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SOME MIDDLE DEVONIAN STROMATOPOROIDS FROM MICHIGAN AND SOUTHWESTERN ONTARIO, INCLUDING THE TYPES DESCRIBED BY ALEXANDER WINCHELL AND A. W. GRABAU

BY

J. J. GALLOWAY and G. M. EHLERS

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THE UNIVERSITY OF MICHIGAN
ANN ARBOR

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VOLUME XV

1. *Leiopteria rafinesquii* Hall and A New Species of the Genus from the Thedford-Arkona Region of Southwestern Ontario, by George M. Ehlers and Edward P. Wright. Pages 1–13, with 2 plates.
2. Quasillitid and Alanellid Ostracods from the Centerfield Limestone of Western New York, by Robert V. Kesling, Emadeddin Kavary, Robert S. Takagi, John R. Tillman, and George R. Wulf. Pages 15–31, with 4 plates.
3. A New Species of *Mahonia* from the Oligocene Ruby flora of Southwestern Montana, by Herman F. Becker. Pages 33–38, with 1 plate.
4. Some Middle Devonian Stromatoporoids from Michigan and Southwestern Ontario, Including the Types Described by Alexander Winchell and A. W. Grabau, by J. J. Galloway and G. M. Ehlers. Pages 39–120, with 13 plates.

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SOME MIDDLE DEVONIAN STROMATOPOROIDS FROM MICHIGAN AND SOUTHWESTERN ONTARIO, INCLUDING THE TYPES DESCRIBED BY ALEXANDER WINCHELL AND A. W. GRABAU

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CONTENTS

INTRODUCTION

THE MIDDLE DEVONIAN STRATA of Michigan contain a great wealth of stromatoporoids, which were more important than the corals in building most of the bioherms and biostromes of the rocks. When these stromatoporoids are thoroughly investigated, it probably will be found that no Middle Devonian rocks elsewhere in the world surpass those of Michigan in respect to number of species and specimens.

Very few studies of the Middle Devonian stromatoporoids of Michigan have been made. Over ninety years ago Alexander Winchell (1866, pp. 90–91) described four species from the Middle Devonian Traverse group of Michigan. A year later, in a paper discussing the structure and zoological affinities of the Stromatoporoidea, he (1867, pp. 91–99) referred to these species and assigned two of them to new genera. Over forty years later A. W. Grabau (in Sherzer and Grabau, 1909, pp. 547–48; 1910, pp. 87–94) described several stromatoporoids from strata of southeastern Michigan and southwestern Ontario that he believed were of Silurian age but which are now recognized as belonging to the Detroit River group of Middle Devonian age. Twenty-six years later, Professor W. A. Parks (1936, pp. 33–34; 38–42, 46–52, and 83–86) described several species from the Traverse group of the Alpena region.

Winchell and Grabau described most of their stromatoporoids without illustration of well-prepared thin sections. The detailed information, available from the descriptions and illustrations of good thin sections by Parks and recent investigators, shows at a glance that the specific characteristics and relationships of Winchell's and Grabau's types can be obtained only by restudy.

The results of an investigation of Winchell's and Grabau's types by the present authors are presented in two parts in the subsequent pages. Part I deals almost entirely with types and other material collected by Winchell from the Traverse rocks of the Petoskey region. A few specimens, collected by J. J. Galloway from Traverse strata of this region and assigned by him to two new species, are described for purposes of comparison with Winchell's species. Part II has to do chiefly with types and other specimens obtained by Grabau from the Detroit River group of southeastern Michigan and the so-called "Anderdon" quarry, located in Ontario only 12 miles south of Detroit, Michigan. Specimens collected by G. M. Ehlers from the Bois Blanc formation, which underlies the Detroit River group, are identified and described in Part II for purposes of comparison with Detroit River species.

Most of the stromatoporoids described in this paper are in the University of Michigan Museum of Paleontology; some specimens are in the Indiana University Paleontological Collection. Unless stated as having been deposited at Indiana University, types and other specimens are at The University of Michigan under the numbers indicated.

Acknowledgments

The authors wish to express their indebtedness to Dr. Lewis B. Kellum of the Museum of Paleontology, University of Michigan, for helpful criticism of parts of the manuscript. To Dr. Robert V. Kesling, of the same museum, and Miss Katharine A. Fellows, Assistant Editor, The University of Michigan, they extend their thanks for indicating many improvements in the written material and for suggesting changes in the format of the paper.

Glossary of Structural Terms

The definitions of the principal structural terms applied to stromatoporoids are helpful in recognizing the characters differentiating the stromatoporoids described in this paper. A glossary of structural terms, some of which described at greater length than below, was published by Galloway (1957, pp. 350–60) in his paper on the *Structure and Classifica-*

tion of the Stromatoporoidea. A delineation of most structures is shown in Plates 31–37 of Galloway's publication.

AMALGAMATED. United without visible sutures; coalesced or fused;—particularly applicable to union of the horizontal and vertical structures in the family Stromatoporoidae.

ASTRORHIZA. A group of radiating, branching grooves, generally centering at a mamelon and superposed in the axis of a mamelon.

AXIAL TUBE. A tube, generally tabulate, in axis of most ramose stromatoporoids; may be part of an astrorhizal system (Lecompte, 1956, p. F115).

CAESPITOSE, CESPITOSE. Bushy, fasciculate, as the growth habit of *Idiostroma* and *Dendrostroma.*

CAUNOPORE TUBE. A conspicuous, vertical tube, 0.5 to 1.5 mm. in diameter, having its own walls, generally with cystose or infundibular tabulae. It is generally agreed that it is a corallite of the compound tabulate coral *Syringopora.*

CELL. See gallery.

CHAMBER. A continuous interlaminar space traversed by pillars—more appropriately termed a gallery.

COENOSTEUM. Head or colony, or skeleton of a milleporoid or a stromatoporoid. (Term proposed by Moseley, 1881, p. 12, for the skeleton of the Hydrocorallina and adopted by Nicholson, 1886, p. 28, for that of the Stromatoporoidea).

COLUMN. A vertical structure much larger than a pillar, 1 to 10 mm. in diameter, making a mamelon at the surface, composed primarily of upturned laminae with astrorhiza in many coenostea.

COMPACT. Homogeneous, neither alveolar, porous, or maculate, nor like a mineral crystal or glass, but of calcareous tissue closely appressed.

CURVED PLATE or TABULA. See dissepiment.

CYST. Vesicle formed by outwardly convex plates.

CYST PLATE. See interlaminar septum.

DENDRITIC. Repeatedly branching, treelike as the Idiostromatidae;—also applied to the branching canals of astrorhizae.

DENSE. Apparently solid, compact and homogeneous, except for small variations in texture. Rare, except for dissepiments. Not dense like glass. Not maculate, as in the family Stromatoporidae, nor with transverse pores, nor with fibers.

DISSEPIMENT. One of the thin, upward or obliquely curved plates that compose the coenostea of the family Labechiidae and in the galleries in many genera; also called interlaminar septum, curved plate or tabula, cyst plate, partition, and so on.

EPITHECA. See peritheca.

FIBER, "FIBRE." Skeletal tissue; strands or threads, collectively; also skeletal fiber.

FIBROUS. Composed of short strands transverse to the laminae; distinguished from porous.

FORAMEN. A large or principal opening between two chambers, cells, or superposed galleries.

GALLERY. An interlaminar space, traversed by pillars, not vertical walls;—sometimes less aptly called chamber and cell.

HOLOTHECA. See peritheca.

INFILTRATED. Filled in solid by calcite from solution after burial, preserving the hard parts nearly perfectly.

INTERLAMINAR SEPTUM. One of the thin, outwardly or upward curved or oblique

plates or tabulae in the galleries;—also called dissepiment, cyst plate, and partition.

INTERLAMINAR SPACE. A gallery, cavity, space, or chamber between laminae. The spaces are more aptly designated as galleries, since they consist of connected rooms. They are narrow or more or less completely filled with porous and maculate tissue in the Stromatoporidae and by fibrous or compact tissue in the family Idiostromatidae.

LAMELLA; -AE. A thin plate, as septum. See lamina.

LAMINA, -AE. One of the thin parallel or concentric layers that make up most of the coenosteum. Laminae are the fundamental structures of most stromatoporoids. Primary or original laminae are very thin and are called microlaminae. In most genera the laminae have been thickened by secondary layers deposited above and below the primary laminae. Rarely called lamellae.

LATILAMINA, -AE. A thick layer or stratum, 1 to 20 mm. thick, composed of many laminae or cysts; seen in most weathered specimens of stromatoporoids. Term proposed by Nicholson, 1886, p. 40. Latilaminae seem to have resulted from annual pauses in growth, due to warm and cold seasons of the year. They are of some ecological but no taxonomic significance. Curved latilaminae are a means of distinguishing stromatoporoids from rock in the field; they do not serve to separate stromatoporoids from stromatolites. Latilaminae are not merely thick laminae, but consist of many laminae.

MACULA, -AE. One of many dark or light, spherical spots or dots in a gray groundmass. They are 0.01 to 0.06 mm. in diameter, usually with clear centers, and occur in the laminae, pillars, and secondary tissue. They are typical in *Stromatopora* and are very large in *Parallelopora*. Not tubular-like pores.

MACULATE. Having maculae. Compare reticulate.

MAMELON. Round, regular or irregular elevations on the surface, as in *Stromatopora pustulifera* and *S. monticulifera*.

MICROLAMINA. See lamina.

PARTITION. See interlaminar septum.

PERITHECA. The basal layer of a coenosteum; less aptly called epitheca and holotheca.

PILA, -AE. A pillar. Little used.

PILLAR. Small vertical structure between laminae (short) or passing through many laminae, or superposed (long, continuous), 0.05 to 0.06 mm. in diameter, not to be confused with the larger columns. Pillars are smaller than columns. They may be round, irregular, branched, and frequently divide and expand in the laminae, making vermicular, areolate, and odd patterns, as seen in tangential sections. Pillars are mostly built on the primary lamellae, and are frequently superposed, as in *Idiostroma*.

PORE. A fine tube, generally transverse through the laminae.

POROUS. Having pores, distinguished from fibrous. Compare reticulate.

PRIMARY TISSUE. The material of the laminae and dissepiments as first constructed.

PSEUDOZOOIDAL TUBE. A vertical tube or superposed and restricted gallery, irregular in cross section, only incidentally round, generally crossed by thin tabulae, the remnants of laminae. Pseudozooidal tubes are characteristic of the Stromatoporidae, but not present in all species. They have been called "zooidal tubes," but there is little or no evidence that they were occupied by zooids.

RAMOSE. Branching; applied especially to branching, erect, cylindrical to subcylindrical coenostea of *Idiostroma* and *Amphipora*.

RETICULATE. Consisting of a network of laminae and pillors. "Continuously reticulated" of Nicholson (1886, pp. 34, 74) refers to a network of laminae and pillars which are so united that the laminae and pillars are not discernible, but amalgamated, as in the Stromatoporidae. Reticulate is not synonomous with maculate or porous, although it has been so used by some authors.

SECONDARY TISSUE. Tissue laid on the primary plates or laminae and pillars, in many genera and constituting the bulk of the tissue as in *Stromatopora*.

SKELETAL FIBER.=*fiber*.

SKELETON. All the hard parts of a stromatoporoid, usually implying the totality of internal structures.

TABULA, -AE. One of the thin, flat or curved plates found in vertical tubes or between superposed galleries. They may be distinct structures or remnants of laminae.

TANGENTIAL. Refers to a section nearly parallel with the laminae, especially as applying to small, globular or ramose forms, and in descriptions called the "tangential section."

TISSUE. The structural material of the laminae, pillars, cysts, or other finer structures. Sometimes called "ultimate fibre" (Parks, 1936, p. 8), but actually does not represent the finest calcite granules which compose the skeleton. The term "fibre" is not appropriate, because the substance is not composed of threadlike bodies.

TUBE. Round, elongate opening, as in the axis of the Idiostromatidae, and in the axes of some mamelon columns.

ULTIMATE FIBER. See tissue.

VERTICAL TUBE. A remnant of superposed galleries; a pseudozooidal tube, often called "zooidal tube."

WALLS. The substance surrounding tubes, chambers, or vesicles.

"ZOOIDAL TUBES." Vertical tubes, small and generally irregular and not round in cross section, usually tabulate, characteristic of forms with maculate tissue, as *Stromatopora* and *Parallelopora*. They are restricted galleries which are superposed. Better called pseudozooidal or vertical tubes.

PART I. SPECIES FROM TRAVERSE GROUP, INCLUDING WINCHELL'S SPECIMENS

PREVIOUS WORK

Alexander Winchell, then Professor of Geology, Zoology, and Botany in The University of Michigan, published in 1866, "The Grand Traverse Region; a Report on the Geological and Industrial Resources of the Counties of Antrim, Grand Traverse, Benzie, and Leelanaw in the Lower Peninsula." In this paper (1866, pp. 41–42, 45, 48, 84–88) he announced the discovery of abundant stromatoporoids in the Middle Devonian Hamilton group of Michigan and called one formation the "Stromatopora Beds." He stressed the similarity of stromatoporoids to corals, except for the absence of corallite walls. In pages 90 and 91 Winchell named and described, but did not figure, four stromatoporoids, *Stromatopora pustulifera, S. monticulifera, S. nux,* and *S. caespitosa*. The last mentioned

species was the first reported occurrence of an erect, branching, dendritic or caespitose stromatoporoid in America.

The following year (1867) Winchell issued a special paper entitled the "Stromatoporidae: Their Structure and Geological Affinities." He did not describe the tissue structure, but stressed the form of the coenosteum ("polypi," "corallum"), the latilaminae ("concentric layers," "laminae," "diaphragms"), the pillars ("lamellar structure," "lamellar system"), mamelons ("little eminences," "monticules"), and astrorhizae ("radial arrangement of vermicular passages"), and sizes of the "masses." He concluded that stromatoporoids were related to Zoantharia, and because of the radiating pillars (which he mistook for vertical lamellae) in the caespitose form, *Idiostroma,* he considered them allied to the coral family Cyathophyllidae.

Winchell (1867, pp. 98–99) erected the family Stromatoporidae and defined it as comprising fossils made of "concentric layers (not diaphragms) of vesicular tissue separated and perforated by vermicular, ramifying passages [= astrorhizae], which are either radially or confusedly disposed." He stated that these fossils never have a cup-like form and indicated that they are without corallite walls; he made an effort to distinguish stromatoporoids from corals. The family Stromatoporidae, as now defined, embraces stromatoporoids in which the coenosteum is either massive or laminar, tissue is maculate (full of spherical dots), and laminae and pillars are amalgamated; it does not now include *Idiostroma* and similar genera.

Winchell (1867, p. 99) described *Idiostroma* as follows: "Genus *Idiostroma* (n.g.)—Polypi completely isolated, forming branching masses; lamellar system, represented by radial structure. Species, *I. caespitosum, gordiaceum.*"

Idiostroma was recognized by Nicholson (1886, pp. 98–104) and by most subsequent authors on stromatoporoids in spite of the fact that Winchell's types have never been figured nor their internal structure described. Nicholson (1886, pp. 99–104, Pl. 9, Fig. 6 and text-figs. 14–15) described two species of *Idiostroma: I. roemeri* Nicholson which he considered to be "a typical example of the genus," and *I. oculatum* Nicholson. *I. roemeri* is ramose, with axial tube, has compact but vaculate tissue, and the pillars are superposed, simulating the "lamellar system" noted by Winchell. Although its stemlike coenostea are larger than those of *I. caespitosum, I. roemeri* and *I. caespitosum* appear to be congeneric. This is a fortunate circumstance, since the generic characters of *Idiostroma* have been based on *I. roemeri* whose internal structure is much better known than that of *I. caespitosum.*

The second species recognized by Nicholson, *I. oculatum,* is also ramose and has an axial tube, but the tissue is transversely fibrous and the pillars are short and not superposed. Lecompte (1952, pp. 315–17, 320–21) proposed the name *Dendrostroma* for the form with short pillars. The genus *Dendrostroma* exists in strata of Michigan belonging to the Traverse group. Although apparently unknown to Winchell, it is abundantly represented by an undescribed species in the Petoskey formation at Mud Lake, 1 mile northeast of Bay View, Emmet County, Michigan (Loc. 21), and by many specimens of apparently the identical form in the Potter Farm formation in a small shale pit near the northwest corner of the Alpena Cemetery (Evergreen Cemetery) at Loc. 68, and in rock cuts along the Alpena–Hillman Road (M-32), between ¼ and ¾ mile west of the entrance to the Alpena Cemetery (Loc. 89*e*). *Idiostroma* and *Dendrostroma* are easily confused and can be distinguished only by means of polished surfaces or by thin sections. One of Winchell's syntypes of *Idiostroma caespitosum* (No. 32402B) is a *Dendrostroma*. Another of Winchell's species, *I. gordiaceum,* from Iowa City, Iowa, is still unrecognized, and no specimens have been found in his material.

Winchell (1867, p. 99) described *Coenostroma* as follows (with present terminology inserted): "Genus, *Coenostroma,* (n.g.)—Polypi [coenosteum] confluent, but individualized, forming elongated, or spheroidal, compound masses; diaphragms [latilaminae] common and continuous throughout; lamellar system indicated by the radiate arrangement of the vermicular passages [astrorhizae] which commonly diverge from the summits of little eminences [mamelons] raised in the concentric laminae. Species, *C. pustulosum* [error for *pustuliferum*], *monticuliferum, granuliferum, polymorphum, radiosum, ramosum.*"

Nicholson (1886, pp. 11–12) pointed out that genera cannot be distinguished by the presence or absence of either mamelons or astrorhizae. This has been confirmed by nearly all succeeding workers, although species may be so recognized. Even though the internal structure in *Coenostroma* has up to now not been described, the genus has been placed by workers in synonomy with *Stromatopora,* which also consists of massive forms that commonly have mamelons and astrorhizae. *C. pustuliferum* and *C. monticuliferum* are represented in Winchell's material and are described and figured under *Stromatopora* (below).

The "Genus, *Caunopora,*" described by Phillips (1841, pp. 18–19), is not a valid group but comprises several kinds of stromatoporoids infested by a colonial coral, *Syringopora.*

Caunopora was included by Winchell (1867, p. 99) in his classification and three European species mentioned. None of Winchell's recognized

specimens are in the so-called "caunopore state," that is, infested by a tubular coral. It should be noted, however, that many specimens of stromatoporoids from the Petoskey formation of Mud Lake, 1 mile northeast of Bay View, Emmet County, Michigan (Locality 21), are highly infested with a small *Syringopora* and specimens of the species named by Winchell may be discovered which are so infested. The presence or absence of caunopore tubes si of neither generic nor specific value.

The genus *Stromatopora* Goldfuss (1826, p. 21) was also included by Winchell (1867, p. 99) in his classification. He considered that it differed from *Coenostroma* in lacking mamelons and astrorhizae. The type species of *Stromatopora, S. concentrica* Goldfuss, has astrorhizae but no mamelons. Many other species of *Stromatopora* have both mamelons and astrorhizae. The presence or absence of these two structures (see Nicholson, 1886, pp. 11–12) is not considered to be of generic significance by specialists on stromatoporoids, but is generally regarded as of specific importance.

