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FENESTRATE BRYOZOANS FROM THE GLEN DEAN LIMESTONE (MIDDLE CHESTER) OF SOUTHERN INDIANA

by

JOHN UTGAARD

T. G. PERRY

Indiana Department of Conservation

GEOLOGICAL SURVEY

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FENESTRATE BRYOZOANS FROM THE GLEN DEAN LIMESTONE (MIDDLE CHESTER) OF SOUTHERN INDIANA

BY JOHN UTGAARD[1] AND T. G. PERRY[2]

ABSTRACT

Fenestrate bryozoans are particularly abundant in shale and argillaceous limestone beds in the upper part of the Glen Dean Limestone (middle Chester) of late Mississippian age in south-central Indiana. Several hundred specimens were obtained from two excellent collecting localities in Perry County and from one exposure in northwestern Crawford County. The collected specimens are assigned to the genera *Fenestella* Lonsdale, *Lyroporella* Simpson, and *Polypora* McCoy of the Family Fenestellidae King and to the genus *Septopora* Prout, a member of the Family Acanthocladiidae Zittel. *Fenestella* is the most abundantly represented genus in our collections and includes five species, *Fenestella burlingtonensis* Ulrich, *F. cestriensis* Ulrich, *F. exigua* Ulrich, *F. matheri* Condra & Elias, and *F. tenax* Ulrich. *Polypora* is the next most abundant genus and is represented in the fauna by three species, *Polypora corticosa* Ulrich, *P. multispinosa* McFarlan, and *P. nodolinearis* McFarlan.

Frequency-distribution diagrams showing number of branches and fenestrules in a 10-millimeter distance and number of zooecia and nodes in a 5-millimeter distance have been prepared for each described species except *Septopora cestriensis* Prout; only one specimen of this species displays the obverse side of the frond. Such diagrams permit clearer differentiation of closely allied species in which ranges of one or more structural characters may overlap, and these diagrams present a more accurate understanding of each species.

The Glen Dean fenestrate bryozoan fauna, exclusive of *Archimedes* Owen, which is not treated in this study, includes 11 species. Although fenestrate bryozoan faunas have been described in considerable detail from Glen Dean beds in Illinois and Kentucky, these faunal elements of the Glen Dean of Indiana hitherto have not received significant attention.

INTRODUCTION

Ulrich (1890, p. 534-634) and McFarlan (1942, p. 437-458) have described fenestrate bryozoans from the Glen Dean Limestone of Kentucky and Illinois. Consequently, we envisioned at the outset of this study that few, if any, new species would result from this investigation. Three purposes prompted this study: (1) determination of the genera and species that constitute the Glen Dean fenestrate bryozoan fauna of Indiana, (2) improvement of concepts of previously known species by depicting graphically the frequency distribution of the structural components of their meshwork, and (3) refinement of existing knowledge con-

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cerning the stratigraphic range of some of the species recognized in the Glen Dean. McFarlan (1942) has furnished in chart form the most detailed information concerning the stratigraphic distribution of Chester fenestrate bryozoans. Our investigation, however, has resulted in the recognition in Chester strata of some forms not recorded by McFarlan, as *Fenestella burlingtonensis* Ulrich; this species, described by Ulrich (1888, p. 71; 1890, p. 536) from the Burlington Limestone of Osage (early Mississippian) age, now has its range extended upward through the Glen Dean as a result of this study.

Fenestrate bryozoans on which this project was based were collected mainly from beds in the upper part of the Glen Dean Limestone at the following localities (fig. 1) where detailed stratigraphic sections have been described by Perry and Smith (1958, p. 97-100):

1. *Leopold section*: an abandoned quarry in the SE¼ SW¼ sec. 6, T. 5 S., R. 1 W., about 1.5 miles east of the village of Leopold, Perry County, Ind.
2. *Branchville section*: an abandoned quarry in the NW¼SW¼ sec. 18, T. 4 S., R. 1 W., about 0.6 mile east of the village of Branchville, Perry County, Ind.
3. *Mulzer Brothers quarry section*: an active quarry in the E½ sec. 10, T. 2 S., R. 2 W., 0.8 mile south of the junction of Indiana State Highways 145 and 164 and about 2.5 miles north of the village of Eckerty, Crawford County, Ind.

At the above localities fenestrate bryozoans are especially abundant on bedding planes of argillaceous limestone and calcareous shale beds in the upper part of the formation. In contrast, fissile dark-gray shale and siltstone strata in this stratigraphic position generally lack bryozoans of this type. The upper surface of the lower massive part of the Glen Dean commonly displays fenestrate bryozoans. Conspicuously fewer specimens are found, however, in the lower massive strata of the Glen Dean than in beds in the upper part of the formation, and forms in the lower Glen Dean are most difficult to collect and to extricate from the surrounding matrix for study. Because specimens are extremely abundant at these sites and because these localities are near the central part of the Glen Dean outcrop belt, we believe that the collections adequately represent the Glen Dean fenestrate bryozoan fauna.

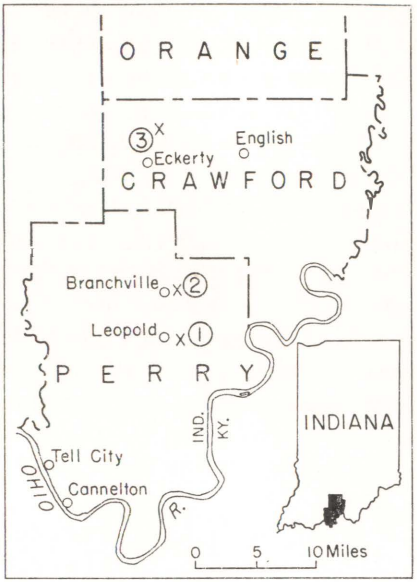

Figure 1.—Map showing collecting localities.

Many species of Mississippian fossils have long ranges that extend through a significant part of this system. Some of these long-ranging species, however, are most abundant in some particular formation and thus may be regarded as index fossils for that formation. Some species of fenestrate bryozoans described herein are also long-ranging forms. For example, Cumings (1906, p. 1278-1279) recorded *Fenestella tenax* and *F. exigua* Ulrich from the Salem Limestone of Meramec (middle Mississippian) age. McFarlan (1942) indicated that *F. exigua* is found commonly in Glen Dean and older Chester formations in Illinois and Kentucky and that *F. tenax* is common in the Glen Dean and younger Chester formations, although it has been recorded from pre-Glen Dean Chester rocks. Elias and Condra (1957, p. 107) noted rare occurrences of *F. tenax* in strata of Pennsylvanian and Permian age. Some Pennsylvanian species of *Fenestella* possess structural characteristics that relate them closely to Mississippian forms (Condra and Elias, 1944, p. 162-164). All species described herein are found in formations other than the Glen Dean. The most abundant fenestrate bryozoan in the Glen Dean of Indiana is *Fenestella tenax* Ulrich, and the next most abundant species is *F. matheri* Condra & Elias. Three species, *Polypora multispinosa* McFarlan,

Lyroporella divergens (Ulrich), and *Septopora subquadrans* Ulrich are found commonly and in approximately the same numbers; these species, however, are not as abundant as *Fenestella matheri.* Consideration of the relative abundance of these species may permit identification of the Glen Dean Limestone in Indiana and elsewhere.

All identified specimens are hypotypes, except those of *Fenestella cestriensis* Ulrich, and have been deposited in the collections of the Indiana Geological Survey, Bloomington, Ind. Identified specimens of *Fenestella cestriensis* are homoeotypes, as they have been compared directly with type material of the species.

The senior author, John Utgaard, gratefully acknowledges the assistance from two awards that contributed financially toward the completion of this study, namely, the Standard Oil Co. of Texas Fellowship in Geology and a National Science Foundation Fellowship. Mrs. Lois S. Kent, curator of fossil collections of the Illinois Geological Survey, kindly made available type material of *Fenestella cestriensis* Ulrich and *F. flexuosa* Ulrich for comparative purposes.

GLEN DEAN LIMESTONE

Exposures near the village of Glen Dean in Breckenridge County, Ky., suggested the name for the Glen Dean Limestone (Butts, 1917, p. 97-101). At the type section the Glen Dean is overlain by the Tar Springs Sandstone and underlain by the Hardinsburg Sandstone, a stratigraphic relationship which is maintained throughout the southern part of the Glen Dean outcrop belt in south-central Indiana.

The Glen Dean Limestone is the youngest formation of middle Chester age in southern Indiana, where it generally ranges in thickness from 27 to 60 feet (Perry and Smith, 1958, p. 92). The formation is particularly well exposed in western and southwestern Crawford County and in eastern Perry County and southwestern Orange County. The full thickness of the Glen Dean is observed in few exposures north of west-central Orange County, 35 to 40 miles north of the Ohio River, as pre-Pennsylvanian erosion in this area of its outcrop has removed all formations of late Chester age, as well as the upper beds of the Glen Dean in many localities (Malott, 1951, p. 243). Consequently, the Mansfield Formation of early Pennsylvanian age rests unconformably on the Glen Dean in many localities. Still farther north the pre-Pennsylvanian erosion surface descends regionally to stratigraphic

levels below the Glen Dean, and thus incomplete sections of the formation are found only in local areas. Perry and Smith (1958, pl. 2) mapped the boundary between rocks of middle and late Chester age; this mapped boundary outlines the areal distribution of the Glen Dean in south-central Indiana.

Two sharply contrasting lithologic units may be recognized in the Glen Dean. The lower part of the formation, generally 20 to 40 feet thick, contains light- to medium-gray massive crystalline limestone that is fossiliferous and commonly oolitic. The upper part of the formation, commonly 10 to 20 feet thick, is a heterogeneous assemblage of dark-gray thin-bedded shale, argillaceous fine-grained sandstone, and medium- to dark-gray partly crystalline to crystalline argillaceous limestone that forms beds generally ranging from 1 to 3 feet in thickness. Individual sandstone and limestone beds are prominent in the upper part of the Glen Dean but generally do not maintain their lithologic individuality laterally for more than a few hundred feet. Perry and Smith (1958, p. 90-101) have presented more detailed information concerning the lithology of the Glen Dean.

The Glen Dean Limestone probably has a more diversified fauna than any other formation of the Chester Series in the Illinois Basin. Ulrich (1917, p. 226-230) listed 162 species that had been described from the Glen Dean of Kentucky, and Coryell and Rozanski (1942, p. 137-151) described a Glen Dean microfauna consisting of 2 species of Foraminifera and 32 species and 2 varieties of Ostracoda from Hardin County, Ill. Horowitz (1957) and Horowitz and Perry (1956, p. 1707-1708) completed a faunal study of the Glen Dean that was based largely on material collected in Indiana. These authors recorded 26 species of brachiopods, 23 crinoid species, 21 species of the genus *Pentremites* Say, and 28 bryozoan species that were assigned to the genera *Archimedes* Owen, *Tabulipora* Young, *Fistulipora* McCoy, *Meekopora* Ulrich, *Prismopora* Hall, *Anisotrypa* Ulrich, and *Eridopora* Ulrich. Corals, gastropods, conulariids, trilobites, and pelecypods were included in eight species. Horowitz and Perry further demonstrated that a distinctive fauna characterized the lower and upper parts of the formation. The massive limestone beds in the lower Glen Dean contain a rich brachiopod fauna in which *Linoproductus pileiformis* (McChesney), *Productus cestriensis* Worthen, *Stenoscisma explanatum* (McChesney), *Torynifer setiger* (Hall), *Martinia contracta* (Meek & Worthen), and *Spirifer leidyi* Norwood &

Pratten predominate. The upper Glen Dean strata abound in the brachiopod species *Cleiothyridina sublamellosa* (Hall), *Composita subquadrata* (Hall), *Punctospirifer transversus* (McChesney), *Reticulariina spinosa* (Norwood & Pratten), and *Spirifer increbescens* Hall. The ramose bryozoan *Tabulipora ramosa* (Ulrich), species of *Pterotocrinus* Lyon & Casseday and *Pentremites* Say, and fenestrate bryozoans are found plentifully in the upper Glen Dean beds.

