using as a subgenus of *Lithostrotion* Fleming. Material referred to *Lithostrotion whitneyi* Meek by various authors (see synonymy) includes a wide variety of Upper Mississippian forms actually referable to *Siphonodendron* McCoy, *Dorlodotia* Salée, and *Pseudodorlodotia* Minato. No new species to include these forms are proposed in this paper because existing specimens are too imperfect and their locality data too vague to provide an adequate basis for new taxonomic units.

**Family AULOPHYLLIDAE**  
**Subfamily AMYGDALOPHYLLINAE**  
**Genus FABEROPHYLLUM Parks**

1951. *Faberophyllum* Parks, p. 177.

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

Plate 8, figures 1–9; plate 9

1852. *Cyathophyllum*. Stansbury, p. 173, 196.  
1852. *Faphrentis stansburii* Hall, p. 408, pl. 1, figs. 3a, b.  
1852. *Faphrentis? multilamellata* Hall, p. 408, pl. 1, fig. 2.  
1858. [not] *Zaphrentis stansburyi* Hall. Marcou, p. 52, pl. 7, fig. 7.  
1860. *Zaphrentis Stansburyi* Hall. Milne-Edwards, p. 347.  
1860. *Zaphrentis? multilamella* Hall=Z. *Stansburyi* Hall. Milne-Edwards, p. 347.  
1873. [?] *Zaphrentis Stansburyi* Hall (?). Meek, p. 470.  
1877. [?] *Zaphrentis multilamella* Hall. Emmons in Hague and Emmons, p. 465.  
1877. [?] *Zaphrentis Stansburyi* Hall. Emmons in Hague and Emmons, p. 385, 465, 600.  
1877. [?] *Zaphrentis multilamella* Hall. Hague in Hague and Emmons, p. 458, 460.  
1877. [?] *Zaphrentis Stansburyi* Hall. Hague in Hague and Emmons, p. 404, 423, 460.  
1877. *Zaphrentis? multilamella* Hall? Meek, p. 53, pl. 6, figs. 4, 4a, b.  
1877. [?] *Zaphrentis? Stansburii* Hall? Meek, p. 54, pl. 6, figs. 3, 3a–c.  
1878. *Zaphrentis multilamella* Hall. King, p. 199.  
1878. [?] *Zaphrentis Stansburyi* Hall. King, p. 181, 199, 239, 242, 245, 255.  
1889. *Zaphrentis multilamella* Hall. Miller, p. 209 (bibliographic citation).  
1889. *Zaphrentis stansburyi* Hall. Miller, p. 210 (bibliographic citation).  
1898. *Zaphrentis multilamella* Hall. Weller, p. 648 (bibliographic citation and synonymy).  
1898. *Zaphrentis stansburyi* Hall. Weller, p. 649 (bibliographic citation and synonymy).  
1900. [?] *Zaphrentis stansburyi* Hall. Knight, pl. 3, fig. 4.  
1905. *Zaphrentis? multilamella* Hall. Schuchert, p. 703 (bibliographic citation).  
1905. *Zaphrentis? multilamella* Hall. Schuchert, p. 704 (bibliographic citation).  
1905. *Zaphrentis stansburyi* Hall. Schuchert, p. 704 (bibliographic citation).  
1905. [?] *Zaphrentis? stansburii* Hall? Schuchert, p. 704, bibliographic citation).  
1917. [?] *Zaphrentis multilamella?* Girty in Umpleby, p. 29.  
1917. [?] *Zaphrentis stansburyi?* Girty in Umpleby, p. 29, 30.  
1920. [?] *Zaphrentis stansburyi* Hall. Girty, pl. 52, fig. 1.  
1920. *Zaphrentis? multilamella* Hall? Girty, pl. 52, figs. 2, 2a.  
1929. [?] *Cyathophyllum? multilamella*. Girty in Mansfield, p. 25.  
1941. [?] *Zaphrentis multilamella?* Girty, in Richardson, p. 23.  
1943. [?] *Zaphrentis stansburyi* Hall. Williams, p. 596.  
1945. [?] *Zaphrentis stansburyi* Hall. Williams and Yolton, p. 1146, 1148.  
1950. *Zaphrentis multilamella* Hall. Bassler, p. 220 (bibliographic citation).  
1950. *Zaphrentis stansburyi* Hall. Bassler, p. 220 (bibliographic citation).  
1951. *Zaphrentis? multilamellata* Hall. Parks, p. 171.  
1951. *Zaphrentis stansburii* Hall. Parks, p. 171.

*Type material.*—The syntype lot consisted of four specimens cataloged under USNM number 15055. The incomplete specimen figured by Hall (1852, pl. 1, fig.

3b), presumably from the Cloth Cap locality, is here designated paralectotype and given the new USNM number 144771.

A more complete specimen, not illustrated by Hall, from Flat Rock Point is chosen as lectotype and given the new USNM number 144770.

The two additional specimens, one of which was figured by Hall (1852, pl. 1, fig. 3a) are too immature and imperfect for generic and specific determination. These are retained under the original syntype number, USNM 15055.

*Description of lectotype.*—This specimen (pl. 8, figs. 1 and 2) is a free trochoid corallum that has a calicular angle of approximately  $50^\circ$ . The tip of the corallum was broken off at a diameter of about 15 mm, but the corallum is quite clearly curved in the cardinal-counter plane, and the cardinal position is on the convex side. Most of the calice rim has been broken away but enough remains to establish a calice depth of about 15 mm. The observed length of the corallum (incomplete) is approximately 35 mm. The maximum diameter, measured at the top of the calice is about 40 mm.

The youngest transverse section (pl. 8, fig. 4), cut at approximately 4 mm above the imperfect lower extremity of the corallum, has a diameter of 19 mm. At this stage, 47 radially arranged dilated major septa extend to the axial region of the corallum, where their attenuated axial ends are slightly deflected in a counterclockwise direction and join a columella. The columella is ovate in cross section (1.5 by 2.5 mm in diameter), oriented at a slight angle to the cardinal-counter plane, and appears to be composed of a single dilated sinuous axial plate. The cardinal septum extends halfway to the axis of the corallum and is in a long, narrow fossula, which extends to the axis and is slightly inflated at its axial terminus. The fossula is bounded by fibro-lamellar deposits of stereoplasm plastered against the axial ends of the major septa. The counter septum is slightly shorter than the other major septa. Minor septa are approximately one-third the length of the major septa. A diffuso-trabecular septal microstructure is well preserved in this section.

A transverse peel section (pl. 8, fig. 5) made at approximately 15 mm above the imperfect lower extremity of the corallum has a diameter of about 29 mm and has 66 major septa. Major and minor septa are much thinner than in the previous section. The cardinal septum is now very short; the counter septum is about the same relative length as before. Minor septa are approximately half the length of the major septa. The columella is approximately circular in cross section and 2.0 mm in diameter and although its internal structure

is somewhat obscure, there is evidence of open areas within it.

A transverse section (pl. 8, fig. 6) cut 2 mm above the preceding section has a diameter of 33 mm and has 70 major septa. This section was cut virtually at the floor of the calice. With the exception of the columella, most of the internal features are similar to those of the previous sections. The solid columella of previous sections is here replaced by an axial complex of intertwined plates, whose traces on the plane of section are sinuous. The cardinal septum remains very short and in a narrow pronounced fossula. The counter septum, although not in a fossula, is well marked by being conspicuously shorter than adjacent major septa. The dissepimentarium consists of six to eight rows of regular dissepiments confined to the zone of minor septa.

A longitudinal section (pl. 8, fig. 3) was cut in the cardinal-counter plane between the upper two transverse sections. This section shows four to six series of elongate dissepiments inclined parallel to the epitheca of the corallum. Tabulae, not well displayed in the section, appear to be discontinuous and mostly horizontal but inclined away from the columella. The axial complex is made up of tabulae and septal lamellae.

*Description of paralectotype.*—This specimen (pl. 8, figs. 7–9) is a free decorticated silicified corallum lacking the entire left counter quadrant. The observed length of the corallum is about 40 mm, but the rim of the calice is not preserved. The maximum diameter, measured near the floor of the calice, is approximately 31 mm. The calicular angle is approximately  $45^\circ$ .

Silicified structural elements are well displayed at the naturally etched floor of the calice in this specimen. Although the corallum is incomplete, the estimated septal complement is 70 major septa at a corallum diameter of 31 mm. The axial region of the corallum is occupied by a complex axial structure similar to that seen in the latest transverse section of the lectotype. The tabulae slope away from the axial complex.

*Type specimens of Zaphrentis multilamellata Hall.*—The original syntype lot of *Z. multilamellata* consisted of two specimens cataloged under USNM number 15054. The incomplete specimen from Flat Rock Point figured by Hall (1852, pl. 1, fig. 2) is here designated lectotype and given the new USNM number 144772. Hall's unfigured specimen from Cloth Cap is designated paralectotype and now bears USNM number 144773.

The lectotype (pl. 9, figs. 8 and 9) consists of the right half of a corallum approximately 40 mm long (incomplete) that has a maximum diameter of 43 mm, measured near the top of the calice. The calicular angle is between  $50^\circ$  and  $60^\circ$ .

A longitudinal section (pl. 9, fig. 10) cut from this specimen is close to the cardinal-counter plane. However, this section is slightly oblique, so that the lower half is to one side of the axial plane. Evidence for a solid axial plate in the earlier stages is ambiguous, but the section clearly shows the complex axial structure of later stages. The axial structure is manifested in the calice as an axial boss which projects 5 mm above the calicular floor. The tabularium consists of numerous incomplete vesicular tabulae slightly inclined from the axial complex.

The paralectotype (pl. 9, figs. 6 and 7) is a decorticated, partly silicified corallum having a calicular angle of about 45°. The corallum is curved in the cardinal-counter plane and the cardinal side is convex. Most of the lower part of the corallum was broken off at a diameter of approximately 18 mm. The observed length of the corallum (incomplete) is approximately 45 mm. The calice is about 20 mm deep. The maximum diameter, measured at the top of the calice, is 36 mm.

I have cut four transverse sections and one longitudinal section from this specimen. The transverse sections (pl. 9, figs. 1–4) show 51 major septa at a diameter of 23 mm and 58 major septa at diameters of 30, 32, and 36 mm. Internal features displayed by these sections and the longitudinal section (pl. 9, fig. 5) are virtually the same as those seen in the lectotype of *Zaphrentis stansburyi*. However, the paralectotype of *Z. multilamellata* has fewer major septa at approximately the same corallum diameter (58 at a diameter of 32–36 mm vs. 70 at a diameter of 33 mm. The paralectotype of *Z. multilamellata* has an axial structure like that seen in the intermediate transverse section (pl. 8, fig. 5) of *Z. stansburyi*.

The observed differences between the types of *Z. multilamellata* and *Z. stansburyi* are within my concept of the expectable limits of individual variation for a species. Therefore, I regard *Z. multilamellata* as a junior synonym of *Z. stansburyi*.

*Type locality*.—Hall (1852, p. 408) listed three localities for *Zaphrentis stansburyi*: Stansbury Island, Cloth Cap, and Flat Rock. An old label pasted on the lectotype reads "from debris of Flat rock pt." One of the specimens figured by Hall (1852, pl. 1, fig. 3a) is similarly designated. The paralectotype is not labeled; this specimen is presumably from Cloth Cap, because it is very similar in preservation and general aspect to the paralectotype of *Zaphrentis multilamellata* which is so labeled. The lectotype of *Z. multilamellata*, although unlabeled, is presumed to be from Flat Rock Point because it compares favorably in preservation and general aspect with the lectotype of *Z. stansburyi*.

Thus, Stansbury Island seems to be unrepresented in the collections.

Flat Rock Point is described by Stansbury (1852, p. 172–173) and is on his map of the Great Salt Lake. According to Stansbury, the specimens were collected from loose blocks of dark fine-grained limestone on the shore of the small cove just south of the point. The area at the mouth of North Canyon near the NE. cor. sec. 15, T. 7 N., R. 6 W., Box Elder County, Utah, shown on Olson's (1956, fig. 11) preliminary geologic map of the Promontory Range, best fits Stansbury's description of the type locality. According to Olson (unpub. data, 1961) the hills immediately surrounding the cove are composed of rocks of Cambrian to Devonian age. Therefore, the most likely source of Hall's specimens is the area of Mississippian rocks at the head of North Canyon, approximately 2 miles from the shore of the cove. Olson originally assigned these rocks to the Madison Limestone but now (unpub. data, 1961) regards them as Great Blue(?) Formation. Collections from the headlands of North Canyon referred to me for study by Olson contain corals that I regard as conspecific with Hall's material.

The Cloth Cap locality is not marked on Stansbury's map, but Stansbury's (1852, p. 195–196) description of the locality indicates that Cloth Cap is the first prominent peak at the north end of the mountain range south of Strong's Knob, on the west side of the Great Salt Lake. The peak marked with altitude of 4,985 feet on the U.S. Geological Survey Brigham City quadrangle map (1:250,000 series, 1962 ed.), about 2 miles southwest of Lakeside, Box Elder County, Utah, would seem to be the most logical choice for the Cloth Cap locality. The corals were collected from very fossiliferous limestone at the summit of this peak. Although no geologic maps including the type locality have been published, corals of the *Faberophyllum stansburyi* type have been reported from the Great Blue Formation in the southern part of the Lakeside Mountains, approximately 25 miles south of the type area (Young, 1955, p. 32).

*Discussion*.—The poor preservation, paucity of specimens, and lack of precise stratigraphic position of the original type material (including that of both *Zaphrentis stansburyi* and *Z. multilamellata*) make it very difficult to construct a realistic species concept. Moreover, Hall's specimens are all short trochoid coralla that lack a cylindrical stage. Inasmuch as the presence of a cylindrical stage is characteristic of the genus *Faberophyllum*, these specimens may represent merely the early stages of the species.

Among the collections referred to me for study during R. H. Olson's investigation of the geology of the Prom-

ontory Range are several suites of corals collected from the area of Mississippian rocks in the headlands of North Canyon. At least some of these are probably topotypes, inasmuch as the lectotypes of *Zaphrentis stansburyi* and *Z. multilamellata* were probably derived from this area. Approximately a dozen specimens are from three localities in the drainage area of North Canyon. These specimens compare very favorably with Hall's types in size, shape, septal number, and nature of the columella. None of the specimens attain a cylindrical stage.

Two of Olson's collections are from the drainage area of Miller Canyon, immediately north of North Canyon, and two additional collections are from an area that drains into the Boothe Valley, on the east side of the Promontory Range. Although these collections cannot be regarded as rigorously topotypic, they are of some interest because they may represent approximately the same stratigraphic level as the types. Sixteen specimens are present in the collections. Twelve of these specimens, all fragmentary coralla, have a cylindrical stage and attain a length of as much as 140 mm. Although the earliest stage of development is not seen in most of these specimens owing to imperfect lower extremities, the axial structure compares favorably with the types in later stages. However, there is considerable variation in the rate of expansion of the corallum, the maximum diameter in the cylindrical stage, and the maximum number of major septa. In the cylindrical stage, the maximum observed variation is from a corallum 36 mm in diameter that has 69 major septa to a corallum 50 mm in diameter that has 92 major septa.

The lack of precise stratigraphic data makes it impossible to evaluate the significance of the observed variations. The area is complexly faulted, and Olson informs me that he was unable to determine the relative stratigraphic positions of the various collections. Inasmuch as I cannot confidently determine the limits of the species, I am restricting the species name to the abbreviated coralla represented by Hall's types, the topotypes from the North Canyon drainage, and Meek's (1877, p. 53, pl. 6, figs. 4, 4a, b) specimen from Strong's Knob.

Although I have not seen the specimen that Marcou (1858, p. 52, pl. 7, fig. 7) referred to the species, his illustrations indicate that the specimen is probably not even congeneric with the types. Most of the other citations of the species in my synonymy (exclusive of bibliographic references) occur in faunal lists pertaining to various localities in the Mississippian of Utah, Nevada, and Idaho. Meek's (1877, p. 54, pl. 6, figs. 3, 3a-c) specimens (USNM 24541) from Box Elder Peak, Utah, cannot be referred unequivocally to the species

because of the reasons stated above. Similarly, Girty's (in Umpleby, 1917, pl. 29, 30) specimens (USGS locs. 537, 545, 546, 1138, 1141a) from the Mackay region, Idaho, are also provisionally referred to the species. In view of the difficulties in establishing practical limits for the species, decisions as to the identity of various specimens referred to the species must be deferred until new taxa are established on better type material.

The morphology of the later stages of the type specimens of *Zaphrentis stansburyi* place it unquestionably in the genus *Faberophyllum* Parks. The discovery of a solid styliiform columella in the earlier stages of Hall's species is an important contribution to our knowledge of the genus. Parks (1951, p. 175) proposed the genus *Ekvasophyllum* for corals that differ from *Faberophyllum* principally by having a solid styliiform columella in the mature stages. Both genera were erected on material in which the earlier growth stages are not preserved. However, Parks was able to construct a phylogenetic sequence from *Ekvasophyllum* to *Faberophyllum* based on the stratigraphic occurrence of mature forms. The type specimens of *Faberophyllum stansburyi* Hall, which include early stages not present in Parks' material, support Parks' interpretation of the phylogeny.

When Parks proposed the genus *Faberophyllum*, he recognized five species, all based solely on mature (cylindrical) growth stages. Because *F. stansburyi* Hall may represent only the early trochoid phase of a cylindrical form, I cannot establish its exact relationships to any of Parks' species. Lack of complete type specimens is a serious deterrent to the identification of Park's species.

#### Family CYATHOPSIDAE

##### Genus CANINIA Michelin in Gervais

- 1840. *Caninia* Michelin in Gervais, p. 485.
- 1844. *Siphonophyllia* Scouler in McCoy, p. 187.
- 1850. *Cyathopsis* d'Orbigny, p. 105.
- 1904. *Pseudozaphrentoides* Stuckenburg, p. 90-91.
- 1924. *Peetzia* Tolmachev, p. 309.
- 1939. *Caninia* Michelin. Hill, p. 105-106.
- 1944. *Caninia* Michelin. Easton, p. 123-124.