Winchell (1867, p. 99) gave the following diagnosis of *Stromatopora*: "Genus, *Stromatopora* (Goldf.)—Polypi confluent, with individualities sensibly obliterated. Corallum consisting essentially of confluent diaphragms, or concentric layers, which generally inclose a foreign body,—being secreted on all sides of it and forming a sphaeroidal mass."

When giving his diagnosis of *Stromatopora,* Winchell (1867, p. 99) listed six species as representative of this genus. One of these, *S. nux,* was described by Winchell from the Traverse strata of Michigan. Winchell's diagnosis of the genus was based in large part on the structure of *Stromatopora nux.* This species does not enclose a "foreign body" as a nucleus nor "form a sphaeroidal mass," two characteristics noted by Winchell in his generic diagnosis. The types of *S. nux* are water-worn pebbles of a *Trupetostroma,* which were broken from complete coenostea of adjacent bioherms and biostromes by waves of the Middle Devonian Petoskey sea. *Stromatopora nux* is represented in Winchell's material by thirteen syntypes and is described under *Trupetostroma nux.*

The genus *Stromatopora* may now be diagnosed as follows: Coenostea massive; tissue highly maculate and amalgamated, largely filling interlaminar spaces but leaving superposed galleries (pseudozooidal tubes); commonly without definite laminae or pillars, with or without mamelons and astrorhizae. *Stromatopora* lacks the long pillars and coarse maculae of *Parallelopora;* it has small maculae and pseudozooidal tubes like *Syringostroma* but not the large, long pillars of that genus. *Ferestromatopora* does not have pseudozooidal tubes, and *Taleastroma* has thin, round pillars.

Winchell assigned seventeen species to the Stromatoporoidea in page 99

of his 1867 publication. His names for these species are shown at the left of the list below in the order of their appearance in Winchell's paper. Names of the authors of the species were not recorded by Winchell on page 99; they are given in the following list. The present names of these fossils and the presence or absence of representative specimens of the species in Winchell's collection are given to the right of Winchell's specific designations.

Idiostroma caespitosum (Winchell), 1867, p. 99. This name is presently recognized for *Stromatopora caespitosa* Winchell, 1866, p. 91; 4 syntypes, 2 homomeotypes, and 4 topotypes; syntype 32402B is *Dendrostroma petoskeyensis,* sp. nov.

Idiostroma gordiaceum Winchell, 1867, p. 99. No specimen; not identified.

Coenostroma pustulosum (Winchell), 1867, p. 99 (*pustulosum* in error, 12th line below top of p. 99; correctly given as *pustuliferum,* 6th line from bottom, p. 99) = *Stromatopora pustulifera* Winchell, 1866, p. 91. Holotype in 2 pieces; 6 homeotypes.

Coenostroma monticulifera (Winchell), 1867, p. 99. Two syntypes from Loc. 861A and 4 fragments from Loc. 862B are now recognized as *Stromatopora monticuliferum* Winchell, 1866, p. 91. Three fragments (Nos. 40243B, C, D) from Loc. 862B are *Parallelopora winchelli,* sp. nov.

Coenostroma granuliferum Winchell, 1867, p. 99. No specimen; not identified.

Coenostroma polymorphum (Goldfuss), 1831, p. 215. No specimen.

Coenostroma radiosum (d'Orbigny)? No specimen.

Coenostroma ramosum Winchell, 1867, p. 99. Probably = *Caunopora ramosa* Phillips, which is now known as *Amphipora ramosa* (Phillips). No specimen.

Caunopora placenta Winchell, 1867, p. 99. Possibly = *Coscinopora placenta*? Goldfuss in Lonsdale 1840, p. 697 = *Caunopora placenta* (Lonsdale) in Phillips, 1841, pp. 18–19. No specimen.

Caunopora ramosum Winchell, 1867, p. 99 = *Amphipora ramosa* (Phillips). No specimen.

Caunopora verticillata McCoy, 1850, p. 377. = *Stachyodes verticillata* (McCoy). No specimen.

Stromatopora concentrica Goldfuss, 1826, p. 22. Type species of *Stromatopora.* No specimen.

Stromatopora striatella d'Orbigny, 1850, p. 51 = *Anostylostroma striatellum* (d'Orbigny). No specimen.

Stromatopora nux Winchell 1866, p. 91 = *Trupetostroma nux* (Winchell). Thirteen syntypes.

Stromatopora rugosa Winchell, 1867, p. 99 = *Stromatocerium rugosum* Hall, 1847, p. 48. No specimen.

Stromatopora compacta Billings, 1865, pp. 55, 212 = *Solenopora compacta* (Billings), an alga. No specimen.

Stromatopora nummulitisimilis Lonsdale, 1839, p. 681 = pisolitic limestone, *teste* Nicholson, 1886, p. 6. No specimen.

Only four of the above listed species, *Idiostroma caespitosum, Coenostroma pustuliferum, C. monticuliferum,* and *Stromatopora nux,* were described by Alexander Winchell from Michigan. The types of these

species are in the Winchell Collection of the Museum of Paleontology, University of Michigan, and have been redescribed in this paper.

REGISTER OF LOCALITIES

The localities described below are in the northern part of the Southern Peninsula of Michigan. The locality numbers at the left side of the list are those used by the Michigan Geological Survey and the University of Michigan Museum of Paleontology. Numbers used by Alexander Winchell for his localities, which are at or near the above mentioned places, are added. See Ehlers and Kline, 1934, pp. 143–8, Map 1, Fig. 1.

LOCALITY

14. Quarry of Penn-Dixie (formerly Petoskey) Portland Cement Company, about 1½ miles west of Petoskey, Emmet County, SW¼ sec. 2 and SE¼ sec. 3, T. 34 N., R. 6 W. Locality 861A of Winchell (1866, pp. 43–44 and map accompanying report; letter "A" refers to one of Winchell's divisions of the stratigraphic section at this place). Middle Devonian Traverse group—Gravel Point formation and lowermost Charlevoix formation.

14*e*. Abandoned "Bell" quarry and ledges on shore about 2 miles east of Bay Shore, Emmet County, near NE cor. sec. 8, T. 34 N., R. 6 W. Locality 862B of Winchell (1866, p. 45 and map accompanying report; letter "B" refers to one of Winchell's divisions of the stratigraphic section at this place). "Rose Quarry" of Fenton and Fenton (1930, pp. 5–6, 9, 11). Middle Devonian Traverse group—upper part of Gravel Point formation and lower part of overlying Charlevoix formation.

18. Abandoned quarry of Northern Lime Company, bordering Little Traverse Bay, northeast side of Petoskey, Emmet County, SW¼ sec. 32, T. 35 N., R. 5 W. Locality 856C of Winchell (1866, pp. 41–42 and map accompanying report; letter "C" refers to one of Winchell's divisions of the stratigraphic section at this place). Middle Devonian Traverse group—Charlevoix formation and overlying Petoskey formation.

21. Kegomic (or Mud Lake) quarry on southeast shore of Mud Lake just southeast of the old Harbor Springs Road (M-131), about ½ mile northeast of the juncture of this road with U. S. Highway 31; road juncture about ½ mile east of Bay View, Emmet County. Quarry located in SE¼ sec. 27, T. 35 N., R. 5 W. Middle Devonian Traverse group—Petoskey formation.

68. Small shale pit at northwest corner of the Alpena Cemetery (Evergreen Cemetery) near west side of Alpena, Alpena County, SW¼ sec. 21, T. 31 N., R. 8 E. Middle Devonian Traverse group—Potter Farm formation. See Warthin and Cooper, pp. 590–91.

89*e*. Rock cut along Alpena–Hillman Road (Michigan Highway 32), between ¼ and ¾ mile west of entrance to Alpena Cemetery (Evergreen Cemetery), Alpena County; road on south line of sec. 20, T. 31 N., R. 8 E. Middle Devonian Traverse group—Potter Farm formation.

KEY TO TRAVERSE STROMATOPOROIDEA OF MICHIGAN

I. Coenosteum massive or laminar
  A. Tissue maculate
    1. Maculae small, not superposed; pillars obscure.....*Stromatopora*
      a. Mamelons 10 mm. in diameter.....*S. monticulifera* Winchell
      b. Mamelons 3 mm. in diameter.....*S. pustulifera* Winchell
    2. Maculae coarse, superposed in laminae and pillars; laminae of several microlaminae.....*Parallelopora winchelli,* sp. nov.
  B. Tissue vacuolate and flocculent; laminae of one microlamina and secondary tissue.....*Trupetostroma nux* (Winchell)
II. Coenosteum ramose or caespitose; tissue not maculate
  A. Without ring pillars
    1. Without axial tube.....*Clavidictyon kegomicense,* sp. nov.
    2. With axial tube
      a. Pillars long, superposed, in radial lines; branches with axial tubes; tissue vacuolate.....*Idiostroma*
        (1) Branches 4–6 mm. in diameter; pillars small..*I. caespitosum* (Winchell)
        (2) Branches 8–15 mm. in diameter; pillars large.....*I. roemeri* Nicholson
      b. Pillars short, not making long radial lines; tissue fibrous...*Dendrostroma*
        (1) Axial tube well formed; branches 2–8 mm. in diameter .....*D. petoskeyensis,* sp. nov.
        (2) Axial tube discontinuous; branches 8–12 mm. in diameter .....*D. fibrosum,* sp. nov.
  B. With ring pillars .....*Stromatoporella*
    1. Coenosteum explanate.....*S. elevata* Parks
    2. Coenosteum subramose, with axial tube.....*S. mudlakensis,* sp. nov.

SYSTEMATIC DESCRIPTIONS

Phylum COELENTERATA
Class HYDROZOA
Order STROMATOPOROIDEA
Family Stromatoporidae Winchell 1867
Genus *Stromatopora* Goldfuss 1826

Stromatopora Goldfuss, 1826, p. 21. See Galloway, 1957, pp. 447–48 for other references.
Coenostroma Winchell, 1867, p. 99; type species (selected by Miller, 1889, p. 157), *Stromatopora monticulifera* Winchell, 1866, p. 91 (Middle Devonian, Michigan).

Type species.—By monotypy, *Stromatopora concentrica* Goldfuss, p. 22, Pl. 8, Figs. 5*a–c*. Middle Devonian, Eifel region, Germany.

Diagnosis.—Coenosteum massive; surface smooth or with mamelons or astrorhizae or both; latilaminate. Laminae and pillars obscure, amalgamated; interlaminar spaces largely filled with maculate tissue, leaving small galleries and vertical pseudozooidal tubes. Maculae small, not superposed. Dissepiments scarce.

Silurian and Devonian, widely distributed.

Stromatopora monticulifera Winchell

(Pl. I, Figs. 1*a–d*, 2)

Stromatopora monticulifera Winchell, 1866, p. 91; Quenstedt, 1878, p. 582, Pl. 142, Fig. 11 (from a topotype; the figures are accurate); Kühn, 1928, p. 59.

Coenostroma monticuliferum Winchell, 1867, p. 99; Nicholson, 1886, p. 11; Miller, 1889, p. 157.

Stromatopora (*Coenostroma*) *monticulifera* Grabau and Shimer, 1909, Vol. 1, p. 44.

Original description (Winchell, 1866, p. 91).—"In very large spheroidal masses constituted like those of *S. pustulifera,* but differing therefrom in the much larger and more remote eminences on the upper surfaces of the concentric beds, and in the larger and more distinctly radiate character of the passages which diverge from the apices of the monticules. These passages, on the exposed surface, are little flexuous, somewhat branching channels which diminish in size and disappear within 5 mm. (.2). Distance of monticules .76 mm. (.3) to 10.2 mm. (.4). Attains a diameter of at least 3.5 metres (12 ft.)."

Revised description.—The following revision is based on the lectotype, No. 32409A, and a paralectotype, No. 32409B.

Coenosteum: Coenosteum of large size. Its surface is marked with large mamelons, with rounded summits, about 10 mm. in diameter, 2 mm. high, and 10 to 15 mm. apart from center to center; 13 to 15 mamelons are in an area of 16 square centimeters. The summit of each mamelon is occupied by a typical astrorhiza, about 10 mm. in diameter, with regularly dichotomizing branches which connect with branches from adjacent astrorhizae. There is no axial, astrorhizal tube. The astrorhizae are not well exposed on the surface of the lectotype, because the specimen is split above the astrorhizal canals; they are well shown on the bottom of the lectotype and on both upper and lower surfaces of the paralectotype. The surface, on and between the mamelons, has small, low, roundish papillae, which are the ends of pillars; they are about ¼ mm. in diameter and half as high. The surface is convex, curved 1 cm. in 12 cm. indicating a coenosteal diameter of at least 1 meter. Latilaminae, as seen on weathered and cut surfaces are unusually thin for stromatoporoids, ranging from 1 to 1.5 mm. thick, with about 8 in 1 cm.

Vertical section: In vertical section the laminae appear thick, some twice as thick as the interlaminar spaces, and are composed of 2 to 4 similar, maculate microlaminae to a lamina. There are 8 to 10 laminae in 2 mm. The interlaminar spaces are largely filled with secondary, maculate tissue, leaving round, oval and elongate galleries, about 0.08 to 0.1 mm. wide, generally transected by the microlaminae, and separated by small, short pillars, up to 0.12 mm. wide and in general superposed. In addition

to the smaller pillars, there are many long pillars, 0.23 mm. in diameter, separated by pseudozooidal tubes half as wide as the pillars. The characteristic long pseudozooidal tubes cause the intervening tissue to resemble long pillars. The laminae and the short and long pillars are made of maculate tissue, and are completely amalgamated. The laminae rise smoothly into the mamelon columns. Round astrorhizal canals, 0.2 mm. in diameter, are conspicuous in the columns, and elongate astrorhizal canals of the same diameter extend outward from the columns, divide, diminish in size, and merge with the galleries between the columns. The maculae are small, about 0.02 mm. in diameter, and are dark, fuzzy specks, but those which are cut through the middle are up to 0.04 mm. in diameter, and show a clear center; they are arranged uniformly throughout the tissue, not in vertical lines as in *Parallelopora*. Slides from the lectotype show no tabulae or dissepiments in either galleries, pseudozooidal tubes, or astrorhizal canals; slides from the paralectotype show a few tabulae in the astrorhizal canals. There are no vertical tubes in the mamelons.

Tangential section: In tangential section, different aspects are presented, depending upon whether the section has been cut across the mamelons, or in or between the laminae. Seventy or eighty per cent of the section is maculate tissue; tissue of laminae and pillars, and in interlaminar spaces is smoothly amalgamated. In the mamelons the tissue is nearly uniform and maculate, with only obliquely cut, radial astrorhizal canals. Where the section cuts the laminae the tissue is solidly maculate, and with round pseudozooidal tubes; between the laminae, it shows galleries, 0.08 or 0.09 mm. across, joining around roundish or amoeboid pillars, densely maculate and 0.23 to 0.24 mm. in diameter. In the lectotype, neither the galleries nor astrorhizal canals have tabulae or dissepiments. As in the vertical section, the maculae appear as dark, fuzzy spots, about 0.02 mm. in diameter and about the same distance apart.

Preservation.—The specimens are light brownish gray (Munsell notation 2.5Y5/2). Preservation in most specimens is excellent; the coenostea are heavy, and largely infiltrated with calcium carbonate, but the astrorhizae are mostly open. The specimens are only slightly weathered, especially along vertical cracks. In some places the specimens are leached, accentuating the galleries and astrorhizal canals; in others they are recrystallized, largely destroying the finer tissues.

Remarks.—Stromatopora monticulifera is characterized by the large, rounded mamelons, each with a typical astrorhiza but without an axial canal, the thick, microlaminate laminae, low galleries, narrow pseudo-

zooidal tubes, and small, long pillars of darker tissue, and the small, fuzzy maculae. There are no caunopore tubes.

S. monticulifera was designated by Miller (1889, p. 157) as the type species of the genus *Coenostroma* Winchell, a genus supposedly distinguished by the presence of astrorhizae on the mamelons. Neither astrorhizae nor mamelons, however, are generic characters; their presence or absence are specific differences. The species is here placed in *Stromatopora,* because of the large amount of maculate tissue and the pseudozooidal tubes. The small, long pillars give it a similarity to the genus *Syringostroma,* which differs from *Stromatopora* only in the presence of large or conspicuous pillars. *Syringostroma* Nicholson (1875, p. 251) was first named for the astrorhizal canals, but Nicholson later (1886, pp. 97–98) distinguished it from *Stromatopora* by its more important character, the large pillars. *S. monticulifera* does not have distinct, round, long pillars.

S. monticulifera has more definite laminae and pillars than the type of *Stromatopora, S. concentrica* (see Nicholson, 1886, Pl. 11, Figs. 15–18), but many species with laminae and pillars as well as with pseudozooidal tubes have been included in *Stromatopora,* as for example, *S. cooperi* Lecompte (1952, Pl. 60, Figs. 1–4), *S. dybowskii* Yavorsky (1955, Pl. 47, Figs 1–5), and *S. nices* Yavorsky (1955, Pl. 49, Figs. 5–7).

Types and Occurrence.—The material on which Alexander Winchell based *Stromatopora monticulifera* consisted of 9 syntypes. One of these specimens, No. 32409A, is about 15 by 15 cm. broad and 7 cm. high and is here designated the lectotype. A second specimen, No. 32409B, about 8 x 10 cm. broad and 5 cm. high, is regarded as a paralectotype; it has the same external and internal appearance as the lectotype and may have been broken from the same coenosteum. Both types were collected from the middle part of the Gravel Point formation of the Traverse group at Locality 14, Winchell's Locality 861B (see Register of Localities). The third, fourth, fifth, and sixth specimens, respectively bearing the Nos. 32410A, 32410B, 32411, and 32412, are designated paralectotypes. These four paralectotypes were obtained from a stratum in the Gravel Point formation that possibly is higher than that from which types 32409A and B were collected; they were found at Locality 14*e,* Winchell's Locality 862B (see Register of Localities).

Slides, containing thin sections of the above-mentioned types, are deposited in the University of Michigan Museum of Paleontology and in Indiana University Paleontological Collection under the following numbers:

Lectotype: No. 32409A (slides W1–1, 2, 3, 4). Slides of lectotype and some paralectotypes in Indiana University Paleontological Collection under Nos. 306—52–57.

Paralectotypes: Nos. 32409B (W1–5, 6, 7); 32410A (W1–8, 9); 32410B (W1–17); 32411 (W1–12, 13); 32412 (W1–14, 15).

The seventh, eighth, and ninth syntypes of Winchell's *Stromatopora monticulifera,* Nos. 40243A, B, and C, have such conspicuous maculae in vertical files as to qualify as *Parallelopora* and are described in this paper as *P. winchelli,* sp. nov.

Stromatopora pustulifera Winchell
(Pl. II)

Stromatopora pustulifera Winchell, 1866, p. 91; Quenstedt, 1878, pp. 581–82, Pl. 142, Fig. 10; Nicholson, 1886, pp. 10, 17; Grabau and Shimer, 1909, Vol. 1, p. 44.

Coenostroma pustulosum (Winchell), 1867, p. 99 (*pustulosum* in error, 12th line below top of p. 99; correctly given as *pustuliferum,* 6th line above bottom of p. 99)

Original description (Winchell, 1866, pp. 90–91).—"In very large, spheroidal, ovoid or elongate masses, composed of arching, transverse layers, formed of laminae of coralline substance separated by a network of minute passages which, at intervals, coalesce and turn upwards through the layer, radiating and ramifying again on its upper side. The places where the layers are thus traversed are raised on the upper side into little eminences. The distinction of layers is produced by variations in the density of the coralline substance. Masses of coral several feet in diameter; distance of pustules 4.06 mm. (.16); mean thickness of laminae .20 mm. (.008). Occurs also at Iowa City."