TAXONOMIC CHARACTERS OF DESCRIBED FORMS

Principal characters used for differentiating species of fenestrate bryozoans are branches and fenestrules in a 10-millimeter distance and zooecia and nodes in a 5-millimeter distance. These structural components are expressed commonly in the so-called meshwork formula which was first used extensively in this country by Condra and Elias (1944).

The meshwork formula for Glen Dean specimens of *Fenestella tenax* Ulrich is 25-37/22-34//24-31/24-34 (p. 22). The suite of numbers left of the first oblique line in the meshwork formula shows the variability in the number of branches in 10 millimeters. The next suite of figures to the right (22-34) indicates the variability in number of fenestrules in 10 millimeters. Figures to the right of the double oblique lines show range in number of zooecia (24-31) and carinal nodes (24-34) in 5 millimeters. The meshwork formula is thus a conveniently abbreviated method for expressing these specific characters.

Measurements of the structural characters expressed in the meshwork formula were made in accordance with the "space-unit method" described by Condra and Elias (1944, p. 55). For all species, including those bearing more than one row of nodes on the obverse surface, figures in the meshwork formula show number of nodes in 5 millimeters for one row. We have extended the use of the meshwork formula to our descriptions of species of *Polypora*, *Lyroporella*, and *Septopora* and recommend the use of this formula in fenestrate genera other than *Fenestella* in which these characters are used to discriminate between species.

The outline of the zooecial chamber base for all Glen Dean species of *Fenestella* has been obtained. In our opinion, this character generally has secondary importance for recognizing *Fenestella* species, although it is useful, in conjunction with other characters, in separating *Fenestella matheri* Condra & Elias from *F. serratula* Ulrich and from *F. cumingsi* Condra & Elias. We have

noted that the outline of the chamber base can vary considerably within the same specimen and further that depth of sectioning influences the observed outline of the chamber.

Other specific characters of secondary importance are: branch width above, below, and between branch bifurcations; presence of nodes and (or) striations on the reverse side of the frond; relative width of branches, fenestrules, and dissepiments; and fenestrule length and width. For all measurements fenestrule length is the greatest dimension of the fenestrule parallel to the branches, and fenestrule width is the greatest dimension of the fenestrule perpendicular to the branches. We do not consider that the zooecial apertural diameter or the distance between branch bifurcations have significant specific importance. For greater consistency all measurements were made by the senior author.

Although the meshwork formula shows the range of variability that any meshwork character may display, it does not show the mode for any of the meshwork characters. Accordingly, we have constructed histograms for the meshwork characters of all identified species except *Septopora cestriensis* Prout; histograms of meshwork characters of this species would lack significance because of the insufficient number of measurements that could be obtained. Such diagrams permit clearer differentiation of closely allied species in which ranges of one or more structural characters may overlap. We strongly recommend this kind of analysis for all fenestrate genera in which these characters are of specific importance.

Our collections do not contain recognizable *Fenestella*-type fronds attached to *Archimedes* shafts. Pronounced lateral flaring of the branches to the right and left near the frond margins and base is a characteristic feature of the foliate type of zoarium common in *Fenestella* (Condra and Elias, 1944, p. 24) ; such flaring is not developed in *Fenestella*-type fronds attached to *Archimedes* shafts. Central and distal parts of *Fenestella* fronds, however, do not show conspicuous flaring of the branches. One or several fragmentary specimens of each Glen Dean species display pronounced lateral flaring of the branches and can be assigned unquestionably to *Fenestella.* Other fragments, regarded as conspecific with those which show lateral flaring, have essentially straight branches and may represent fronds originally attached to *Archimedes* or central or distal parts of a *Fenestella* zoarium; such fragments are common in our collections. We concur with

Condra and Elias (1944, p. 61) that such *Fenestella*-type frond fragments of uncertain generic affinity should be assigned to the genus *Fenestella* rather than to *Archimedes*. Therefore, we have included in *Fenestella* fragmentary specimens, possibly disassociated from *Archimedes*, which do not display pronounced lateral flaring of the branches, as well as incomplete specimens which show conspicuous flaring of the branches and undoubtedly belong to *Fenestella*.

SYSTEMATIC DESCRIPTIONS

Order CRYPTOSTOMATA Vine, 1883
Family FENESTELLIDAE King, 1850
Genus FENESTELLA Lonsdale, 1839
Fenestella burlingtonensis Ulrich

Plate 1, figures 1-4

Fenestella burlingtonensis Ulrich, 1888, Denison Univ., Sci. Lab., Bull., v. 4, p. 71; 1890, Illinois Geol. Survey, v. 8, p. 536, pl. 49, figs. 1-1a.

Zoarial form.—Zoarium a slightly undulatory foliate expansion; largest fragmentary specimen in our collections 25 mm long and 14 mm wide. Branches nearly straight except near lateral frond margins where branches locally flaring; in local areas branches slightly undulatory; branches moderately undulatory and flaring near base of frond; average branch width above bifurcation 0.26 mm, ranging from 0.23 to 0.30 mm, and average branch width below bifurcation 0.39 mm, ranging from 0.37 to 0.43 mm; branch widths above and below bifurcations based on six measurements in each location; average branch width between bifurcations, based on 22 measurements, 0.31 mm, ranging from 0.27 to 0.38 mm.

Reverse side.—Branches nonstriate, evenly rounded, and showing a median row of somewhat irregularly spaced nodes; generally two or three nodes per fenestrule and rarely one or two of these structures on dissepiment. Fenestrules subrectangular or broadly ovate.

Obverse side.—Branch width in most specimens equal to or slightly greater than fenestrule width; width of dissepiment invariably slightly less than branch width or fenestrule width. Carina wide, broadly rounded, and bearing one row of nodes; generally about 1½ nodes per fenestrule. Fenestrules broadly ovate or subrectangular; fenestrule length variable from 0.67 to 0.92 mm, averaging 0.76 mm, and fenestrule width ranging from 0.20 mm to 0.40 mm, averaging 0.30 mm; fenestrule dimensions based on 32 measurements of length and width. Sides of branches sloping abruptly away from carina. Zooecia averaging nearly four per fenestrule, rarely three per fenestrule; zooecial chamber base subrectangular. Meshwork moderately coarse; meshwork formula 14-20/9½-11½//17-23/5-11.

Remarks.—*Fenestella morrowensis* Mather has a meshwork formula that is nearly identical to that of *F. burlingtonensis*. Distinguishing features of these closely allied species are:

1. *F. morrowensis* has a pentagonal zooecial chamber base, as Elias (1957, p. 407) stated following his examination of the type material. In contrast, the zooecial chamber base of *F. burlingtonensis* is subrectangular.
2. On the reverse side, branches in *F. morrowensis* are coarsely grooved and dissepiments faintly grooved, according to Elias (1957, p. 407), who examined type material of this species. In contrast, *F. burlingtonensis* bears nodes on the reverse surface of the branches (Ulrich, 1890, p. 536); our material has nodes but lacks any suggestion of grooves or striations on the reverse surface of the branches.

The meshwork formula of *Fenestella burlingtonensis* is similar to that of *F. cestriensis* Ulrich except for the number of nodes in 5 mm; the former species has 5 to 11 nodes, most commonly 6 to 8, in this distance, and the latter species has 11½ to 16, most commonly 14 or 15, in 5 mm. This distinguishing character is shown clearly by comparison of the appropriate histograms of the two species (figs. 2, 3, and 4). Histograms of the meshwork characters of *F. burlingtonensis* indicate the moderate coarseness and the relatively variable nature of the meshwork. The dominance and constancy of 10 to 11½ fenestrules in 10 mm should be noted.

One of our specimens shows a branch that is produced into a striated spine-like protuberance or appendage whose proximal diameter is 0.50 mm.

Fenestella burlingtonensis was obtained from locality 2 where it was found in the upper beds of the Glen Dean.

Types.—Hypotypes: figured, InGS 334; unfigured, InGS 335.

Fenestella cestriensis Ulrich

Plate 1, figures 5-9

Fenestella cestriensis Ulrich, 1890, Illinois Geol. Survey, v. 8, p. 547-548, pl. 51, figs. 5-5b; Elias, 1957, Jour. Paleontology, v. 31, no. 2, p. 411-412, pl. 48, figs. 2, 3.

Fenestrellina cestriensis McFarlan, 1942, Jour. Paleontology, v. 16, no. 4, p. 444.

Zoarial form.—Zoarium flat or mildly undulatory; largest fragmentary specimen in our collections 22 mm long and 18 mm wide. Branches slightly flaring near frond margins; average branch width above bifurcation 0.24 mm, ranging from 0.20 to 0.28 mm, and average branch width below bifurcation 0.39 mm, ranging from 0.32 to 0.43 mm; branch widths above and below bifurcations based on 17 measurements in each location; average branch width between bifurcations 0.30 mm, ranging from 0.25 to 0.37 mm for 79 measurements. Branches nearly straight or slightly flexuose in most of zoarium and more flexuose locally where branches generally are in closest proximity opposite dissepiments.

Reverse side.—Branches striate through most of frond, each branch displaying four or five striae; locally, branches nonstriate but in these areas bearing small inconspicuous nodes; in restricted areas both nodes and striae observed. Fenestrules ovate to broadly ovate.

Obverse side.—Branches almost invariably wider than fenestrules; generally dissepiments nearly as wide as branches. Carina moderately elevated and bearing one row of nodes; generally three nodes per fenestrule. Average

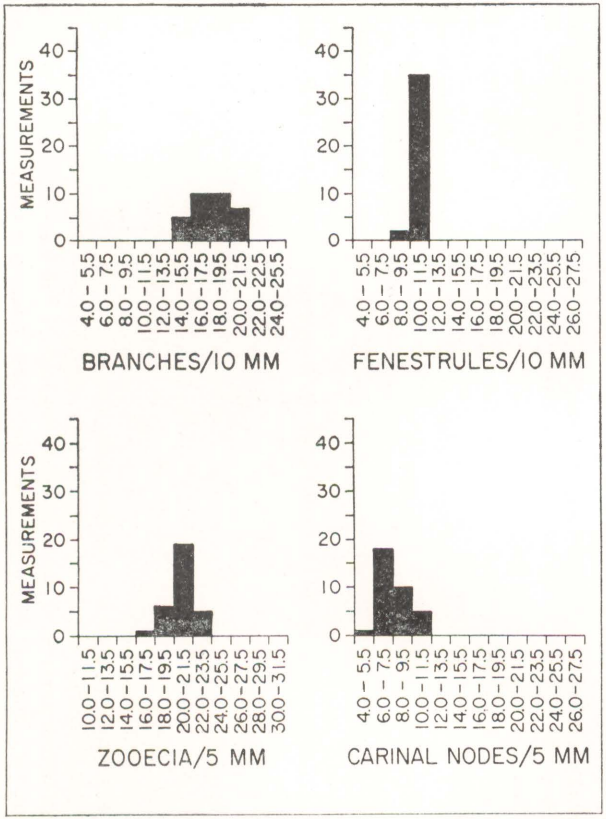

Figure 2.—Analysis of meshwork characters of six specimens of *Fenestella burlingtonensis* Ulrich.