*Type species.*—*Caninia cornucopiae* Michelin (in Gervais, 1840, p. 485). Lower Carboniferous, Belgium.

*Diagnosis.*—Trochoid to scolecoid solitary corals having amplexoid major septa in mature stages. Cardinal fossula variably developed and variable in position with respect to curvature of corallum. Tabulae well developed, ordinarily complete, flat axially but turned down at margins. Dissepimentarium vertically discontinuous in some species, variably developed in others, composed of regular, herringbone, or lonsdaleoid dissepiments.

*Discussion.*—The diagnosis given above reflects the broad definition commonly given to this genus (Hill, 1939, p. 105–113; Easton, 1944, p. 123–124). Hill (1939, p. 102–104) segregated the species into several groups which may ultimately be recognized as genera or subgenera when a comprehensive study of *Caninia* is undertaken. The species described below have a dissepimentarium composed of lonsdaleoid as well as non-lonsdaleoid dissepiments. Inasmuch as the distinction between the *Caninia cylindrica* species group and the *Caninia juddi* species group is based largely on the lonsdaleoid vs. nonlonsdaleoid nature of the dissepimentarium, an unequivocal reference to either group cannot be made.

*Caninia excentrica* (Meek)

Plates 10–12

1873. *Zaphrentis excentrica* Meek, p. 468.  
 1875. [not] *Zaphrentis excentrica* Meek. White, p. 101, pl. 6, fig. 3a.  
 1877. *Zaphrentis excentrica*. Hague in Hague and Emmons, p. 404.  
 1877. *Zaphrentis excentrica* Meek, p. 52, pl. 4, figs. 1–1d.  
 1877. [not] *Zaphrentis excentrica* Meek. White, p. 101, pl. 6, fig. 3a.  
 1878. *Zaphrentis excentrica*. King, p. 181, 238, 239, 244.  
 1889. [part] *Zaphrentis excentrica* Meek. Miller, p. 209 (bibliographic reference).  
 1898. [part] *Zaphrentis excentrica* Meek. Weller, p. 647 (bibliographic reference).  
 1905. [part] *Zaphrentis excentrica* Meek. Schuchert, p. 703 (bibliographic reference).  
 1917. [not] *Zaphrentis excentrica*? Girty in Umpleby, p. 30.  
 1920. *Zaphrentis excentrica* Meek. Girty, pl. 52, fig. 4.  
 1931. [?] *Zaphrentis excentrica*. Girty in Hewett, p. 28.  
 1943. *Zaphrentis excentrica* Meek. Williams, p. 596.  
 1945. [?] *Caninia juddi* (Thomson). Sloss, p. 311, pl. 48, figs. 1–4.  
 1945. *Zaphrentis excentrica* Meek. Williams and Yolton, p. 1146, 1149.  
 1951. [?] *Caninia* sp. A. Parks, p. 181, pl. 29, figs. 6a, b.  
 1951. [?] *Caninia* sp. B. Parks, p. 182, pl. 29, figs. 7a, b.  
 1959. [not] *Caninia excentrica* (Meek). Duncan in Crittenden, p. 71, 72.  
 1963b. *Caninia* cf. *C. excentrica* (Meek). Sando in Dutro and Sando, p. 1974, 1982.

*Type material.*—Meek's original material, cataloged in May, 1882, was apparently overlooked or lost when Schuchert and his colleagues (1905) published their catalog of type specimens of fossil invertebrates that are in the U.S. National Museum. Schuchert (1905, p. 703) erroneously listed Meek's Utah specimens as cotypes of the species. The actual type material from Montana was rediscovered in 1961 in a drawer in one of the old offices of the U.S. Geological Survey in the U.S. National Museum. These specimens agree with Meek's (1873, p. 468, footnote) diagnosis and are accompanied by a label written by Meek's hand.

The syntype lot consisted of 13 specimens cataloged under USNM 11664. Four of these are identified as *Zaphrentites* cf. *Z. spinulosa* (Milne-Edwards and Haime) and have been segregated from the type lot under USNM 144792. The specimen now cataloged under USNM 144791 is here chosen as the lectotype of *Caninia excentrica*. The paralectotypes, unfigured, are retained under USNM 11664.

The species concept has been fortified by study of approximately 30 well-preserved topotypes from USGS locality 17498-PC collected in 1957 by me and J. B. Hadley. Figured topotypes are cataloged under USNM 144793–144796. The remaining unfigured topotypes have been retained in the collections of the U.S. Geological Survey under USGS locality 17498-PC.

*Description of lectotype.*—This specimen (pl. 10, figs. 4–6) consists of a slightly crushed decorticated mature corallum. The measured length is about 10.5 cm from the top of the calice to the imperfect tip of the corallum. The corallum is moderately curved in the cardinal-counter plane, and the cardinal side is convex. Maximum diameter is approximately 10 cm, measured at the top of the calice, which was at least 6 cm deep. The calicular angle is approximately 70°. Longitudinal ornamentation consists of rounded interseptal ridges and sharp septal grooves. Transverse ornamentation consists of fine growth lines (2 per mm) and broad irregular rugae spaced 2–4 mm apart.

A transverse section (pl. 10, fig. 2) cut 8 mm above the imperfect tip of the corallum shows approximately 40 major septa at an alar diameter of approximately 26 mm. Septa of the cardinal quadrants are well preserved in this section by virtue of their strong dilation, whereas those of the counter quadrants have been largely crushed. The cardinal septum is about three-fourths the length of the other major septa and is in a poorly defined fossula.

A transverse section (pl. 10, fig. 3) cut 45 mm above the tip of the corallum shows about 60 major septa at an alar diameter of approximately 66 mm. Approximately the central half of the corallum is occupied by the septum-free tabularium, which in this specimen has been broken and filled in by matrix. The peripheral half of the corallum is occupied by septa and dissepiments. In the counter quadrants, the dissepimentarium is divided into three zones of approximately equal width. The peripheral zone consists of major and minor septa that project inward from a thin epitheca and are combined with regular and herringbone dissepiments. The peripheral zone is succeeded by an intermediate zone of lonsdaleoid dissepiments where the septa, if present at all, are represented only by short discontinuous crests on some of the dissepiments. In



the inner zone, major septa are again continuously developed and dissepiments are of the herringbone and regular types, confined to the interseptal loculi. Cardinal quadrants are characterized by the same tripartite division, but the inner zone is much broader than it is in the counter quadrants, and the major septa are dilated in this zone. The cardinal septum is moderately long and is in a moderately well defined fossula whose axial terminus is bounded by tabular traces.

A longitudinal section (pl. 10, fig. 1) cut in the cardinal-counter plane between the two transverse sections described above illustrates features of the tabularium and dissepimentarium. The tabulae are very thin and slope into the cardinal fossula at an angle of about  $45^\circ$  from the horizontal. The dissepiments are steeply inclined, small and globose at the periphery, but mostly large and elongate in the inner parts of the dissepimentarium.

The septal microstructure is diffusotrabecular and has fibro-lamellar dilation.

*Description of paralectotypes.*—The paralectotypes are slightly crushed coralla exhibiting mainly the same features seen in the lectotype. Two of the paralectotypes are mature coralla approximately the same size and shape as the lectotype. The remaining specimens are immature forms that have a maximum diameter of 50 mm or less and a length not exceeding 8 cm. The coralla are all slightly curved in the cardinal-counter plane, and the cardinal side is convex. Calicular angles in the mature specimens range from about  $40^\circ$  to  $60^\circ$ , and calices are as much as 6 cm deep. Septal complements at several stages in one of the paralectotypes are plotted in figure 6 along with data from the lectotype and topotypes.

*Description of topotypes.*—The topotype coralla are mostly mature specimens rather strongly curved in the cardinal-counter plane, and their cardinal sides are convex and somewhat flattened. In some of the specimens, the cardinal-counter plane is twisted through an angle of as much as  $90^\circ$  with respect to the plane containing maximum curvature. The calicular angle for most of these specimens ranges from about  $40^\circ$  to  $65^\circ$ . A few coralla are principally straight cones that have flaring calices producing a calicular angle of as much as  $78^\circ$ . Rejuvenation is evident in the late stages of some of the larger specimens. The maximum alar diameter of the largest specimens is 10.6 cm. Measured length is as much as 13.5 cm. Calices are as much as 6 cm deep. Characteristic exterior and calicular features are well illustrated by the etched specimen shown on plate 11, figures 1–3. This specimen has a broad scar of attachment near the tip. Septal complements at various alar diameters in nine topotypes are plotted

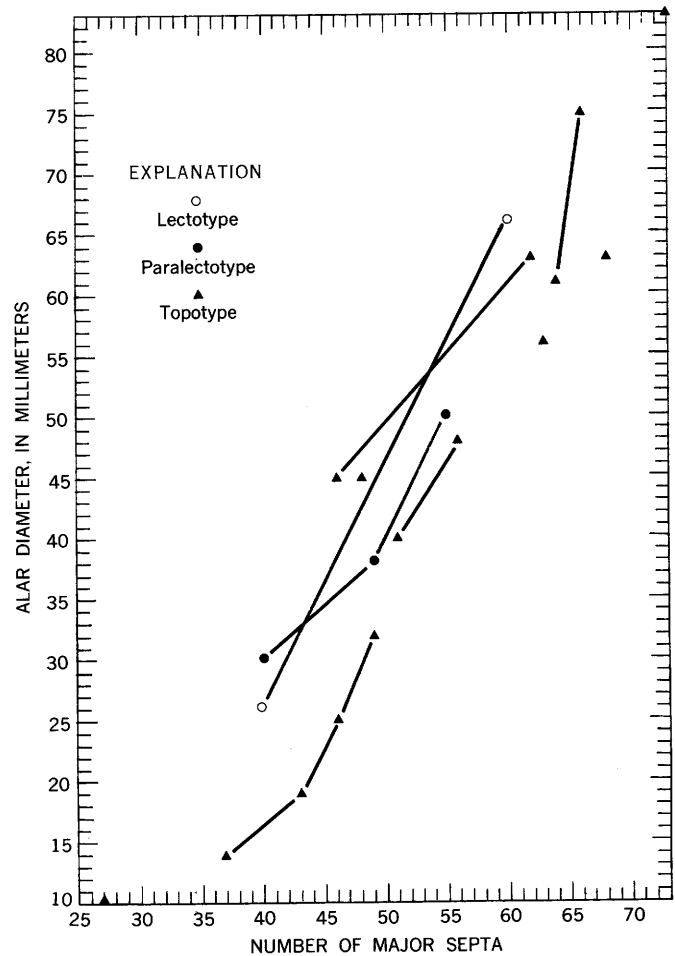


FIGURE 6.—Scatter diagram showing relation between alar diameter and number of major septa by means of 20 measurements on 11 specimens of *Caninia excentrica* (Meek). Straight lines connect measurements made on the same specimen.

in figure 6 along with similar measurements made on the lectotype and a paralectotype. This graph does not include the maximum number of major septa, which could not be counted at the top of the calice in the largest specimens.

Thin sections of the topotypes serve to illustrate characteristic features of the species better than the primary type material owing to less pronounced crushing of internal structures. Although the earliest growth stages are not preserved in any of the specimens studied, serial transverse sections (pl. 12, figs. 1–6) of a young individual illustrate internal features from an alar diameter of approximately 10–33 mm. These sections exhibit a breviseptal stage throughout the part of the corallum represented. Septa of the cardinal quadrants are dilated, whereas those of the counter quadrants are very thin. The cardinal septum is short and is in an ill-defined fossula. Dissepiments first become evident

at a stage represented by 43 major septa at an alar diameter of 19 mm.

Transverse sections (pl. 12, figs. 7 and 8) of another topotype illustrate characteristic internal features of the mature corallum. The dissepimentarium consists of a broad zone of lonsdaleoid dissepiments between two narrow zones of herringbone and regular dissepiments. The dissepimentarium may occupy as much as half the radius of the corallum, although it is notably constricted at the points of septal insertion (cardinal and alar positions). The central tabularium is approximately rhomboid in transverse section, and has an acute cardinal angle and a broadly rounded counter side. Short major and minor septa are present in the narrow peripheral zone of the dissepimentarium. The major septa are represented by sporadic crests on some of the lonsdaleoid dissepiments and their axial extensions protrude for short distances into the tabularium. Major septa of the cardinal quadrants are strongly dilated; those in the counter quadrants are thin. The cardinal septum is short and is in a moderately well defined fossula.

A longitudinal section (pl. 11, fig. 4) cut in the cardinal-counter plane of another topotype shows other features of the dissepimentarium and tabularium. The tabulae are complete and incomplete, generally horizontal, but ranging from flat to slightly concave or convex and turned down at the cardinal side of the corallum. The tabular plates are very thin, 0.1–0.2 mm in thickness, and variably spaced from less than 1 mm to as much as 6 mm apart. Dissepiments on the cardinal side of the corallum are small, globose, and steeply inclined. On the counter side of the corallum, the dissepiments are steeply inclined at the inner and outer sides of the dissepimentarium but become more nearly horizontal in the intermediate zone. Inner and outer parts of the dissepimentarium are characterized by small globose dissepiments, whereas the intermediate (lonsdaleoid) zone consists of large elongate dissepiments.

*Type locality.*—Meek's specimens were collected on "Old Baldy" mountain which is at the head of Alder Gulch, famous for its placer gold, south of Virginia City, Mont. The locality is described briefly by Hayden (1873, p. 64) in his report on the expedition of 1872. Meek (1873, p. 434) recognized Chester and pre-Chester equivalents in the faunas collected from Old Baldy.

It was my good fortune to visit the area of the type locality in 1957 with J. B. Hadley, who was at that time mapping the Varney quadrangle. The name Baldy Mountain is now applied to the 9,600-foot promontory at the culmination of an eastward-trending ridge and a northwestward-trending ridge at the head of

Alder Gulch in the Gravelly Range. Baldy Mountain proper is made up of rocks which belong to the Mission Canyon Limestone, but younger rocks mapped as Big Snowy Group by Hadley (1960) crop out at the head of Arasta Creek on the southeast flank of a large cirque bounded by the high ridges. A stratigraphic section including the Big Snowy Group was measured here in NE $\frac{1}{4}$  sec. 35, T. 7 S., R. 3 W., Madison County, Mont. A bed containing abundant *Caninia excentrica* was found in the upper part of a 20-foot cherty limestone unit that occurs approximately 430 feet above the top of the Mission Canyon Limestone. Specimens collected at this locality are virtually identical in morphology, preservation, and matrix to Meek's types. Consequently, I regard the specimens collected in 1957 as topotypes. Associated brachiopods indicate that the topotypes occur in strata of Late Mississippian (Middle Chester) age (Dutro and Sando, 1963a, p. 94).

*Discussion.*—Meek (1873, p. 468) founded this species with a footnote diagnosis appended to a faunal list for a collection made in Montana. The original type material was then evidently misplaced until rediscovered during the present study. Subsequent concepts of the species were based on Meek's (1877, p. 52, pl. 4, figs. 1–1d) illustrations and description of a specimen from Utah, which Schuchert (1905, p. 703) incorrectly listed as a cotype.

The lectotype, paralectotypes, and topotypes described and illustrated in the present paper provide an excellent basis for the species concept. Judging from this material, the species is characterized by its large curved rapidly expanding trochoid corallum having the cardinal septum generally on the convex side, broad tabularium approximately rhomboid in cross section, septal dilation confined to the cardinal quadrants, and dissepimentarium composed of a lonsdaleoid zone between inner and outer zones of herringbone and regular dissepiments.

*Caninia nevadensis* (Meek) (1877, p. 60, pl. 5, figs. 3–3b) and *Caninia enormis* Easton (1945, p. 524, figs. 3–7) differ from *C. excentrica* by their smaller calicular angle and their cylindrical corallum at maturity. A discussion of the relationships of these similar taxa is given elsewhere in this paper under the heading of *Caninia nevadensis*. Although future studies may prove that the three species are merely variants of a single biologic unit, present evidence favors continued separation.

I have found several recorded occurrences of *Caninia excentrica* that I regard as incorrect identifications of the species. White (1875, p. 101, pl. 6, fig. 3a) illustrated and described a specimen (USNM 8464) from Fossil Hill, Nev. This specimen, illustrated herein

for comparison (pl. 13, figs. 1-6), appears to be a decorticated example of *Caninia trojana* Easton (1960, p. 574, text figs. 2-4) and probably was derived from beds of Pennsylvanian age (Easton, 1963). A specimen from the Mississippian of the Mackay region, Idaho (USGS loc. 1145-PC) assigned questionably to the species by Girty (in Umpleby, 1917, p. 30) is a large horn coral of uncertain affinities, definitely not *Caninia excentrica*. Girty's (in Hewett, 1931, p. 28) specimen from the Bird Spring Formation, Goodsprings quadrangle, Nevada (USGS loc. 4260B-PC) is a large horn coral of approximately the right size and shape for *C. excentrica*, but complete destruction of internal details by recrystallization makes generic and specific determination impossible. Duncan's (in Crittenden, 1959, p. 71, 72) usage of the name refers to a large suite of specimens from an Upper Mississippian black shale unit in the western Uinta Mountains, Utah (USGS loc. 10390-PC). These specimens differ from the types of *C. excentrica* by their weakly colonial habit, ordinarily nonlonsdaleoid dissepimentarium, narrower tabularium, and smaller maximum diameter.

The presence of *Caninia excentrica* has been confirmed at several localities in Utah and Idaho. A specimen (USNM 24539) from the Upper Mississippian at Boxelder Peak, Utah, was correctly referred to the species by Meek (1877, p. 52, pl. 4, figs. 1-1d). This specimen, which shows strong rejuvenation in the calice, is illustrated herein (pl. 12, figs. 9-13) for comparison with the types. The species has been recorded in the Upper Mississippian at Dry Lake, Utah, a few miles from the Boxelder Peak locality, by Williams (1943, p. 596) and Williams and Yolton (1945, p. 1146, 1149). Although I have not examined Williams' material, specimens (USGS locs. 15178, 15179-PC) collected by Mackenzie Gordon, Jr., from the same locality compare very favorably with the types and are here included in the species. Parks' (1951, p. 181, 182, pl. 29, figs. 6a, b, 7a, b) *Caninia* sp. A and *Caninia* sp. B from the Dry Lake section, although based on fragmentary and probably immature specimens, may also belong in the species. A large suite of specimens from the Monroe Canyon Limestone of the Chesterfield Range, southeast Idaho (USGS locs. 18715, 18718, 18719-PC), which was provisionally identified previously (Sando in Dutro and Sando, 1963b, p. 1982) is now confidently assigned to the species. The specimen that Sloss (1945, p. 311, pl. 48, figs. 1-4) described and illustrated under the heading of *Caninia juddi* (Thomson) may belong in *C. excentrica*, but I have not examined this material and could not determine all the species characters from Sloss' paper.