Revised description.—The following description is based on the holotype, No. 32398.

Coenosteum: The holotype, a fragment of a large coenosteum, is 22 cm. in its larger diameter, 8 cm. high, and curved 1 cm. in 10 cm.; it is in two pieces, split between latilaminae. The latilaminae average about 1 mm. thick in the specimen, but are 1 to 4 mm. thick in topotypes; they are conspicuous on weathered edges. The surface has small, regular, low-conical mamelons, 3 mm. in diameter, 1 mm. high, and 4 to 5 mm. apart; about 21 mamelons are present in an area of 4 sq. cm. Each mamelon has a small, poorly formed astrorhiza at its summit, 2 mm. in diameter. The astrorhizae are scarcely visible even with a lens because of the imperfect preservation, but each has 5 to 8 thin, radiating, rarely branched canals about 1 mm. long. Between the mamelons are minute papillae 0.2 mm. in diameter. Polished surfaces of the specimen, cut perpendicular to the laminae, exhibit mamelon columns that are 2 to 3 mm. wide and 3 to 4 mm. apart; they are composed of upturned laminae, denser tissue, and astrorhizal canals and are several centimeters in vertical extent.

Vertical section: The laminae are thick, nearly filling the interlamellar spaces, and composed of many maculate microlaminae. There are about 6 laminae in a vertical space of 2 mm. The pillars are continuous, darker in color than the laminae, about 5 in a space of 2 mm., and composed of finely but indistinct maculate tissue, and fused with laminae. Between the laminae and pillars there are some small, round or oval galleries, 0.03 to 0.05 mm. in diameter, in general superposed and constituting pseudozooidal tubes. These tubes are thin, clear, and continuous and cause the tissue between them to resemble pillars, as is generally the case in the genus *Stromatopora,* rather than having pillars as well-defined, separate structures. Tabulae in the pseudozooidal tubes are formed by the microlaminae, which do not arch upward in the tubes. In places the interlamellar spaces are completely filled with secondary, maculate tissue and the pseudozooidal tubes show as lighter streaks between the pillars. Astrorhizal canals are about 0.12 mm. in diameter in the mamelon columns, half as wide between the columns, and merge into the small galleries. Mamelon columns have no axial tubes; in some there are oblique, tabulate astrorhizal canals. Although the tissue is finely maculate, the maculae are obscured by recrystallization; black specks of foreign material, probably iron oxide, occur in some of the tissues. Dissepiments are absent.

Tangential section: In tangential section the tissue appears smoothly amalgamated and uniformly maculate. About 80 per cent is tissue and 20 per cent galleries and astrorhizal canals. The mamelon columns consist of denser tissue, in which there are 4 to 6 radial, oval canals, the oblique astrorhizal canals. Each column is surrounded by a vague ring of irregular galleries. Between the mamelon columns the skeleton consists of roundish pillars 0.14 mm. in diameter, mostly joining other pillars, and between which there are thin, anastomosing galleries. There are numerous round pseudozooidal tubes, 0.06 mm. in diameter. Where well shown the maculae are 0.03 mm. in diameter; in much of the specimen the tissue has been recrystallized and most of the maculae and other finer structures are destroyed.

Preservation.—The holotype, obtained at Locality 18, is light yellowish gray to light buff gray like that of the limestone from which the specimen came. It is porous, only partly infiltrated with calcium carbonate, somewhat leached and chalky, and largely recrystallized. On account of these imperfections in preservation, the character of the minute structures of the coenosteum is largely destroyed.

Remarks.—Stromatopora pustulifera is characterized by its small mamelons and small, poorly formed astrorhizae. It is nearly identical in structure with *S. divergens* Galloway and St. Jean, but differs from that

species in lacking axial tubes in the mamelons. The poor preservation of all specimens of *S. pustulifera* seen by the authors makes detailed comparison between the two species impossible. In *S. divergens* the mamelons are of the same size as those of *S. pustulifera,* but are less regular in arrangement. It would be difficult to distinguish *S. pustulifera* from several species of *Stromatopora* described by Yavorsky (1955, Pls. 42–59); most of them have astrorhizae and many have mamelons.

Types and Occurrence.—The holotype, No. 32398, was obtained from the Petoskey formation at Locality 18. Slides of thin sections of this specimen are deposited in the Museum of Paleontology, University of Michigan, under Nos. W1–18, 19, 20, 21, 22, and 23. A set of slides, also made from this specimen, is in Indiana University under Nos. 306–60, 62, and 63.

Six fragments were found in the Museum of Paleontology, University of Michigan, that were identified by Alexander Winchell as *Stromatopora pustulifera;* all were collected at Locality 18. One fragment, a homeotype bearing the number 32397, is correctly identified as *S. pustulifera.* Three fragments are identified as *Trupetostroma nux* (Winchell) from a study of thin sections. They and slides containing thin sections made therefrom bear numbers 40291 (slides W2–1, 2), 40292 (slide W2–3), and 40293 (slide W2–4). Two fragments are molds of calices of a favositoid coral; they are preserved under number 40294.

Winchell's specimens of *Stromatopora pustulifera* and *Trupetostroma nux* were obtained from a cliff exposure adjacent to the shore of Little Traverse Bay (Winchell's Loc. 856). In the course of quarrying, the cliff was removed; another section of the strata once seen in the cliff, is fortunately visible in the wall of the now abandoned Northern Lime Company's quarry a short distance back (south) of the cliff (Locality 18). *Stromatopora pustulifera, Trupetostroma nux,* and other species of stromatoporoids are represented by abundant specimens in the lower Petoskey strata exposed in the quarry wall.

The striking reef structures in the rocks at Locality 18 were formed largely by the stromatoporoids; they have been described by A. W. Grabau (1913, p. 429), Mildred A. Fenton (1931, pp. 195–202), and M. Lecompte (1938, p. 16). *Stromatopora pustulifera* is represented by numerous fragments and large, complete coenostea in unit 10 of the section described by Mildred A. Fenton (1931, p. 196). Most, possibly all, specimens of *Trupetostroma nux* occur in the overlying unit 11 (M. A. Fenton, 1931, p. 196).

Genus *Parallelopora* Bargatsky 1881

Parallelopora Bargatsky, 1881, p. 291; Nicholson, 1886, pp. 95–96, Pl. 2, Figs. 6, 7; 1891, pp. 191–96; Galloway, 1957, pp. 450–51, Pl. 31, Fig. 16; Pl. 35, Fig. 6.

Type species.—*Parallelopora ostiolata* Bargatzky, 1881, p. 292, by subsequent designation of Nicholson, 1891, p. 193. Middle Devonian, Germany.

Diagnosis.—Coenosteum massive; surface smooth or with mamelons or astrorhizae or both; latilaminate. Laminae and pillars well developed; pillars continuous, pseudozooidal tubes well marked; tissue coarsely maculate, with maculae superposed in both laminae and pillars. Dissepiments scarce.

Silurian and Devonian, widely distributed.

Parallelopora winchelli Galloway and Ehlers, sp. nov.

(Pl. I, Fig. 3 *a–c*)

Description.—The following description is based on three fragments of coenostea; the largest fragment is the holotype; the other two fragments are much smaller than the holotype and are designated paratypes.

Coenosteum: The holotype is a fragment 70 mm. in diameter and 14 mm. thick. It is flat to concave upward, with strong, conical mamelons 5 mm. in diameter, 1½ mm. high, 10 to 12 mm. apart from center to center, with flat spaces between; 4 to 5 mamelons are in an area of 4 sq. cm. The entire surface has round, convex papillae about one-third mm. in diameter and 1 mm. apart. On the summit of each mamelon is an astrorhiza, with about a dozen radiating and dichotomizing grooves, but no axial tube. Latilaminae are conspicuous, 3 to 4 mm. thick, between which the coenosteum readily splits.

Vertical section: The laminae are composed of several microlaminae with maculate tissue between, about 6 laminae in 2 mm. They are separated by layers of round galleries; the smaller galleries are superposed, making long pseudozooidal tubes. Pillars are long, extending through a latilamina, and composed of maculate tissue. The maculae are large, rather uniform in size (0.025 to 0.04 mm. in diameter), and light in color, but surrounded by dark dusty tissue, so that most of them appear as dark spots. They are arranged in vertical lines in both laminae and pillars, the characteristic feature of *Parallelopora*. The galleries are also superposed between the pillars. The laminae rise smoothly into the mamelon columns, in each of which there is no single axial tube, but several oblique, tabulate astrorhizal canals and many round canals, mostly about 0.03 mm. in diameter with an occasional one up to 0.05 mm. in diameter. Infrequently, there is a dissepiment in a gallery.

Tangential section: Laminae and pillars are amalgamated; about 60 per cent of the field is tissue. The pillars are coarsely maculate, about 0.15 mm. wide, with galleries 0.05 mm. wide separating them; they are confluent and form a pattern. Among the pillars are many round pseudozooidal tubes 0.15 mm. in diameter. In the mamelons the maculae are smaller and closer together. One mamelon column, 3 mm. in diameter, has 25 round astrorhizal canals (0.23 mm. in diameter) and many canals extend from the periphery of the mamelon.

Preservation.—The specimens are the same light brownish gray as those of *Stromatopora monticulifera*. In general the galleries are filled with clear calcite, but some of the galleries and most of the astrorhizal canals are empty. The excellent preservation leaves little to be desired.

Remarks.—The types of *Parallelopora winchelli* were found among Winchell's specimens labeled "*Stromatopora monticulifera* Win." In surface aspect *P. winchelli* is scarcely distinguishable from *S. monticulifera,* although the mamelons of the former are smaller. Thin sections of the types of *P. winchelli,* however, show large maculae in vertical files, conspicuous pillars, and open galleries arranged in vertical tiers, all of which are found in typical species of *Parallelopora.*

In thin tangential sections of *P. winchelli* it is apparent that the pillars are not so large as those in the genus *Syringostroma.*

Types and Occurrence.—The holotype No. 40243A (slide W1–10), and two paratypes Nos. 40243B (slide W1–11) and 40243C (slide W1–16), are from the middle part of the Gravel Point formation at Locality 14*e,* Winchell's Locality 862 (see Register of Localities). They were found in association with types of *Stromatopora monticulifera* at this locality. Specimens of *P. winchelli* have not been found with *S. monticulifera* at Locality 14, Winchell's Locality 861.

Family Actinostromatidae Nicholson 1886
Genus *Trupetostroma* Parks 1936

Trupetostroma, Parks, 1936, pp. 52–55; Galloway and St. Jean, 1957, pp. 158–69; Galloway, 1957, p. 439.

Type species.—By original designation, *Trupetostroma warreni* Parks, 1936, pp. 52–57, Pl. 10, Figs. 1–2. Middle Devonian, Great Slave Lake, Canada.

Diagnosis.—Coenosteum massive; surface smooth or with mamelons or astrorhizae or both. Laminae with median, light or dark microlamina with vacuolate, secondary tissue on both sides. Secondary tissue continuing into the superposed pillars. Galleries superposed, without or with dissepiments. Both laminae and pillars are vertically porous in places.

Lower, Middle, and Upper Devonian: North America, Belgium, and Russia.

Remarks.—Trupetostroma is characterized by the superposed pillars and vacuolate tissue. It does not have the large, regular, superposed maculae typical of *Parallelopora.* Although *Gerronostroma* Yavorsky (1931, pp. 1392–93, 1406) has superposed pillars, it lacks vacuolate tissue. Because they have similar pillars, *Trupetostroma* could be placed in synonomy with *Gerronostroma.*

Trupetostroma nux (Winchell)
(Pl. III)

Stromatopora nux Winchell, 1866, p. 91; Winchell, 1867, pp. 96, 99; Kühn, 1928, p. 59.

Original description.—"In small, spheroidal, sometimes contiguous and coalesced masses, formed unlike the foregoing species [*Stromatopora monticulifera*], by accretions on all sides. External surfaces of layers not pustulose. Masses occur from 25 mm. to 125 mm. in greater diameter. A species apparently the same occurs on Kelly's Island, Lake Erie."

There are 13 of Winchell's syntypes. They are 2 to 5 cm. in diameter, and are rounded pebbles of pieces of stromatoporoids obtained from a cliff adjacent to the shore of Little Traverse Bay on the northeast side of Petoskey (Loc. 18; Winchell's Loc. 856). The nutlike forms of these pebbles, which suggested to Winchell the use of *"nux"* as the trivial name for the species, are the result of abrasion of fragments broken by waves from coenostea composing a reef at this locality. The worn surfaces and the lime mud adhering to them explain the apparent absence of mamelons ("pustules" of Winchell) which are exhibited by all of the syntypes, except one (No. 32417J) that is a fragment of reef rock. None of the specimens was formed "by accretion on all sides" as Winchell thought; the appearance of concentric additions is seen to have been produced by concentric laminae around mamelons when the curved surface is ground flat. Specimen No. 32417E consists of two coenostea held together by lime mud; both grew upward into small bulbs by eccentric additions of laminae. All of the twelve coenostea represent the same species; they appear to have been small, because they were broken from their moorings by waves, abraded, and mixed with the lime mud. Winchell's large specimens, "25 to 125 mm. in greater diameter," are not preserved in the type material.

J. J. Galloway found a specimen that is 50 mm. in longest diameter at the same locality (Pl. III, Fig. 7*a*). It is a Devonian boulder, an abraded fragment of a larger specimen, which has the outside worn smooth, and many worm tubes attached. The outer 10 mm. is case-hardened by

infiltration of lime and addition of lime mud. An accidental fracture, 20 mm. below the surface (Pl. III, Fig. 7*b*), shows the mamelons, non-filled galleries radiating from the mamelons, and long canals of the astrorhizae between the mamelons, and even the vacuoles, much as the skeleton must have been in life; it was not infiltrated with calcium carbonate, as most stromatoporoids are. Latilaminae range from 3 to 5 mm. thick. This very unusual specimen is perfectly preserved in the interior.

Revised description.—The following description is based on Winchell's lectotype and paralectotypes (Winchell's syntypes) and other specimens.

Coenosteum: The original surface of the lectotype and of all other specimens, had low, unequal, smoothly convex mamelons, 2 to 4 mm. in diameter and 1 mm. high, 4 to 6 mm. from center to center, 15 to 20 in 4 sq. cm. All the specimens show mamelons, especially where cut and polished. Latilaminae are inconspicuous in most, in others well formed, 3 to 5 mm. thick. Galleries radiate from the centers of the mamelons, in which there are no astrorhizae, but between the mamelons there are conspicuous tabulate canals much larger and longer than galleries which must be astrorhizal canals, but they have no apparent centers as do typical astrorhizae.

Vertical section: Each lamina consists of a thin, clear, homogeneous microlamina, with darker thick vacuolate secondary tissue above and below, often completely filling the interlaminar spaces. There are twelve or more laminae in 2 mm. Pillars are spool-shaped and superposed, more conspicuous on the polished vertical surface than in thin sections; each has several longitudinal pores, which extend through the microlaminae and secondary deposits. In vertical section the vacuoles and pores are not as conspicuous as they are in tangential section, and the maculate appearance is less pronounced. The pillars not being round but flat, appear as continuous, parallel pillars only where they are cut the thin way, 8 in 2 mm., and the galleries are also superposed, but do not appear as pseudozooidal tubes. Where the pillars are cut the flat way or obliquely, they are inconspicuous, the interlaminar spaces are nearly filled with secondary, vacuolate tissue, and galleries are scattered, roundish spaces, 0.1 to 0.15 mm. in diameter. The laminae do not arch up in the pillars, but rise smoothly into the mamelon columns. The mamelon columns are small, variable in size, 2 or 3 mm in thickness; most of them are well presented in the sections and polished surfaces of the small, fragmental syntypes, although all the syntypes exhibit the mamelons. In a few mamelons there are oblique astrorhizal canals, but there appears to be no axial canal. Dissepiments are wanting in the lectotype; there are a few in one topotype.

Tangential section: The vacuoles and vertical pores are conspicuous,

variable in size (0.02 to 0.19 mm. in diameter), and with the flocculent tissue and secondary crystals, give an appearance of maculae that is not seen in the vertical section. The pillars are flat, 0.1 to 0.15 mm. in thickness, rarely round, join others and tend to radiate from the mamelon centers. Microlaminae appear as light streaks. Tissue and galleries occupy about the same area. There are no pseudozooidal tubes other than the galleries. The mamelons are about 3 mm. in diameter, and indicated by radial or confused pillars surrounded by a ring or two of thicker tissue, the laminae.

Preservation.—The skeleton is porous in texture except for the outer, more infiltrated rind. The tissue has been slightly recrystallized, more in some specimens than in others, and calcite crystals extend out into the empty galleries. Winchell's syntypes are all yellowish and chalky, as is most of the rock and stromatoporoids of that part of the Petoskey formation at Locality 18.

Remarks.—Trupetostroma nux is characterized by the microlaminae, thickened vacuolate tissue, superposed galleries and transverse pores, and the lower mamelons of variable size, averaging 3 mm. in diameter, the tops of which are more rounded than those of *Stromatopora pustulifera;* the nutlike shape of the coenosteum and the apparent but not actual lack of mamelons ("pustules" of Winchell), noted by Winchell, are not specific characters. Curiously, specimens of *T. nux* in place in the Petoskey reef are rare, whereas specimens of *S. pustulifera* in their original form and also broken, occur in great profusion; *S. pustulifera* must have been better able to resist wave erosion.

T. nux, in its parallel files of pillars and galleries and its vacuoles and pores in vertical rows, has some of the attributes of *Parallelopora.* Careful scrutiny is necessary to distinguish vacuolate and porous tissue from maculate tissue. *T. nux* in internal characters bears great resemblance to *Idiostroma caespitosum* and *I. roemeri,* but differs from both in its massive form, lack of axial canal, and presence of mamelons and astrorhizae. There is no indication that *T. nux* represents bases of the ramose *Idiostroma,* and under present practice the two forms belong in different genera. The continuous pillars of *Gerronostroma* do not have vacuoles, but the laminae are thick and conspicuously porous transversely, with no median microlamina.

Types and Occurrence.—Of the thirteen syntypes of Winchell's species we chose No. 32414 as the lectotype, because thin sections of it show the structure better than in any of the other six types sectioned. Winchell cut the lectotype vertically and polished it, but if he ever made sections of it they have not been found. One of Winchell's syntypes, No. 32417J, is a

fragment of reef rock. The remaining eleven are here designated paralectotypes and listed below.

Types and slides of thin sections made from them are deposited in the University of Michigan Museum of Paleontology and at Indiana University under the following numbers:

Lectotype: No. 32414 (slides W2–5, 6, 7, 8).

Paralectotypes: Nos. 32415 (W2–9, 10); 32416 (W2–11); 32417A (W2–12, 13); 32417B (W2–14); 32417C (W2–15, 16); 32417D; 32417E; 32417F; 32417G; 32417H; 32417I.

Homeotypes: Nos. 40291 (W2–1, 2); 40292 (W2–3); 40293 (W2–4).

Topotype: Indiana University Paleontological Collection, slides 306—64, 65, 66, 67, 68.