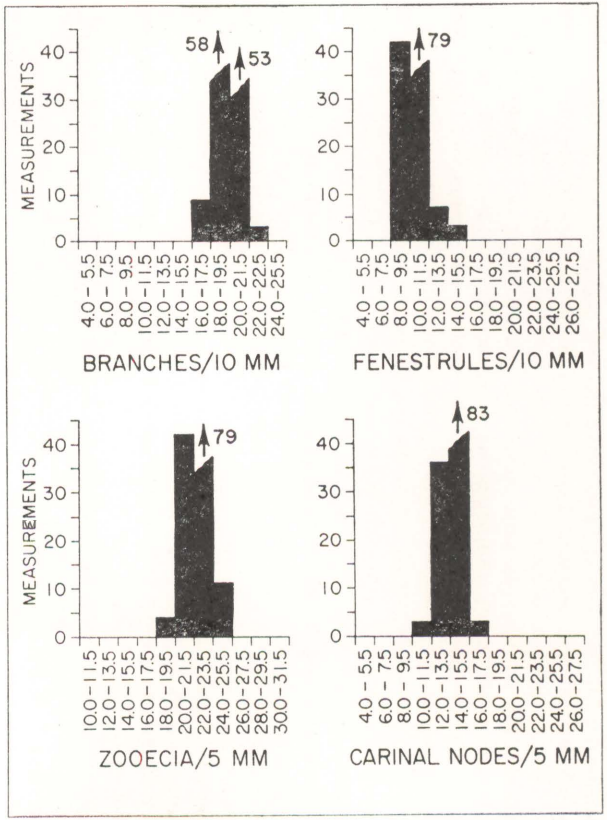

Figure 3.—Analysis of meshwork characters of 17 specimens of *Fenestella cestriensis* Ulrich.

fenestrule length 0.81 mm, ranging from 0.58 to 1.17 mm, and average fenestrule width 0.27 mm, ranging from 0.13 to 0.42 mm; fenestrule dimensions based on 119 measurements of length and width; fenestrules range in shape from broadly ovate to ovate with attenuated ends to nearly rectangular; lateral margins irregular in some fenestrules. Zooecia averaging four per fenestrule; zooecial chamber bases pentagonal, grading upward to rectangular. Meshwork moderately coarse; meshwork formula 16-22/8-14//19-25/11½-16.

Remarks.—One specimen shows a striated spine rising perpendicularly to the obverse surface of a branch for a distance of approximately 1.0 mm; the distal end of the broken spine is 0.58 mm in diameter.

Throughout the frond the branches are generally straight or mildly flexuose; locally, however, the branches are more conspicuously flexuose. The local development of flexuose branches in some of our specimens led us to compare our material with the presumed type specimen (Illinois State Museum Catalogue No. 2828) of *Fenestella flexuosa* Ulrich (*Reteporina flexuosa* of some authors), whose meshwork formula is similar to that of *F. cestriensis*. *F. flexuosa* differs from *F. cestriensis*, as the former species is more strongly flexuose throughout the frond than the locally flexuose areas in *F. cestriensis*.

We also compared our material with the type specimen (Illinois State Museum Catalogue No. 2750) of *Fenestella cestriensis*. Branches in local areas of the frond of the type specimen are mildly flexuose. Fenestrule length in the type specimen averages 0.71 mm, ranging from 0.67 to 0.80 mm, and fenestrule width averages 0.23 mm, ranging from 0.18 to 0.27 mm; fenestrule dimensions are based on 16 measurements of length and width. Average branch width below bifurcation is 0.37 mm, ranging from 0.35 to 0.38 mm, and average branch width above bifurcation is 0.24 mm, ranging from 0.23 to 0.25 mm; branch widths above and below bifurcations are based on three measurements in each location. Average branch width between bifurcations is 0.30 mm, ranging from 0.27 to 0.33 mm for 11 measurements. The meshwork formula of the type specimen is 18-22/10-13//18-22/11½-14.

Fenestella cestriensis and *F. exigua* Ulrich have closely related meshwork formulae. The former species (figs. 3 and 4) generally has 10 fenestrules in 10 mm, and the latter species (fig. 5) commonly has 12 or 13 in this distance. Further, the average fenestrule length in *F. exigua* is 0.61 mm compared with 0.81 mm in *F. cestriensis*. Histograms (fig. 3) of the meshwork characters of our specimens of *F. cestriensis* show the variability and moderate coarseness of the meshwork elements. One or two classes in all four histograms dominate. The histograms of the type specimen (fig. 4) suggest this distinctive feature, but the comparatively small number of measurements involved in these illustrations masks any appearance of striking dominance by one or two classes in each histogram.

McFarlan (1942, p. 443) reported the frond characters of *Archimedes laxus* (Hall) to be essentially those of *Fenestella cestriensis*. Condra and Elias (1944, p. 159), however, considered that the *F. cestriensis* frond type of McFarlan is more appropriately identified as *F. exigua*.

Fenestella cestriensis was found at localities 2 and 3 in the upper beds of the Glen Dean; it was more abundant at locality 2, where it was collected also on the upper surface of the lower massive part of the formation.

Types.—Homoeotypes: figured, InGS 336; unfigured, InGS 337, 338, 339.

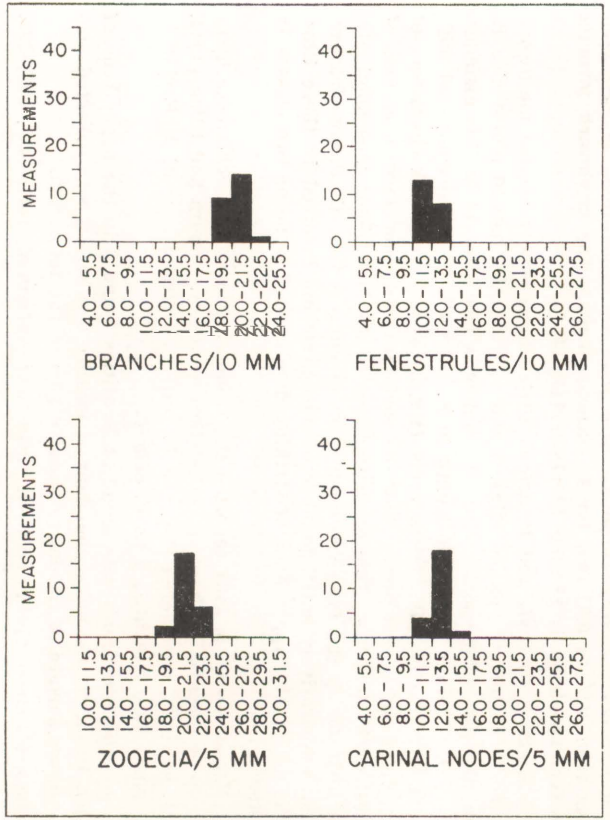

Figure 4.—Analysis of meshwork characters of *Fenestella cestriensis* Ulrich. From type specimen 2750, Illinois State Museum.

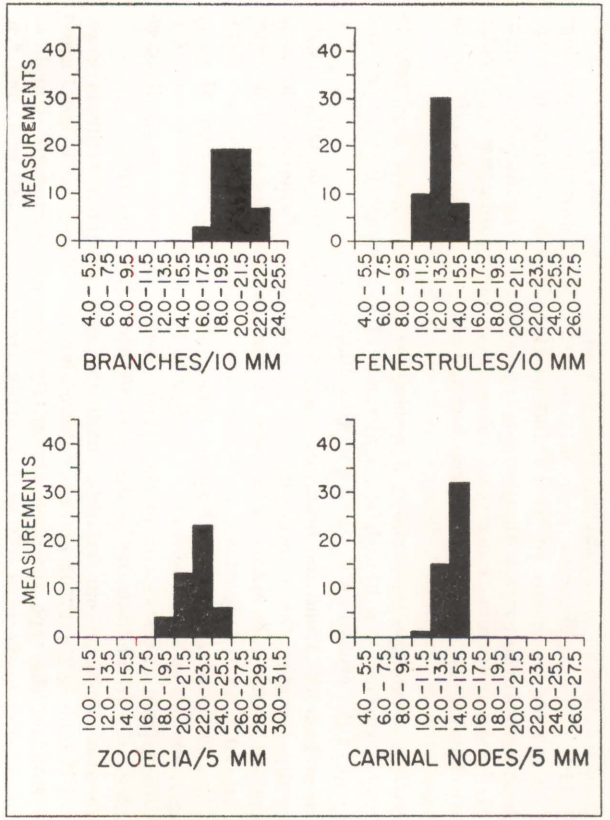

Figure 5.—Analysis of meshwork characters of six specimens of *Fenestella exigua* Ulrich.

Fenestella exigua Ulrich

Plate 2, figures 1-4

Fenestella exigua Ulrich, 1890, Illinois Geol. Survey, v. 8, p. 545-546, pl. 51, figs. 1-1a; Cumings, 1906, Indiana Dept. Geology and Nat. Resources, Ann. Rept 30, p. 1278, pl. 28, figs. 3-3a; Condra & Elias, 1944, Geol. Soc. America Spec. Paper 53, p. 112-113, 190.

Fenestrellina exigua McFarlan, 1942, Jour. Paleontology, v. 16, no. 4, p. 444.

Zoarial form.—Zoarium slightly undulatory, the largest fragmentary specimen 35 mm long and 15 mm wide. Branches flaring conspicuously near basal attachment and edges of frond; branches nearly straight in center of frond; average branch width above bifurcation 0.27 mm, ranging from 0.23 to 0.30 mm, and average branch width below bifurcation 0.36 mm, ranging from 0.33 to 0.43 mm; branch widths above and below bifurcations based on six measurements in each location; average branch width between bifurcations 0.31 mm, ranging from 0.28 to 0.35 mm for 25 measurements. Branches mildly flexuose and in closest proximity at dissepiments.

Reverse side.—Branches nonstriate but showing a lowly elevated ridge centrally located on branches and dissepiments; ridge zigzags along length of branch, but each internodal segment of ridge straight. Poorly developed nodes at junctions of ridges on dissepiments and branches and rarely on ridges between these junctions. Fenestrules ovate.

Obverse side.—Branches generally wider than fenestrules; branches and fenestrules mostly wider than dissepiments. Carina conspicuously elevated and bearing one row of closely spaced nodes; generally about two nodes per fenestrule. Average fenestrule length 0.61 mm, ranging from 0.50 to 0.68 mm, and average fenestrule width 0.26 mm, ranging from 0.20 to 0.38 mm; fenestrule dimensions based on 35 measurements of length and width; fenestrules ovate. Sides of branches sloping away from carina. Zooecia averaging nearly four per fenestrule; zooecial chamber bases subrectangular. Meshwork of medium coarseness; meshwork formula 17-23/10-14//19-24/11-15.

Remarks.—Branched, striated, barbed, pillarlike appendages, developed as prolongations of the branches, were found near the basal part of the largest fragmentary frond. These structures are as much as 9.2 mm long and range from 0.19 mm in diameter at the distal extremity to 0.37 mm in diameter at the end attached to the frond. One stublike basal part of a striated pillar (0.70 mm in diameter), directed perpendicularly to the obverse side, was noted. All characters of our specimens compare favorably with those given in the original description of the species except for the lesser prominence of the reverse nodes and the presence of a lowly elevated ridge on the reverse side of our specimens. Histograms (fig. 5) of the meshwork characters of *F. exigua* show the moderate variability of the meshwork elements and the lack of dominance of any class for branches in 10 mm.

The *Fenestella exigua*-type of frond is associated with the axis of *Archimedes laxus* (Hall) according to Condra and Elias (1944, p. 112-113, 159, 190).

Fenestella exigua was found at all localities in the upper part of the formation but was especially abundant in lenticular argillaceous limestone beds at locality 2; specimens were collected also at this locality from the top of the lower part of the Glen Dean.