Attention has been drawn recently to the widespread

occurrence of *Caninia* in beds of Late Mississippian (Chester) age in the northern Cordilleran region (Parks, 1951, p. 183; Duncan in Crittenden, 1959, p. 72; Dutro and Sando, 1963a, p. 94; Dutro and Sando, 1963b, p. 1974). The known occurrences of *Caninia excentrica* are confined to this Upper Mississippian zone. At present two other species of *Caninia*, *C. nevadensis* and *C. enormis* are recognized in the zone. Because these species are both rather similar to *C. excentrica*, future studies should be directed toward establishing the range of variability in the species in order to determine whether they are actually distinct.

#### *Caninia nevadensis* (Meek)

##### Plate 13, figures 7-11

- 1877. *Cyathophyllum* (*Campophyllum*?) *Nevadense* Meek, p. 60, pl. 5, figs. 3-3b.
- 1877. *Cyathophyllum Nevadensis*. Hague in Hague and Emmons, p. 405.
- 1878. *Cyathophyllum Nevadensis*. King, p. 181.
- 1878. *Cyathophyllum* (*Campophyllum*) *Nevadensis* Meek. King, p. 239, 244.
- 1889. *Cyathophyllum nevadense* Meek. Miller, p. 182 (bibliographic reference).
- 1898. *Cyathophyllum nevadense* Meek. Weller, p. 204 (bibliographic reference).
- 1905. *Cyathophyllum* (*Campophyllum*?) *nevadense* Meek. Schuchert, p. 191 (bibliographic reference).
- 1920. *Cyathophyllum nevadense* Meek. Girty, p. 650, pl. 52, fig. 3.
- 1943 [?] *Campophyllum Nevadense*? Girty in Calkins and Butler, p. 28.
- 1944. *Caninia nevadensis* (Meek). Easton, p. 124, figs. 1a, b.
- 1950. *Caninia nevadensis* (Meek). Bassler, p. 219 (bibliographic reference).
- 1959. [?] *Caninia nevadensis* (Meek). Duncan in Crittenden, p. 72.
- 1961. [?] *Caninia nevadensis* (Meek)? Duncan in Tooker and Roberts, p. 25.

*Type material*.—The species was founded on a single specimen, the holotype, cataloged under USNM 24544. The original specimen illustrated as Meek's (1877, pl. 5) figure 3 was evidently partly destroyed by the author of the species in order to examine internal details. All that remained when I examined the material was the upper half of the specimen. This was broken longitudinally by Meek and half of the specimen was illustrated as his figure 3a. I cemented the broken halves together in order to make transverse thin sections.

*Description of holotype*.—The fragmentary corallum (pl. 13, figs. 10 and 11) is seemingly nearly cylindrical, expanding from a diameter of 38 mm to a maximum diameter of 52.5 mm in an observed length of 70 mm. Judging from Meek's (1877, pl. 5, fig. 3) illustration, this specimen was originally about twice as long as it is now, and the corallum was strongly curved. The cardinal side is convex.

Two transverse sections (pl. 13, figs. 7 and 8) cut 50 and 60 mm below the top of the calice show internal features of the mature corallum. These sections show 49 and 50 major septa at diameters of 43 and 44 mm, respectively. In both sections, the septa of the cardinal quadrants are dilated, whereas those of the counter quadrants are undilated. The cardinal septum is short and is in a moderately well defined fossula. The counter septum is also shorter than neighboring major septa. Minor septa are confined to the peripheral region of the corallum. The dissepimentarium composes approximately a third to half the radius of the corallum and consists of an inner zone of herringbone and regular dissepiments, an intermediate zone of lonsdaleoid dissepiments, and an outer zone of regular and herringbone dissepiments.

A longitudinal section (pl. 13, fig. 9) cut in the cardinal-counter plane shows only a few thin tabulae (6 in 5 mm), but there is evidence that many tabulae at higher levels in the corallum were removed during or before deposition of the enclosing sediment, so that the calice appears deeper than it actually was. The tabulae are mostly flat and horizontal and have slightly down-turned edges. The dissepiments are globose to elongate and steeply inclined.

The septal microstructure is diffusotrabecular and has fibrolamellar dilation.

*Type locality.*—The type locality as stated by Meek (1877, p. 60) is: "Boxelder Peak, Wasatch Range, Utah; Carboniferous." The locality is described briefly by Hague (in Hague and Emmons, 1877, p. 404–405). According to Williams (1948, p. 1126), Boxelder Peak marks the highest point of Wellsville Mountain, an altitude of 9,355 feet. Although there are no published geologic maps of the area including Boxelder Peak, the species listed by Hague (in Hague and Emmons, p. 404, 405) are the same as those found in the "Brazer" Limestone as mapped by Williams and Yolton (1945) at Dry Lake in the Logan quadrangle, approximately 5 miles southeast of the peak. Inasmuch as *Caninia* is restricted to Williams and Yolton's units 4 and 5 of the Dry Lake section, the type material of *Caninia nevadensis* was probably collected from the same strata on Boxelder Peak. According to Williams and Yolton (1945, p. 1149–1150), their units 4 and 5 of the "Brazer" Limestone are of Late Mississippian (Chester) age.

*Discussion.*—The exact relationship of *Caninia nevadensis* to two contemporaries, *C. excentrica* Meek and *C. enormis* Easton, remains to be determined. Although the three taxa are very similar, the available type material does not permit a final decision as to whether they are conspecific or merely closely related species.

*Caninia enormis* Easton (1945, p. 524, figs. 3–7) was founded on material collected from the Big Snowy Group (Otter Formation equivalent) at Lombard, Mont. My knowledge of this taxon is based on studies of the primary type lot, which consists of 39 mostly fragmentary and immature individuals, and a suite of 36 topotypes collected at the precise stratigraphic level and geographic location of the primary types.

Several misconceptions concerning the morphology and growth habit of *Caninia enormis* need clarification. Although Easton (1945, p. 526) did not find lonsdaleoid dissepiments in the type material, many of the mature specimens in the primary type lot as well as the topotypes show a lonsdaleoid zone between outer and inner nonlonsdaleoid zones in the dissepimentarium. The transverse sections, including those of the holotype, illustrated by Easton represent immature stages. According to Easton (1945, p. 524) the cardinal side of the corallum is convex in this species. My study of the primary types revealed that the cardinal side is convex on the holotype and six paratypes but concave on four paratypes. Moreover, on three topotypes the cardinal side is concave and on one topotype the cardinal septum is 90° from the plane of curvature. Many of the specimens are vermiform or uncurved so that the cardinal position cannot be related to curvature of the corallum. I conclude that *Caninia enormis* is characterized by a cardinal position that is variable with respect to curvature of the corallum. Easton (1945, p. 524, 526, 528) also emphasized the presumed colonial tendency of this species. Two etched silicified paratypes are cemented together near their tips and along a distance of 4 cm higher in the corallum, but I can find no evidence of skeletal confluence and regard this phenomenon as the result of silicification. A block of matrix contains several immature individuals lying in a parallel position, but other individuals in the same block are in various positions at large angles to the parallel ones. Moreover, the topotypes show no evidence of colonial habit. I conclude that a colonial habit remains to be conclusively demonstrated in *Caninia enormis*.

The holotype of *Caninia nevadensis* falls well within the limits of variation seen in the type lot of *Caninia enormis* with regard to both internal and external morphology. Figure 7 shows the close correspondence in the ratio of alar diameter to number of major septa in the two taxa. However, I am reluctant to regard *C. enormis* as a junior synonym of *C. nevadensis* because the latter is known only from a single specimen, which does not permit an evaluation of the variability of Meek's species. A final decision concerning the exact relationship of the two taxa must await a study of topotype material of *C. nevadensis*.

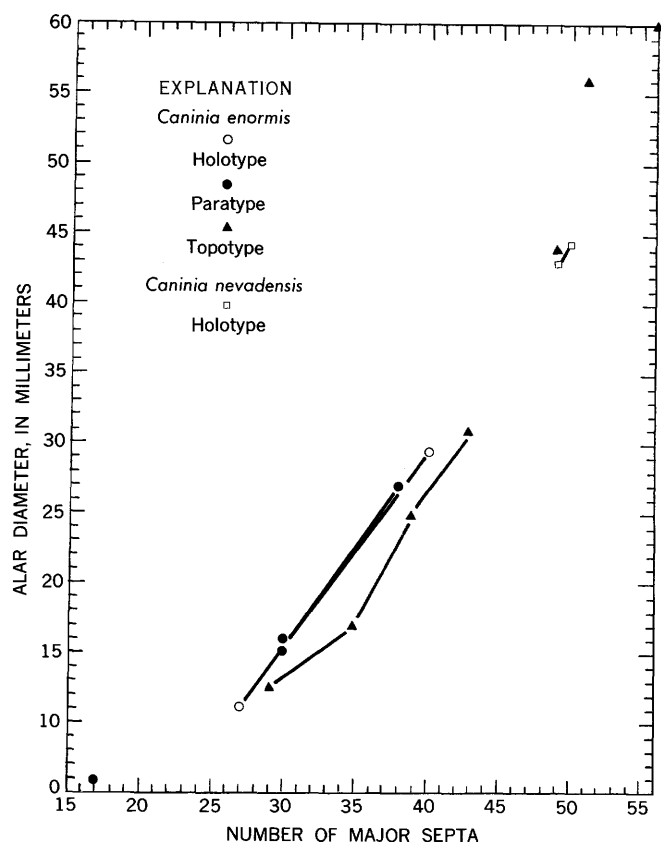


FIGURE 7.—Scatter diagram showing relation between alar diameter and number of major septa by means of 13 measurements on 8 specimens of *Caninia enormis* Easton and 2 measurements on the holotype of *Caninia nevadensis* (Meek). Straight lines connect measurements made on the same specimen.

*Caninia excentrica* (Meek) pertains to curved conical rapidly expanding (calicular angle ordinarily 45°–70°) coralla having an internal morphology like that of *Caninia nevadensis*. *C. nevadensis* and *C. enormis* differ from *C. excentrica* only by the form of the corallum, which is narrowly expanding (calicular angle generally about 30°) in early stages and cylindrical in later stages. In spite of this difference in the form of the corallum, specimens of *C. nevadensis* and *C. enormis* show similar trends in the ratio of alar diameter to number of major septa (compare figs. 6 and 7). Neither the primary type lot nor the topotype collection of *C. excentrica* contain cylindrical forms. In the absence of accessory type material, the presence of rapidly expanding coralla at the type locality of *C. nevadensis* has not been established. Consequently, present evidence favors continued separation of these two similar taxa.

Specimens questionably referred to *Caninia nevadensis* by Girty (in Calkins and Butler, 1943, p. 28) from USGS locality 3982a-PC, Humbug Formation, Cotton-

wood quadrangle, Utah, and by Duncan (in Tooker and Roberts, 1961, p. 25) from USGS locality 16329-PC, Oquirrh Formation, Oquirrh Mountains, Utah, are too fragmentary and immature for specific identification.

#### Genus FAVIPHYLLUM Hall

1852. *Faviphyllum*? Hall, p. 407.

1889. *Faviphyllum*. Miller, p. 187.

1940. *Faviphyllum* Hall. Lang, Smith, and Thomas, p. 60.

*Type species*.—*Faviphyllum*? *rugosum* Hall (1852, p. 407, pl. 1, figs. 1a, b). Lower Mississippian, Utah.

*Diagnosis*.—Conico-cylindrical solitary corals having major septa which may or may not reach the axis of the corallum but do not unite to form an axial structure. Septal plan may be radial or septa may be arranged bilaterally with respect to cardinal-counter plane. Tabulae concave or bowl shaped. Dissepimentarium composed mainly of lonsdaleoid dissepiments.

*Discussion*.—Hall described a single species under the heading of *Faviphyllum*?. The genus was neither described, diagnosed, nor discussed. Neither the generic name nor the specific name has ever been applied to specimens other than Hall's types. The presence of a question mark after the generic name in the original citation adds to the ambiguity of Hall's intent in using the name. The possibility that *Faviphyllum* is merely a *lapsus* for *Favosites* Lamarck seems unlikely because in his discussion Hall (1852, p. 408) pointed out features which differentiated his coral from *Favosites*. Lang, Smith, and Thomas (1940, p. 60) regarded *Faviphyllum* as a *nomen nudum*. Their reasoning was based on the interpretation that the species was only doubtfully referred to the genus and hence could not serve as type species by monotypy. Therefore, the genus was without a type species and the generic name must lapse.

It seems extremely unlikely to me that Hall would questionably refer his new species to his own new genus. I can conceive of no logical reason for taking such an action, even at a time when the system of zoological nomenclature was in its infancy. Therefore, I do not agree with the interpretation of Lang, Smith, and Thomas that *Faviphyllum* is a *nomen nudum*. Instead, I offer two alternative interpretations: (1) *Faviphyllum* was proposed as a provisional genus; this interpretation is consistent with taxonomic practice of Hall's time, when taxonomic relationships were much more poorly known than they are today; or, (2) The question mark following the generic name is a typographical error; this interpretation is supported by the appearance of the name without a question mark in the index to Stansbury's report, and by the fact that there are numerous editorial discrepancies in Hall's paper. In either case, it seems to me that the generic

name meets the criteria of availability stated in Chapter IV of the International Code of Zoological Nomenclature (1961).

In spite of the availability of *Faviphyllum* as a generic name, there are cogent reasons for invalidating it. Aside from the original reference, this name has been published only in compilations such as those cited in the present synonymy. No specimens other than the type specimens of the type species have been referred to it. Although the type material is poorly preserved and fragmentary, the type species exhibits generic characters which link it unquestionably with *Vesiculophyllum* Easton, a well-established and widely used genus. If *Faviphyllum* Hall, 1852, were regarded as a valid generic name, it would preoccupy *Vesiculophyllum* Easton, 1944. Inasmuch as *Faviphyllum* is based on limited and poorly preserved material of uncertain stratigraphic position and the name has not been used in the primary zoological literature for more than a hundred years, I can find no logical reasons for retaining it in the taxonomic hierarchy. Therefore, I have petitioned the International Commission on Zoological Nomenclature to suppress *Faviphyllum* Hall under the provisions of Article 79 of the International Code of Zoological Nomenclature (1961).

**"Faviphyllum rugosum" Hall**

Plate 14, figures 1-9

1852. [?] *Favosites*, Stansbury, p. 211.

1852. *Faviphyllum? rugosum* Hall, p. 407, pl. 1, figs. 1a, b.

1898. *Faviphyllum? rugosum* Hall, Weller, p. 271.

1905. *Faviphyllum? rugosum* Hall, Schuchert, p. 268.

1940. *Faviphyllum?* [sic] *rugosum* Hall. Lang, Smith, and Thomas, p. 60.

1950. *Faviphyllum rugosum* Hall. Bassler, p. 220.

*Type material*.—The syntype lot consisted of the two specimens illustrated by Hall and cataloged under USNM number 15056. I have chosen the specimen illustrated by Hall (1852, pl. 1, fig. 1b) as lectotype and given it the new USNM number 144768.

Hall's other specimen was partly destroyed by Bassler, who made three longitudinal sections and one transverse section from it. The specimen, now regarded as paralectotype, has been given the new USNM number 144769.

*Description of lectotype*.—This specimen (pl. 14, figs. 5 and 6) is a decorticated silicified mainly cylindrical corallum approximately 90 mm long. Neither the tip of the corallum nor the top of the calice is preserved. The corallum expands from a diameter of approximately 20 mm at its imperfect lower extremity to a maximum observable diameter of approximately 35 mm. Rejuvenation occurs approximately 50 mm above the lower extremity.

A transverse section approximately 20 mm in diameter cut 7 mm above the lower extremity (pl. 14, fig. 2) shows 33 thin slightly sinuous major septa arranged mostly radially with respect to the axis of the corallum. This is not the true septal complement because one sector of the corallum is not preserved in this section. Neither cardinal, counter, nor alar septa can be identified. Minor septa are not present. Straight to inwardly convex intercepts of regular dissepiments occur in the interseptal loculi. No lonsdaleoid dissepiments were noted, but their absence at this stage cannot be confirmed, because an undeterminable amount of the outer corallum is not preserved. A septum-free axial zone occupies approximately one-fourth the diameter of the corallum. The axial zone is bounded by concentric traces of incomplete tabulae, interrupted in places by the axial ends of some of the major septa, which project into the tabularium.

In a transverse section approximately 25 mm in maximum diameter cut 25 mm above the lower extremity of the corallum (pl. 14, fig. 3), only about half the lumen is preserved. Twenty-one major septa (approximately half of the true septa complement) can be observed in this section. As in the previous section, the major septa are thin and somewhat sinuous, and the primary septal elements cannot be determined. The septal pattern is difficult to determine owing to the incompleteness of the section, but there is evidence of palmate groupings of three or more septa. The major septa extends almost to the axis of the corallum so that the open axial zone of the previous section is no longer evident. The major septa terminate peripherally against a zone of large lonsdaleoid dissepiments whose true width cannot be determined owing to the absence of preserved epitheca. Minor septa are absent.

A transverse section about 35 mm in maximum diameter cut 45 mm above the lower extremity of the corallum (pl. 14, fig. 4) presents a pattern of internal elements similar to that of the preceding section. However, the septa now appear to be somewhat regularly arranged with respect to an axial plane of bilateral symmetry. Approximately two-thirds of the lumen is preserved in this section. Thirty-two major septa can be seen in the incomplete section. Minor septa were not observed. The lonsdaleoid dissepimentarium is about twice as wide as in the previous section, but the true width of this zone is indeterminate owing to incomplete preservation.