All of Winchell's syntypes, including the fragment of reef rock (No. 32417J) that he identified in error as *Stromatopora nux,* three homeotypes, and one topotype were collected from the Petoskey formation at Locality 18 (Winchell's Loc. 856). They probably came from a slightly higher stratigraphic position in the stromatoporoid reef there than that containing numerous coenostea of *Stromatopora pustulifera. S. pustulifera* occurs in unit 10 of the reef section described by Mildred A. Fenton (1931, p. 196); most, possibly all, of Winchell's types of *T. nux* came from the overlying unit 11 of the section she described.

Family Idiostromatidae Nicholson 1886

Genus *Idiostroma* Winchell 1867

Idiostroma, Winchell, 1867, p. 99; Nicholson, 1886, pp. 10, 99, Pl. 9, Figs. 6–11; Galloway, 1957, pp. 443–44, Pl. 31, Fig. 12, Pl. 34, Fig. 9.

Type species.—First species selected by Nicholson (1886, p. 11), *Stromatopora caespitosa* Winchell (1866, p. 91). Middle Devonian Traverse group, Petoskey formation; cliff bordering Little Traverse Bay, northeast side of Petoskey, Michigan. Locality 18 (856C of Winchell).

Diagnosis.—Coeosteum caespitose, with axial tube and branches; laminae arching, with much secondary tissue; tissue vacuolate but not maculate; pillars superposed, radially arranged; mamelons not typically developed; astrorhizae other than axial tube and branches absent. Dissepiments rare.

Devonian, widely distributed.

Remarks.—There are at lease five other genera of stromatoporoids with ramose branches.

Idiostroma has been confused with *Dendrostroma* by Lecompte (see Lecompte, 1952, pp. 320–21, Pl. 61, Fig. 1), by Quenstedt (see Quenstedt, 1878, pp. 584–85, Pl. 142, Fig. 14), and others. *Dendrostroma* grows in

tufts of small branches similar to *Idiostroma caespitosum* and specimens of this genus are common in the lower part of the Petoskey formation of the Traverse group in the Kegomic (or Mud Lake) quarry, about 1 mile east of Bay View, Michigan (Loc. 21), and in the Potter Farm formation of this group in the Alpena Cemetery (Evergreen Cemetery) near Alpena, Michigan (Loc. 68). *Dendrostroma* differs from *Idiostroma* in having short pillars, which are confined to one interlaminar space, and in possessing fibrous tissue.

A good example of *Idiostroma* is *I. uralicum,* which was described by Yavorsky (1955, pp. 137–38, Pl. 73, Figs. 1–5) and is nearly if not identical with *I. roemeri* Nicholson. *Idiostroma cumulus* Yavorsky (1955, pp. 138–39, Pl. 74, Figs. 1–4), seems to be a species of *Dendrostroma;* it lacks superposed pillars and porous tissue. Yavorsky's *Idiostroma* aff. *uralicum* (1957, pp. 55–56, Pl. 29, Figs. 1–2) appears to be a *Dendrostroma,* and his five species of *Stachyodes* seem more like *Dendrostroma. Idiostroma* and *Stachyodes* are much alike, but *Dendrostroma* is easily distinguished by its discontinuous pillars and porous tissue.

Idiostroma resembles *Trupetostroma* in having parallel pillars, strong pseudozooidal tubes, and compact but vacuolate tissue, as was noted by Lecompte (1952, pp. 314–15). Its similarity to *Hermatostroma,* however, is in the superposed pillars rather than character of tissue.

Idiostroma caespitosum (Winchell)

(Pls. IV, Figs. 1*a–e,* 2; XIII, Figs. 4–5)

Stromatopora caespitosa Winchell, 1866, p. 91. One of Winchell's eight syntypes belongs to *Dendropora petoskeyense,* sp. nov. described below. Not *Stromatopora caespitosa* Quenstedt, 1878, pp. 584–85, Pl. 142, Fig. 14, which seems to be a *Dendrostroma.*

Idiostroma caespitosum Winchell, 1867, pp. 96, 99; Nicholson, 1886, pp. 10, 17, 99; Grabau and Shimer, 1909, p. 43; Kühn, 1928, pp. 40–41; Ripper, 1937*b,* p. 194; Kühn, 1939*b,* p. A52; Lecompte, 1952, p. 311; Galloway, 1957, pp. 443–44, Pl. 31, Fig. 12 (Winchell's syntype, No. 32701).

Original description (Winchell, 1866, p. 91).—"In general form resembling a large, caespitosely branching, cyathophylloid coral; stems externally in contact or more than 25 mm. distant. A longitudinal section shows the characteristic layers arching across the stem and resembling *S. pustulifera* in miniature; a transverse section exhibits radiating lamellae as in Cyathophyllidae, but there is no outer wall, and the interior is completely filled with concentric circles of coralline substance, except a small perforation in the center. Mural system entirely wanting, as in other Stromatoporae; exterior of stem longitudinally [s]triate. Diameter of

stems 4.5 mm. (.18) to 7.6 mm. (.30). Occurs in masses two to three feet in diameter.

"This remarkable species exhibits a transition from *Stromatopora* to *Cyathophyllum* and might well form the type of a new genus."

Revised description.—The following description is based on Winchell's lectotype and six paralectotypes.

Coenosteum: The lectotype is an ovoid mass of branches, 10 cm. in longer diameter, 8 cm. in shorter diameter and 4 cm. thick. It is a good specimen to show the characters of the coenosteum, but is incomplete; the early stage and base are missing, and the upper surface had been smoothed before the attachment of the original label. The branches are from 4 to 6 mm. in diameter, new branches spring nearly full size from the sides of older branches; they touch in many places, but remain round and are mostly less than their own diameters apart.

The surface of the branches is in general smooth, with many growth irregularities, but no mamelons. It consists of the ends of round and elongate pillars, which join in a general pattern elongate to the branch but leave elongate and round openings between. There are no typical astrorhizae, not even at the ends of perfect branches where the axial tube is visible. Lecompte (1952, p. 314; 1956, pp. F131–132), however, considered the axial canal and lateral branches to represent an astrorhizal system.

Vertical section: In this section the axial tube is 0.5 to 0.6 mm. in diameter, in some specimens showing a length of 10 or more mm., and crossed by tabulae which arch upward, 1 to 3 in 1 mm., some incomplete and joining other tabulae. The axial tube is intermittent in development, especially between latilaminae, or breaks up into several smaller tubes. Its position tends to be central, but it may be to one side of center, especially where the branch divides.

Latilaminae are from 1 to 4 cm. thick, and are marked by closely spaced laminae and dense tissue between latilaminae. The laminae arch smoothly across the stem (the smooth arch not ordinarily affected by the axial tube), are variable in thickness and in density of structure; they are farthest apart in the branch axis, about 4 in 2 mm., and closest together at the edges of the branches, where they may be 6 in 1 mm. and where they overlap earlier ones. A lamina consists of a thin, light, median microlamina, on each side of which the tissue is darker, dense, flocculent, and variable in thickness. The thicker tissue, in the axis of the branch, has many round and irregular vesicles; in the outer third or fourth of the branch the tissue is more dense, with many roundish vacuoles, nearly filling the interlaminar spaces, and pierced by pseudozooidal tubes or

superposed galleries, and by many long, thin, vertical pores or dark lines when the pores are filled, as figured by Lecompte (1952, Pl. 62, Fig. 3; Pl. 63, Fig. 2*a*). The tissue is not maculate, but is of variable compactness and is vacuolate, light, dark and mottled, with abundant dustlike particles.

In both the axial and outer regions there are many oval galleries, 0.1 to 0.2 mm. in diameter. The axial region, about one-third the width of the branch, contains innumerable round vacuities, neither maculae nor pores, 0.03 to 0.15 mm. in diameter, each surrounded by a thick, dark ring of tissue. Pillars are scarcely distinguishable in the axial region of the branches, because this region is occupied largely with numerous round vacuoles; they are well shown in the submature region, where they are definitely superposed, 0.08 to 0.17 mm. in diameter, about 8 to 2 mm., and separated by superposed galleries of similar width. In the section about half is tissue and half openings.

Cross section: The axial tube may or may not show in the axial region, which region is about one-half the diameter of the branch and is made up of dark-gray, compact, dusty and flocculent tissue with numerous round and elongate vacuities. In the submature and mature regions there are concentric laminae, superposed pillars, round galleries, and superposed galleries.

Tangential section: The section consists of about 60 per cent of tissue, in which the laminae and latilaminae make concentric arches. The pillars are elongate and anastomose vertically, and the galleries are round and elongate vertically, much as in *Stachyodes gracilis* Lecompte (1952, Pl. 61, Figs. 5, 5*a*).

Preservation.—The specimens are well preserved, tan in color, friable, slightly leached but not replaced, and buried in fine, loose, calcareous silt, which silt may be rapidly and nearly completely dissolved in dilute, cold hydrochloric acid, leaving a residue of perhaps 5 per cent of siliceous grains, with brownish, flocculent material and strands of chitinous material.

Remarks.—*Idiostroma caespitosum* (Winchell) is characterized by the small branches, about 5 mm. in diameter, the small axial, tabulate tube, the axial zone of vacuolate tissue, the submature and mature zones with arching laminae, superposed pillars, pseudozooidal tubes, and filling tissue with abundant roundish vacuoles and transverse pores. It would be difficult to distinguish *Stachyodes gracilis* Lecompte (1952, p. 302, Pl. 61, Fig. 5) and *Stachyodes parallelporoides* Lecompte (1952, pp. 308–309, Pl. 63, Fig. 3; Pl. 64, Figs. 1, 2) from Winchell's species. *Idiostroma roemeri* Nicholson (1886, p. 100, Pl. 9, Figs. 6–11; Lecompte, 1952, Pl. 66, Fig. 3), long considered a typical species of *Idiostroma,* has larger branches, more prominent pillars, and the axis lacks the vesiculose zone of *I. caespitosum.*

Occurrence.—Idiostroma caespitosum occurs in the Petoskey formation at Locality 18. Winchell's types were obtained from a cliff exposure adjacent to the shore of Little Traverse Bay (Winchell's Loc. 856). In the course of quarrying, the cliff was removed; another section of the strata once seen in the cliff, is fortunately visible in the wall of the now abandoned Northern Lime Company's quarry a short distance back (south) of the cliff (Loc. 18).

Specimens of *Idiostroma caespitosum* are fairly common near the top of the above-mentioned quarry in strata comprising unit 13 of the section described by Mildred A. Fenton (1931, p. 196). A. W. Grabau (1913, p. 429), previously noted the occurrence of this stromatoporoid in the reef at this locality and stated that "In the upper beds the branching stromatoporoid *Idiostroma caespitosum* is the chief organism, and this is often found in the position of growth, its finger like branches spreading to capture the coral sand."

Pohl (1930, p. 14) reported the occurrence of "digitate *Stromatoporas*" in Bed 1 of his undifferentiated zones of the Petoskey formation exposed in the quarry. The lower half or more of Bed 1 is composed of numerous specimens of *Stromatopora pustulifera* Winchell. If the "digitate *Stromatoporas*" are *Idiostroma caespitosum,* their stratigraphic occurrence is most likely in the upper half of Bed 1. Strata in this part of Bed 1 probably also contain *Trupetostroma nux* (Winchell).

Types.—Winchell's material consists of eight syntypes, six of which have much the same size, size of branches, preservation, and appearance, Nos. 32400A–B, 32401A–B, and 32402A–B, and two consisting of small, branches of coenostea, Nos. 32405A–B, from which five thin sections had been cut by Dr. W. A. Parks. Specimen No. 32401A is here selected as the lectotype. It had been labeled "*Idiostroma caespitosum* Win." and signed "A.W." and, subsequently, simply "Type" in a different hand, and also so indicated by an attached, red-paper diamond. All are typical *I. caespitosum* except specimen No. 32402B, which is a *Dendrostroma,* described below as *D. petoskeyense,* sp. nov.

Types and slides of thin sections made from them are deposited in the University of Michigan Museum of Paleontology under the following numbers:

Lectotype: No. 32401A (slides W2–17, 18).

Paralectotypes: Nos. 32401B (W2–19, 20); 32400A (W5–10); 32400B; 32402A (W2–21); 32405A; 32405B (5 unnumbered slides from specimens Nos. 32405A and B).

Idiostroma roemeri Nicholson

(Pl. V)

Idiostroma roemeri Nicholson, 1886, pp. 100–101, Pl. 9, Figs. 6–11. Holotype, M. Devonian, Hebborn, Germany; Kühn, 1928, p. 41; other references given.

Idiostroma roemeri Lecompte, 1952, pp. 316–17, Pl. 66, Fig. 3 (holotype refigured); Lecompte, 1956, pp. F131–32, Fig. 107, 3 (holotype refigured).

Description.—The following description is based on two hypotypes Nos. 32406 and 32408.

Coenosteum: In specimen No. 32408 the coenosteum is an elongate mass 155 mm. long and 70 mm. wide, consisting of about a dozen branches, ranging in breadth from 8 to 15 mm. and giving rise to smaller branches at irregular intervals up to 30 mm. The surface of the coenosteum generally smooth, in places showing latilaminae 2 to 3 mm. in thickness and many round pores, about 0.25 mm. in diameter, surrounded by small, anostomosing ridges, the ends of pillars, which tend to be elongate vertically to the branches. The ends of most branches show no axial tube; some branches have one axial tube, 0.05 to 1 mm. in diameter, and others have several tubes, in and outside of the axial region. Broken branches show well-defined pillars extending from the axis to the surface and up to 8 concentric laminae. The pillars are more conspicuous and longer than those in *I. caespitosum,* which Winchell (1867, p. 99) described as having a "lamellar system, represented by radial structure." In specimen No. 32406, which has been ground down to near the axial zone, the laminae and strong, superposed pillars are clearly visible under a hand lens. The main branch is 18 to 20 mm. wide, with 8 or more bases where smaller side branches have been broken off.

Vertical section: The axial tube is variable in occurrence and size, and in its manner of dividing. It is missing in many parts of the branches; when present it ranges from 0.5 to 1 mm. in diameter. In places it is divided into 2 or as many as 6 tubes of similar diameter; these tubes occupy a position in the axial zone or in the outer zone as exhibited in the holotype of the species (Nicholson, 1886, Pl. 9, Fig. 8). Usually, the branching tubes extend downward and along the laminae, as astrorhizal canals usually do. The laminae arch strongly upward; in the axial region there are 6 or 7 in 2 mm. They overlap more closely in the outer than the axial region. Each lamina shows a thin, clear median line, on both sides of which there is thicker tissue replete with round and irregular vacuoles. In some places the interlaminar spaces are nearly filled with secondary tissue, in which vacuoles are scarce but there are some transverse pores, much as in *Stachyodes*. The pillars are prominent and superposed, so that they seem to be continuous and to resemble laminae in size

and distance apart. The pillars extend from the axial tube or from the narrow axial zone to the surface, and become somewhat thicker toward the surface.

Cross section: There is usually a single axial tube, 0.4 to 0.6 mm. in diameter. In some parts of a branch it is missing; in other parts there may be as many as six tubes scattered throughout. In one branch there is a single axial tube at one level, but higher a double tube with 12 smaller tubes in the submature region. See slide W2–23. The axial zone is narrow, about 1 mm. in diameter; it has radial pillars, secondary tissue and vacuoles, but no laminae. In the submature region laminae and pillars are conspicuous, the superposed galleries either open or largely closed with secondary tissue containing vacuoles and fine, transverse tubules; about 7 laminae in 2 mm. Pillars increase mainly by bifurcation, so that they remain about the same distance apart from axis to edge of branch. In the outer or mature region the laminae are closer together and many pillars are not well defined because they are conjoined.

Tangential section: The pillars are round and elongate and tend to be arranged lengthwise of the branch; many are joined with others; some single and conjoined pillars are confluent with laminae. Branches of the axial tube are shown in some thin sections. Galleries round, 0.1 to 0.15 mm. in diameter. Vacuoles are conspicuous, especially in the deep tangential section, ranging from 0.03 to 0.1 mm. in diameter; they are more variable in size and arrangement than are maculae, with which they might readily be confused. The galleries are partly open, anastomose and tend to be arranged parallel to the branch; some are closed by secondary, vacuolate tissue.

Preservation.—The specimens are porous, chalky and fragile, slightly leached, only partly infiltrated with calcium carbonate. They were originally buried in a fine, calcareous silt.

Remarks.—The specimens from the Petoskey formation of Michigan agree with the holotype from the Middle Devonian of the Eifel region of Germany in nearly all respects, size of branches, narrow axial zone, long radial pillars, variable axial tubes, vacuolate tissue, and size and distribution of laminae. The holotype has obscure mamelons at the surface (Nicholson, 1886, Pl. 9, Fig. 6) and in vertical sections (Lecompte, 1952, Pl. 66, Fig. 3*a*), and there are many low knobs on the Michigan specimens. Tabulae in the axial tubes and pseudozooidal tubes are present in the Michigan specimens but much less conspicuous than those in the holotype as shown by Nicholson (1886, Pl. 9, Fig. 11). *I. roemeri* differs from *I. caespitosum* in having larger branches, smaller axial zone, and larger and more conspicuous pillars. There are no astrorhizae, unless the axial

tube is an astrorhizal tube, as considered by Lecompte (1952, p. 314). The conspicuous, superposed pillars immediately distinguish *I. roemeri* from the caespitose *Dendrostroma petoskeyense,* sp. nov., (described below) from the Petoskey strata at Locality 18 and from *D. fibrosum,* sp. nov., (described below) from slightly higher rocks at Locality 21. The superposed pillars and vacuolate tissue of *I. roemeri* are much like those of *Trupetostroma;* the pillars and laminae lack the outer, light-colored zone which is characteristic of *Hermatostoma.* A similar species occurs higher in the Petoskey formation at Locality 21, 1 mile northeast of Bay View, Michigan.

Occurrence.—This species has the same form and character of preservation as *I. caespitosum,* and with little doubt occurs in the higher strata of the Petoskey formation at Locality 18 (Loc. 856 of Winchell).

Types.—Hypotype No. 32406, possibly found by Dr. Alexander Winchell and given to Dr. Carl Rominger; hypotype No. 32408 (slides W2–22, 23, 24) found by Dr. Carl Rominger.

Genus *Dendrostroma* Lecompte 1852

Dendrostroma Lecompte, 1952, pp. 320–21; Galloway, 1957, p. 443.

Type species.—Idiostroma oculatum Nicholson, 1886, pp. 101–102, Figs. 14–15; 1892, pp. 225–28, Pl. 29, Figs. 10–11, Text Figs. 32–33, by designation of Lecompte, 1952, pp. 320–21, Pl. 61, Fig. 1. Middle Devonian, Büchel, Germany.

Diagnosis.—Coenosteum ramose or caespitose, with axial tubes more or less well developed; laminae well developed; tissue transversely fibrous, not maculate; pillars not superposed, confined to one interlaminar space; mamelons and astrorhizae absent unless axial tubes and their branches be considered as astrorhizae; dissepiments few to many.

Devonian: Germany, Russia, and Michigan.

Remarks.—The axial tubes and their branches may be isolated astrorhizae, as considered by Lecompte (1956, F131–132). Astrorhizae are not of generic importance in massive forms of stromatoporoids (Galloway, 1957, pp. 378–81). Hence, it might be maintained that ramose forms without axial canals, as *Clavidictyon,* and those with sporadic axial canals, as *Dendrostroma fibrosum,* sp. nov., are not generically distinct from forms that usually have them, as *Idiostroma* and *Amphipora.* Even in *Amphipora* there are occasional cross sections which show no axial canal.