Types.—Hypotypes: figured, InGS 340; unfigured, InGS 341, 342, 343, 344.

Fenestella matheri Condra & Elias

Plate 2, figures 5-8

Fenestella matheri Condra & Elias, 1944, Geol. Soc. America Spec. Paper 53, p. 108-110, pl. 22, figs. 5-7.

Zoarial form.—Zoarium a foliate, fan-shaped, nearly flat expansion; largest fragmentary specimen 40 mm long and 20 mm wide. Branches straight, except near base and frond margins where branches are flaring; average branch width above bifurcation 0.22 mm, ranging from 0.20 to 0.25 mm, and average branch width below bifurcation 0.33 mm, ranging from 0.28 to 0.37 mm; branch widths above and below bifurcations based on 12 measurements in each location; average branch width between bifurcations 0.27 mm, ranging from 0.21 to 0.33 mm for 43 measurements.

Reverse side.—Branches showing five or six moderate to coarse striae but lacking nodes. Fenestrules ovate to subrectangular.

Obverse side.—Branch width generally somewhat greater than fenestrule width; branch width and fenestrule width conspicuously greater than dissepiment width. Carina sharply elevated and having one row of prominent closely spaced nodes; generally about 2½ nodes per fenestrule. Fenestrules ovate to subrectangular; average fenestrule length 0.47 mm, ranging from 0.37 to 0.57 mm, and average fenestrule width 0.21 mm, ranging from 0.13 to 0.28 mm; fenestrule dimensions based on 66 measurements of length and width. Sides of branches sloping away from carina. Zooecia averaging between 2½ to 3 per fenestrule; zooecial chamber base nearly rectangular. Meshwork moderately fine; meshwork formula 18-25/14-19//21-25/17-26.

Remarks.—Finely striated and barbed pillarlike appendages were observed on the lateral margin near the base of the frond; one of these appendages clearly is a prolongation of a branch, but the other may be developed as a lateral extension of branch material. The larger broken appendage is 4 mm long, 0.27 mm in diameter at its distal extremity, and 0.58 mm in diameter at its proximal end where the appendage joins the branch. According to Condra and Elias (1944, p. 110), a *Fenestella matheri*-type of meshwork is associated with the following forms of *Archimedes*: *A. compactus* Ulrich, *A. lativolvis* Ulrich, *A. meekanus* Hall, *A. proutanus* Ulrich, *A. macfarlani* Condra & Elias, *A. invaginatus* Ulrich, and *A. magnus* Condra & Elias; none of our specimens of *F. matheri* was associated with *Archimedes* shafts.

If one considers only the characters expressed in the meshwork formula, *Fenestella matheri* is difficult to distinguish from the closely allied species *F. cumingsi* Condra & Elias and *F. serratula* Ulrich. The latter two species, however, do not have a nearly rectangular zooecial chamber base (Condra and Elias, 1944, p. 75, 104). *F. matheri* also resembles *F. paradisensis* Condra & Elias in the number of branches and fenestrules in 10 mm and zooecia in 5 mm. Carinal nodes have not been demonstrated definitely in *F. paradisensis* (Condra and Elias, 1944, p. 107), however, and *F. matheri* differs further from *F. paradisensis* in the relative widths of branches, fenestrules, and dissepiments.

Histograms (fig. 6) of the meshwork characters of *Fenestella matheri* show that one class dominates in fenestrules in 10 mm and zooecia in 5 mm and that the number of nodes in 5 mm varies greatly. No class in branches in 10 mm, however, has great dominance.

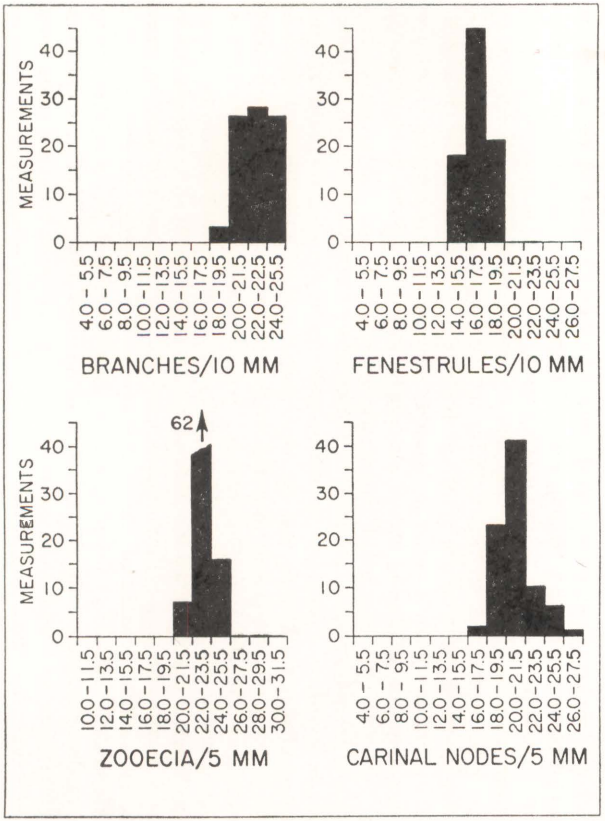

Figure 6.—Analysis of meshwork characters of 10 specimens of *Fenestella matheri* Condra & Elias.

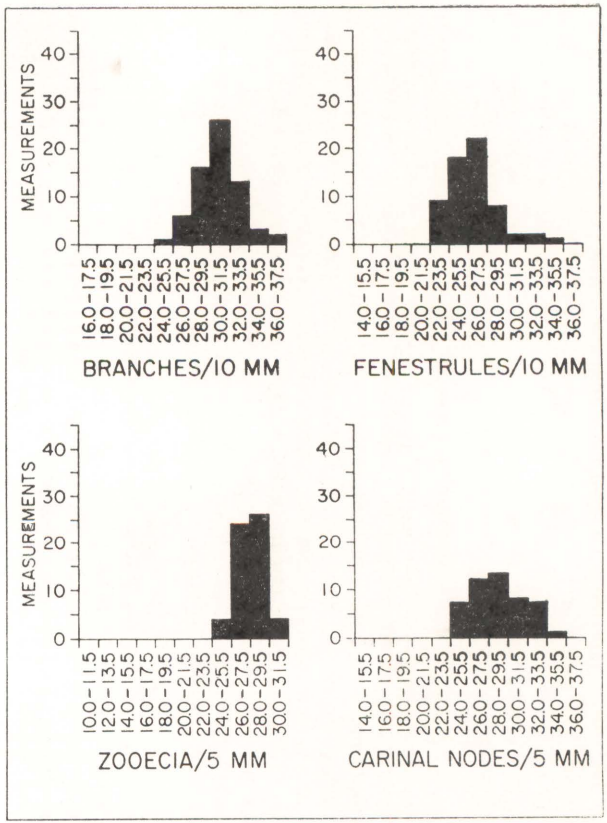

Figure 7.—Analysis of meshwork characters of 12 specimens of *Fenestella tenax* Ulrich.

Fenestella matheri is the second most abundant species of *Fenestella* in the Glen Dean Limestone of Indiana. This species was collected from the upper beds of the formation at localities 2 and 3 but is more abundant at locality 2, where it was found also on the upper surface of the lower part of the formation.

Types.—Hypotypes: figured, InGS 345; unfigured, InGS 346, 347, 348.

Fenestella tenax Ulrich

Plate 3, figures 1-5

Fenestella tenax Ulrich, 1888, Denison Univ., Sci. Lab., Bull., v. 4, p. 71; ——— 1890, Illinois Geol. Survey, v. 8, p. 546-547, pl. 51, figs. 2-2e; Cumings, 1906, Indiana Dept. Geology and Nat. Resources, Ann. Rept. 30, p. 1279, pl. 30, fig. 1; pl. 31, figs. 1-1b; Condra & Elias, 1944, Geol. Soc. America Spec. Paper 53, p. 99-102, pl. 21, figs. 1-3; Elias, 1957, Jour Paleontology, v. 31, no. 2, p. 410, pl. 44, fig. 1; pl. 48, fig. 6; Elias & Condra, 1957, Geol. Soc. America Mem. 70, p. 106-107, pl. 16, figs. 1, 2.

Zoarial form.—Zoarium nearly flat, the largest fragmentary specimen 50 mm long and 20 to 50 mm wide. Branches mostly straight, but some displaying pronounced lateral flaring; average branch width above bifurcation nearly 0.17 mm, ranging from 0.14 to 0.21 mm, and average branch width below bifurcation slightly over 0.26 mm, ranging from 0.24 to 0.30 mm; branch widths above and below bifurcations based on 10 measurements in each location; average branch width between bifurcations, obtained from 42 measurements, 0.20 mm, ranging from 0.17 to 0.24 mm.

Reverse side.—Branches finely striate. Fenestrules more broadly ovate and more nearly rectangular than when viewed from obverse side.

Obverse side.—Branches slightly wider than fenestrules; branches and fenestrules both wider than dissepiments. Carina strongly elevated and bearing one row of closely spaced small nodes; generally about two nodes per fenestrule. Average fenestrule length 0.26 mm, ranging from 0.17 to 0.36 mm, and average fenestrule width nearly 0.14 mm, ranging from 0.09 to 0.20 mm but only one measurement greater than 0.17 mm; fenestrule dimensions based on 61 measurements of length and width. Sides of branches sloping away from carina; zooecial apertures bearing prominent peristomes and inclined away from plane including carina; zooecia averaging nearly two per fenestrule, generally one aperture opposite middle of fenestrule and one at extremity of each dissepiment; zooecial chamber bases triangular or subtriangular. Meshwork very fine and highly variable; meshwork formula 25-37/22-34//24-31/24-34.

Remarks.—One specimen showing pronounced lateral flaring of the branches displays eight broken, barbed, striated, and pillarlike appendages developed as prolongations of the branches at the frond margin. The longest broken appendage is 4.5 mm long and 0.5 mm in diameter at its proximal end.

Histograms (fig. 7) for *Fenestella tenax* show the great variability of the meshwork elements. No modal class in nodes in 5 mm dominates greatly as compared with the other three histograms of this species. Data from two measured specimens were omitted in compiling the histogram depicting the number of fenestrules in 10 mm. Each of these specimens shows one measurement of 29 fenestrules in 10 mm and five or six measurements of 30 fenestrules in this distance; all measurements of more than 30 fenestrules in 10 mm were noted on one specimen. All other measured characters on these specimens,

however, fell within the variability range of Chester forms as given by Condra and Elias (1944, p. 100) and compared favorably with the original illustrations and description of the species (Ulrich, 1890, p. 546-547). According to Condra and Elias (1944, table 79, p. 188-189; table 80, p. 190-191), the *Fenestella tenax*-type of frond is associated with *Archimedes bassleri* McFarlan and *A. fosteri* Condra & Elias.

Fenestella tenax is the most abundant fenestrate species in our collections. It was found in the thick-bedded limestone in the lower Glen Dean as well as in the lenticular argillaceous limestone beds in the upper part of the formation at all localities.

Types.—Hypotypes: figured, InGS 349; unfigured, InGS 350, 351, 352, 353.

Genus LYROPORELLA Simpson, 1895
Lyroporella divergens (Ulrich)

Plate 3, figures 6-8

Lyropora divergens Ulrich, 1890, Illinois Geol. Survey, v. 8, p. 584, pl. 58, figs. 4-4d.

Lyroporella divergens McFarlan, 1942, Jour. Paleontology, v. 16, no. 4, p. 450, pl. 66, figs. 17, 18.