A longitudinal section cut between the second and third transverse sections described above (pl. 14, fig. 1) shows a dissepimentarium approximately 13 mm wide and an axial tabularium 9 mm in diameter. The dissepiments are large, elongate, and steeply inclined. The

tabulae are incomplete and generally bowl shaped; they are flat or concave in the axial region and steeply inclined peripherally, where they tend to merge with the dissepiments.

Septal microstructure has been obliterated by recrystallization.

*Description of paralectotype.*—The preservation of this specimen is similar to that of the lectotype. Judging from Hall's illustration (1852, pl. 1, fig. 1a), it consisted of a fragmentary cylindrical corallum approximately 65 mm long and 25 mm in maximum diameter. Only the lower 30 mm of the specimen remained intact when I examined it.

Two transverse sections, one cut 11 mm above the lower extremity of the corallum (pl. 14, fig. 7) and the other cut 28 mm above the lower extremity (pl. 14, fig. 8), reveal an internal structure similar to that seen in the lowest transverse section of the lectotype (pl. 14, fig. 2). These sections exhibit 37 major septa at a maximum diameter of 12 mm and 38 major septa at a maximum diameter of 15.5 mm. The septa in the lower section are slightly dilated and wedge-shaped. In both sections, the axial zone is virtually open, and only a few septa project into the tabularium. Lonsdaleoid dissepiments are not evident, but their absence cannot be confirmed owing to decortication. The major septa are mainly radially arranged. Minor septa are absent.

Bassler's longitudinal section (pl. 14, fig. 9), cut from an unknown position in the corallum, shows a series of elongate nearly vertically inclined dissepiments surrounding an axial tabularium approximately 2–3 mm in diameter. The tabulae are bowl shaped.

*Type locality.*—Hall did not state the locality from which his specimens were collected. However, the lectotype bore an old label upon which was written "Stansbury's I.," and Bassler's slides cut from the paralectotype are similarly designated. The locality is unquestionably Stansbury Island, a mountainous prong which is actually connected by salt flats to the southwest shore of the Great Salt Lake, Tooele County, Utah.

Stansbury (1852, p. 211) described a coralliferous black and gray limestone that occupies the summit of the highest peak on the island, near the center of the mountain range. According to Stansbury, the limestone is underlain by 200 feet of "white siliceous sandstone." Inasmuch as this is the only mention of fossiliferous outcrops on Stansbury Island in Stansbury's report, it seems likely that Hall's specimens were collected at this locality.

The known stratigraphic range of the genus *Vesiculophyllum*, which is synonymous with *Faviphyllum*, is restricted to the Madison Group and its

equivalents in the Western United States. Corals that belong to this genus occur in the Gardner Dolomite as used by Rigby (1958) in the Stansbury Mountains, immediately south of Stansbury Island. According to Walter Sadlick (written commun., 1963), the most likely source of Hall's specimens on Stansbury Island is the Gardison Limestone, which is exposed near the center of R. 6 W. on both sides of the boundary between T. 1 N. and T. 2 N. Judging from Stansbury's (1852, p. 211) description of the locality, the corals were probably collected on one of the two peaks which are located on either side of the boundary between T. 1 N. and T. 2 N. (U.S. Geol. Survey, Tooele quadrangle map, 1:250,000 series, 1962 ed.).

*Discussion.*—The status of Hall's species is as tenuous as that of his genus. The two specimens that form the basis for the species concept are so poorly preserved and incomplete that specific characters are at best only doubtfully ascertained. The type locality is obscure, and it is questionable whether anyone searching for topotype material could ever be sure that he had located the exact type locality. This name, like the generic name, has not been used in the primary zoological literature for more than a hundred years. Therefore, I have made application to the International Commission on Zoological Nomenclature to have Hall's species name suppressed under Article 79 of the International Code of Zoological Nomenclature (1961).

Suborder COLUMNARIINA  
Family LONSDALEIIDAE  
Subfamily LONSDALEIINAE

Genus *SCIOPHYLLUM* Harker and McLaren

1950. *Sciophyllum* Harker and McLaren, p. 31.

*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 adjunctivum* (White)

Plate 15

- 1880a. *Acervularia adjunctiva* White, p. 255, pl. 1, figs. 1–3.
- 1880b. *Acervularia adjunctiva* White, p. 120, pl. 35, figs. 1a–d.
- 1889. *Acervularia adjunctiva* White. Miller, p. 170 (bibliographic citation).
- 1898. *Acervularia adjunctiva* White. Weller, p. 53 (bibliographic citation).
- 1905. *Acervularia adjunctiva* White. Schuchert, p. 20 (bibliographic citation).



1950. *Acervularia?? adjunctiva* White. Bassler, p. 219 (bibliographic citation).

*Type material.*—The syntype lot consisted of 30 fragments of coralla cataloged under USNM 8030. Bassler made eight thin sections from these specimens. One specimen, partly destroyed by Bassler, was segregated from the other syntypes and bore the USNM designation for holotype. This specimen appears to be one of the specimens figured by White (1880b, pl. 35, fig. 1a). I could not identify any of the other specimens illustrated by White in the syntype lot.

The holotype designation is undoubtedly invalid and may have been added erroneously by a recent curatorial assistant. However, White's figured specimen is the logical choice to serve as lectotype and is so designated. This specimen is now cataloged under USNM 144786. The figured paralectotype is now cataloged under USNM 144787. The unfigured paralectotypes are retained under USNM 8030.

*Description of lectotype.*—The lectotype (pl. 15, fig. 1) is a fragment of a cerioid corallum approximately 5 by 5 by 2 cm. The prismatic corallites separate readily, displaying both longitudinal and transverse corrugations on their external faces. There are commonly four to seven evenly spaced longitudinal corrugations on a corallite face. Transverse corrugations are broader and less regular; there may be as many as four or five in 1 cm. Fine transverse striations (three to five per millimeter) apparently represent increments of vertical growth of the corallite walls.

Corallites are inequidimensional, probably owing to distortion of the corallum by deformation which affected the enclosing rock. Short corallite diameters range from 3.7 to 6.0 mm (average 4.8 mm) and long corallite diameters range from 7.0 to 10.5 mm (average 9.0 mm). Budding is intermural.

Delicate internal features are remarkably well preserved despite coarse recrystallization of sparry calcite that fills open spaces in the corallum. In transverse section (pl. 15, figs. 2 and 3), the tabularium appears as a well-defined ellipse (owing to deformation), whose long axis ranges from 2.5 to 5.5 mm and whose short axis ranges from 2.0 to 3.5 mm. The traces of two to four dissepiments are commonly visible in transverse section. The dissepimentarium occupies approximately half the radius of the corallum. Vestigial septa were identified in 6 out of 16 corallites; as many as 8 septa were found in a single corallite. None of the septa are more than 4 mm long, and they invariably arise on the inner wall of the tabularium where they project inward toward the axis of the corallite. The epitheca is approximately two-tenths of a millimeter thick.

In longitudinal section (pl. 15, figs. 4 and 5) the dissepimentarium is seen to consist of a single series of large inflated steeply inclined dissepiments. There are ordinarily two to three dissepiments in 5 mm. Tabulae are mostly concave and many are disposed at angles of as much as 45° from the horizontal. There are three to five tabulae in 5 mm.

*Description of paralectotypes.*—The paralectotypes are all fragments of coralla; the largest specimen is about 9 by 4.5 by 5 cm. Like the lectotype, these specimens are deformed and break readily between corallites. Available evidence does not indicate how many coralla are represented by these fragments. Longitudinal and transverse thin sections cut from two of the paralectotypes show mainly the same features seen in the lectotype.

*Type locality.*—The material was collected by Orestes St. John from Carboniferous strata in the "Blackfoot Range, south of Yellowstone National Park" (White, 1880a, p. 255). The mountains referred to are located in Bingham County in southeastern Idaho. St. John (1879, p. 342–344) mentions "*Lithostrotion*" at his topographic stations 8 and 9 in the Blackfoot Range. One of these stations is presumably the type locality, because lithostrotionoid corals are not mentioned elsewhere in St. John's description of the geology of the Blackfoot Range.

Location of the localities in terms of modern geographic coordinates was made by studying positions of the stations as shown on St. John's (1879, pl. 7) drainage sketch, his geologic cross sections (1879, pls. 13 and 14), and his descriptions of the areas (1879, p. 342–344) and comparing them with Mansfield's (1952, pl. 1) geologic map of the Ammon and Paradise Valley quadrangles. The most logical location for St. John's Station 8 is somewhere within the area mapped as Brazer Limestone by Mansfield on Blue Ridge in secs. 2, 3, 11, and 12, T. 3 S., R. 39 E. A probable location for St. John's Station 9 is in the continuation of the same Brazer belt southeast of Horse Creek in secs. 17, 20, 29, and 28, T. 3 S., R. 40 E.

The rocks mapped as Brazer by Mansfield in southeastern Idaho are now assigned to the Chesterfield Range Group, of Late Mississippian age (Dutro and Sando, 1963b, p. 1967). Judging from Mansfield's (1952, p. 20) description of the lithic sequence in the type area of White's species, the type material was probably collected from the Monroe Canyon Limestone (Dutro and Sando, 1963b, p. 1967). Evidently White's species is rare because I did not find other specimens in the many collections made by Mansfield and his co-workers or by Dutro and myself from the Mississippian of southeastern Idaho.



*Discussion.*—White's coral appears to be closely related to the type species of *Sciophyllum*, *S. lambarti* Harker and McLaren (1950, p. 31, pl. 4). However, *Sciophyllum adjunctivum* has a narrower tabularium relative to the corallite diameter and fewer and larger dissepiments arranged in only one series. Moreover, in White's species the tabulae are mostly concave and inclined, rather than flat or arched and horizontal as they are in the type species. *S. adjunctivum* also has fewer septa, and the septa are confined to the tabularium.

**Order TABULATA**  
**Family AULOPORIDAE**  
**Subfamily SYRINGOPORINAE**  
**Genus SYRINGOPORA Goldfuss**

1826. *Syringopora* Goldfuss, p. 75.

*Type species.*—*Syringopora ramulosa* Goldfuss (1826, p. 76, pl. 25, fig. 7). Carboniferous, Germany.

*Diagnosis.*—Erect fasciculate coralla composed of cylindrical corallites connected by hollow connecting tubes. Septa absent or represented by septal spines. Tabulae infundibular, commonly incomplete, coalesced in some species to form an axial tube which may be continuous or interrupted by horizontal tabulae.

***Syringopora occidentalis* Meek**

Plate 8, figures 10–14.

1877. *Syringopora occidentalis* Meek, p. 51, pl. 6, figs. 2, 2a.

1898. *Syringopora* (undet. sp.) Meek. Weller, p. 619 (bibliographic citation).

1905. *Syringopora occidentalis* Meek. Schuchert, p. 637 (bibliographic citation).

1950. *Syringopora occidentalis* Meek. Bassler, p. 220, (bibliographic citation).

*Type material.*—The holotype is the specimen figured by Meek (1877, pl. 6, figs. 2, 2a) and cataloged under USNM 24547.

*Description of holotype.*—The holotype (pl. 8, fig. 11) is a fragment of a colony approximately 4.5 by 3 by 2.5 cm. The corallites are silicified and partly imbedded in yellowish limestone.

Corallites are sinuous and erect, except for several horizontal branches at the base of the specimen, which apparently represents a level at or near the base of the original colony. Mature corallite diameters range from 2.0 to 2.3 mm, averaging 2.1 mm in 17 corallites. Corallite frequency ranges from six to eight corallites per square centimeter (average 6.8) in five measurements. Corallites are thick walled; walls range from 0.25 to 0.35 mm in thickness. Connecting tubes are abundant and occur at 2–5 mm intervals; three or four commonly arise at the same level.

In transverse section (pl. 8, figs. 12 and 14), the tabulae appear as nearly straight or slightly curved traces

arranged more or less concentrically around a central or slightly eccentric axial canal except in the vicinity of connecting tubes, where the axial canal is modified by its junction with the connecting tube structure. No septal spines or ridges are evident in any of the corallites.

Longitudinal sections (pl. 8, figs. 10 and 13) are mostly oblique cuts owing to sinuosity of the corallites. They show, rather poorly, an axial canal bounded by one to three rows of infundibular tabulae and transected by a few horizontal tabulae in some places.

*Type locality.*—Locality data given by Meek (1877, p. 51) are: "Southwest of Bald Mountain, Uinta Range, and at Morgan Peak, Wasatch Range, Utah; in a dark Carboniferous limestone." An old locality label with the holotype reads: "From the S. W. of Bald Mt. (Loose), Carb." The Morgan Peak locality is not represented in the available type material.

Inasmuch as S. F. Emmons surveyed and described (in Hague and Emmons, 1877, p. 311–325) the geology of the western Uinta Range for the King Survey, Meek's specimen was probably collected by the Emmons party. Emmons (in Hague and Emmons, 1877, p. 313) listed a fauna including *Syringopora multattenuata* and *Syringopora?* from "drab limestones of the Upper Coal-Measures" on Rhodes' Spur at the junction of Stanton Creek (now called Wolf Creek or West Fork) and the Duchesne River. Although this locality is almost due south, rather than southwest of the Baldy Mountain, it is the only place from which Emmons recorded a collection containing *Syringopora*.

Rhodes' Spur is composed of rocks mapped as Weber Sandstone and Park City Formation by Huddle and McCann (1947). According to Huddle and McCann, limestone occurs sparingly in the upper part of the Weber and the lower member of the Park City. The upper member of the Park City is mostly sandy and silty dolomitic limestone. Judging from Huddle and McCann's descriptions of the lithologies, Meek's specimens could have come from either the upper part of the Weber or the lower or upper member of the Park City. The entire Park City Formation is now considered to be Permian, and all of the Weber is regarded as Pennsylvanian in the area concerned (Helen Duncan, oral commun., 1964). Meek's specimen may be of upper Weber or Park City origin and is probably of Pennsylvanian or Permian age.

*Discussion.*—Although Meek (1877, p. 51) proposed the name *Syringopora occidentalis* conditionally, it nevertheless fulfills the criteria of availability of the International Code of Zoological Nomenclature (International Commission on Zoological Nomenclature, 1961, article 17). Unfortunately, the type specimen

is not well preserved and appears to represent the immature part of a corallum. These circumstances make it difficult to characterize the species. The possibility of collecting topotype material seems unlikely in view of the inadequate data on type locality. Meek's name has never been applied to any specimen other than the holotype and has not appeared in the primary zoological literature since 1877. In view of the uncertainties surrounding the type material I believe it best to regard *Syringopora occidentalis* as a nomen dubium.

Meek's coral appears to be related to *Syringopora multattenuata* McChesney (1859, p. 75; 1867, p. 2, pl. 2, figs. 4, 4a). I have made my comparison on the basis of McCutcheon's (1961) description and illustrations of the neotype of McChesney's species. The two species have about the same corallite diameter and density, wall thickness, and connecting tube spacing. The absence of septal processes and presence of an axial tube are other features that indicate close relationship. However, in *Syringopora multattenuata* the axial tube is more clearly defined and the incomplete tabulae are more numerous, more variable in size, and generally more inflated than in *S. occidentalis*.

#### Order TABULATA, position uncertain

##### "*Leptopora winchelli*" White

Plate 14, figures 10–16

1879. *Leptopora* sp.? Peale, p. 599, 620.  
 1879. *Leptopora winchelli* White, p. 211.  
 1880b. *Leptopora winchelli* White, p. 121, pl. 34, fig. 11a.  
 1889. *Leptopora winchelli* White. Miller, p. 194 (bibliographic citation).  
 1898. *Leptopora winchelli* White. Weller, p. 323 (bibliographic citation).  
 1903. [not] *Leptopora winchelli* White. Girty, p. 249, 250, 259, 327.  
 1905. *Leptopora winchelli* White. Schuchert, p. 351 (bibliographic citation).  
 1917. *Leptopora winchelli* White. Robinson, p. 164 (bibliographic citation).  
 1950. *Cleistopora winchelli* (White). Bassler, p. 219 (bibliographic citation).  
 1955. *Cleistopora typa winchelli* (White). Jeffords, p. 7, fig. 2.

*Type material.*—The syntype lot consisted of three specimens cataloged under USNM 8230. The largest specimen, not figured by White, is here designated as lectotype and now bears USNM number 144788. White's (1880b, pl. 34, fig. 11a) figured specimen, partly destroyed in making thin sections, is regarded as a paralectotype and is now cataloged under USNM 144789. White's other unfigured specimen, another paralectotype, is now cataloged under USNM 144790.

*Description of lectotype.*—This specimen (pl. 14, figs. 10 and 14) consists of a thin sheetlike corallum having imperfect margins so that the original size is indetermi-

nate. The specimen is approximately 4 by 2.5 by 1 cm and nearly completely covers the piece of brown dolomite matrix to which it adheres and which obscures the underside of the corallum. The entire corallum is composed of coarse silica.

The corallum is composed of approximately 75 polygonal corallites. Mature corallites are 2.5–3 mm in diameter and 1–2 mm deep. Tabulae are either absent or not preserved, and no other internal deposits can be identified. Corallite walls are 0.1–0.4 mm thick. Mural pores 0.1–0.2 mm in diameter were observed in the walls of some of the corallites; no pores were seen along the angles of the walls. Septa, septal spines, or septal ridges are either absent or not preserved.

*Description of paralectotypes.*—White's (1880b, pl. 34, fig. 11a) illustrated specimen (pl. 14, figs. 11 and 13) is very similar to the lectotype in all essential details. It appears to represent a somewhat smaller fragment of a corallum and contains about half as many corallites as the lectotype. Two thin sections were cut from this specimen. One of these (pl. 14, fig. 15) is an oblique longitudinal cut which shows very little other than the general outline of the walls owing to coarse silicification of wall structure. The other section (pl. 14, fig. 16) is a transverse cut made near the base of the corallum. Here again, silicification is so crude that only vague outlines of the corallites are discernible.