Dendrostroma petoskeyense Galloway and Ehlers, sp. nov.

(Pl. VI, Fig. 1*a–c*)

Stromatopora caespitosa Winchell, 1866, p. 91. One of Winchell syntypes, No. 32402B.
Idiostroma caespitosum Winchell, 1867, pp. 96, 99.

Description.—The following description is based on the only known specimen, one of the eight syntypes of *Stromatopora caespitosa* Winchell.

Coenosteum: A loose clump of anastomosing branches, originally over 80 mm. broad and 50 mm. high. Branches 2 to 8 mm. in diameter, short and irregularly branched, with many knobs, each the beginning of other branches. Their surface in general smooth, covered with a calcareous film, which may or may not be an original secretion. No mamelons or astrorhizae unless the axial tubes with their smaller branches are so regarded. The base of the coenosteum, where cut by Winchell or some other worker, shows cross sections of 24 branches.

Vertical section: Each branch has an axial tube, 0.3 to 0.6 mm. in diameter; each tube may have smaller tubes. The tubes have many curved and joined tabulae and dissepiments. The laminae, about 10 in 2 mm., are much thickened near the axial tube and become thinner toward the surface of the branch. The pillars are only one interlaminar space long, and are only incidentally superposed. Both laminae and pillars are composed of the same kind of tissue, which is fibrous and in whorls, with fibers directed toward the galleries. The tissue rarely has definite pores. Some laminae and pillars have a dark median line. Galleries are small, roundish, and largely filled with fibrous tissue near the axial tube; they tend to be quadrangular near the outside of the branches. There are abundant, thin, oblique, curved dissepiments in the galleries, with the general curvature outwards.

Cross section: The axial tube is surrounded by a fibrous wall and by short radial pillars which are transversely fibrous. Some pillars have a dark median line, as in *Amphipora*. The laminae and pillars become thinner toward the surface, and the numerous curved dissepiments are shown as in the vertical section.

Tangential section: This section shows a network of thin laminae, the pillars, and the curved dissepiments; also, that the tissue is fibrous and that the fibers are in imperfect whorls. There is no indication of pores or ring pillars, and little evidence of the dark median line in the laminae or pillars.

Preservation.—The specimen was considerably broken and had been buried loosely in the calcarous mud of the reef in which it grew, with fragments of brachiopod shells and small corals in the interstices. The branches have not been infiltrated with calcium carbonate; galleries and axial tubes are open. The tissue appears much as it may have been in life, but with some recrystallization.

Remarks.—The single specimen known was considered an example of *Idiostroma caespitosum* by Winchell, who placed it with other syntypes of

this species. *Dendrostroma petoskeyense* differs from *I. caespitosum* in having smaller branches and, especially, in the lack of long radial pillars and vesicular tissue. *D. petoskeyense* resembles species of *Amphipora* in size of branches, radially fibrose tissue, and in the occasional dark median line in the tissue, but it does not have the large peripheral vesicles characteristic of *Amphipora* and *Paramphipora*. It seems to be a typical *Dendrostroma,* but has more dissepiments than either *D. oculatum,* the type species, or *D. fibrosum,* sp. nov., and the branches are also much smaller than in either species.

Type and Occurrence.—The holotype, formerly one of the syntypes of Winchell's *Stromatopora caespitosa* (= *Idiostroma caespitosum*) bears No. W2–25. The holotype was found by Winchell at Locality 18 (Winchell's Loc. 856) and most probably came from strata of the Petoskey formation containing *Idiostroma caespitosum.*

Dendrostroma fibrosum Galloway, sp. nov.

(Pl. VI, Figs. 2*a–d,* 3)

Description.—The following description is based on specimens collected by the senior author.

Coenosteum: Irregularly ramose; branches 8 to 12 mm. in diameter and 2 to 3 cm. long; surface in general smooth, without mamelons or astrorhizae but with round and joining knobs with irregular canals between; branches with small, sporadic axial canal.

Vertical section: The axial region is about one-third the width of the branch with small, tabulate axial tube or tubes. Laminae and pillars are much thinner in the axial than in the outer region. Laminae arch sharply over the axial region, are irregular, discontinuous, and thin, and merge with the thin, irregular pillars. In the peripheral or mature region the laminae and pillars are much thickened, and the galleries elongate and much reduced in size. The laminae are transversely fibrous with scattered small indistinct vertical pores and in places with fine anastomosing pores, much as in some species of *Stromatoporella.* Pillars are short, in part formed by laminae which curve upward; most of them are additions to the laminae, but in separate structures as in *Anostylostroma,* and are composed of the minute fibers. Their tissue is precisely like that of the laminae. Occasional thin, outwardly curved dissepiments are present and more common in the submature region.

Cross section: The axial region is narrow to broad with axial tube or tubes; laminae and pillars are rather thin and join in an intermingled mass. The laminae are regular in the submature and mature regions, and

are rather thick, from 0.1 mm. to 0.15 mm. The galleries are round, oval, or very elongate; some have oblique dissepiments. The pillars join the laminae smoothly and both laminae and pillars are conspicuously fibrous, in general transversely, but having a tendency to be radial around the galleries. They are short and only incidentally superposed. There are many large foramina through the laminae but no long vertical tubes which might be called pseudozooidal tubes.

Tangential section: Especially near the surface, the laminae and pillars are joined into a fibrous mass, so that only a third or fourth of the section is represented by reduced galleries. As is true for *Stromatoporella,* there is little indication of vertical pores and only very few large rings similar to ring pillars, but these are by no means as perfect nor porous as they are in *Stromatoporella.* Some galleries are long and some branch; they might be called imperfect astrorhizae.

Preservation.—The specimens have been preserved in a calcareous, argillaceous mud and are now perfectly infiltrated with calcium carbonate.

Occurrence.—This species occurs in the walls of the small abandoned quarry at Locality 21. It occurs with *Stromatoporella mudlakensis,* which has porous laminae and ring pillars and from which it cannot be distinguished except by thin sections; it also is present with *Clavidictyon kegomicense,* which is smaller but can be distinguished only by means of thin sections. Specimens are associated also with robust branches of *Idiostroma* sp. cf. *I. roemeri.* The latter can be readily distinguished from *D. fibrosum;* polished sections, observed with a hand lens, reveal large and continuous radial pillars characteristic of *Idiostroma,* especially of *I. roemeri* Nicholson.

Dendrostroma fibrosum also occurs with medium-sized specimens of corals, *Emmonsia* sp. and phaceloid forms like *Cylindrophyllum,* many of which are overgrown by stromatoporoids. Small and large nodular stromatoporoids belonging to *Stromatoporella, Parallelopora, Stromatopora,* and other genera are also present. Since there are so many species of ramose stromatoporoids, it is remarkable that some of them, as *Stromatoporella,* have not heretofore been reported in the ramose condition.

Dendrostoma fibrosum is very similar to a caespitose stromatoporoid which occurs in the Potter Farm formation on the west edge of Alpena, Michigan, Localities 68 and 89*e*. Many species of fossils, which are present with *D. fibrosum* in the Petoskey strata at Locality 21, are represented by specimens in the Potter Farm beds at Localities 68 and 89*e*. The occurrences of the two closely related stromatoporoids supports the other fossil evidence that the strata at these localities are of the same age.

Type.—The holotype and slide made from it and a paratype are in the Indiana University Paleontological Collection.

Genus *Clavidictyon* Sugiyama 1939

Clavidictyon, Sugiyama, 1939, pp. 441–42, Pl. 25, Figs. 6–8; 1940, p. 109, Pl. 14, Figs. 7–9; Pl. 15, Fig. 7; Pl. 16, Figs. 1–2; Pl. 29, Fig. 4; Galloway, 1957, p. 441, Pl. 34, Fig. 6.

Type species.—Clavidictyon columnare Sugiyama (1939, p. 441, Pl. 25, Figs. 6–8) by original designation. Middle Silurian, Kawauti series, Hikoroitimura, Japan.

Diagnosis.—Coenosteum ramose, without axial tube, with laminae and short pillars. Tissue structure unknown for Silurian forms, flocculent in Devonian forms. Mamelons and astrorhizae absent.

Middle Silurian, Japan; Middle Devonian, Michigan.

Clavidictyon kegomicense Galloway, sp. nov.

(Pl. XIII, Figs. 1*a–e*, 2–3)

Description.—The following description is based on types collected by J. J. Galloway.

Coenosteum: Coenosteum consists of small, ramose branches, 4 to 8 mm. in diameter, branching at irregular intervals, 5 to 20 mm., probably caespitose; no specimen consisting of a bushy mass was found. Surface irregular, in general smooth; most specimens covered with foreign organisms, other stromatoporoids, and *Aulopora,* a small branching coral. In some places round and confluent pillars and pores are recognizable. There are no mamelons or astrorhizae; typically without axial tube.

Cross section: Usually, no well-marked axial tube. There may be one small tube, 0.4 mm. in diameter, or several smaller tubes; a paratype (slide 306–85) has a single, tabulate axial tube. The axial zone is 2 to 3 mm. wide and consists of a loose network composed of thin or thick pillars, and is surrounded by several closely spaced annuli of laminae. In the peripheral zone the laminae are close together or in contact; the pillars are short and thick and merge with the laminae, and the galleries are filled with flocculent tissue.

Vertical section: There are several short, irregularly branching axial tubes, rarely a single tube. The axial zone is wide, extending to the peripheral zone as in the type species of *Clavidictyon;* a similar wide axial zone may apply to any ramose form. The laminae are transverse in the axial region and parallel to the edge in the cortical region. The laminae are made up of three layers, a median branched layer consisting of light-colored tissue and two layers of flocculent tissue, one below and the other

above the median layer. The structure of the laminae resembles that of *Stromatoporella granulata* (see Galloway, 1957, Pl. 31, Fig. 7). The pillars are short and irregular, some reaching the next lamina and others not; they are not superposed. The tissue of the pillars is flocculent, not maculate, with a fine network of light tissue between the roundish floccules. Galleries are irregularly anastomosing, and compose 40 to 60 per cent of the axial region. The axial tubes rarely have curved tabulae. In the mature or cortical region the laminae and pillars thicken abruptly and lose their identity; the cortical tissue is flocculent, with anastomosing pores (not to be confused with maculae), and irregular remnants of galleries and pillars. Thin discontinuous laminae appear to arch over the axial region, but are indefinite in the outer region.

Tangential section: Shallow tangential sections show thickened pillars and laminae amalgamated, in 50 to 80 per cent of the section, that surround elongate and joining amoeboid galleries. The tissue is flocculent, the floccules separated by light-colored, anastomosing tissue. The floccules are not maculae, since they are not uniform in size or shape and do not have a central cavity; sometimes, however, difficulty may be experienced in separating floccules from maculae. Deep tangential sections show the laminae with a light-colored median layer having flocculent tissue on both sides. The pillars are moderately thick and composed of flocculent tissue; they meander to join other pillars and the laminae. The galleries are irregular and join; they compose 40 to 50 per cent of the field.

Preservation.—The specimens are perfectly preserved by infiltration of calcite, without perceptible recrystallization of tissue. They had been embedded in clay mud; most of their surfaces are covered with this material and attached organisms.

Remarks.—*Clavidictyon kegomicense* has the same kind of flocculent tissue as *C. millcreekense,* sp. nov., which occurs in the Middle Devonian Bois Blanc formation of the Mackinaw City region of Michigan. It differs from *C. millcreekense* in that its axial structures are much thinner, peripheral structures much thicker, laminae more definite, and pores indefinite. Furthermore, *C. kegomicense* has no epitheca.

Occurrence.—The species is abundant in the Petoskey formation of the abandoned Kegomic quarry, Locality 21. It is associated with massive *Stromatopora, Anostylostroma,* and *Parallelopora,* and with irregular and branching species of *Stromatoporella* (not easily distinguished but having ring pillars and coarsely porous laminae), and with ramose species of *Idiostroma, Dendrostroma,* and *Clavidictyon.* Many favositoid corals, the rugose coral *Cylindrophyllum,* and several simple rugose corals are also associated with *C. kegomicense.*

Types.—Holotype No. 4637A (slides 282–77) and paratypes Nos. 4637B, C (slides 306—83, 84, 85), Indiana University Paleontological Collection.

Family Clathrodictyidae Kühn 1939*a*
Genus *Stromatoporella* Nicholson 1886

Stromatoporella Nicholson, 1886, pp. 92–95; 1891, p. 202; 1892, pp. 203–204; Parks, 1936, pp. 90–95; Yavorsky, 1950, pp. 243–63; 1955, pp. 111–12; 1957, pp. 51–52; Lecompte, 1951, pp. 152–60; Galloway, 1957, pp. 436–37.

Type species.—*Stromatopora granulata* Nicholson, 1873, p. 94, Pl. 4, Figs. 3, 3*a*, by designation of Nicholson, 1886, p. 93. Middle Devonian Hamilton group, Ontario, Canada.

Diagnosis.—Coenosteum laminar, massive, or subramose; laminae coarsely porous, rising into ring pillars; dissepiments, mamelons, and astrorhizae common.

Silurian and Devonian; widespread and abundant.

Stromatoporella elevata Parks
(Pl. VII, Figs. *a–c*)

Orthoceras pustulosum Winchell (part), 1866, Appendix, pp. 86, 97.
Stromatoporella elevata Parks, 1936, pp. 110–11, Pl. 15, Figs. 1–3.

Original description (Winchell, 1866, p. 97).—"ORTHOCERAS. Characterized by having the exterior covered with pustules of varying sizes and unequally distributed."

Revised description.—The following description is based on part of the holotype of Winchell's *Orthoceras pustulosum.*

Coenosteum: The coenosteum consists of a fragment attached to a small part of an orthoceroid shell; prior to sectioning, it was about 60 mm. long, 40 mm. wide and 1 mm. thick. The surface is black, smooth and glisteny, and has conical pustules 1 to 2 mm. wide, ½ to 1 mm. high, and irregularly distributed, 2 to 5 mm. apart. A few of the smallest pustules have a pore at the top, but the largest pustules have no apical pore, not counting some pustules which have had the summits broken off. There are no pores or granules between the pustules, and no indication of astrorhizae. The coenosteum is perfectly preserved by infiltration of calcite.

Vertical section: There are about 6 laminae in 1 mm., which is the ordinary thickness of the coenosteum, with only a lamina for a peritheca. The laminae are fairly straight, thin to thick, coarsely porous, with labyrinthic pores where the laminae are thickest; they rise into large ring pillars, and in many places there are foramina between upper and lower

galleries. The galleries are in part round, extending up to over 1 mm. horizontally. Dissepiments are rare, and no astrorhizal canals recognized.

Tangential section: The laminae are coarsely and unequally porous; each lamina one-third the width of the ring pillar; many ring pillars 0.2 to 0.27 mm. in outer diameter. The pustules show a central, porous mass of tissue, with ring pillars and oval to irregular galleries that are surrounded by irregular galleries; a pustule is an irregular laminar annulus. There are no astrorhizae.

Remarks.—Winchell's specimen of *S. elevata* is attached to a fragment of an orthoconic cephalopod which was obtained from a dark-gray limestone. The specimen is dark buff-gray. The smooth shiny surface of the coenosteum between the pustules is due to the lack of granules, papillae and ring pillars, structures that appear at the surface of many species.

Some specimens of *S. elevata* that occur in the Thedford-Arkona region of Ontario, Canada, are attached to corals (*Heliophyllum, Alveolites,* and *Emmonsia*) and others spread over the original calcareous mud of the sea bottom. The Ontario specimens are light-buff. Some specimens from that region have one or more pores at the summit of a pustule.

Occurrence.—*S. elevata* is abundant in the coral bed of the Middle Devonian Hungry Hollow formation exposed at Hungry Hollow in the Ausable River Valley about 2 miles east of Arkona and in the same bed shown in the tileyard about one-half mile north of Thedford.

Winchell's specimen, a hypotype, was obtained from his "Bryozoa beds," at his Locality 857 (see Winchell, 1866, pp. 42–43, 86). Winchell's Locality 857 is about 1½ miles east of his Locality 861, which is a part of Locality 14 of the Michigan Geological Survey and the Museum of Paleontology, University of Michigan (see Register of Localities in this paper). The strata at Winchell's Locality 857 crop out along the shore of Little Traverse Bay; they occupy a position in the lower part of the Gravel Point formation of the Traverse group.

The Ontario and Michigan occurrences of *S. elevata* indicate that the coral bed of the Hungry Hollow formation may be a correlative of some of the Gravel Point strata of Michigan.

Types.—Hypotype No. 14310, from which slides W4–24, 25 were made, was found in 1860 by A. D. White, a member of the Michigan Geological Survey. Winchell was in error in believing that the pustulose surface of this hypotype was the outer surface of a cephalopod conch to which he applied the name *Orthoceras pustulosum.* The stromatoporoid is a good example of *S. elevata* but the cephalopod is too incomplete and poorly preserved to permit a generic or specific identification.

Stromatoporella mudlakensis Galloway, sp. nov.
(Pl. VII, Figs. 2*a–b*, 3, 4*a–b*, 5*a–b*)

Description.—The following description is based on specimens collected by J. J. Galloway in 1941.

Coenosteum: The coenosteum is irregular in form, of small size, up to 7 cm. in longer dimension, and composed of several round but contiguous and amalgamated branches, 5 to 10 mm. in diameter, with many short ramose branches. The surface is in general smooth without mamelons or astrorhizae; the pillars make a network of minute intergrown ridges with channels between and, where the surface is well exposed, exhibiting conspicuous ring pillars. These characters distinguish it from associated ramose forms of *Clavidictyon, Dendrostroma,* and *Idiostroma.*

Vertical section: The axial region has no axial tube but consists of an irregular network of fine, coarsely porous lines, which are the arched laminae and the radial pillars. The peripheral region consists of thick laminae, 0.12 to 0.15 mm. thick, 6 or 8 in 2 mm., and short discontinuous pillars. The laminae turn upward into ring pillars and join the overlying laminae. Both the laminae and these pillars are coarsely perforate transversely. The pores are about 0.03 mm. in diameter; where the laminae are very thick the pores join a median, longitudinal pore. Between the laminae there are many thin, convex and oblique dissepiments.

Cross section: In cross section the same features are shown as in the vertical section; there is no indication of an axial tube and the laminae are regularly concentric but the outer ones join the laminae of adjoining branches. The transverse laminae are much thinner over the axial region than in the cortical region. There are occasional typical, coarsely porous ring pillars.

Tangential section: In both shallow and deep tangential sections as well as in oblique sections the laminae are thick and vertically porous. Attached to the laminae, as well as between the laminae, are abundant ring pillars, 0.3 mm. in diameter and with central lumina about 0.1 mm. in diameter. In places the laminae are much thickened and the galleries correspondingly reduced in thickness.

Remarks.—This species is characterized by its irregular ramose form, large ring pillars, and coarse pores transverse to the laminae and pillars. It occurs with massive specimens of *Stromatoporella,* which lack ramose branches but have mamelons. It bears considerable resemblance to *Dendropora fibrosum,* sp. nov., with which it occurs; *D. fibrosum,* however, lacks porous tissue and ring pillars.