Zoarial form.—Zoarium a flat or gently undulatory expansion, the largest specimen 55 mm long and 30 mm wide; distal extremities of branches merge laterally and terminally into solid calcareous deposit that is elliptical or ovate in most cross sections and less than 2 mm in maximum diameter. Branches mildly flexuose and in closest proximity at dissepiments; branch width below bifurcation ranging from 0.50 to 0.67 mm, averaging 0.58 mm, and branch width above bifurcation ranging from 0.27 to 0.41 mm, averaging 0.29 mm; branch widths below and above bifurcations based on eight measurements in each location; branch width between bifurcations ranging from 0.32 to 0.47 mm, averaging 0.36 mm for 44 measurements. Basal support not observed.

Reverse side.—Branches and dissepiments generally showing inconspicuous, nearly straight, and vermiculiform striae. Dissepiments on same level as branches and nearly equal to branches in width. Fenestrules broadly ovate to nearly circular.

Obverse side.—Branches approximately twice as wide as fenestrules; average dissepiment width 0.39 mm, ranging from 0.27 to 0.58 mm for 59 measurements; prominent node located midway between extremities of dissepiments; average branch width, based on 60 measurements, 0.38 mm. Carina inconspicuous, lowly elevated especially between nodes, and bearing one row of nodes except below branch bifurcation where nodes are in two rows; length of branch bearing two rows of carinal nodes variable from 0.7 to 8.5 mm, averaging 2.6 mm for 40 measurements; generally about three nodes per fenestrule. Average fenestrule length 0.39 mm, ranging from 0.30 to 0.52 mm, and average fenestrule width 0.19 mm, ranging from 0.13 to 0.25 mm; fenestrule dimensions based on 58 measurements of length and width. Fenestrules broadly ovate to nearly circular and commonly somewhat inflected by zooecia where peristomes preserved. Zooecia in two rows except below bifurcations where branches bear three rows of zooecia and two rows of nodes; zoecia averaging four per fenestrule. Meshwork formula 16-22/10-15//21-25/16-19.

Remarks.—One specimen shows several broken spinelike calcareous processes arising from the thickened calcareous frond margin; diameter of proximal ends of spines ranges from 0.33 to 1.0 mm. Histograms (fig. 8) of the meshwork characters of *Lyroporella divergens* show the relatively peaked distribution of all characters except fenestrules in 10 mm which have a bimodal distribution showing peaks at 11 and 14 fenestrules in this distance.

Lyroporella divergens is found in the upper beds of the Glen Dean at all collecting localities.

Types.—Hypotypes: figured, InGS 354, 355; unfigured, InGS 356, 357, 358.

Genus POLYPORA McCoy, 1844
Polypora corticosa Ulrich

Plate 4, figures 3-5; plate 5, figure 1

Polypora corticosa Ulrich, 1890, Illinois Geol. Survey, v. 8, p. 596-597, pl. 60, figs. 5-5c; pl. 61, fig. 1; McFarlan, 1942, Jour. Paleontology, v. 16, no. 4, p. 445, tables 2, 3; pl. 66, fig. 10.

Zoarial form.—Zoarium a mildly undulatory expansion, the largest fragmentary specimen 20 mm long and 14 mm wide; branches near margin of frond flaring rapidly outward near frond base; average branch width above bifurcation 0.45 mm, ranging from 0.32 to 0.55 mm, and average branch width below bifurcation 0.79 mm, ranging from 0.67 to 0.95 mm; branch width based on 11 measurements in each location; average branch width between bifurcations 0.59 mm, ranging from 0.42 to 0.67 mm for 41 measurements; average branch width for 63 measurements 0.60 mm. Basal supporting stalk noncelluliferous, finely striate, as much as 2.25 mm in diameter, and growing out of a flangelike base as much as 6.0 mm in diameter. Pillarlike finely striate appendages as much as 4.0 mm long and nearly 1.0 mm in diameter extend downward from frond adjacent to supporting stalk. Striate tissue restricts size of basal fenestrules and obliterates zooecia near base of frond.

Reverse side.—Not observed.

Obverse side.—Branch width above striated tissue near frond base about twice width of dissepiment; branches about 1½ times as wide as fenestrules. Average fenestrule length 0.78 mm, ranging from 0.62 to 1.02 mm, and average fenestrule width 0.43 mm, ranging from 0.27 to 0.62 mm; fenestrule dimensions based on 58 measurements of length and width; most fenestrules broadly ovate, but some elongate-ovate. Three rows of zooecia immediately above bifurcations, most commonly four between bifurcations, and six, rarely seven, immediately below bifurcations. Rows of nodes faintly to moderately developed between rows of zooecia in local areas of frond. Sinuous ridges faintly developed between rows of zooecia in localized areas of frond. Meshwork formula 8-11/6-10//18-20/14-18.

Remarks.—*Polypora corticosa* closely resembles *P. spinulifera* Ulrich in branches and fenestrules in 10 mm and zooecia in 5 mm. *P. corticosa* is distinguished from *P. spinulifera* by having: (1) somewhat fewer branches in 10 mm, (2) stouter branches and somewhat larger fenestrules, (3) a striated supporting stalk which has not been reported for *P. spinulifera*, and (4) faintly developed sinuous interzooecial ridges, which have not been mentioned in the description of *P. spinulifera* (Ulrich, 1890, p. 598-599).

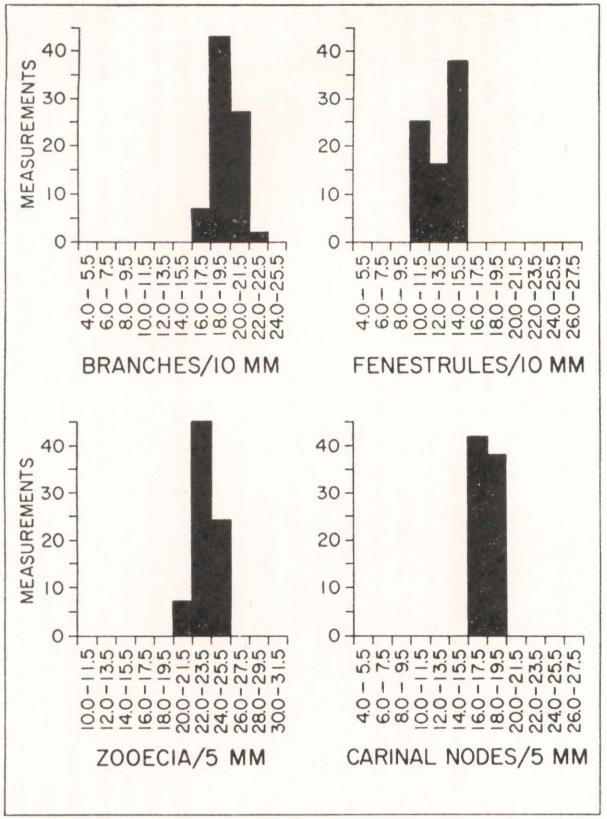

Figure 8.—Analysis of meshwork characters of eight specimens of *Lyroporella divergens* (Ulrich).

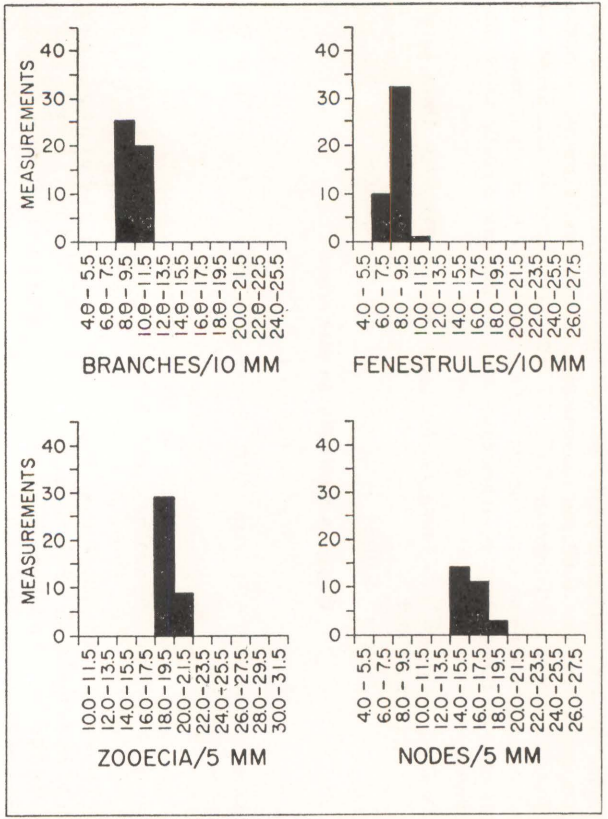

Figure 9.—Analysis of meshwork characters of four specimens of *Polypora corticosa* Ulrich.

Nodes in our specimens of *Polypora corticosa* have relatively constant spacing locally in the frond and commonly are superposed on the sinuous interzooecial ridges. Histograms (fig. 9) of the meshwork characters of *P. corticosa* show that no class dominates in branches in 10 mm and nodes in 5 mm and that one class in fenestrules in 10 mm and zooecia in 5 mm dominates.

Polypora corticosa was found in the upper beds of the Glen Dean Limestone at localities 2 and 3.

Types.—Hypotypes: figured, InGS 359, 360; unfigured, InGS 361, 362.

Polypora multispinosa McFarlan

Plate 4, figures 1, 2

Polypora multispinosa McFarlan, 1942, Jour. Paleontology, v. 16, no. 4, p. 445, pl. 66, figs. 3-7.

Zoarial form.—Zoarium a flat or mildly undulatory expansion, the largest fragmentary specimen 40 mm long and 35 mm in maximum width. Branches mildly flaring near base of frond, elsewhere straight; average branch width above bifurcation 0.44 mm, ranging from 0.40 to 0.50 mm, and average branch width below bifurcation 0.80 mm, ranging from 0.67 to 0.94 mm; branch widths above and below bifurcations based on seven measurements in each location; average branch width between bifurcations 0.59 mm, ranging from 0.47 to 0.78 mm for 41 measurements; average branch width including all 55 measurements 0.60 mm.

Reverse side.—Branches smooth or having 5 to 8 fine striae between bifurcations, but as many as 11 in local areas below bifurcations. Nodes not observed. Fenestrules elongate-ovate to subquadrate, the latter shape predominating.

Obverse side.—Branch width generally twice dissepiment width and slightly greater than fenestrule width. Average fenestrule length 1.39 mm, ranging from 1.10 to 1.92 mm, and average fenestrule width 0.51 mm, ranging from 0.33 to 0.68 mm; fenestrule dimensions based on 40 measurements of length and width; fenestrule shape same as viewed from reverse. Number of rows of zooecia typically three or four, increasing to six or seven below branch bifurcations, and separated by a row of nodes; usually five or six nodes per fenestrule. Meshwork coarse; meshwork formula 7-11/5½-7//16-20/14-18.

Remarks.—*Polypora multispinosa* differs from *P. spinulifera* Ulrich, its closest ally, in having a coarser meshwork and in the size and proportion of the fenestrules. In *P. spinulifera* fenestrules average 0.6 mm in length and 0.3 mm in width; measurements on the type figure of *P. multispinosa* (McFarlan, 1942, pl. 66, figs. 3-7) show that fenestrule length ranges from approximately 1.1 to 1.7 mm and fenestrule width from 0.4 to 0.6 mm. Fenestrule measurements on our specimens agree well with those of the type figures. Histograms (fig. 10) of the meshwork characters of *P. multispinosa* show moderate dominance of one class for each character.

Polypora multispinosa was found in the upper beds of the Glen Dean at all localities and was noted on the upper bedding surface of the lower part of the formation at locality 2.

Types.—Hypotypes: figured, InGS 363; unfigured, InGS 364, 365, 366, 367.