White's other unfigured specimen (pl. 14, fig. 12) is probably an immature corallum. The corallum is circular in outline and has a diameter of 5.5 mm. A central corallite 1.5 mm in diameter is surrounded by 11 radially arranged corallites. Corallite walls rise to a maximum height of 1.5 mm above the basal disk near the center of the corallum.

*Type locality.*—According to White (1880b, p. 121), the type material was "brought in by Dr. A. C. Peale, in the autumn of 1877, from near the forks of Logan River, in Bear River range, near the northern boundary of Utah." Peale (1879, p. 599) mentions *Leptopora* at his station 125 located on top of a hill on the east side of the North Fork of Logan River. The fossil was collected from westward-dipping "white saccharoidal limestone" that caps the hill and overlies "massive blue limestone."

Peale's description indicates that the locality is on top of the 7,000-foot hill in SW $\frac{1}{4}$  sec. 8, T. 12 N., R. 3 E., Cache County, Utah. This area was mapped as Laketown and Fish Haven Dolomites by Williams (1948, pl. 1). The matrix of the specimens is fine-grained brownish gray dolomite very similar to a rock type that is common in both the Laketown and Fish Haven Dolomites. Therefore, I believe that Peale's identification of the locality as Carboniferous is erro-

neous and that the material was actually collected from rocks of Ordovician or Silurian age.

*Discussion.*—The type material of this species is so poorly preserved that even generic identification is virtually impossible. Although the material has many features suggestive of *Favosites* and allied genera, the apparent absence of tabulae makes it impossible to refer the specimens unequivocally to this group. Reference to *Cleistopora* is neither supported by the morphology of the specimens nor by the probable Ordovician or Silurian age of the rocks from which they were collected.

In view of the existing uncertainties concerning the type material, the best interests of taxonomy would be served by avoiding the use of White's taxon. I suggest that *Leptopora winchelli* White be relegated to the status of *nomen dubium*.

Only one specimen outside of the type lot has ever been allocated to White's species. This specimen is the one described by Girty (1903, p. 327) from the Hermosa Formation of Colorado. I have examined Girty's specimen (USGS loc. 2279-PC) and find it to be a species of *Michelinia* similar to *M. latebrosa* Moore and Jeffords.

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**PLATES 1-15**

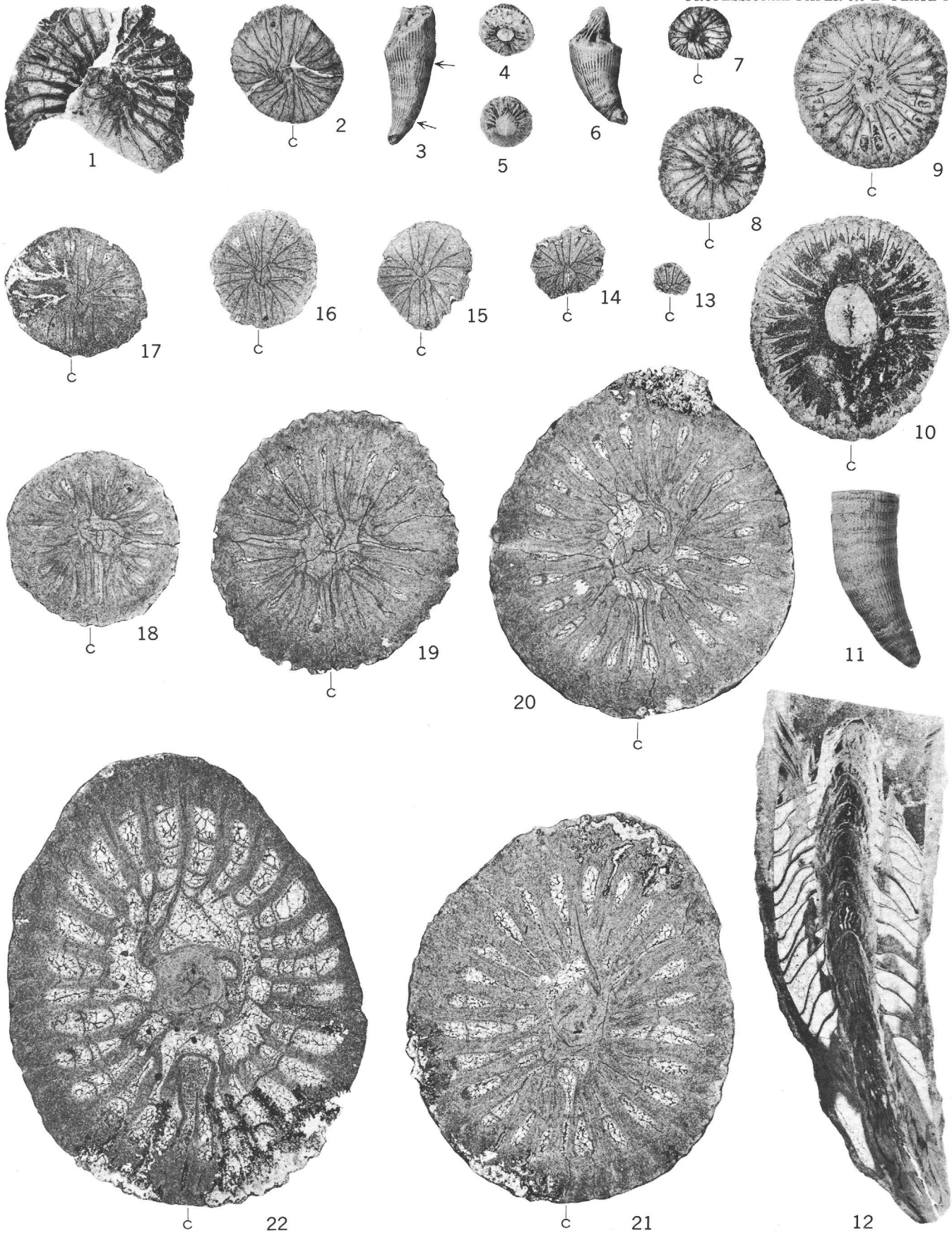
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## PLATE 1

FIGURES 1-22. *Lophophyllidium sauridens* (White) (p. E3).

- 1, 2. Serial transverse thin sections ( $\times 4$ ); paralectotype; USNM 144763c and 144763d, respectively.
- 3, 4. Alar and calicular views, respectively ( $\times 1$ ); paralectotype; USNM 144763; arrows in fig. 3 indicate positions of transverse sections shown in figs. 1 and 2.
- 5, 6. Calicular and alar views, respectively ( $\times 1$ ); paralectotype, original of White, 1875, pl. 6, fig. 4d; USNM 144765.
- 7-10. Serial transverse thin section ( $\times 4$ ); lectotype; USNM 144762a-d, respectively.
11. Alar view ( $\times 1$ ); paralectotype, original of White, 1875, pl. 6, fig. 4a; USNM 144764.
12. Longitudinal thin section ( $\times 3$ ); paralectotype, original of White, 1875, pl. 6, fig. 4b; USNM 144764.
- 13-22. Serial transverse peel sections ( $\times 8$ ); topotype; USNM 144766a-g, i-l, respectively; photographs slightly retouched.



*LOPHOPHYLLIDIUM SAURIDENS* (WHITE)

## PLATE 2

FIGURES 1-9. *Barytichisma zaphrentiforme* (White) (p. E7).

1. Longitudinal thin section ( $\times 2$ ); paralectotype, USNM 144778a.
2. Alar view ( $\times 1$ ); paralectotype, original of White, 1880a, pl. 33, fig. 1b; USNM 144777.
3. Alar view ( $\times 1$ ); lectotype, original of White, 1880a, pl. 33, fig. 1a; USNM 144776; arrows indicate positions of serial transverse thin sections shown in figs. 4-8.
- 4-8. Serial transverse thin sections ( $\times 3$ ); lectotype; USNM 144776a-e, respectively.
9. Longitudinal thin section ( $\times 3$ ); lectotype; USNM 144776f; section cut in the cardinal-counter plane between transverse sections illustrated in figs. 6 and 7.



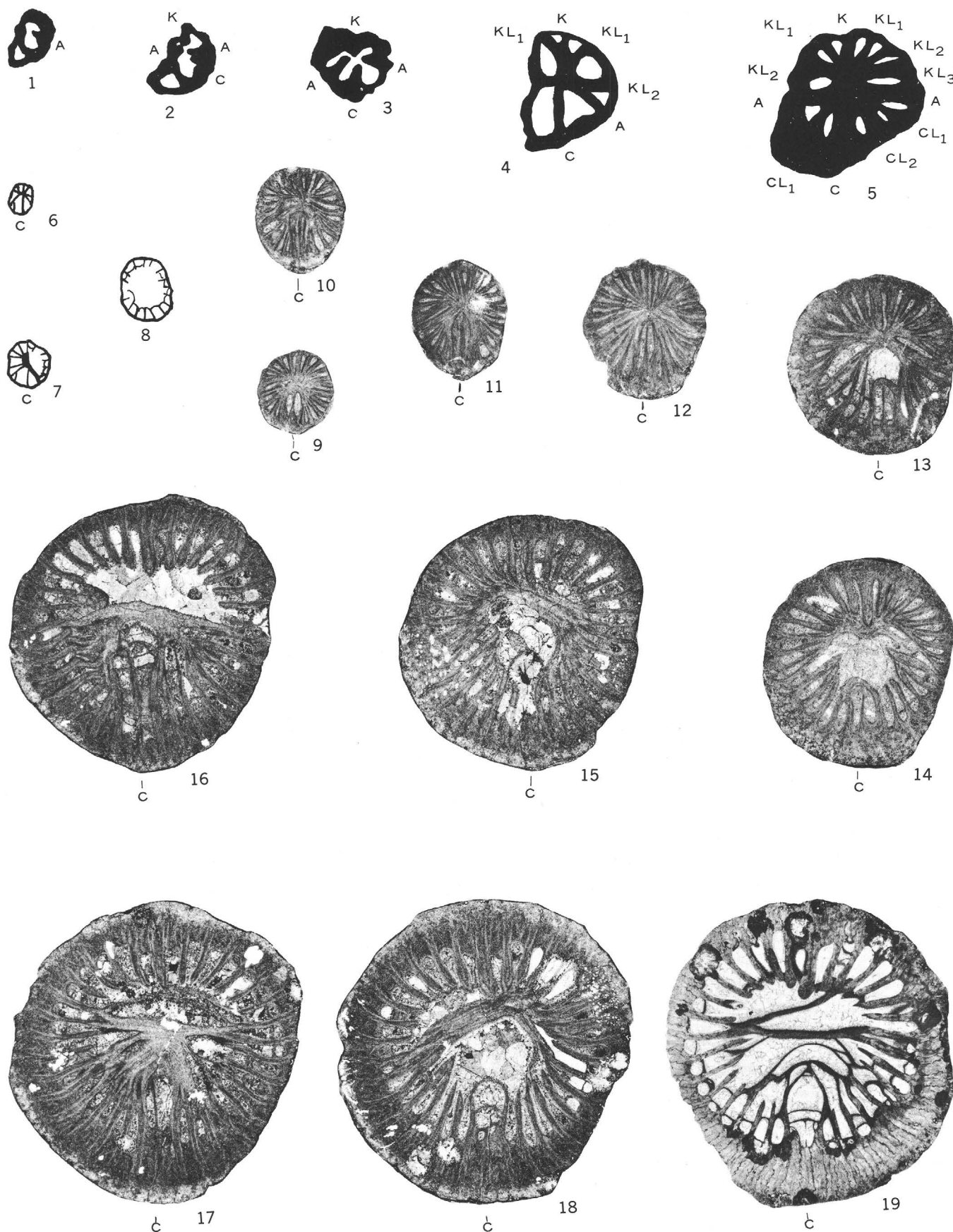
*BARYTICHISMA ZAPHRENTIFORME* (WHITE)

### PLATE 3

FIGURES 1-19. *Barytichisma zaphrentiforme* (White) (p. E7).

1-5. Drawings traced from photographs of serial transverse peel sections ( $\times 10$ ); paralectotype; USNM 144780a-e.

6-19. Serial transverse sections ( $\times 3$ ); paralectotype; USNM 144779a-n; figs. 6-8 are drawings traced from photographs of peel sections; figs. 9-18 are slightly retouched photographs of peel sections; fig. 19 is a photograph of a thin section.



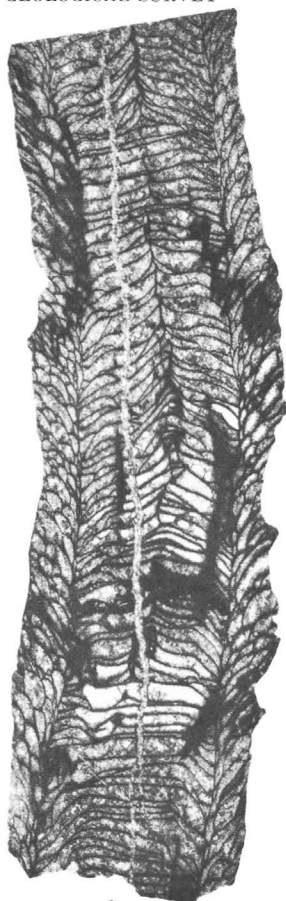
*BARYTICHISMA ZAPHRENTIFORME* (WHITE)

## PLATE 4

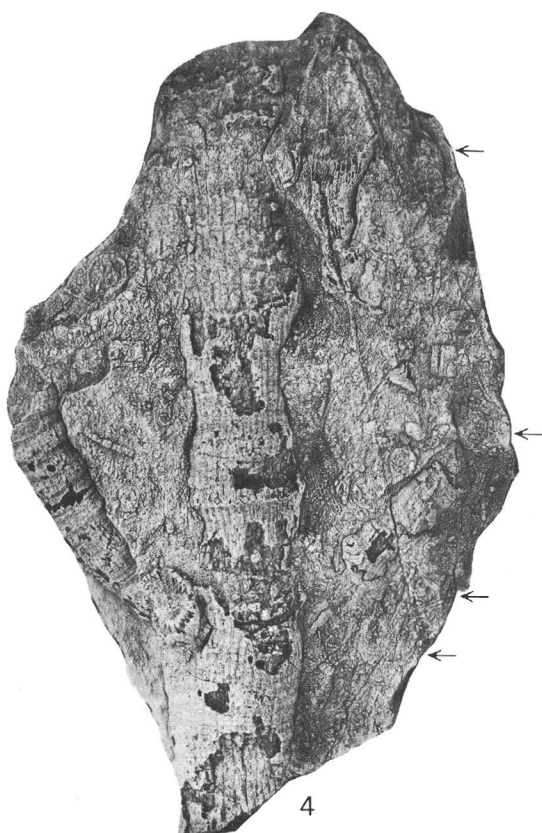
FIGURES 1-9. *Dorlodotia subcaespitosa* (Meek) (p. E11).

1. Longitudinal thin section ( $\times 2$ ); paralectotype; USNM 144784b; section cut above transverse section shown in fig. 2.
2. Transverse thin section ( $\times 2$ ); paralectotype; USNM 144784a.
3. Lateral view ( $\times 1$ ); paralectotype; USNM 144784; arrow indicates position of transverse section shown in fig. 2.
4. Lateral view ( $\times 1$ ); lectotype; USNM 144783; arrows indicate positions of transverse sections shown in figs. 5, 7-9.
5. Transverse thin section ( $\times 2$ ); lectotype; USNM 144783d.
6. Longitudinal thin section ( $\times 2$ ); lectotype; USNM 144783e; section cut between transverse sections shown in figs. 5 and 7.
- 7-9. Serial transverse thin sections ( $\times 2$ ); lectotype; USNM 144783c, b, and a, respectively.

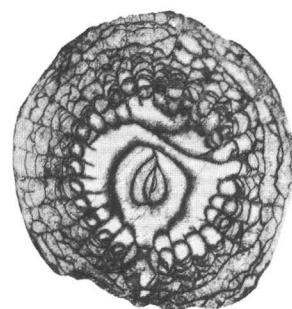




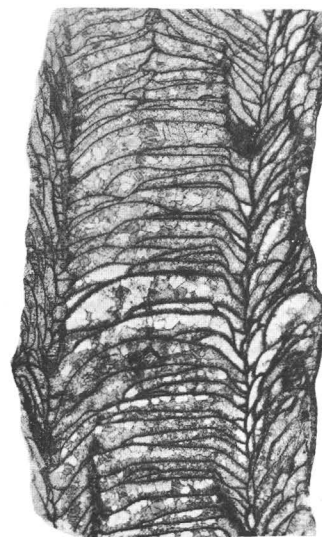
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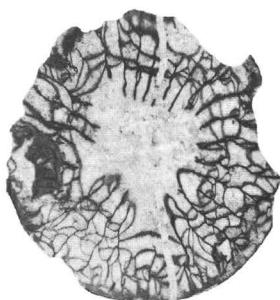
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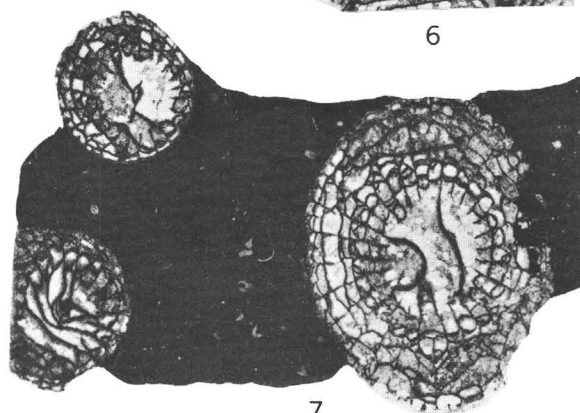
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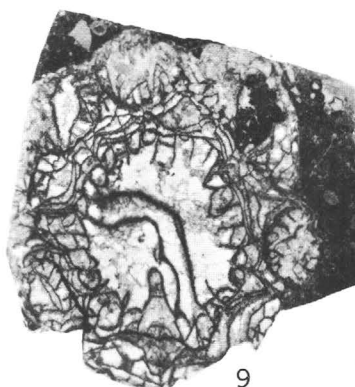
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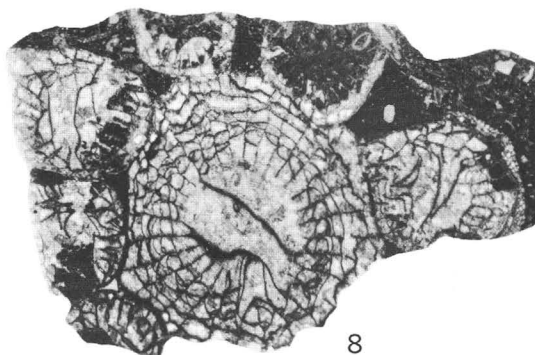
7



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*DORLODOTIA SUBCAESPITOSA* (MEEK)

## PLATE 5

FIGURES 1-9. *Orygmophyllum? whitneyi* (White) (p. E15).