Occurrence.—Many specimens of *S. mudlakensis* occur in the Petoskey formation at Locality 21, the abandoned Kegomic (or Mud Lake) quarry

about 1 mile east of Bay View, Emmet County, Michigan. They are associated with numerous specimens of a dendritic form, *Dendrostroma fibrosum,* sp. nov., which has fibrous laminae and no typical ring pillars, with *Clavidictyon kegomicense,* sp. nov., which is characterized by having flocculent rather than porous or fibrous tissue, and with ramose branches of *Idiostroma roemeri,* which has compact but vacuolate tissue and continuous pillars.

Specimens of *S. mudlakensis* occur in association with other ramose stromatoporoids in the Potter Farm formation at Locality 68, a small pit at the northwest corner of the Alpena Cemetery (Evergreen Cemetery) near the west side of Alpena, Michigan.

Types.—Holotype No. 4641A (slide 282—82), paratype 4641B, paratype 4641C (slides 282—83, 84) and paratype 4641D (slide 306—82), from the Petoskey formation at Locality 21, are in the Indiana University Paleontological Collection. Specimens No. 34917C (slide W4–1), from Petoskey strata at Locality 21, and No. 34919D (slide W3–19), from the Potter Farm formation at Locality 38, are in the University of Michigan Museum of Paleontology.

PART II. SPECIES FROM DETROIT RIVER GROUP AND BOIS FORMATION, INCLUDING GRABAU'S SPECIMENS

PREVIOUS WORK

W. H. Sherzer and A .W. Grabau (1909, January 30, pp. 547–48) listed several species of stromatoporoids from the Anderdon and Amherstburg beds of the "Upper Monroe Series," two formations now included in the Detroit River group. In their notation regarding a synopsis of the faunas of the "Monroe beds," Sherzer and Grabau (1909, p. 545) state that the species listed ". . . are fully described and illustrated in a memoir of this fauna (by Grabau), now awaiting publication by the Michigan Geological Survey . . ." Some of the stromatoporoids listed (1909, pp. 547–48) as occurring in the Anderdon and Amherstburg beds, were identified as belonging to previously described species and others listed under manuscript names; those listed with manuscript names were accompanied by little or no description sufficient to determine their specific identities.

A. W. Grabau, then Professor of Geology at Columbia University, described and figured the Stromatoporoidea of the Detroit River series (now designated a group) in 1910, in *The Monroe Formation of Southern Michigan and Adjoining Regions* by Grabau and Sherzer (1910, pp. 87–94, Pls. 8–9, 13, 16). Six of the species were described and figured by Grabau

from external characters. Inasmuch as neither genera nor species of stromatoporoids can be recognized from external characters alone, the true identity of Grabau's species has not been known. Furthermore, since Grabau considered the Detroit River strata to be of Silurian age, he identified some of the stromatoporoids with Middle Silurian species and assigned his new species to the Upper Silurian strata. However, he (pp. 93–94) noted that his new species had characters very similar to those present in previously described Middle Devonian forms.

Grabau identified stromatoporoids from a brownish, dolomitic limestone of the Detroit salt shaft with stromatoporoids from the very light gray to cream-colored, typical Anderdon limestone of the "Anderdon Quarry," 1¼ miles northeast of Amherstburg, Ontario. Neither the stromatoporoids nor the lithology of the rocks containing them are the same. The brownish, dolomitic limestone of the salt shaft is now considered to be a part of the Amherstburg dolomite or a part of the overlying Lucas dolomite, both of which are older than the Anderdon limestone.

With one exception, all of Grabau's figured and unfigured stromatoporoids are preserved in the Museum of Paleontology, University of Michigan. The exception is a missing specimen, identified by Grabau as *Clathrodictyon ostiolatum* Nicholson and figured by him in Plate 13, Figure 1 of his 1910 publication. The stratigraphic occurrences of Grabau's available specimens and other Detroit River stromatoporoids collected by G. M. Ehlers were determined by the junior author; all of these fossils were sectioned, identified, descried, and figured by the senior author.

The specimen from the Detroit salt shaft, figured by Grabau (1910, Pl. 16, Fig. 18), apparently is a *Stictostroma,* not *Clathrodictyon ostioslatum*. It is in a block of brownish dolomite from either the Amherstburg or Lucas dolomite but not from the Anderdon limestone as stated by Grabau (1910, explanation to Pl. 18, Fig. 3). The specimen is small and occurs in the piece of dolomite with *Stictostroma anomalum,* sp. nov., described in this paper, *Favosites tuberoides* Grabau (an *Emmonsia*), *Favosites rectangularis* Grabau, and other fossils. It was not sectioned because several of the other fossils in the rock would have been destroyed in the making of a thin section; preservation of the fossil assemblage seemed more important for further faunal and stratigraphic studies of the Detroit River group than a small section of the stromatoporoid unlikely to provide a specific identification.

Two species of stromatoporoids from the Bois Blanc formation, which underlies the Detroit River group, are described below for the purpose of comparison with ramose forms occurring in Detroit River strata.

Grabau's specimens are fragmentary and unsuited for illustrations of the exterior.

The Detroit River stromatoporoids identified by Grabau in 1910 are listed below with their present names. Some of the specimens, as indicated in the list, were not figured by Grabau.

"Clathrodictyon ostiolatum" Grabau

Pp. 87–89, Pl. 8, Fig. 6 (No. 13069) = *Clathrodictyon arvense* Parks = *Anostylostroma arvense* (Parks); see Galloway and St. Jean, 1957, pp. 110–11. Amherstburg dolomite or Lucas dolomite; Detroit salt shaft, Oakwood, Detroit, Michigan.

Specimens not figured by Grabau (Nos. 36079, 36080, and 36086) = *Anostylostroma arvense* (Parks). Same horizon and locality as above.

Pl. 13, Fig. 1. Amherstburg dolomite; Gibraltar quarry. Specimen missing and undetermined.

Pl. 16, Fig. 18 (No. 13068) = *Stictostroma* sp.

Specimen not figured by Grabau (No. 36085) = *Stictostroma anomalum* Galloway and Ehlers, sp. nov., paratype. Amherstburg dolomite or Lucas dolomite; Detroit salt shaft, Oakwood, Detroit, Michigan.

"Clathrodictyon variolare" Grabau

Pp. 89–90, Pl. 9, Figs. 1–2 (No. 14039) = *Stictostroma anderdonense* Galloway and Ehlers, sp. nov., Anderdon limestone; "Anderdon quarry," operated by Brunner, Mond Canada, Ltd., 1¼ miles northeast of Amherstburg, Ontario.

"Idiostroma nattressi" Grabau

P. 94, Pl. 8, Figs. 2 (No. 14040) and 3 (No. 14041) = *Amphipora ramosa* (Phillips) (1841, p. 19). Amherstburg dolomite or Lucas dolomite; Detroit salt shaft, Oakwood, Detroit, Michigan.

Specimen not figured by Grabau (No. 36082) = *Amphipora ramosa* (Phillips) (1841, p. 19). Same horizon and locality as above.

"Idiostroma nattressi" Grabau

P. 94, Pl. 9, Figs. 5 and 6 (No. 14038) and 7 (No. 14039) = *Amphipora nattressi* (Grabau). Anderdon limestone; "Anderdon quarry," operated by Brunner, Mond Canada, Ltd., 1¼ miles northeast of Amherstburg, Ontario.

Specimen not figured by Grabau (No. 30681) = *Amphipora nattressi* (Grabau). Same horizon and locality as above.

"Stromatopora galtense" Grabau

Pp. 90–91, Pl. 8, Fig. 1 (No. 14062) = *Stromatopora gallowayi* Fritz and Waines (1956, pp. 98–100). Amherstburg dolomite or Lucas dolomite; Detroit salt shaft, Oakwood, Detroit, Michigan.

Specimen not figured by Grabau (No. 36078) = *Stictostroma anomalum* Galloway and Ehlers, sp. nov., paratype. Same horizon and locality as above.

"Stromatopora (Coenostroma) pustulosum" Grabau

Pp. 91–92, Pl. 9, Fig. 3 (No. 14075) = *Syringostroma aurora* Parks (1904, pp. 182–83). Anderdon limestone; "Anderdon quarry," operated by Brunner, Mond Canada, Ltd., 1¼ miles northeast of Amherstburg, Ontario.

Pp. 91–92, Pl. 9, Fig. 4 (No. 14057) = *Syringostroma aurorella* Fritz and Waines (1956, pp. 103–104). Same horizon and locality as above.

Specimen not figured by Grabau (No. 36077B) = *Stictostroma anomalum* Galloway and Ehlers, sp. nov., holotype. Amherstburg dolomite or Lucas dolomite, Detroit salt shaft, Oakwood, Detroit, Michigan.

"Stylodictyon sherzeri" Grabau

Pp. 92–94, Pl. 8, Figs. 4–5 (No. 13093) = *Syringostroma sherzeri* (Grabau). Amherstburg dolomite or Lucas dolomite; Detroit salt shaft, Oakwood, Detroit, Michigan.

Specimens not figured by Grabau (Nos. 13094, 13095, 36077A, and 36083) = *Syringostroma sherzeri* (Grabau). Same horizon and locality as above.

REGISTER OF LOCALITIES

The localities where A. W. Grabau obtained Detroit River stromatoporoids and the places from which Boic Blanc specimens were obtained are described below:

LOCALITY

A. "Detroit salt shaft" of Grabau. This is the first of two shafts sunk by the property of the International Salt Company, Fort and Sanders Streets, Oakwood, greater Detroit, Michigan. Upper Silurian Salina group to Middle Devonian Dundee limestone.

B. "Anderdon quarry" of Grabau. This is the presently known Brunner, Mond Canada, Ltd. quarry, located in Anderdon Township about 1¼ miles northeast of Amherstburg, Ontario, Canada. Middle Devonian: Anderdon limestone with underlying Lucas dolomite and overlying Dundee limestone.

C. "Gibraltar quarry" of Grabau. Abandoned, water-filled, quarry about 1½ miles northwest of Gibraltar, Wayne County, Michigan. Middle Devonian: Lucas dolomite and underlying Amherstburg dolomite.

D. Small, abandoned quarry on west side of Mill Creek, approximately 200 yards southwest of New York Central Railroad and 4 miles southeast of Mackinaw City, Michigan. Middle Devonian: Bois Blanc limestone.

KEY TO DETROIT RIVER AND BOIS BLANC STROMATOPOROIDEA OF MICHIGAN AND ONTARIO

I. Coenosteum massive
  A. Tissue not maculate
    1. Pillars not made by upturned laminae.....*Anostylostroma arvense* (Parks)
    2. Pillars in part made by upturned laminae.....*Stictostroma*
      a. Laminae 6 in 2 mm.....*S. anomalum,* sp. nov.
      b. Laminae 12 in 2 mm.....*S. anderdonense,* sp. nov.
  B. Tissue maculate
    1. Pillars absent or indefinite.....*Stromatopora gallowayi* Fritz and Waines
    2. Pillars long, strong, definite.....*Syringostroma*
      a. Without mamelon columns
        (1) Astrorhizae absent.....*S. aurora* Parks
        (2) Astrorhizae conspicuous.....*S. aurorella* Fritz and Waines
      b. With mamelon columns.....*S. sherzeri* (Grabau)

II. Coenosteum ramose or caespitose
  A. With peripheral vesicles; pillars with dark medium line.....*Amphipora*
    1. Galleries largely open.....*A. ramosa* (Phillips)
    2. Galleries largely filled with tissue.....*A. nattressi* (Grabau)
  B. Without peripheral vesicles; pillars without dark median line
    1. Tissue porous.....*Stachyodes*
      a. Galleries not filled with tissue.....*S. parallelloporoides* Lecompte
      b. Galleries largely filled with tissue.....atypical species of *Stachyodes*
    2. Tissue flocculent.....*Clavidictyon millcreekense,* sp. nov.

SYSTEMATIC DESCRIPTIONS

Phylum COELENTERATA
Class HYDROZOA
Order STROMATOPOROIDEA
Family Clathrodictyidae Kühn 1939*a*
Genus *Anostylostroma* Parks 1936

Anostylostroma Parks, 1936, pp. 44–46; Galloway and St. Jean, 1957, pp. 94–95 (includes other references); Galloway, 1957, p. 434.
Clathrodictyon (part) of authors, forms with definite laminae and pillars.

Type species.—Anostylostroma hamiltonense Parks, 1936, pp. 46–50, by original designation of Parks, 1936, p. 44. Middle Devonian Traverse group [probably Genshaw formation]; Long Lake, Alpena County, Michigan.

Diagnosis.—Coenosteum flat to massive, composed of regular, transversely fibrous laminae, and separate short pillars, spreading upward, rarely superposed. Mamelons, astrorhizae, and dissepiments present or absent.

Silurian, uncommon; Devonian, abundant.

Anostylostroma arvense (Parks)
(Pl. VIII, Figs. 1*a–b*, 2)

Clathrodictyon ostiolatum Grabau (part), in Sherzer and Grabau, 1909, p. 547; Grabau (part), 1910, pp. 87–89, Pl. 8, Fig. 6. Middle Devonian Amherstburg or Lucas dolomite, Loc. A.
Clathrodictyon arvense, Parks, 1936, pp 23–24, Pl. 3, Figs. 1–2. (Middle Devonian, Onondaga limestone; Townsend township, near Simcoe, Ontario, Canada.)
Anostylostroma arvense Galloway and St. Jean, 1957, pp. 110–11, Pl. 4, Figs. 1*a–b*. (Middle Devonian Columbus limestone; Marblehead, Ohio).

Description.—This is based on Grabau's specimen No. 13069, illustrated by Grabau in his Plate 8, Figure 6, and other specimens collected by this paleontologist.

Coenosteum: Grabau's figured specimen, No. 13069, is a fragment 60 mm. long, 40 mm. wide, and 40 mm. high. It is largely silicified; its surface is covered with a thin, brown layer of quartz crystals, which accentuate surface irregularities so that they resemble astrorhizae. The surface has conical mamelons, 2 to 4 mm. high, 4 to 7 mm. in diameter, and 5 to 10 mm. apart. Some of them have short canals with few branches; the latter simulate astrorhizal canals, which, however, seem to be due to some peculiarity of quartz deposition. In describing his material, of which specimen No. 13069 is a part, Grabau stated (1910, p. 88) that "No astrorhizae have been observed, . . ." He (1910, p. 88) was correct in stating that the surfaces of his specimens show no "oscula" such as ". . . described in the original Canadian, Silurian specimen [type of *Clathrodictyon ostiolatum* (Nicholson)]" Latilaminae are obscure, about 3 mm. thick.

Vertical section: The laminae are strong, about 0.1 mm. thick, 6 or 7 in 2 mm., mostly smoothly curved, in some places zigzagging down into a pillar and up into a pillar above. The laminae rise sharply into the mamelon columns, in which there may be oblique tubes, or a single axial tube. The laminae show the transverse fibers and fine pores usual for the genus. The pillars are straight or slightly flaring upward, about 8 in 2 mm., frequently superposed, leaving subrectangular galleries which are higher than wide. Dissepiments are common, and convex upward. Where the specimen had been injured during life, the repair tissue has formed a finer network of pillars than that present in normal tissue. Where the section is not cut precisely vertically the spool-shaped pillars have the false appearance of extending only part way upward or downward across the interlaminar space. Some pillars divide before joining the upper lamina, forming rings, but in no case does a lamina rise to form ring pillars.

Tangential section: The pillars are mostly round, about 0.15 mm. in diameter, some joined by curved dissepiments. The laminae show the cut fibers, and they make annuli around the mamelons, some of which have an axial tube, but astrorhizal canals are not recognized. There are a few rings made where pillars divide, but no ring pillars.

Remarks.—Grabau (1910, Pl. 8, Fig. 6; Pl. 13, Fig. 1; and Pl. 16, Fig. 18) figured three specimens under *Clathrodictyon ostiolatum,* which belong to three different species, none referable to Silurian forms. The first figured specimen (Pl. 8, Fig. 6) is here reidentified as a typical specimen of the Middle Devonian species, *Anostylostroma arvense* (Parks). There are four other, larger specimens which were identified by Grabau as *Clathrodictyon ostiolatum* but not figured by him. They are better preserved than specimen No. 13069 (Pl. 8, Fig. 6), although partly silicified, are from the same formation and place (Loc. A) as this specimen, and are

identified as *Anostylostroma arvense*. The authors do not have specimens of *Clathrodictyon ostiolatum* mentioned by Grabau (p. 89) as coming from the "reef at the Anderdon quarry where it is abundant," nor the specimens "from the Amberstburg bed of the Detroit River." According to Grabau (explanation of Pl. 13, Fig. 1), the missing specimen of his *C. ostiolatum* was obtained from the Amberstburg dolomite of the Gibraltar quarry (Loc. C). Since all of the Amherstburg dolomite and nearly all of the Lucas dolomite of the abandoned quarry are now covered with water, there is little hope of obtaining specimens and information regarding the species of stromatoporoids at this locality. The specimen figured by Grabau in Plate 16, Figure 18, is a young specimen of *Stictostroma* attached to a corallite of a phaceloid corallum (not *Diplophyllum* of Grabau).

Anostylostroma arvense is very similar to *A. ponderosum* (Nicholson), but it has higher, sharper, smaller mamelons, and thinner laminae than the latter. The largest specimen (No. 36086), a massive, conical one, over 14 cm. high and 10 cm. in diameter, is intergrown with many corallites of a *Syringopora;* in places of the coenosteum, the pillars are regularly superposed, much as in *Gerronostroma*. The coenosteum is attached to a few corallites of the rugose coral *Disphyllum;* in the rock matrix surrounding the specimen are abundant examples of *Amphipora ramosa*. It is interesting to note that *Anostylostroma ponderosum* and *A. arvense* not only have many similar structural characters but coenostea of each are attached to rugose corals and intergrown with specimens of *Syringopora*. See Galloway and St. Jean (1957, pp. 111–13, Pl. 4, Fig. 2). Parks (1936, pp. 23–24, 42–44) did not note the similarity of *A. arvense* to *A. ponderosum,* and minimized the taxonomic value of mamelons.

Types and Occurrence.—Hypotype No. 13069 (slides W4–2, 3) is Grabau's specimen illustrated in Pl. 8, Fig. 6; hypotypes (large, partly silicified specimens of Grabau) No. 36079 (slides W4–4, 5), No. 36080 (slides W4–6, 7), and No. 36086 (slides W4–8, 9). All hypotypes are from Amherstburg dolomite or Lucas dolomite of Locality A.

Genus *Stictostroma* Parks 1936

Stictostroma Parks, 1936, pp. 77–78; Galloway and St. Jean, 1957, pp. 124–25; Galloway, 1957, pp. 435–36.

Type species.—*Stictostroma mamilliferum* Galloway and St. Jean, 1957, pp. 125–27, Pl. 6, Figs. 4*a–b,* new name for *Stromatopora mammillata* Nicholson (not Schmidt, 1858), 1873, pp. 94–95, Pl. 4, Fig. 4. Middle Devonian Onondaga limestone; Port Colborne, Ontario, Canada.

Diagnosis.—Coenosteum laminar to massive; laminae regular but

undulating, transversely porous and fibrous; pillars short, in part made by upturns of the laminae but not making regular ring pillars; mamelons, astrorhizae, and dissepiments absent or present. *Stictostroma* is intermediate between *Anonstylostroma* and *Stromatoporella.*

Devonian; North America, Russia.

Stictostroma anomalum Galloway and Ehlers, sp. nov.
(Pl. VIII, Figs. 3*a–d,* 4; Pl. IX, Fig. 1*a–b*)

Description.—The description is based on an examination of three specimens in the Grabau collection.