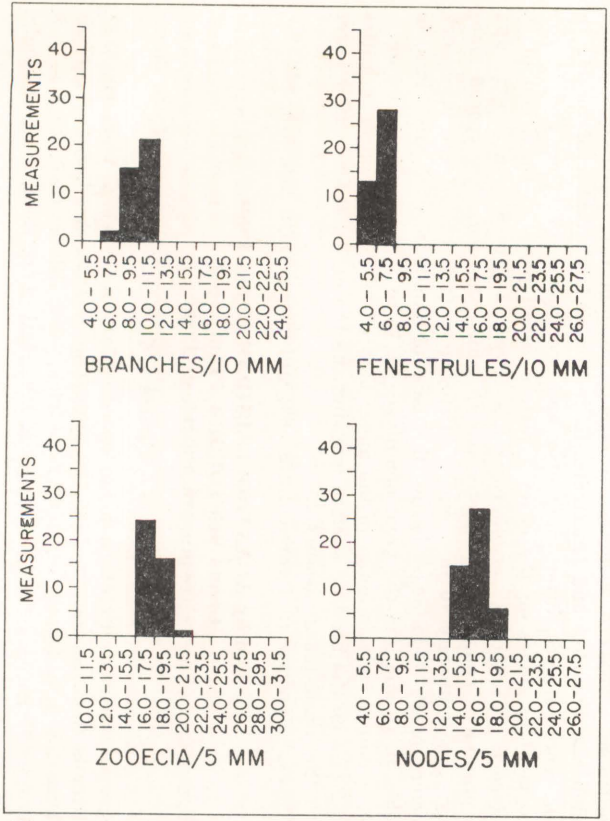

Figure 10.—Analysis of meshwork characters of four specimens of *Polypora multispinosa* McFarlan.

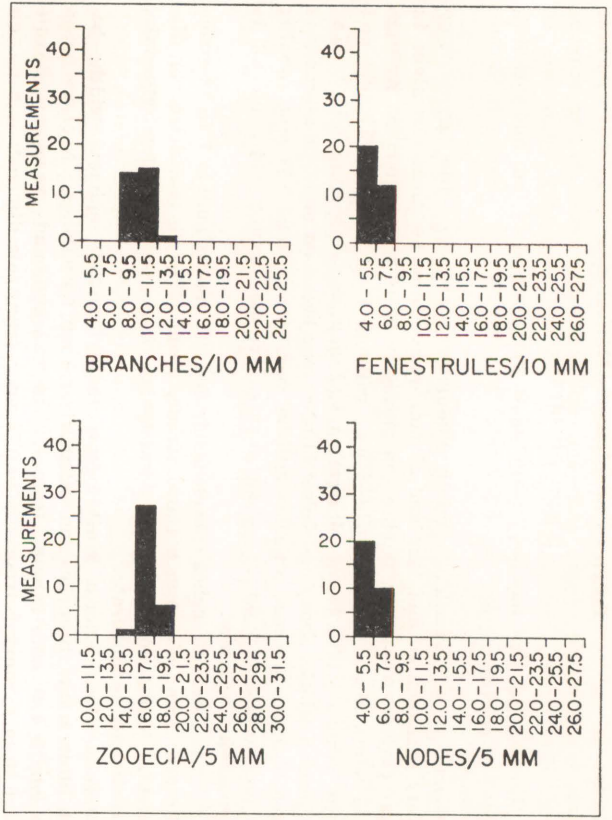

Figure 11.—Analysis of meshwork characters of four specimens of *Polypora nodolinearis* McFarlan.

Polypora nodolinearis McFarlan

Plate 5, figures 2-4

Polypora nodolinearis McFarlan, 1942, Jour. Paleontology, v. 16, no. 4, p. 445, 448, pl. 66, figs. 8, 9.

Zoarial form.—Zoarium a mildly undulatory expansion, the largest fragmentary specimen 30 mm long and 25 mm wide. Branches nearly straight in central part of frond but flaring conspicuously near frond margin; average branch width above bifurcation 0.46 mm, ranging from 0.43 to 0.52 mm, and average branch width below bifurcation 0.82 mm, ranging from 0.73 to 0.89 mm; branch widths above and below bifurcations based on eight measurements in each location; average branch width between bifurcations 0.59 mm, ranging from 0.47 to 0.83 mm for 28 measurements; average branch width for all 44 measurements 0.61 mm.

Reverse side.—Branches conspicuously striate, approximately 7 to 12 striae per branch; some dissepiments also striate, about three to six striae per dissepiment. Nodes not observed. Fenestrules most commonly elongate-ovate, less commonly subquadrate.

Obverse side.—Branch width two to three times dissepiment width; between bifurcations, branches somewhat wider than fenestrules. Average fenestrule length 1.91 mm, ranging from 1.39 to 2.22 mm, and average fenestrule width 0.56 mm, ranging from 0.35 to 0.73 mm; fenestrule dimensions based on 35 measurements of length and width. Fenestrule shape same as viewed from reverse. Three rows of zooecia immediately above bifurcations, most commonly four between bifurcations, but as many as five or six immediately below bifurcations. Prominent ridge between adjacent rows of zooecia. Nodes highly conspicuous and in one row. Meshwork formula 8-12/4-6//15-18/3½-6½.

Remarks.—*Polypora nodolinearis* closely resembles *P. cestriensis* Ulrich in number of branches and fenestrules in 10 mm and in number of zooecia in 5 mm. These species differ in number and prominence of nodes and in the development of ridges on the obverse surface in all parts of the frond of *P. nodolinearis*. Further, *P. nodolinearis* has fewer (3½ to 6½ in 5 mm) and more prominent nodes than *P. cestriensis* in which the nodes are spaced more closely (approximately 10 in 5 mm). Histograms (fig. 11) of the meshwork characters of *P. nodolinearis* show the lack of dominance of any class in branches in 10 mm and the great dominance of 16 to 17½ zooecia in 5 mm.

P. nodolinearis was found in the upper beds of the Glen Dean at localities 1 and 2 and on the bedding surface marking the top of the thick-bedded lower part of the formation at locality 2.

Types.—Hypotypes: figured, InGS 368; unfigured, InGS 369, 370, 371.

Family ACANTHOCLADIIDAE Zittel, 1880
Genus SEPTOPORA Prout, 1859
Septopora cestriensis Prout

Plate 6, figures 6, 7

Septopora cestriensis Prout (non *Septopora cestriensis* Meek & Worthen, 1870, Illinois Geol. Survey, v. 5, pl. 24, figs. 14a-c), 1859, Acad. Sci. St. Louis Trans., v. 1, p. 448, pl. 18, figs 2-2c; Ulrich, 1890, Illinois Geol. Survey, v. 8, p. 628-629, pl. 64, figs. 1-1b; Simpson, 1895, 14th Ann. Rept. State Geologist

New York for the year 1894, p. 515, fig. 65; Morgan, 1924, Oklahoma Bur. Geology Bull. 2, pl. 37, fig. 16; McFarlan, 1942, Jour. Paleontology, v. 16, no. 4, p. 454, pl. 67, fig. 4.

Zoarial form.—Zoarium a flat or gently undulatory expansion, the largest fragmentary specimen 18 mm long and 20 mm wide. Branches nearly straight or mildly divergent and arising by bifurcation; branch width variable from 0.33 mm above bifurcation to 0.58 mm below bifurcation, averaging 0.42 mm for 13 measurements of which 10 were made between bifurcations.

Reverse side.—Surface weathered. Obscure striae locally on branches. Accessory pores generally located at junctions of branches and dissepiments, rare elsewhere. Fenestrules mainly ovate or broadly ovate, less commonly subquadrate. Nodes not observed.

Obverse side.—Branches generally slightly wider than dissepiments; branch width slightly greater than fenestrule width. Average fenestrule width 0.38 mm, ranging from 0.25 to 0.83 mm, and average fenestrule length 0.62 mm, ranging from 0.50 to 0.69 mm; fenestrule dimensions based on 16 measurements of width and length. Carina very low, broadly rounded, and bearing one row of nodes. Accessory pores from one-third to two-thirds size of a typical zooecial aperture, generally located between zooecial apertures on flanks of branches and near extremities of dissepiments and rarely on carina. Branches and dissepiments bearing two ranges of zooecia; generally four zooecia per fenestrule; most commonly 20 (three measurements) or 21 (four measurements) zooecia in 5 mm; number of zooecia on each dissepiment from two to eight, commonly two to four, for 39 measurements. One measurement each of 11, 12, 13, and 15 branches in 10 mm, and two measurements of 14 branches in this distance. Meshwork of medium coarseness; meshwork formula 11-15/10//20-22/5-6.

Remarks.—*Septopora cestriensis* has more branches in 10 mm than *S. subquadrans* Ulrich to which it is related most closely. Fenestrules in *S. cestriensis* are ovate to broadly ovate but are mainly subquadrate in *S. subquadrans;* in the latter species, fenestrules are generally wider than long, but the reverse condition applies to *S. cestriensis.* Nodes were not observed on the reverse side of *S. cestriensis* but were noted on the reverse surface of *S. subquadrans.* Finally, dissepiments in *S. cestriensis* are straighter and shorter and bear fewer zooecia per dissepiment.

Septopora cestriensis was found at localities 2 and 3 in the upper beds of the formation. Our collections include only three specimens of which one shows the obverse surface. Consequently, histograms were not constructed for this species because of the small number of measurements that could be obtained.

Types.—Hypotypes: figured, InGS 372; unfigured, InGS 373.

Septopora subquadrans Ulrich

Plate 6, figures 1-5

Septopora cestriensis Meek & Worthen, 1870, Illinois Geol. Survey, v. 5, pl. 24, figs. 14a-c.

Septopora subquadrans Ulrich, 1890, Illinois Geol. Survey, v. 8, p. 629-630, pl. 56, figs. 7, 8; pl. 64, figs. 2-2c; McFarlan, 1942, Jour. Paleontology, v. 16, no. 4, p. 454, pl. 67, figs. 1-3.

Zoarial form.—Zoarium a flat or mildly undulatory expansion, the largest fragmentary specimen 30 mm long and 65 mm wide. Branches develop by bifurcation; distance between bifurcations shorter near base of frond than in remainder of colony; branches strongly divergent in basal part of frond but mildly divergent in remainder of zoarium; average branch width below bifurcation 0.74 mm, ranging from 0.67 to 0.83 mm, and average branch width above bifurcation 0.43 mm, ranging from 0.37 to 0.50 mm; branch widths below and above bifurcations based on six measurements in each location; average branch width between bifurcations 0.54 mm, ranging from 0.42 to 0.67 for 36 measurements; average branch width for all (48) measurements 0.55 mm. Branches straight.

Reverse side.—Branches virtually smooth but locally faintly striate in distal part of frond. Accessory pores prominent; on branches and dissepiments these structures average 0.15 mm in diameter, ranging from 0.13 to 0.17 mm for 35 measurements; on branches, accessory pores average 15 in a 5-mm distance, ranging from 12 to 19 for 15 measurements; commonly one or two, rarely three, accessory pores on each dissepiment; generally a pore is located near junction of branch and dissepiment; where well preserved, accessory pores have distinct peristomes. Nodes more abundant on branches than on dissepiments; node development variable from specimen to specimen. Fenestrules typically subquadrate, less commonly crescentic to crudely triangular.

Obverse side.—Branches characteristically wider than dissepiments. Fenestrules invariably wider than branches; average fenestrule width 0.86 mm, ranging from 0.42 to 1.50 mm, and average fenestrule length 0.66 mm, ranging from 0.42 to 0.92 mm; fenestrule dimensions based on 47 measurements of width and length. First two fenestrules above each bifurcation generally longer than wide but remaining fenestrules below next bifurcation wider than long. Carina low, bearing a row of shallow accessory pores which are removed readily by weathering; diameter of accessory pore generally somewhat less than diameter of typical zooecium; generally one to three accessory pores and one, rarely two, nodes on each dissepiment; nodes on dissepiment less prominent than those on branches. Dissepiments and branches bearing two ranges of zooecia; generally five zooecia per fenestrule; on dissepiments, number of zooecia, including both rows, ranges from 2 to 16, most commonly 6 to 10, for 71 measurements. Meshwork coarse; meshwork formula 5½-10/8-10//20-24/4-5½.