Lectotype USNM 144774.

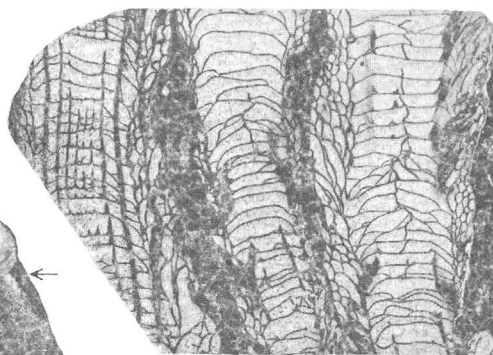
- 1, 2. Top and lateral views, respectively ( $\times 1$ ); original of White, 1875, pl. 6, figs. 1a-c; inscribed lines indicate the sources of White's figs. 1b and 1c; arrows indicate positions of transverse sections illustrated in figs. 5 and 8.
- 3, 4. Longitudinal thin sections ( $\times 2$ ); USNM 144774f and 144774d, respectively.
5. Transverse thin section ( $\times 2$ ); USNM 144774c.
6. Longitudinal thin section ( $\times 2$ ); USNM 144774b; original of White, 1875, pl. 6, fig. 1b.
7. Longitudinal thin section ( $\times 2$ ); USNM 144774e.
8. Transverse thin section ( $\times 2$ ); USNM 144774a.
9. View ( $\times 4$ ) of two of corallites shown in fig. 8.



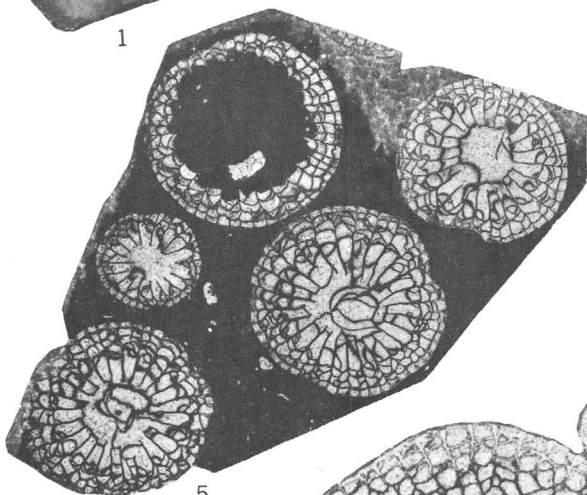
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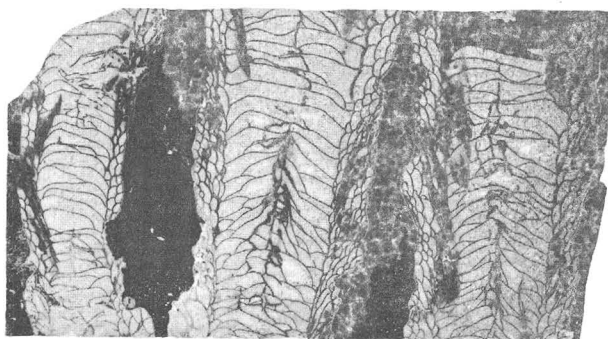
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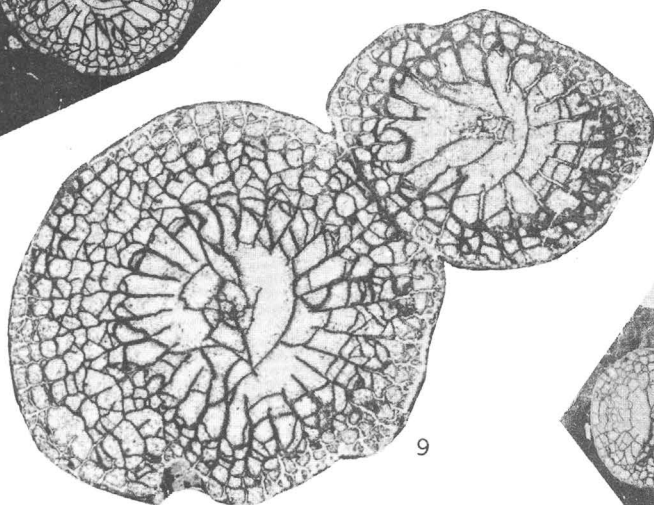
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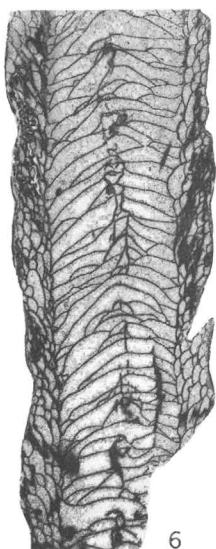
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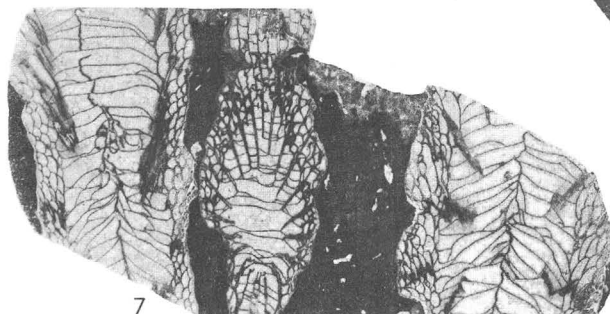
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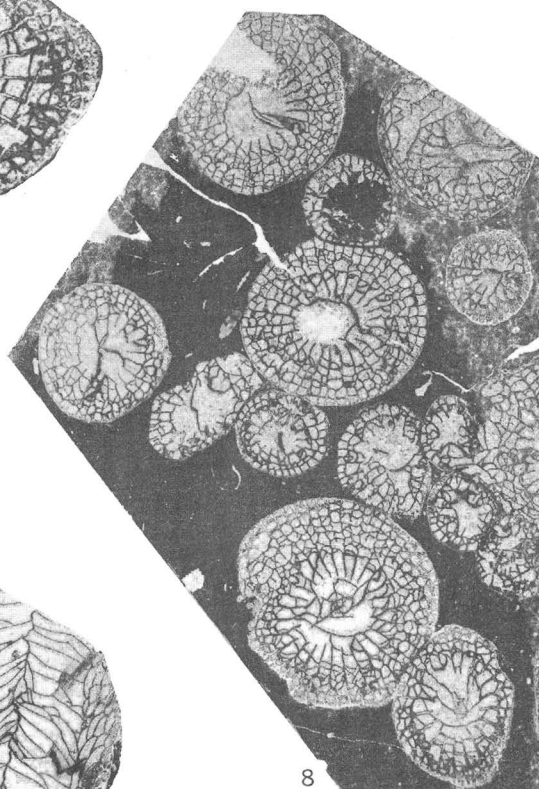
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*ORYGMOPHYLLUM? WHITNEYI* (WHITE)

## PLATE 6

FIGURES 1-5. *Durhamina cordillerensis* (Easton) (p. E17).

Hypotype (paralectotype of *Lithostrotion whitneyi* White), USNM 144775.

1. Longitudinal thin section ( $\times 2$ ); USNM 144775c.
2. Longitudinal thin section ( $\times 4$ ); USNM 144775d.
3. Transverse thin section ( $\times 2$ ); USNM 144775a.
4. Enlarged view ( $\times 4$ ) of one of corallites shown in fig. 3.
5. External view of corallum ( $\times 1$ ).

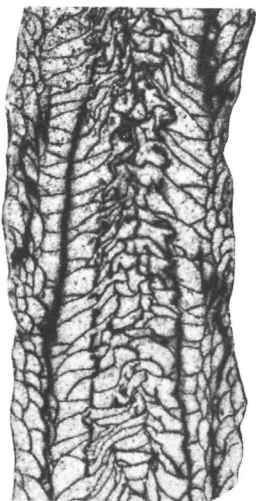
6-11. *Orygmophyllum? whitneyi* (White) (p. E15).

Hypotype (hypotype of *Cyathophyllum subcaespitosum* Meek), USNM 24545. Figs. 7-11 are arranged on plate in approximately same relative positions as corresponding sections were taken from specimen.

6. Lateral view ( $\times 1$ ); original of Meek, 1877, pl. 5, fig. 4; arrows indicate positions of transverse sections shown in figs. 8, 9, and 11.
7. Longitudinal thin section ( $\times 2$ ); USNM 24545e.
- 8, 9. Transverse thin sections ( $\times 2$ ); USNM 24545d and 24545c, respectively.
10. Longitudinal thin section ( $\times 2$ ); USNM 24545b.
11. Transverse thin section ( $\times 2$ ); USNM 24545a.



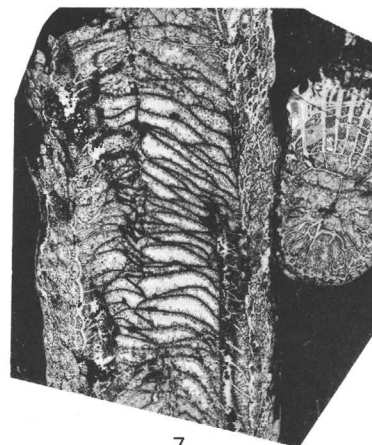
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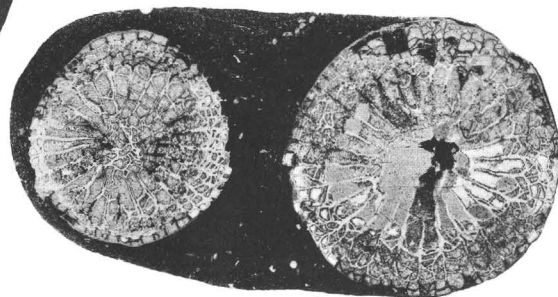
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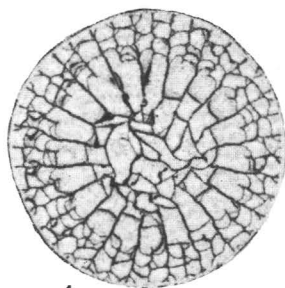
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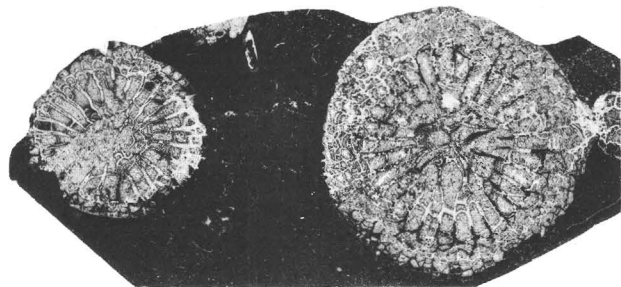
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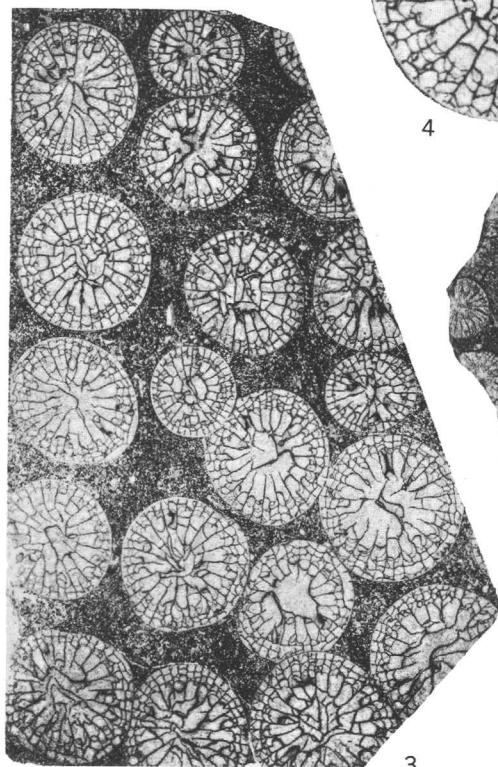
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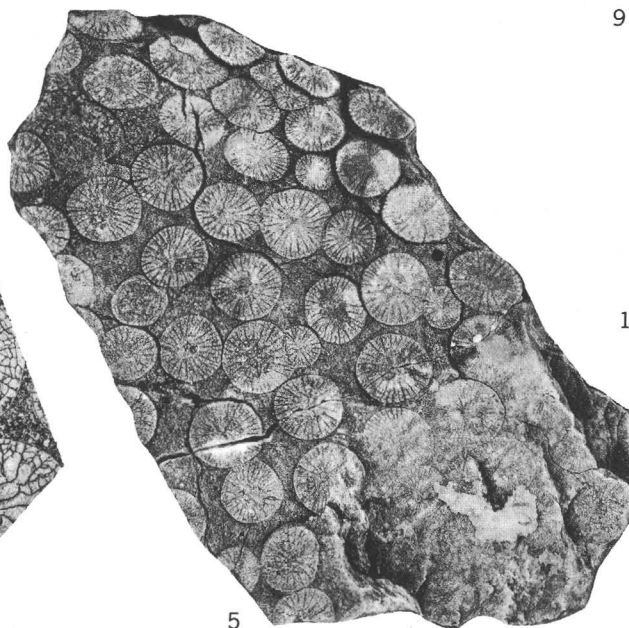
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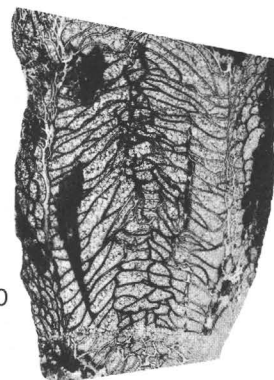
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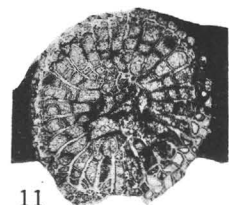
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11

*DURHAMINA CORDILLERENSIS* (EASTON) AND *ORYGMOPHYLLUM?* *WHITNEYI* (WHITE)

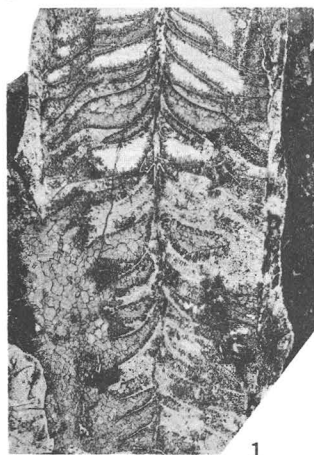
## PLATE 7

FIGURES 1-7. *Lithostrotion* (*Siphonodendron*) sp. (p. E18).

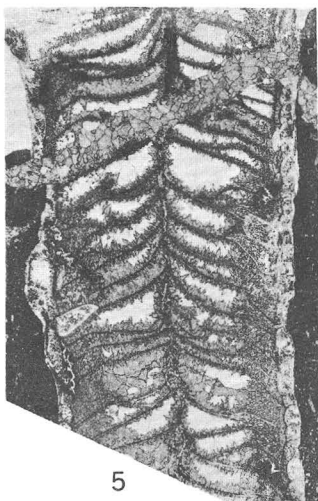
Hypotypes of *Lithostrotion whitneyi* White.

1. Longitudinal thin section ( $\times 4$ ); USNM 144799g.
- 2, 3. Transverse thin sections ( $\times 4$ ); USNM 144799h and 144799b, respectively.
4. Lateral view ( $\times 1$ ); USNM 144799.
5. Longitudinal thin section ( $\times 4$ ); USNM 144800c.
6. Transverse thin section ( $\times 2$ ); USNM 144800a.
7. Lateral view ( $\times 1$ ); original of Meek, 1877, pl. 6, figs. 1, 1a; USNM 144800.