Coenosteum: Three above mentioned coenostea are 10 cm. in diameter, relatively thin, about 3 mm. thick, and have undulatory surfaces; they are attached to a brownish, silty, calcareous dolomite by their lower sides; each shows only one latilamina. It is probable that each specimen is only the basal latilamina of a coenosteum from which the main body of the coenosteum had been broken in collecting. The surface of each specimen has low conical mamelons, 3 to 5 mm. in diameter and 6 to 15 mm. apart from center to center. Nearly every mamelon has a large astrorhiza, about 10 mm. in diameter; in some mamelons there is an axial tube. The astrorhizae have conspicuous, branching canals, some with straight tabulae; the small terminal canals may join the terminal canals of adjacent astrorhize. Between the mamelons and between the astrorhizal canals there are large papillae, 0.2 mm. in diameter, which are pillars not covered by laminae. The pillars are fundamentally round, but many join to form short, oval or irregular groups, and the pillars are joined in many places by thin, short dissepiments. The surface features are more conspicuous than in most stromatoporoids because the skeleton is little infiltrated with calcium carbonate, and the surface has much the appearance of a recent hydroid.

Vertical section. The section consists of two parts, a lower layer, 1 to 2 mm. thick, the peritheca, rarely seen in stromatoporoids, and an upper layer, 1 to 2 mm. thick, the usual coenosteal structure, and in more complete specimens, like No. 36085, followed by a coenosteum 20 mm. thick. The peritheca has a lower, irregular lamina, about 0.15 mm. thick, lying on the lithologic equivalent of the original calcareous mud. The lamina consists of transverse, calcite fibers; there is no dark line excepting oblique lines from which pillars arise. Most of the peritheca consists of thick, oblique and joining pillars, 0.18 to 0.2 mm. thick. The pillars consist of transverse fibers, with a dark, median, granular layer 0.05 mm. thick. The appearance of the pillars, with the dark, median line, is much like that of *Amphipora,* which occurs in the same rock matrix con-

taining the specimens of *S. anomalum*. The pillars are joined in many places by straight or curved dissepiments. The galleries are round, oval, elongate, and oblique; astrorhizal canals are obscure in the peritheca.

Lying above the peritheca and continuous with it is a layer of 3 to 6 laminae and vertical pillars. The laminae are thick, 0.2 to 0.25 mm., and consist of only one transversely fibrous layer, with no dark median line, 6 to 8 in 2 mm. The laminae are in general straight, but bend gradually up into the mamelons; they bend downward to the lower pillars, and upward to the upper pillars, but there is no double upward bend as in *Stromatoporella*. The pillars are thick, 0.15 to 0.2 mm., 6 in 2 mm., flaring upward, short, not superposed, and composed of vertically fibrous tissue continuous with the lamina below and above, with no dark, median line, but with a transverse, granular, dark zone where the tissue from the lower and upper laminae meet. Dissepiments are uncommon in the laminar layer. Astrorhizal canals, so conspicuous at the surface, are scarcely recognizable in four vertical sections.

Tangential section: The peritheca appears as subparallel or radial lines of pillars, each pillar transversely fibrous, with a dark median granular line. The pillars anastomose, leaving elongate galleries, which are crossed by straight or curved dissepiments.

The upper layer of laminae shows broad fibrous tissue, and large round, radially fibrous pillars, 0.27 to 0.37 mm. in diameter; some pillars join each other and the laminae, and some are joined by straight dissepiments. Astrorhizal canals are obscure, probably because the tangential sections are cut too deep. The pillars have no dark center, excepting those at the junction of the peritheca.

Description of well-preserved paratype.—The following description is based on a nearly complete coenosteum which was found and identified but not figured by Grabau. The specimen was erroneously identified by him as *Clathrodictyon ostiolatum* (Nicholson).

Coenosteum: The specimen, a paratype bearing No. 36085, consists of six irregular layers, 5 to 20 mm. thick, joining in places, and separated by silty, bituminous rock. The surface is poorly exposed. The brown, vertical face shows sharp mamelons up to 5 mm. high. Latilaminae are obscure, 2 to 3 mm. thick. The specimen is only partly infiltrated with calcium carbonate, and is well preserved. The shaly beds between the layers of the stromatoporoid are brown, bituminous, have small stylolites, and contain many specimens of *Cladopora bifurcata* Grabau, the bryozoan *Prismopora* and fragments of other fossils.

Vertical section: The laminae are strong, 0.09 to 0.12 mm. thick, about 8 in 2 mm., in general straight to undulating, rising into prominent

mamelons, and rising into pillars suggestive of ring pillars. The laminae are transversely porous, not maculate. The pillars, about 6 in 2 mm., are confined to one interlaminar space and rarely superposed. They are not as thick as the laminae excepting when they are made of upturned laminae. Galleries are round or elongate horizontally. Dissepiments are common, thin and strongly curved. Mamelon columns extend through several latilaminae; some have an axial tube, and all have round or oval astrorhizal canals. Pillars are thicker and dissepiments are more numerous in the mamelon columns than between columns. The peritheca is about ½ mm. thick, consisting, as in the holotype, of oblique pillars with transverse fibers and a dark median line.

Tangential section: The laminae are thick and vertically fibrous. Pillars are large, 0.1 to 0.2 mm. in diameter, and round; many are coalescent and join the laminae and others are joined by dissepiments. Mamelons have 3 or 4 annuli of laminae, some have an axial tube, and some have a few radial astrorhizal canals. There are a few ring pillars, which are neither as characteristic nor as abundant as in *Stromatoporella.*

Remarks.—Grabau identified three specimens as "*Stromatopora* (*Coenostroma*) *pustulosum.*" One of these (No. 14075, Grabau's Pl. 9, Fig. 3) is *Syringostroma aurora* Parks; another (No. 14057, Grabau's Pl. 9, Fig. 4) is *S. aurorella* Fritz and Waines, and a third (36077B, not figured by Grabau) is *Stictostroma anomalum,* sp. nov. A second and a third specimen of *S. anomalum,* sp. nov., identified but not figured by Grabau as "*Stromatopora galtense* (Dawson)," are two fragments in the same piece of rock and are preserved under No. 36078. The three mentioned specimens of *S. anomalum,* sp. nov., served as the basis for the above description of this species.

Stictostroma anomalum is unusual in occurring as broad, thin sheets, and is anomalous in having a thick peritheca composed of oblique pillars without laminae, in which the pillars consist of transverse fibers with a dark median line, resembling *Amphipora* in this respect. It occurs with *Amphipora* in the same rock matrix, but cannot be the basal attachment of *Amphipora* because there is no graduation in form between the present species and the small *Amphipora.*

The repair tissue of *Anostyolostroma arvense* somewhat resembles the peritheca of *Stictostroma anomalum,* but it is finer in structure and the pillars have no dark, median line.

One of Grabau's specimens (No. 36084), labeled "*Clathrodictyon ostiolatum* (Nicholson)," was obtained from the same stratigraphic horizon as *S. anomalum.* It resembles this species, including the structure of

the repair tissue, but has stronger mamelons and fewer astrorhizae. The specimen is identified as *Stictostroma* sp. aff. *S. anomalum.*

The paratype described separately is a typical example of *Stictostroma,* having the porous tissue and upturns of the laminae with incipient ring pillars. Measurements of most structures of this paratype are like those of *Stictostroma jeffersonvillense* Galloway and St. Jean; the pillars of the paratype, however, are larger and farther apart than those of *S. jeffersonvillense.* The mesh of the paratype is somewhat finer than that of the holotype of *S. anomalum,* which is composed of only the basal layers of the coenosteum.

Types and Occurrence.—The specimens which served as the basis for the first description are the holotype No. 36077B (slides W4–10, 11) and two paratypes No. 36078 (slides W4–12, 13) that are in the same piece of rock. The specimen identified as *Stictostroma* sp. aff. *S. anomalum* is preserved under No. 36084. The four specimens occur in rock containing *Syringostroma sherzeri* (Grabau), *Cladopora bifurcata* Grabau, ?*Disphyllum* sp., and fragments of other fossils. Middle Devonian Amherstburg or Lucas dolomite ("Anderdon limestone" of Grabau) of Locality A, Detroit salt shaft.

The paratype No. 36085 (slides W4–14, 15), used for the second description, was obtained from the same strata and locality (Loc. A) as the previously mentioned types of this species.

Stictostroma anderdonense Galloway and Ehlers, sp. nov.

(Pl. IX, Fig. 2*a–c*)

Clathrodictyon variolare Grabau (not Rosen), 1909, in Sherzer and Grabau, 1909, p. 547; Grabau, 1910, pp. 89–90, Pl. 9, Figs. 1–2.

Description.—The description is based on the specimen erroneously identified as *Clathrodictyon variolare* by Grabau and illustrated by him in the reference given above.

Coenosteum: Grabau's specimen is a fragment, 8 x 9 x 3.5 cm., in three pieces. Originally, it was a large, flattish expansion with undulating surface. The upper surface is not well exposed, but the present lower surface, now split between latilaminae, shows the surface characters well. The surface has low mamelons, 4 to 5 mm. in diameter, 2 mm. high, and 8 to 10 mm. apart. Some of them have delicate but typical astrorhizae, as figured by Grabau (Pl. 9, Fig. 2). Latilaminae are about 3 mm. thick, demarked by closer laminae formed in the season of slowest growth, the cold season.

Vertical section: The laminae are mostly straight, where they are closest together, and thin, 0.06 to 0.1 mm.; in many places they pass into

curved plates or cysts, especially where farthest apart and formed during the season of most rapid growth, the warm season. Transverse pores and fibers are obvious in some places, but at most places obscured by recrystallization. The laminae rise smoothly into the mamelons, as indicated in Grabau's figure (Pl. 9, Fig. 1), but then become almost indistinguishable adjacent to the pillars. There are 12 or more laminae in 2 mm., on the average; they are closer together at the base of each latilamina. The pillars are short, partly straight and vertical to the laminae or partly oblique and curved, passing into cyst plates. Pillars in the mamelons tend to be thicker and some are superposed, and pass obliquely through a latilamina. The mamelons do not form mamelon columns; most of them are restricted to only one latilamina. Some of the mamelons have a high conical structure formed of converging pillars and small astrorhizal canals, but this is not conspicuous in the sections. Dissepiments or cyst plates are abundant wherever the laminae are farthest apart. Many of the dissepiments are short and oblique and grade into pillars.

Tangential section: The pillars are round, 0.2 mm. in diameter, mostly joining others, especially in the laminae and mamelons. There are no ring pillars. The galleries are round to anastomosing. The mamelons appear as annuli of laminae and pillars. Astrorhizal canals are thin and scattered, not obvious in the mamelons. There is no axial tube in the mamelons. Owing to imperfect preservation, the tangential section does not show structures as well as the vertical section.

Remarks.—The specimen has been partly infiltrated with calcium carbonate and considerably recrystallized, so that the finer tissue structure is difficult to determine.

This specimen is not a *Clathrodictyon* as believed by Grabau, because it is made up of laminae, structures which are lacking in that genus. Where the laminae in *Stictostroma anderdonense* are farthest apart, in the summer-growth part of the latilamina, dissepiments are more important than laminae, as they are in *Clathrodictyon confertum* Nicholson, to which it bears some resemblance. Where closest, in the winter-growth part of the latilaminae, the laminae are straight and connected by short pillars. *Stictostroma anderdonense* is very similar to *S. mamilliferum* Galloway and St. Jean in having mamelons, close laminae, and inclined pillars; in this species, however, the pillars are larger, there are astrorhizae, and pores in the tissue are less evident than in that species. *S. anderdonense* bears no close resemblance to the Silurian *Clathrodictyon variolare* (Rosen). *C. variolare* is composed of thin-walled, round vesicles, rather than laminae and elongate vesicles.

Type and Occurrence.—Holotype No. 14309 (slides W4–16, 17) is

specimen figured by Grabau (1910, Pl. 9, Figs. 1–2). It was obtained from the typical Anderdon limestone at Locality B.

Family Stromatoporidae Winchell 1867
Genus *Stromatopora* Goldfuss 1826

A description of the genus *Stromatopora* is given in Part I.

Stromatopora gallowayi Fritz and Waines
(Pl. IX, Fig. 3*a–b*)

Stromatopora galtense Grabau (not Dawson) in Sherzer and Grabau, 1909, p. 547; Grabau, 1910, pp. 90–91, Pl. 8, Fig. 1.
Stromatopora gallowayi Fritz and Waines, 1956, pp. 98–100, Pl. 2, Figs. 3–4.

Description.—The following description is based on the specimen erroneously identified as *Stromatopora galtense* by Grabau and illustrated by him in the reference given above.

Coenosteum: The figured specimen is a fragment, 10 cm. long, 5 cm. wide, and 6 cm. high, with latilaminae 1 to 3 mm. thick; with little doubt it was broken from a massive, subhemispherical coenosteum. It has been partly infiltrated with calcium carbonate, but most of the astrorhizal canals are open. The surface, exposed by splitting off of some latilaminae, shows large, low mamelons, 6 to 10 mm. in diameter, 2 mm. high, and 8 to 10 mm. apart from center to center, each occupied by a typical astrorhiza of the same size and having much the same appearance as those of *Stromatopora monticulifera* Winchell from the Traverse group of Michigan. The astrorhizae of *S. gallowayi* have fewer and larger canals than those of *S. monticulifera* and no mamelon columns exist in the former species. The irregularly broken surface of the specimen caused Grabau (1910, p. 90) to observe that "no regular mamelons appear." Small, inconspicuous, round papillae present on mamelons and intermamelon areas.

Vertical section: The laminae are thick, about 0.2 mm., each fused to the ones below and above, about 5 in 2 mm., and composed of several indistinct microlaminae. Laminae rise smoothly into the irregular and discontinuous mamelon columns. There are no definite pillars; the tissue largely fills the interlaminar spaces, leaving small, scattered, round or elongate galleries. The laminae and filling tissue are nearly perfectly amalgamated, and uniformly maculate; the maculae are about 0.015 mm. in diameter, but imperfectly displayed because of many dark specks of variable size, infiltration of calcium carbonate, and some recrystallization. Astrorhizal canals are round, and oblique or horizontal, 0.24 to 0.27 mm. in diameter; there are no vertical astrorhizal tubes. Numerous small, undulating, and

branching pseudozooidal tubes, 0.06 mm. in diameter, extend through several laminae, but, being so small and the section not exactly vertical, the tubes ordinarily seem to extend through one or two laminae. There are only rare tabulae in the pseudozooidal tubes. There are no dissepiments, and the astrorhizal tubes have no tabulae.

Tangential section: The field is mostly finely maculate, amalgamated tissue, with branching astrorhizal canals, and small, round, vermicular pseudozooidal tubes. The galleries are not usually distinguishable from the pseudozooidal tubes. Infrequently the galleries anastomose, surrounding amoeboid and irregular pillars, although definite pillars are not seen in vertical sections.

Remarks.—This species is a typical representative of *Stromatopora,* similar to *S. concentrica* Goldfuss, the type species, but has mamelons, larger astrorhizae, and definite laminae. There appears to be no constant difference between the Detroit River specimens and the ones from northern Ontario. *S. gallowayi* is characterized by the large mamelons, simple astrorhizae, lack of mamelon columns and pillars, the large amount of maculate tissue, and small galleries and pseudozooidal tubes. It bears no close resemblance to *S. foveolata* (Girty), which has astrorhizae only 3 mm. in diameter, and larger galleries and pseudozooidal tubes, and differs from *S. monticulifera* Winchell in having lower and smaller mamelons and in lacking mamelon columns. It resembles *S. laminosa* Lecompte, *S. compacta* Yavorsky, and indeed, most other species of typical *Stromatopora,* in which there are no definite pillars. The identity of *Coenostroma galtense* Dawson, with which Grabau identified the present specimen, has not been determined, and the type specimen is lost (Parks, 1907, p. 25). Grabau's specimen has smaller and more irregular pseudozooidal tubes than *S. galtense* as interpreted by Parks (1907, p. 26, Pl. 4, Figs. 3–4), and the astrorhizae do not have "a continuous wall-less axial canal." *S. gallowayi* is more closely allied to the Devonian species of *Stromatopora,* in which the interlaminar spaces are largely filled with tissue, than to the Silurian ones, which have more gallery space. *Amphipora ramosa* and *Cladopora bifurcata* are common in the same rock which holds the present species.

Type and Occurrence.—Hypotype No. 14062 (slides W4–18, 19) is Grabau's specimen (Pl. 8, Fig. 1). Amherstburg or Lucas dolomite, Detroit salt shaft (Locality A).

Another specimen, No. 36078, is labeled "*Stromatopora galtense* Dawson, Anderdon, Salt Shaft," in Grabau's handwriting; it is very different from his figured specimen and is *Anostylostroma anomalum* Galloway and Ehlers, sp. nov.

Genus *Syringostroma* Nicholson 1875

Syringostroma Nicholson, 1875, p. 251; 1886, pp. 97–98; Lecompte (part), 1951, pp. 195–99; Fritz and Waines, 1956, pp. 102–103; Galloway and St. Jean, 1957, pp. 186–87; Galloway, 1957, pp. 448–49 (includes other references).

Stylodictyon Nicholson and Murie, 1878, p. 221 (not Parks, 1908, which is *Anostylostroma*).

Type species.—*Syringostroma densum* Nicholson, 1875, pp. 251–52, Pl. 24, Figs. 2, 2*a–b* by designation of Nicholson, 1886, pp. 97–98. Middle Devonian; Kelley's Island (Lake Erie), Ohio.

Diagnosis.—Coenosteum massive, composed of laminae and continuous large round pillars, and in some species having mamelon columns; interlaminar spaces largely filled with tissue; tissue of laminae, interlaminar filling, and pillars finely maculate; with or without mamelons, mamelon columns, astrorhizae, and dissepiments. Like *Stromatopora* except that the pillars are long; like *Parallelopora* except for the finer maculae.

Silurian and Devonian; abundant and widespread.

Syringostroma aurora Parks

(Pl. X, Fig. 1*a–b*)

Syringostroma aurora Parks, 1904, pp. 182–83, Pl. 2, Fig. 4; Pl. 3, Figs. 1–2.

Stromatopora (*Coenostroma*) *pustulosum* Grabau (part), 1910, pp. 91–92, Pl. 9, Fig. 3 (not Fig. 4). Homonym of *Stromatopora pustulosa* Safford, 1869, p. 285.

Description.—The following description is based on a hypotype, No. 14075, identified as *Stromatopora* (*Coenostroma*) *pustulosum* by Grabau and illustrated by him in the reference given above.

Coenosteum: A fragment, 5 cm. long and 2 cm. thick, is all that remains of the "large, hemispherical heads, up to a foot or more in diameter," mentioned by Grabau. Latilaminae are 2 to 3 mm. thick. The surface is evenly and strongly papillate; the papillae are smoothly rounded, 0.3 to 0.4 mm. in diameter, the same distance apart at their bases, 0.15 mm. high, and about 1 mm. apart from center to center; they are the ends of pillars. The surface is undulating but there are no mamelons, and no typical astrorhizae on the small surface remaining, although there are obscure grooves which may be astrorhizal canals. The astrorhizae mentioned by Grabau are from another specimen, his Figure 4, a different species, *S. aurorella* Fritz and Waines.