Remarks.—Superficial examination would suggest that these forms display three rows of zooecia on the obverse side which would prompt assignment to the genus *Synocladia* King. Thin sections (pl. 6, fig. 4), however, show clearly that only two ranges of zooecia exist and further that the accessory pores on the carina terminate immediately below the surface of the carina. Our specimens display larger and more closely spaced accessory pores on the reverse surface than the specimen illustrated by Ulrich (1890, pl. 64, fig. 26). In local areas, a process parallel to the branches connects adjacent dissepiments. One specimen shows prolongation of four branches into striated and branching solid appendages that are transverse to the general direction of the branches; the largest appendage is 9.0 mm long and 0.75 mm in diameter at its proximal end.

Two small fragmentary specimens having strongly divergent branches are assigned to *Septopora subquadrans*. These specimens, presumably from the basal part of the frond, display as many as 11 fenestrules in 10 mm and as

many as eight nodes in 5 mm. All other characters of these specimens, however, correspond to those described by Ulrich (1890, p. 629-630) and to those of all other specimens that we have assigned to this species.

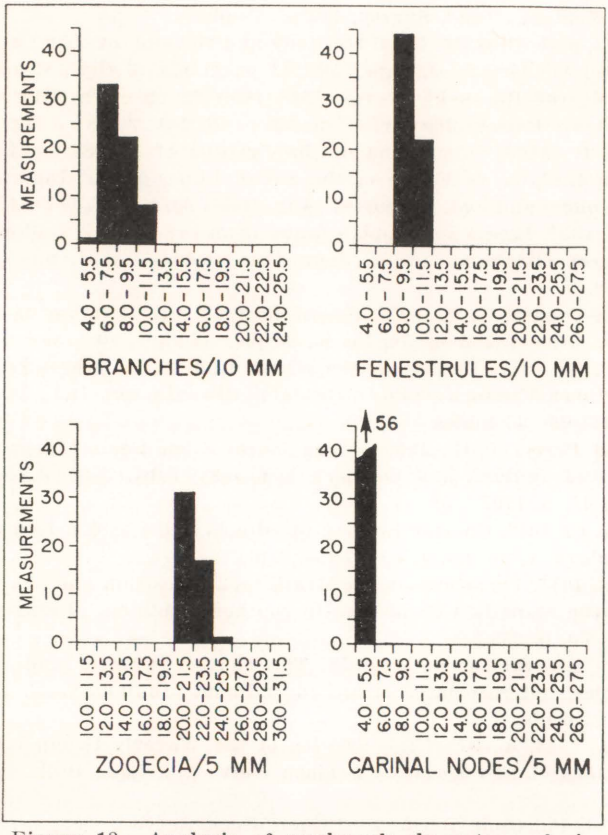

Figure 12.—Analysis of meshwork characters of six specimens of *Septopora subquadrans* Ulrich.

Histograms (fig. 12) of the meshwork characters show that one class dominates in each meshwork character, especially in number of nodes in 5 mm.

Septopora subquadrans was found at all localities and is most abundant at locality 2, where it was collected in the upper beds of the Glen Dean and on the upper surface of the massive lower part of the formation.

Types.—Hypotypes: figured, InGS 374; unfigured, InGS 375, 376, 377, 378.

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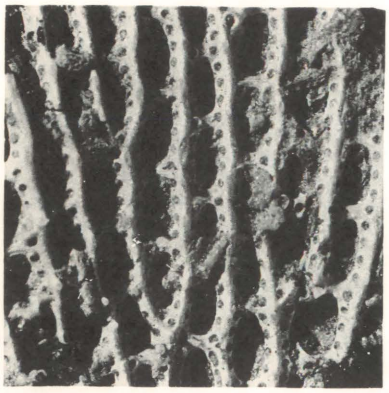
PLATES 1-6

PLATE 1

[All illustrations are X 10.]

Figures 1-4. *Fenestella burlingtonensis* Ulrich. *1,* Obverse surface; *2,* reverse surface showing nodes; *3,* polished obverse surface showing subrectangular chamber bases; *4,* obverse surface. Hypotypes, InGS 334.

5-9. *Fenestella cestriensis* Ulrich. *5,* Polished obverse surface showing pentagonal chamber bases grading upward to rectangular chamber outline; *6,* reverse surface locally showing nonstriate branches; *7,* obverse surface locally revealing mildly flexuose branches; *8,* reverse surface showing prominent striations; *9,* obverse surface. Hypotypes, InGS 336.



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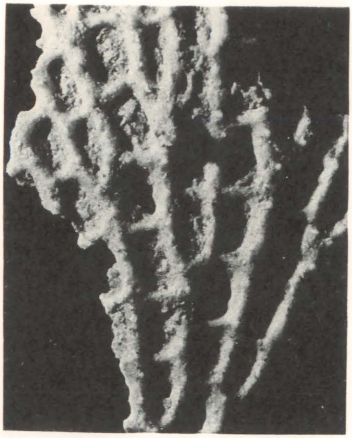

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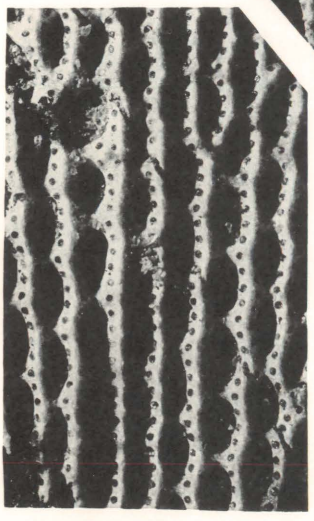

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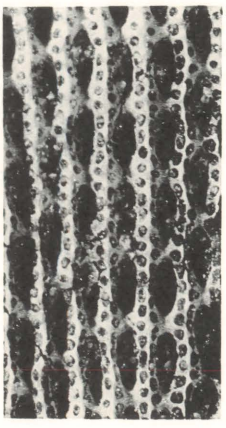


9

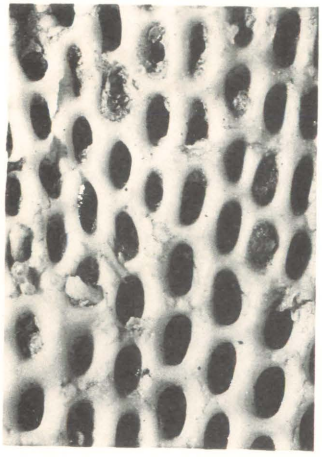
FENESTELLA BURLINGTONENSIS AND FENESTELLA CESTRIENSIS

PLATE 2

[All illustrations are X 10.]

Figures 1-4. *Fenestella exigua* Ulrich. *1*, Reverse surface; *2*, obverse surface showing base of pillar normal to frond surface in lower right; *3*, polished obverse surface showing subrectangular chamber bases; *4*, obverse surface. Hypotypes, InGS 340.

5-8. *Fenestella matheri* Condra & Elias. *5*, Reverse surface showing prominent striations; *6*, obverse surface showing pillarlike appendages at frond margin; *7*, polished obverse surface showing nearly rectangular chamber bases; *8*, obverse surface. Hypotypes, InGS 345.



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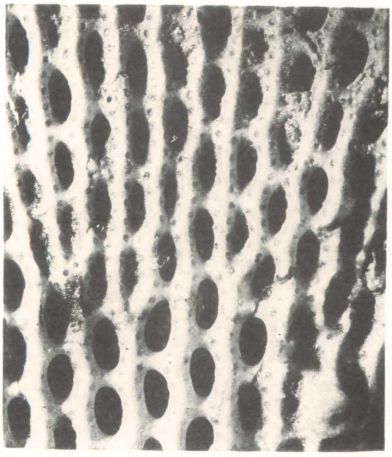

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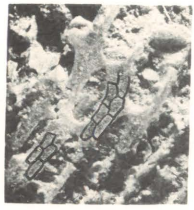

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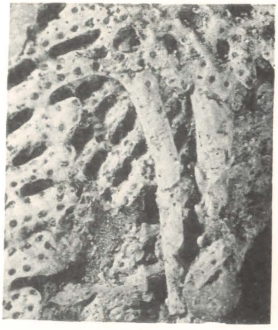

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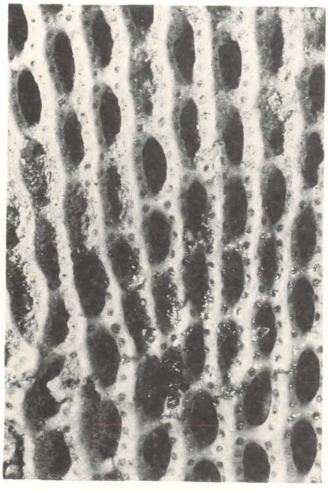

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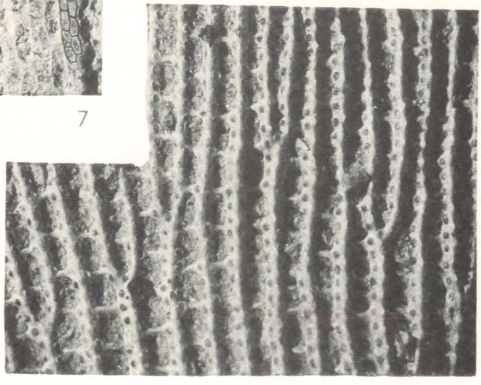


8

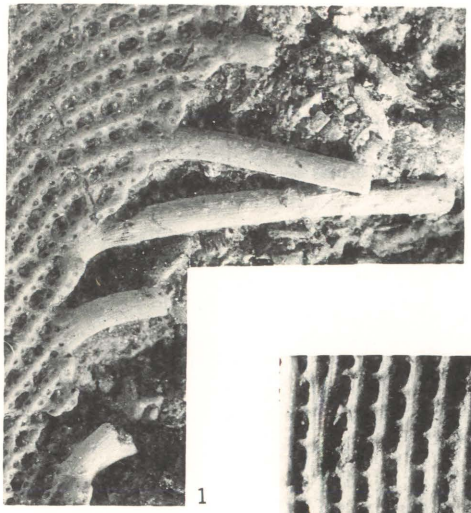
FENESTELLA EXIGUA AND FENESTELLA MATHERI

PLATE 3

[All illustrations are X 10.]

Figures 1-5. *Fenestella tenax* Ulrich. *1,* Obverse surface displaying barbed striated appendages on frond margin; *2,* obverse surface; *3,* polished obverse surface showing triangular chamber bases; *4,* reverse surface showing finely striate branches; *5,* obverse surface. Hypotypes, InGS 349.

6-8. *Lyroporella divergens* (Ulrich). *6,* Obverse surface, hypotype, InGS 355; *7,* reverse surface displaying vermiculiform striae; *8,* reverse surface showing striations. Hypotypes, InGS 354.