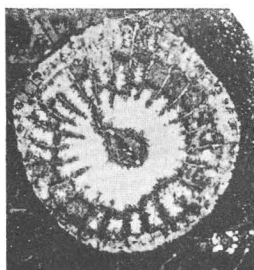
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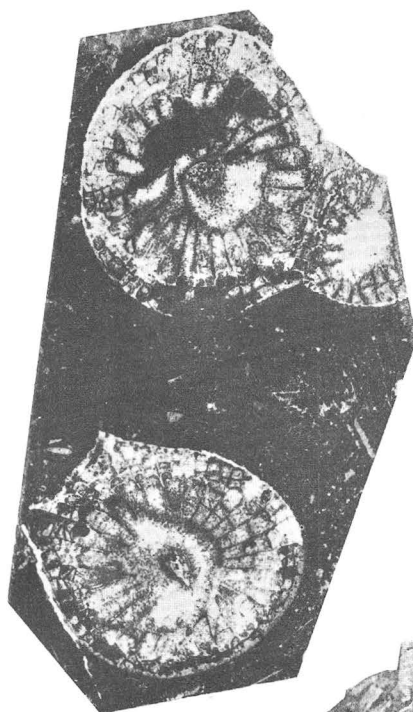
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*LITHOSTROTION (SIPHONODENDRON) SP.*



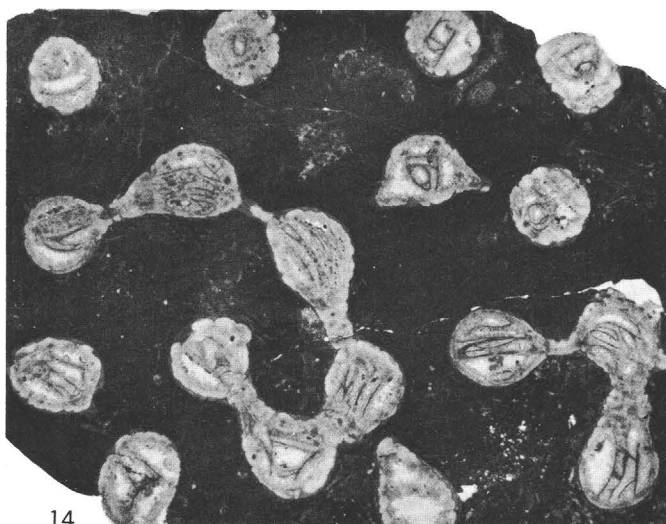
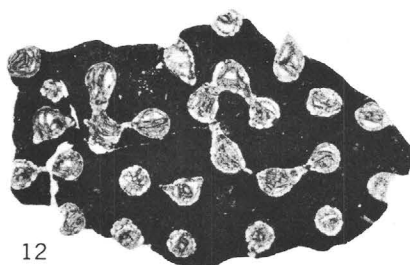
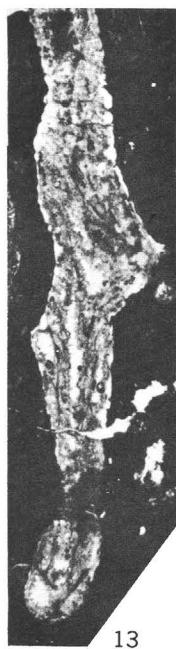
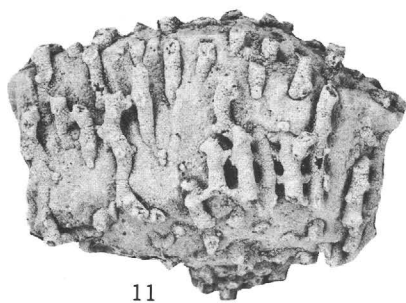
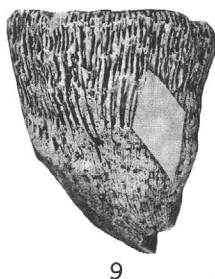
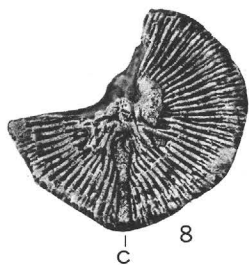
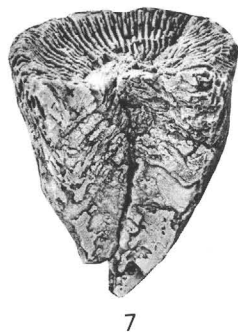
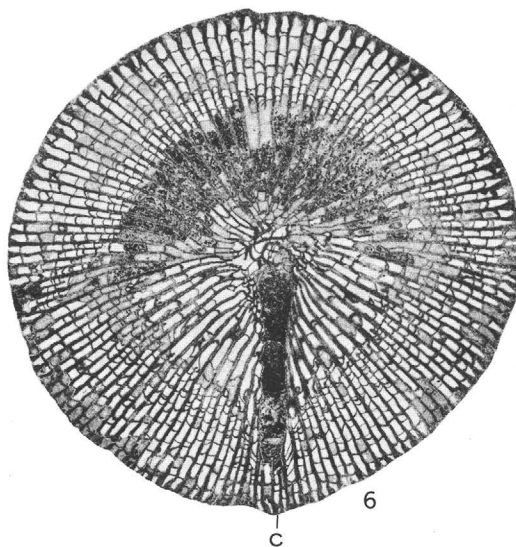
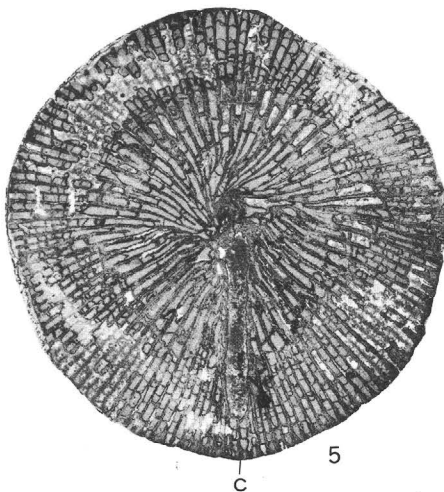
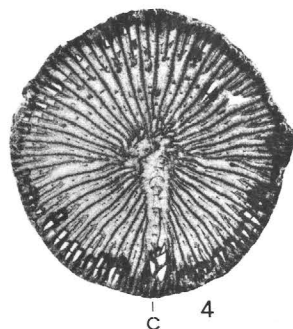
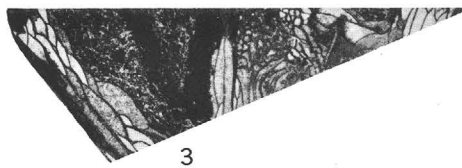
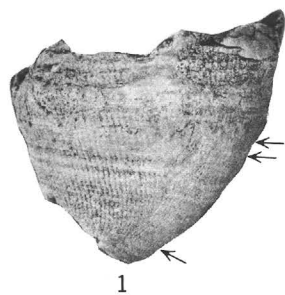
## PLATE 8

FIGURES 1-9. *Faberophyllum stansburyi* (Hall) (p. E18).

- 1, 2. Alar and cardinal views, respectively ( $\times 1$ ); lectotype; USNM 144770; arrows in fig. 1 indicate positions of transverse sections shown in figs. 4-6.
3. Longitudinal thin section ( $\times 2$ ); lectotype; USNM 144770d; section cut just below transverse section shown in fig. 5.
- 4-6. Serial transverse sections ( $\times 2$ ); lectotype; USNM 144770a-c, respectively; fig. 5 is peel section, others are thin sections.
- 7-9. Oblique alar, calicular, and alar views, respectively ( $\times 1$ ); paralectotype, original of Hall, 1852, pl. 1, fig. 3b; USNM 144771.

10-14. *Syringopora occidentalis* Meek (p. E31).

- Holotype, USNM 24547.
10. Longitudinal thin section ( $\times 2$ ); USNM 24547c.
11. Lateral view ( $\times 1$ ); original of Meek, 1877, pl. 6, figs. 2, 2a.
12. Transverse thin section ( $\times 2$ ); USNM 24547b.
13. Longitudinal thin section ( $\times 5$ ); USNM 24547d.
14. Enlarged view ( $\times 5$ ) of some of corallites shown in fig. 12.



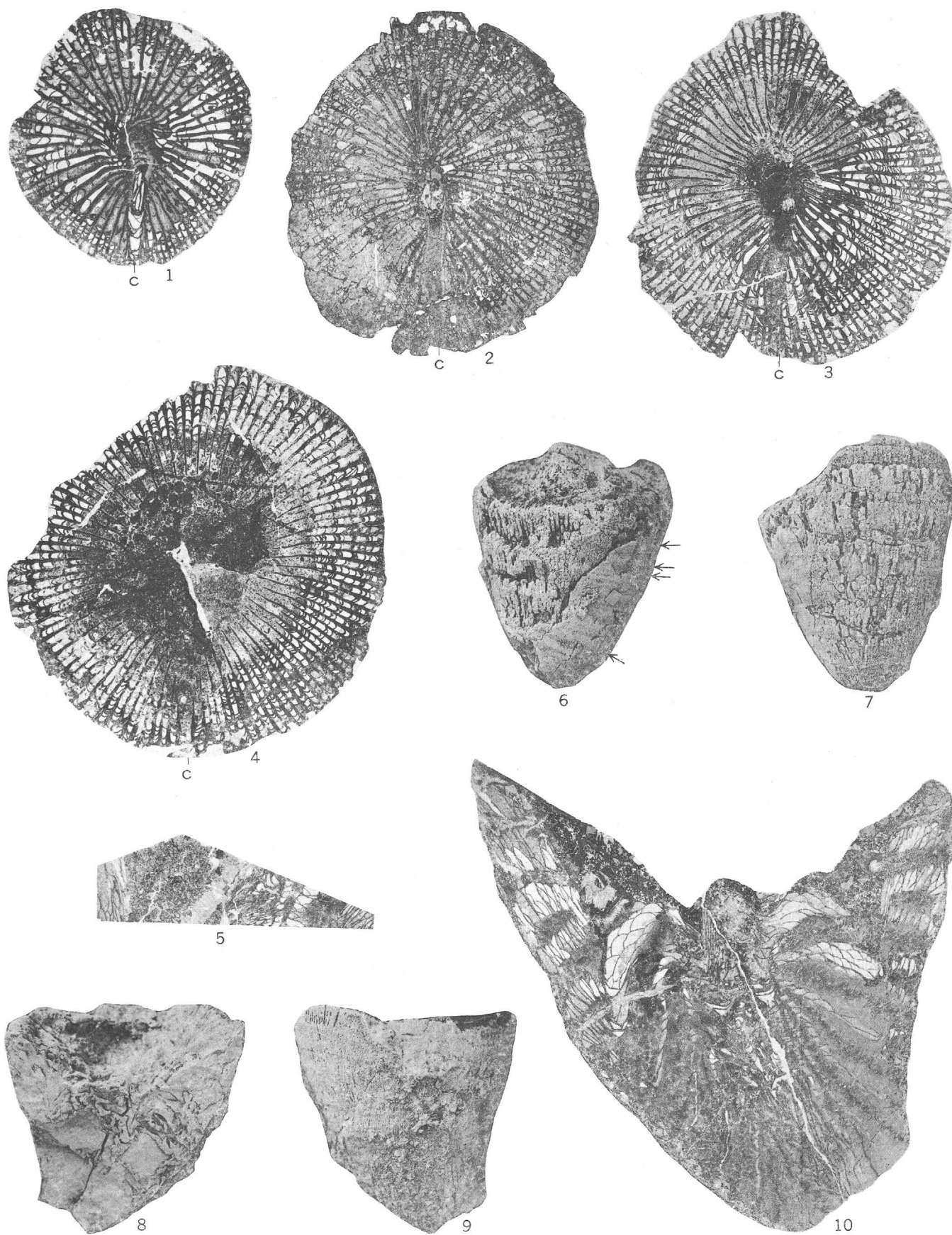
*FABEROPHYLLUM STANSBURYI* (HALL) AND *SYRINGOPORA OCCIDENTALIS* MEEK

## PLATE 9

FIGURES 1-10. *Faberophyllum stansburyi* (Hall) (p. E18).

Hypotypes.

- 1-4. Serial transverse sections ( $\times 2$ ); paralectotype of *Zaphrentis multilamellata* Hall; USNM 144773a-d, respectively; section shown in fig. 2 is peel section, all others are thin sections.
5. Longitudinal thin section ( $\times 2$ ); paralectotype of *Zaphrentis multilamellata* Hall; USNM 144773e; section cut just below transverse section shown in fig. 2.
- 6, 7. Alar and cardinal views, respectively ( $\times 1$ ); paralectotype of *Zaphrentis multilamellata* Hall; USNM 144773; arrows in fig. 6 indicate positions of transverse sections shown in figs. 1-4.
- 8, 9. Alar views ( $\times 1$ ); lectotype of *Zaphrentis multilamellata* Hall, original of Hall, 1852, pl. 1, fig. 2; USNM 144772.
10. Longitudinal thin section ( $\times 2$ ); lectotype of *Zaphrentis multilamellata* Hall; USNM 144772a.



*FABEROPHYLLUM STANSBURYI* (HALL)

## PLATE 10

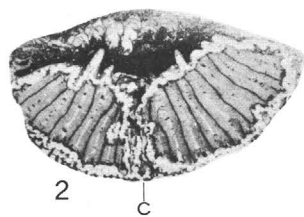
FIGURES 1-6. *Caninia excentrica* (Meek) (p. E22).

Lectotype, USNM 144791.

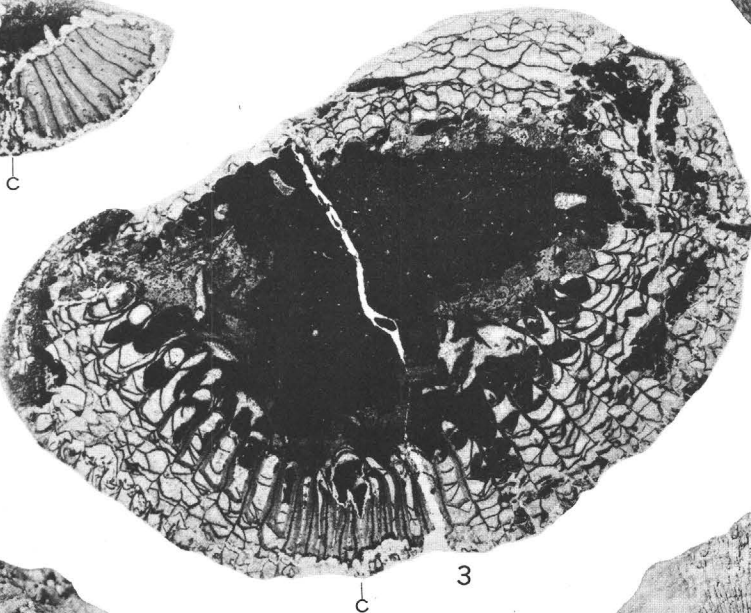
1. Longitudinal thin section ( $\times 1.5$ ); USNM 144791c; section cut in the cardinal-counter plane between transverse sections illustrated in figs. 2 and 3.
- 2, 3. Transverse thin sections ( $\times 1.5$ ); USNM 144791a and b, respectively.
- 4-6. Counter, alar, and cardinal views, respectively ( $\times 1$ ); arrows in fig. 5 indicate positions of transverse sections shown in figs. 2 and 3.



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*CANINIA EXCENTRICA* (MEEK)

## PLATE 11

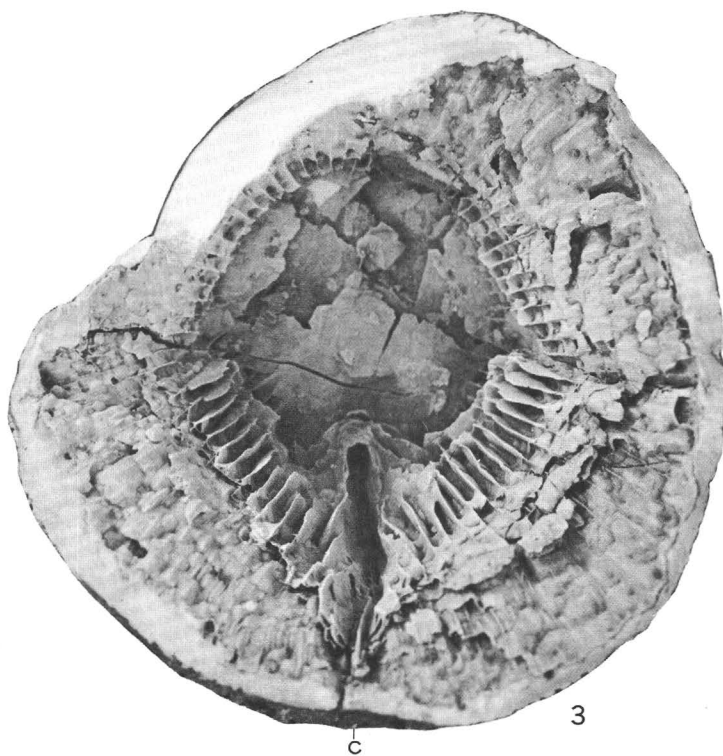
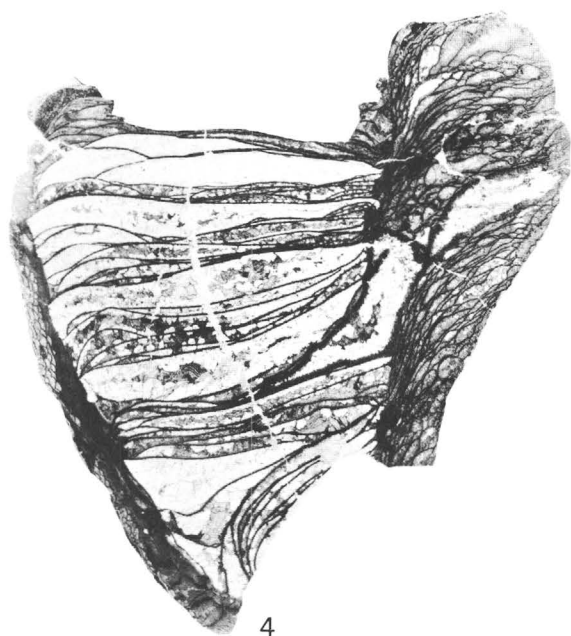
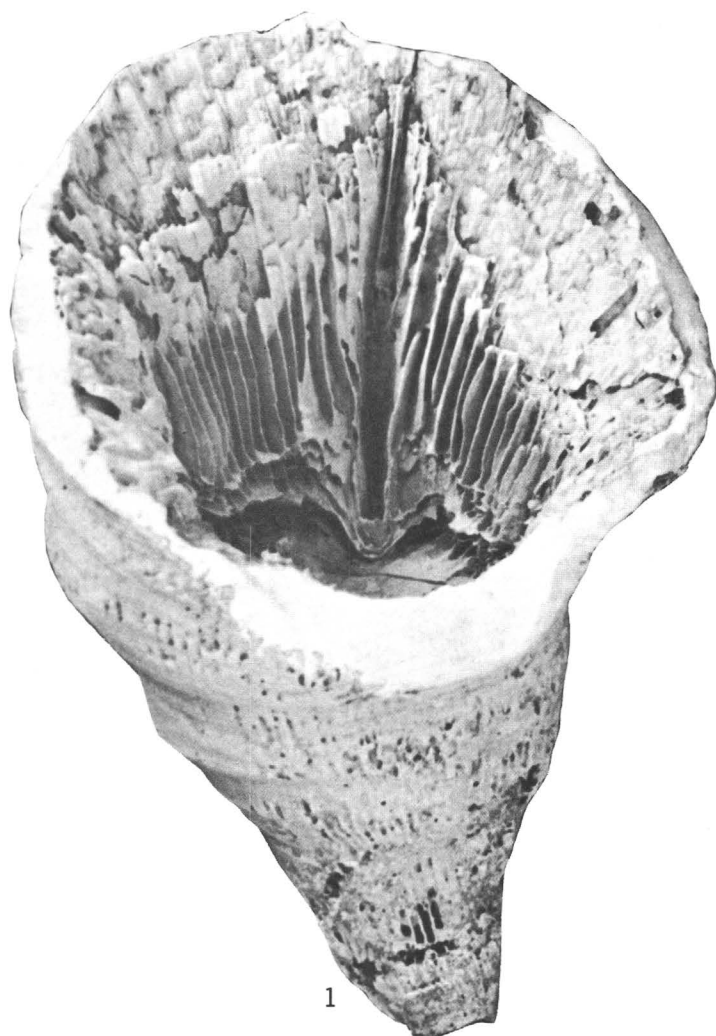
[All figures natural size]

FIGURES 1-4. *Caninia excentrica* (Meek) (p. E22).

Topotypes.

- 1-3. Oblique calicular view from counter side, alar, and calicular views respectively; USNM 144793. Specimen is silicified and was etched from limestone matrix with hydrochloric acid; white area around calice rim is plaster used to fill in unsilicified parts of skeleton which were dissolved during etching.
4. Longitudinal thin section; USNM 144796a; section cut in cardinal-counter plane.





*CANINIA EXCENTRICA* (MEEK)



## PLATE 12

[All figures natural size]

FIGURES 1-13. *Caninia excentrica* (Meek) (p. E22).

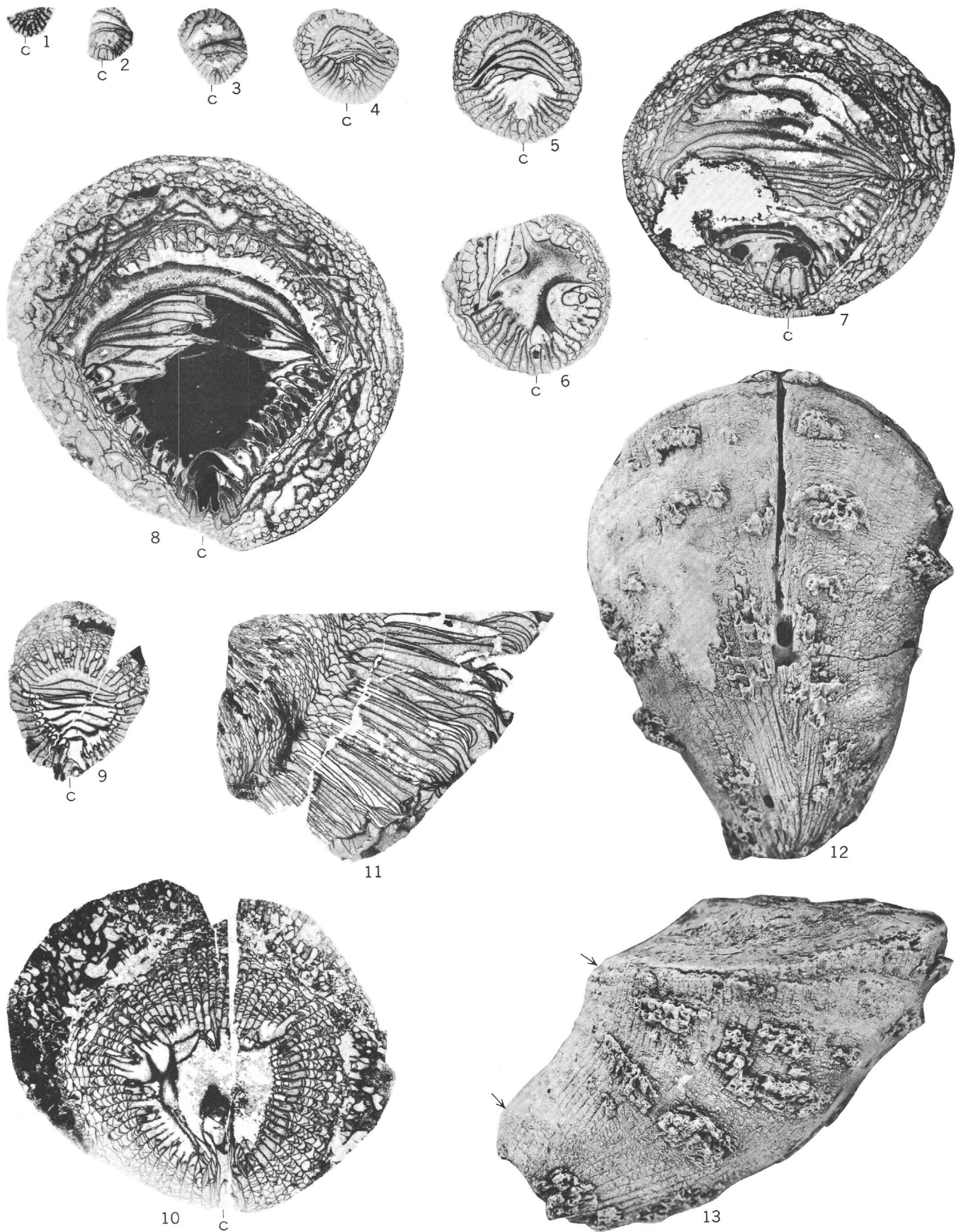
1-6. Serial transverse thin sections; topotype; USNM 144794a-f, respectively.

7, 8. Serial transverse thin sections; topotype; USNM 144795a and b, respectively.

9, 10. Serial transverse thin sections; hypotype; USNM 24539a and b, respectively.

11. Longitudinal thin section; hypotype; USNM 24539c; section cut in cardinal-counter plane between transverse sections shown in figs. 9 and 10.

12, 13. Cardinal and alar views, respectively; hypotype, original of Meek, 1877, pl. 4, figs. 1, 1b, 1c; USNM 24539; arrows indicate positions of transverse sections shown in figs. 9 and 10.



*CANINIA EXCENTRICA* (MEEK)

## PLATE 13

[All figures natural size]

FIGURES 1-6. *Caninia trojana* Easton (p. E24).

Hypotype (hypotype of *Zaphrentis excentrica* Meek), USNM 8464.

1, 2. Cardinal and alar views, respectively; original of White, pl. 6, fig. 3a; arrows in fig. 2 indicate positions of transverse sections shown in figs. 3-5.

3-5. Serial transverse thin sections; USNM 8464a-c, respectively.

6. Longitudinal thin section; USNM 8464d; section cut in cardinal-counter plane between transverse sections shown in figs. 3 and 4.

7-11. *Caninia nevadensis* (Meek) (p. E25).

Holotype, USNM 24544.

7, 8. Transverse thin sections; USNM 24544a and b, respectively.

9. Longitudinal thin section; USNM 24544c; section cut slightly to one side of cardinal-counter plane above transverse section shown in fig. 8.

10, 11. Alar and cardinal views, respectively; part of original of Meek, 1877, pl. 5, fig. 3; arrows in fig. 11 indicate positions of transverse sections shown in figs. 7 and 8.

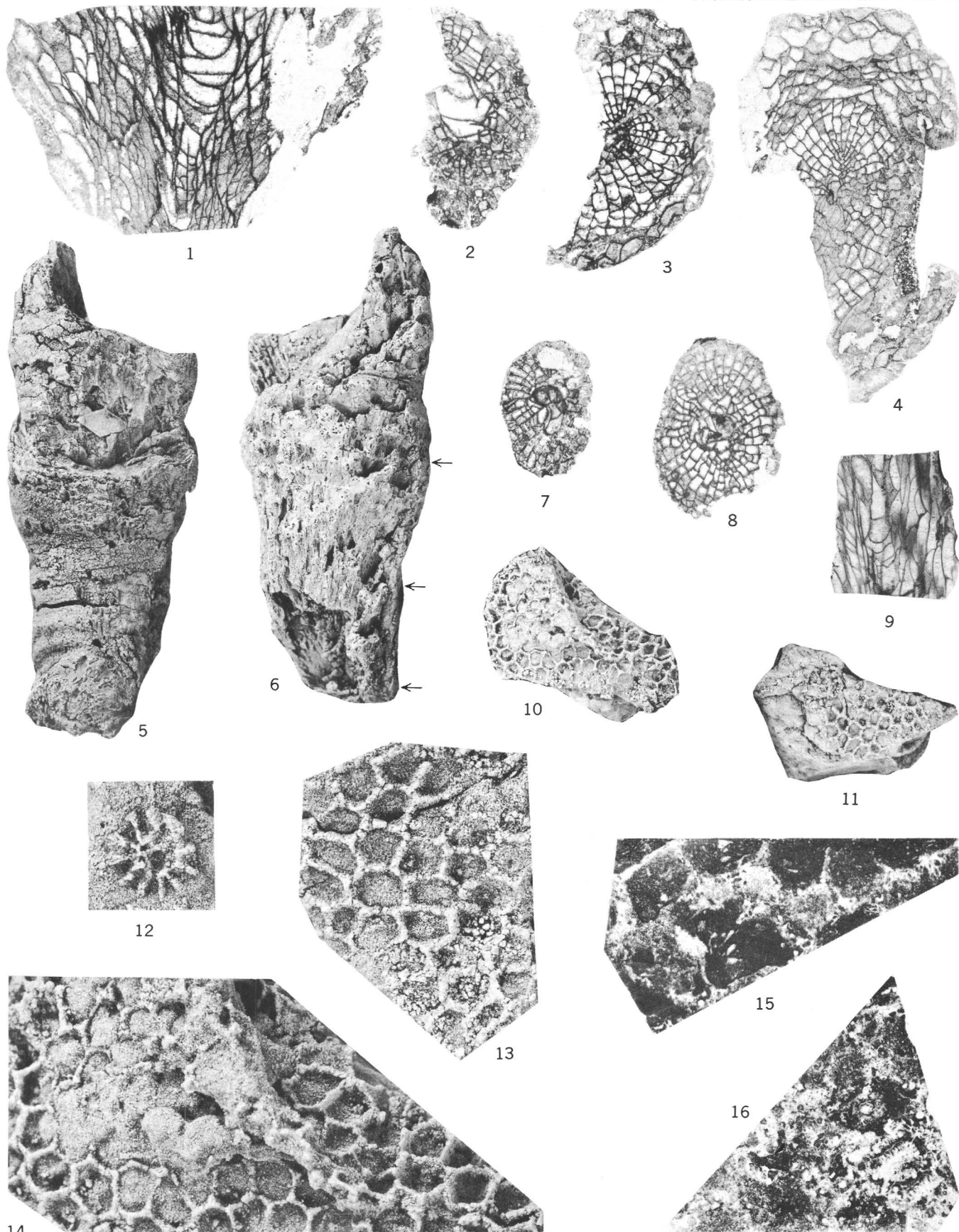


CANINIA TROJANA EASTON AND CANINIA NEVADENSIS (MEEK)

## PLATE 14

FIGURES 1-9. "*Faviphyllum rugosum*" Hall (p. E28).

1. Longitudinal thin section ( $\times 2$ ); lectotype; USNM 144768d; section cut between transverse sections shown in figs. 3 and 4.
  - 2-4. Serial transverse thin sections ( $\times 2$ ); lectotype; USNM 144768a-c, respectively.
  - 5, 6. Lateral views ( $\times 1$ ); lectotype, original of Hall, 1852, pl. 1, fig. 1b; USNM 144768; arrows indicate positions of transverse sections shown in figs. 2-4.
  - 7, 8. Transverse thin sections ( $\times 2$ ); paralectotype; USNM 144769a and b, respectively.
  9. Longitudinal thin section ( $\times 2$ ); paralectotype; USNM 144769c.
- 10-16. "*Leptopora winchelli*" White (p. E32).
10. Top view ( $\times 1$ ); lectotype; USNM 144788.
  11. Top view ( $\times 1$ ); paralectotype, original of White, 1880a, pl. 34, fig. 11a; USNM 144789.
  12. Top view ( $\times 3$ ); paralectotype; USNM 144790.
  13. Enlarged top view ( $\times 3$ ); paralectotype; USNM 144789.
  14. Enlarged top view ( $\times 3$ ); lectotype; USNM 144788.
  15. Longitudinal thin section ( $\times 5$ ); paralectotype; USNM 144789a.
  16. Transverse thin section ( $\times 5$ ); paralectotype; USNM 144789b.



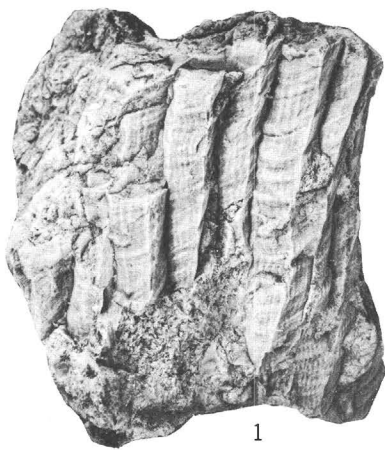
"FAVIPHYLLUM RUGOSUM" HALL AND "LEPTOPORA WINCHELLI" WHITE

## PLATE 15

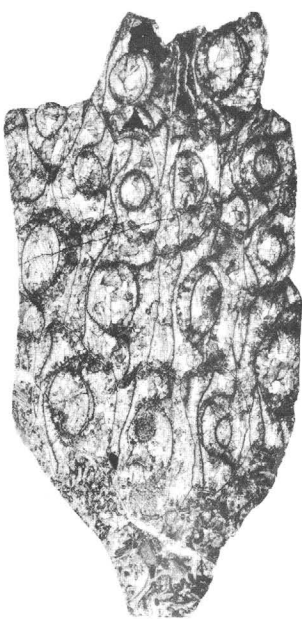
FIGURES 1-7. *Sciophyllum adjunctivum* (White) (p. E29).

1. Lateral view ( $\times 1$ ); lectotype, probably original of White, 1880a, pl. 35, fig. 1a; USNM 144786; arrow indicates position of transverse section shown in figs. 2 and 3.
2. Transverse thin section ( $\times 2$ ); lectotype; USNM 144786a.
3. Enlarged view ( $\times 4$ ) of some of the corallites shown in fig. 2.
4. Longitudinal thin section ( $\times 2$ ); lectotype; USNM 144786b.
5. Enlarged view ( $\times 4$ ); of one of the corallites shown in fig. 4.
6. Longitudinal thin section ( $\times 4$ ) paralectotype; USNM 144787b.
7. Transverse thin section ( $\times 4$ ); paralectotype; USNM 144787a.

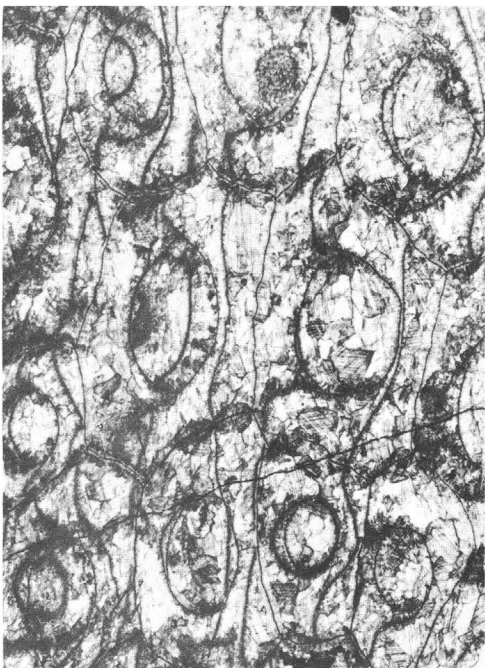




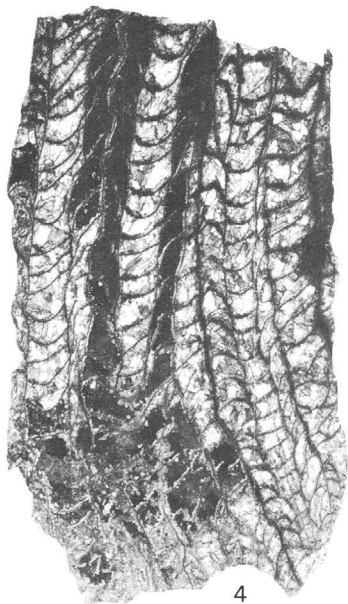
1



2



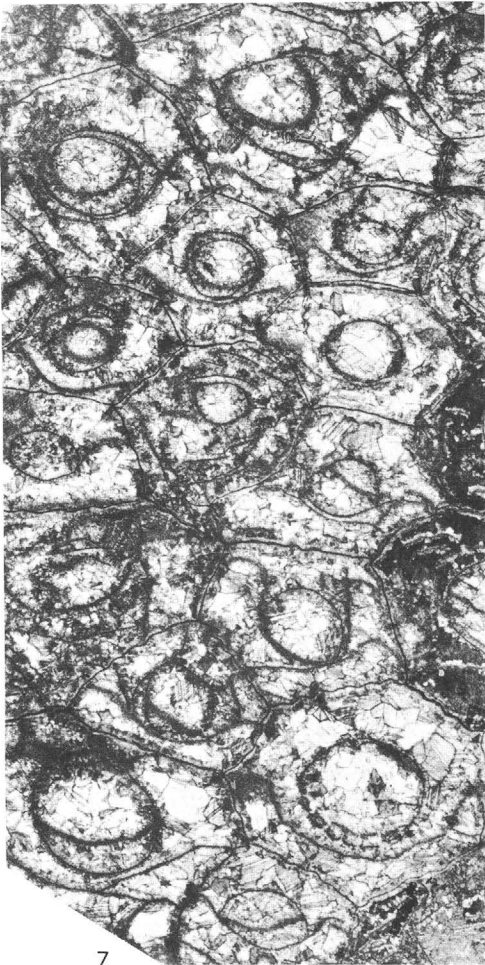
3



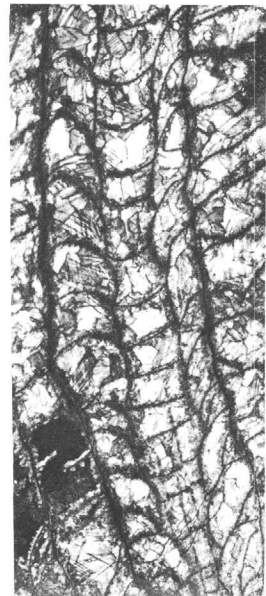
4



6



7



5

*SCIOPHYLLUM ADJUNCTIVUM* (WHITE)