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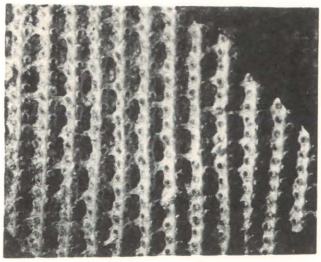

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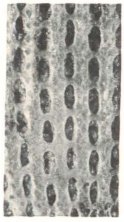

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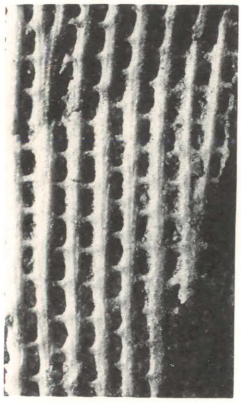

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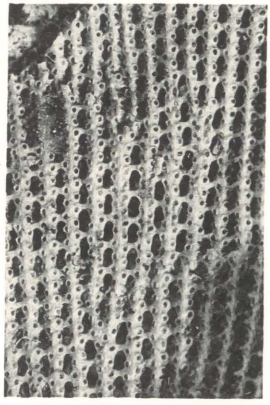

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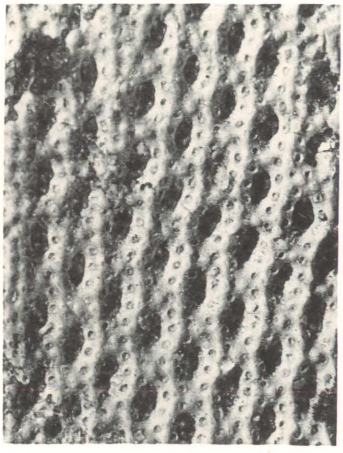

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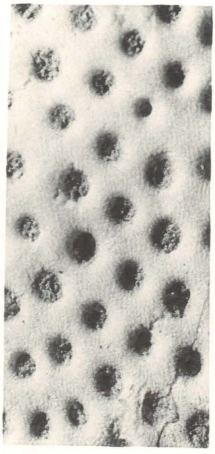

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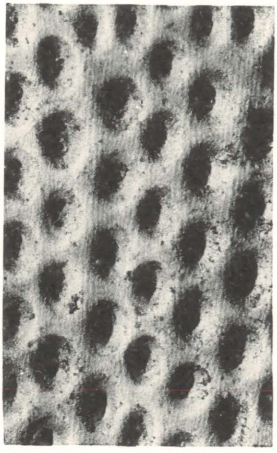

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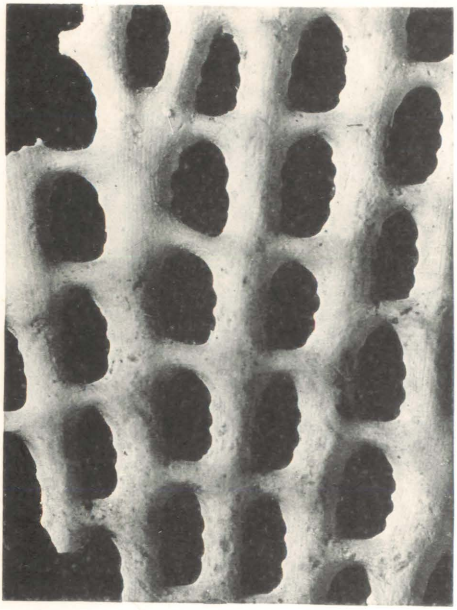
FENESTELLA TENAX AND LYROPORELLA DIVERGENS

PLATE 4

[All illustrations are X 10.]

Figures 1, 2. *Polypora multispinosa* McFarlan. *1,* Reverse surface; *2,* obverse surface displaying prominent closely spaced nodes. Hypotypes, InGS 363.

3-5. *Polypora corticosa* Ulrich. *3,* Obverse surface showing striated appendage extending from basal margin of frond adjacent to supporting stalk; *4,* obverse surface showing faint ridge between adjacent rows of zooecia; *5,* obverse surface displaying striated tissue obscuring zooecia near frond base in lower left. Hypotypes, InGS 359.



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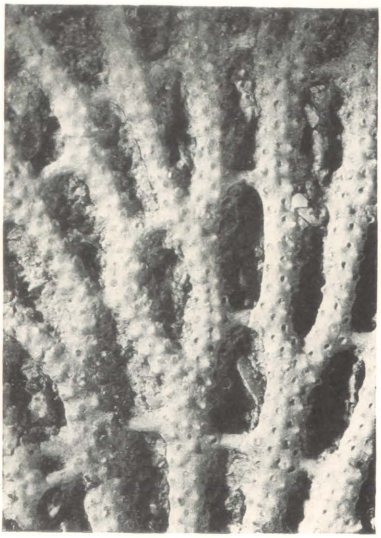

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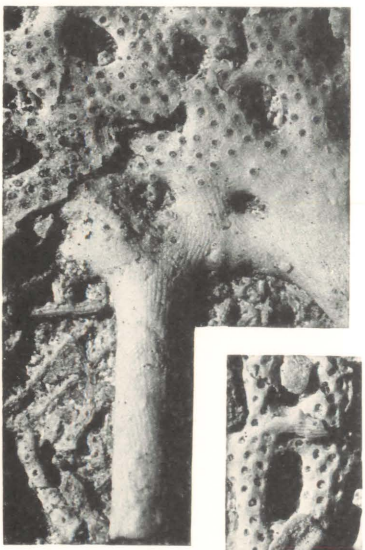

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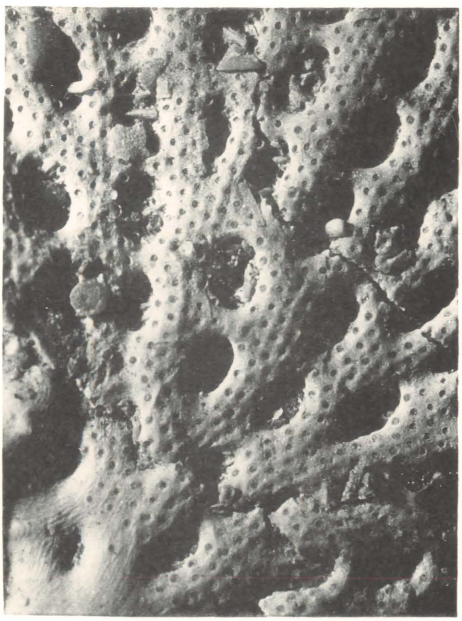

5

POLYPORA MULTISPINOSA AND POLYPORA CORTICOSA

PLATE 5

[All illustrations are X 10.]

Figures 1. *Polypora corticosa* Ulrich. *1,* Supporting stalk of frond. Hypotype, InGS 360.
2-4. *Polypora nodolinearis* McFarlan. *2,* Reverse surface showing conspicuous striae on branches; *3,* obverse surface revealing ridges between adjacent rows of zooecia; *4,* obverse surface. Hypotypes, InGS 368.

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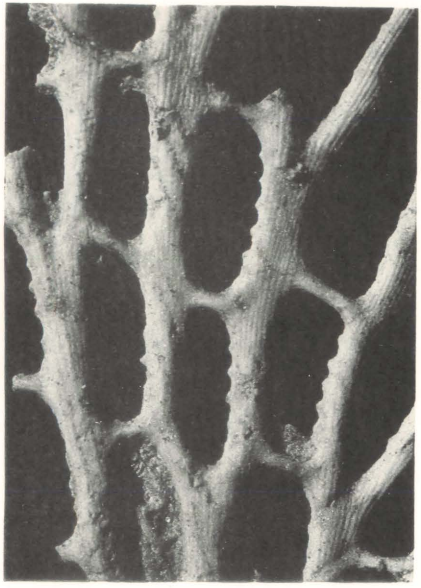

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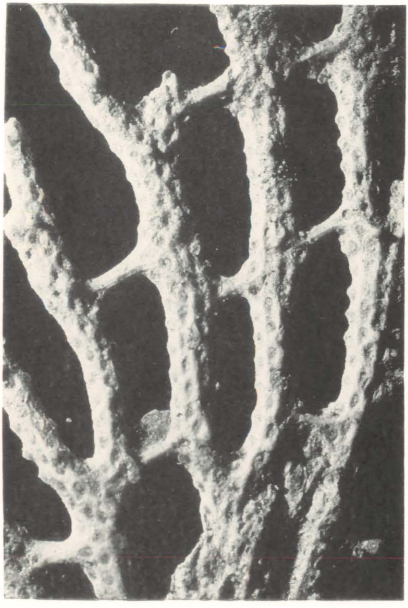

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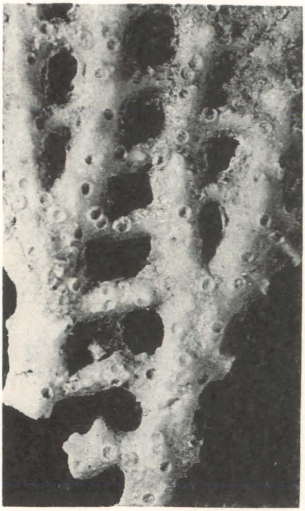
POLYPORA CORTICOSA AND POLYPORA NODOLINEARIS

PLATE 6

[All illustrations are X 10 except figure 3, which is X 4.]

Figures 1-5. *Septopora subquadrans* Ulrich. *1,* Reverse surface demonstrating large accessory pores; *2,* obverse surface; *3,* striated branching appendages on frond margin; *4,* thin section below obverse surface showing two rows of zooecia on branches and dissepiments; *5,* obverse surface displaying prominent accessory pores especially well developed along center line of branch. Hypotypes, InGS 374.

6, 7. *Septopora cestriensis* Prout. *6,* Obverse surface; *7,* reverse surface. Hypotypes, InGS 372.



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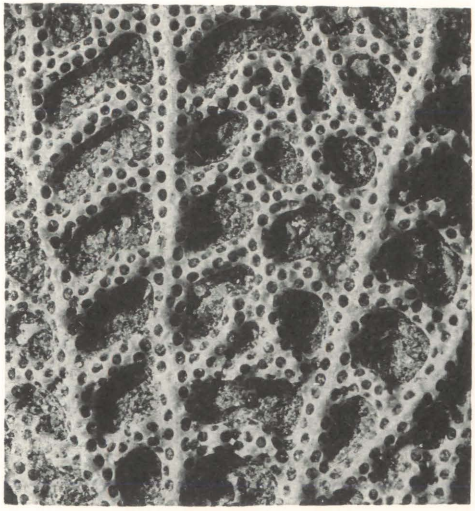

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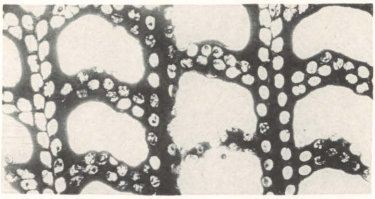

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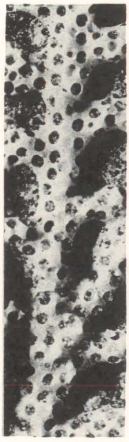

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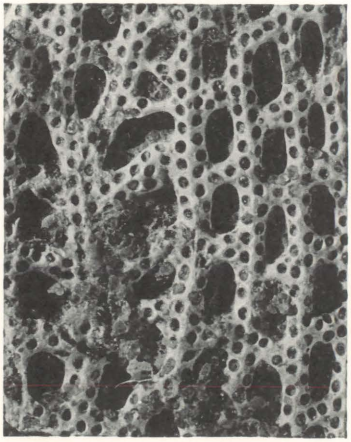

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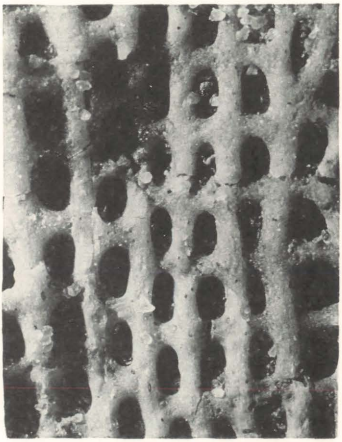

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SEPTOPORA SUBQUADRANS AND SEPTOPORA CESTRIENSIS