Vertical section: The laminae, about 10 in 2 mm., are moderately thick, 0.1 to 0.12 mm., separated by galleries about half as thick. They rise slightly into the pillars, are composed in places of several microlaminae, and are finely but indistinctly maculate. The galleries are mostly elongate horizontally, some round and superposed, making pseudozooidal

tubes. The pillars are long, about 0.3 mm. in diameter, 6 in 2 mm., and composed of fine maculae which tend to form lines that converge toward the centers of the pillars. The maculae are not as large nor arranged in vertical lines as in *Parallelopora*. There are a few larger galleries, which may be scattered astrorhizal canals; no mamelon columns; and dissepiments are rare or absent.

Tangential section: The pillars are round to amoeboid in shape, 0.3 to 0.4 mm. in diameter, close together, many coalescing, separated by thin anastomosing galleries, ¼ to ½ the width of the pillars. Some of the galleries are small and roundish, probably superposed galleries or pseudozooidal tubes. Astrorhizae are not recognizable; dissepiments absent. Maculae are small, well preserved in places, but mostly obscure.

Remarks.—The hypotype No. 14075, only partly infiltrated with calcium carbonate, has open galleries; the tissue is partly recrystallized, obscuring its structure. No astrorhizae are recognizable on the original surface of the fragment, nor in a good tangential section, nor are astrorhizal canals obvious in a large vertical section. Although Parks said (1904, p. 182) his specimen "has well marked astrorhizal systems about 15 mm. apart," his figures do not show the astrorhizal canals. The hypotype is a typical example of *Syringostroma,* with finely maculate tissue, small galleries and long pillars, and belongs to the typical group of the genus, without mamelon columns, that is represented by the type species (*S. densum*) and *S. aurorella* Fritz and Waines and their closely allied species, and by the similar *S. sanduskyense* Galloway and St. Jean. It does not have the mamelon columns of the group of *Syringostroma* represented by *S. sherzeri* (Grabau), *S. tuberosum* Galloway and St. Jean, and *S. recticolumnae* Fritz and Waines. It differs from *S. aurorella* Fritz and Waines and closely allied species in lacking typical astrorhizae and mamelons, and in having larger pillars and papillae. *S. aurora* Parks bears no close resemblance to *Parallelopora nodulatum* (Nicholson), as Parks thought.

Types and Occurrence.—Hypotype No. 14075 (slides W4–20, 21) is Grabau's specimen (Pl. 9, Fig. 3). Anderdon limestone of "Anderdon quarry," Locality B. The type on which Parks based the species was obtained from Middle Devonian strata on the Kwataboahegan River of the James Bay region of Ontario.

Syringostroma aurorella Fritz and Waines
(Pl. X, Fig. 2*a–b*)

Stromatopora (Coenostroma) pustulosum Grabau (part), 1910, pp. 91–92, Pl. 9, Fig. 4 (not Fig. 3). Homonym of *Stromatopora pustulosa* Safford, 1869, p. 285.
Syringostroma aurorella Fritz and Waines, 1956, pp. 103–104, Pl. 3, Figs. 1 and 4.

Description.—The following description is based on hypotype No. 14057, identified as *Stromatopora* (*Coenostroma*) *pustulosum* by Grabau and illustrated by him in the reference given above.

Coenosteum: The specimen is an irregular fragment, 7 cm. long, 6 cm. wide, and 5.5 cm. thick, the lower side figured by Grabau, Pl. 9, Fig. 4. The upper surface, about 4 sq. cm. of which is preserved, is nearly smooth, with round papillae 0.3 to 0.4 mm. in diameter and 1 mm. apart from center to center. On the lower side, low mamelons of irregular size are indicated, 5 to 10 mm. in diameter and 10 mm. apart from center to center, each having a typical astrorhiza with delicate branching radial canals. Latilaminae are 2 to 3 mm. thick.

Vertical section: The laminae are thick, 0.2 to 0.27 mm., about 6 to 8 in 2 mm., finely maculate with suggestion of transverse fibers. The laminae are composed of many microlaminae, and rise slightly into the pillars. The pillars are strong, continuous, 0.23 to 0.3 mm. in diameter, 5 to 7 in 2 mm., the width and number observed depending somewhat on where the section cuts the pillars. The pillars are composed of finely maculate and fibrous tissue, which converge upward from the centers of the pillars (it is difficult to tell up from down in the sections). The galleries are round to elongate horizontally and low vertically, 0.02 to 0.1 mm. high. The astrorhizae tend to be superposed but do not produce columns of arched laminae and thicker pillars. The larger astrorhizal canals are round and up to 0.4 mm. in diameter, and the smaller branches are also round but about 0.15 mm. in diameter. The galleries are superposed but rarely make pseudozooidal tubes. There are no dissepiments.

Tangential section: The pillars are large, round to amoeboid, 0.3 to 0.4 mm. in diameter, many contiguous and others separated by narrow, anastomosing galleries; the smallest galleries, 0.06 to 0.1 mm. in diameter, are round and scattered between the pillars. Astrorhizae appear as thin, irregular canals, not well cut in our sections; there is rarely a vertical astrorhizal tube. Maculae are small, evenly distributed but obscure because of the imperfect preservation.

Remarks.—The skeleton is only partly infiltrated with calcium carbonate, leaving open galleries and astrorhizal canals, but the tissue has been partly recrystallized, obscuring its fine structure. The thick laminae and open galleries and astrorhizal canals may be seen in plices with a 10× lens.

As stated by Fritz and Waines (1956, p. 104), *S. aurorella* appears very similar to *S. aurora,* especially when a comparison of structures in thin sections is made. It differs from *S. aurora* mainly in having typical astrorhizae. There are no astrorhizal columns in *S. aurorella;* the "columns" of Fritz and Waines are the long pillars. *S. aurora* and *S. aurorella*

have smaller pillars than *S. crebricolumnae, S. propinquicolumnae,* and *S. distincticolumnae,* of Fritz and Waines. *S. sanduskyense* Galloway and St. Jean has no mamelons, but has larger astrorhizae which are farther apart.

Type and Occurrence.—Hypotype No. 14057 (slides W4–22, 23) is Grabau's specimen (Pl. 9, Fig. 4). Anderdon limestone of "Anderdon quarry," Locality B. The holotype, on which Fritz and Waines based the species, came from the Middle Devonian Upper Abitibi River formation, Coral Rapids, James Bay Lowlands, northern Ontario.

Syringostroma sherzeri (Grabau)
(Pl. X, Figs. 3, 4*a–b*)

Stylodictyon sherzeri Grabau, in Sherzer and Grabau, 1909, p. 547; Grabau, 1910, pp. 92–94, Pl. 8, Figs. 4–5.

Description.—The following description is based on Grabau's syntypes and unfigured specimens identified by Grabau with his species.

Coenosteum: Grabau said "in the form of a Vienna loaf;" more likely the specimen he referred to was originally an upright, rounded cone, oval in cross section, with latilaminae 2 to 5 mm. thick. Syntype, No. 13094, the largest specimen but not figured by Grabau, is a broken coenosteum, 16 cm. in length, 7 cm. in greater width and 5 cm. in thickness. The axis is oval, 20 by 35 mm., has no axial tube or rod, but is made by the laminae arching evenly over the axis. The original surface has conspicuous, small, convex mamelons, 1½ mm. in diameter, ½ mm. high, and 2 to 3 mm. from center to center, the ends of columns. The mamelons are not crater-like, as figured by Grabau (1910, Pl. 8, Fig. 5, syntype No. 13093); the "craters" in this syntype were produced by splitting of the specimen between latilaminae with a breaking downward into the nearly solid mamelon columns, instead of upward with the laminae. There are small, irregular papillae, which are the ends of short pillars. Astrorhizae are very rare; most of the specimens have none, although there is an occasional groove which may represent an astrorhizal canal. Syntype No. 13095, not figured by Grabau, has at least four typical astrorhizae, 5 mm. in diameter and 15 mm. apart, with no axial tubes.

Vertical section: The laminae are 0.12 to 0.25 mm. thick, about 8 in 2 mm., and the galleries higher or lower and oval in shape. The laminae rise sharply into long, straight mamelon columns, the axes of which are 0.35 to 0.4 mm. in diameter, and are more dense than the laminae and pillars. The columns are bordered by vertical files of galleries, which are crossed by thin laminae. Between the columns there are short, irregular pillars, about 8 in 2 mm., some of which are superposed. Laminae, pillars,

and columns are completely amalgamated, and consist of finely maculate tissue. The microlaminae of which the laminae were originally composed have been largely destroyed in the course of recrystallization. The maculae are not superposed although there is a suggestion of superposition of maculae in the cores of the mamelon columns. Although only slightly infiltrated with calcium carbonate, the skeleton has been very largely recrystallized and slightly dolomitized, so that the maculae have been destroyed except in an occasional spot. Pseudozooidal tubes are obscure, other than where the superposed galleries border the columns. There are no dissepiments and astrorhizal canals are scarce.

Tangential section: Mamelon columns are conspicuous, about 1½ mm. in diameter with a fairly solid, maculate center, and are surrounded by one or two annulae of galleries and radiating spokelike pillars. The borders of the columns are usually about 0.5 mm. apart, and the intervening space is occupied by broad laminae and small galleries. The laminae appear as wide, maculate patches; microlaminae are not apparent. The pillars, between columns, are irregular in shape, not round, and join to form a lacey network of pillars and galleries. Laminae, pillars, and columns are all amalgamated and consist of maculate tissue which has been largely recrystallized. There are no dissepiments or astrorhizae, but there are short canals which probably are astrorhizal canals.

Remarks.—Syringostroma sherzeri closely resembles *S. recticolumnae* Fritz and Waines (1956, pp. 109–11, Pl. 3, Figs. 2–3, 5–6) from the Abitibi River limestone (which may be somewhat younger than the Detroit River group) but has larger columns. *S. sherzeri* is close to *S. tuberosum* Galloway and St. Jean, and has much the same shape; however, its mamelons are larger, the laminae are thicker, fewer in 2 mm., and the laminae do not rise so far into the columns. The galleries of *S. tuberosum,* both in tangential and vertical sections, are largely round, a feature not seen in *S. sherzeri. S. sherzeri* is a typical species of *Syringostroma,* with the maculate tissue and long mamelon columns and pillars.

The genus *Stylodictyon* Nicholson and Murie (1878, p. 221) was founded upon the possession of mamelon columns, a feature which occurs in many genera. The character of the tissue and its skeletal structures, as well as the columns, are not definitely known. If the tissue is amalgamated and maculate as Nicholson seems to show (1886, Pl. 7, Figs. 10–11), then *Stylodictyon,* 1878, is a synonym of *Syringostroma,* 1875, as the present authors believe. Grabau (1910, p. 93) stated that *Stylodictyon columnare* has larger columns than those of *Stylodictyon sherzeri* and has large astrorhizae. The systematic value of mamelon columns was discussed by

Galloway (1957, pp. 381–82); their presence and size are specific, not generic, characters.

Types and Occurrence.—Of Grabau's syntypes, No. 13093 (slides W5–1, 2), figured by Grabau, Pl. 8, Figs. 4–5, is selected as a lectotype, which may be a fragment from the largest specimen, No. 13094. Fragment numbered 13095 and two fragments under Nos. 36083*a* and *b* (slides W5–4, 5), which have the same appearance as the lectotype, may also be parts of the largest specimen. Grabau's syntypes, No. 13094 (slides W5–6, 7, 8), No. 13095 (slide W5–3), and Nos. 36083*a* and *b* are designated as paralectotypes. A small piece and slides from paralectotype No. 13094 are in the Paleontological Collection of Indiana University under No. 307—51, 52.

Grabau (1910, p. 93) was in error in stating that his specimens were obtained from the Anderdon limestone of the Detroit salt shaft. His "Anderdon limestone" of the shaft is not the type Anderdon limestone, exposed at Locality B, the "Anderdon quarry," 1¼ miles northeast of Amherstburg, Ontario. The rock adhering to the types of *Syringostroma sherzeri*—a brown, carbonaceous dolomitic limestone—has the lithology of strata in the Amherstburg dolomite and lower part of the Lucas dolomite. In addition to *S. sherzeri,* it contains the stromatoporoids *Amphipora ramosa* (Phillips) and *Stictostroma anomalum* Galloway and Ehlers, sp. nov., and the coral *Cladopora bifurcata* Grabau. None of the three stromatoporoids occur in the typical Anderdon limestone, which overlies the Lucas dolomite; the types of these stromatoporoids were obtained from strata occupying a position in the lower part of the Lucas or upper part of the Amherstburg dolomite.

Family Idiostromatidae Nicholson 1886
Genus *Amphipora* Schulz 1883

Amphipora Schulz, 1883, pp. 245–46; Yavorsky, 1955, pp. 149–50; 1957, pp. 61–62; Galloway and St. Jean, 1957, pp. 232–33; Galloway, 1957, pp. 442–43 (contains additional references).

Type species.—*Caunopora ramosa* Phillips, 1841, p. 19, Pl. 8, Figs. 22*a–c* by designation of Schulz, 1883, pp. 245–46. Middle Devonian, South Devon, England.

Diagnosis.—Coenosteum of slender, ramose branches, with axial tube and large vesicles near the surface. Laminae and pillars scarcely distinguishable; tissue transversely fibrous with dark median line.

Remarks.—The genus is represented by many species: Upper Silurian, three species, Russia; Middle Devonian, widespread; Upper Devonian, Russia, Belgium, Montana, twenty-two described species. They have been

distinguished on the basis of the thickness of the branch, the size of the axial tube, and the amount of tissue. Many species are difficult to separate with certainty. *Amphipora* differs from *Paramphipora* Yavorsky (1955, pp. 154–55) in having the dark median line in the tissue, a structure not observable in illustrations.

Amphipora ramosa (Phillips)

(Pl. XI, Fig. 1*a–b*)

Caunopora ramosa, Phillips, 1841, p. 19, Pl. 8, Figs. 22*a–c*.

Amphipora ramosa Schulz, 1883, pp. 246–47, Pl. 22, Figs. 5–7; Pl. 23, Fig. 1; Nicholson, 1886, pp. 109–10, Pl. 9, Figs. 1–4; 1892, pp. 223–25, Pl. 29, Figs. 3–7; Ripper, 1937*a*, pp. 38–39, Text-Figs. 1–3, Pl. 1; Lecompte, 1952, pp. 325–28, Pl. 67, Fig. 3; Pl. 68, Figs. 1–7; Yavorsky, 1955, p. 152, Pl. 82, Figs. 1–6; 1957, p. 63, Pl. 41, Figs. 1–9; Gogolczyk, 1956, pp. 224–30, Text-Figs. 2–4, Pl. 2, Figs. 1–4; Galloway and St. Jean, 1957, pp. 233–36, Pl. 23, Figs. 26.

Idiostroma nattressi Grabau (part), in Sherzer and Grabau (1909, p. 547; 1910, p. 94, Pl. 8, Figs. 2–3).

Description.—The following description is based on hypotype No. 14040, identified as *Idiostroma nattressi* by Grabau and illustrated by him in the reference given above.

Coenosteum: Branches delicate, 1.5 to 2.5 mm. in diameter, mostly straight, some bent, either close together or their own diameter or more apart, rarely branching, the rami being 5 to 15 mm. in length. The branches lie in a tangled mass, parallel to the bedding of the enclosing carbonaceous, dolomitic-limestone, and have been compressed somewhat by the compaction of the rock material. In the rock are numerous microstylolites, most of which are parallel to the bedding; some cut through the branches of the *Amphipora*. The rock is made up largely of small, rectangular crystals of dolomite with abundant bituminous streaks parallel to the bedding.

Cross section: In one thin section of Grabau's figured specimen (Pl. 8, Fig. 2) are 14 cross sections of *Amphipora*. Two of the sections show large, axial tubes, 0.4 to 0.5 mm. in diameter; the others have no axial tubes or there are small, irregular tubes in the axial region. The tissue makes an open network in and surrounding the axial region and occupies more than half of the area. Pillars are clearly distinguishable, but laminae are vague. The tissue has the dark median line with transversely fibrous layers on each side, characteristic of the genus. As the result of partial recrystallization, the tissue is not perfectly preserved. Galleries are open and have not been infiltrated with calcite. The vesicles near the surface are of moderate size, and have been, in part, closed by compaction of the enclosing rock material.

Vertical section: The few good vertical sections show a general lack of axial tube, the open network of tissue and galleries characteristic of the species, peripheral vacuoles, joining pillars, vague laminae, dark median line in the tissue, open galleries, recrystallized tissue, and some crushing of the specimens.

Tangential section: Although most of the skeletal structures of the specimens are crushed, the tangential sections show the open network of pillars and galleries characteristic of the species.

Remarks.—*Amphipora ramosa* is the most abundant and widespread species of the genus. The Michigan specimens are typical in all respects except they are smaller than Phillips' type specimens; they are very much like *Amphipora rudis* Lecompte (1952, pp. 329–330) and *A. pinguis* Yavorsky (1957, pp. 63–64).

Type and Occurrence.—Hypotype No. 14040 (slides W3–1, 2, 3, 4), is specimen identified by Grabau as *Idiostroma nattressi* (Pl. 8, Figs. 2–3). Upper part of Amherstburg or lower part of Lucas dolomite, Detroit salt shaft (Locality A).

Amphipora nattressi (Grabau)

(Pl. XI, Figs. 2*a–b*, 3, 4*a–c*, 5–8)

Idiostroma nattressi Grabau (part) in Sherzer and Grabau, 1909, p. 547; 1910, p. 94, Pl. 9, Figs. 5–7 [not specimens, Pl. 8, Figs. 2–3, which are *Amphipora ramosa* (Phillips)].

Description.—The following description is based on Grabau's syntypes indicated above, topotypes which he collected, and topotypes found by G. M. Ehlers.

Coenosteum: Coenosteum ramose, 3 to 5 mm. in diameter, mostly about 4 mm., branching often and irregularly, sending off small branches about 2 mm. in diameter every 5 to 10 mm., in most instances at nearly right angles to the main stem, rather than branching dichotomously; surface with many small knobs, representing incipient branches rather than mamelons. Surface not well preserved, generally smooth, and where weathered, showing a network of pillars that tend to be arranged lengthwise of the branches (shown by Grabau's illustration, Pl. 9, Fig. 6). Weathered ends of branches may show a small axial tube, but there are no "vertical pillars" which "occupy a radial position," as stated by Grabau (1910, p. 94).

Cross section: Most of the 24 cross sections made from topotypes show small, single axial tubes, 0.3 to 0.55 mm. in diameter, surrounded by a dark ring of transversely fibrous tissue. Between the axial tube and the periphery the area is about 90% of fibrous tissue, the fibers in radial

whorls, with only about 10% occupied by galleries, which gives an unusually solid appearance to the section. The peripheral tissue is transversely fibrous. Some of the tissue has the dark median line usual for the genus, but much of it shows no dark median line. The galleries are round, oval or elongate, and filled with clear calcite, with no sharp boundary between tissue and calcite. Near the periphery there are vacuoles characteristic of the genus, but they are small and not conspicuous. Pillars are not well marked and not arranged in any radial pattern. Laminae are very obscure, but in places are indicated by zonal arrangement of galleries and tissue.

Vertical section: Little information was gained from the vertical section. Some sections show the small axial tube, but they are mostly tissue. The tissue is fibrous; laminae are vaguely indicated in some places and in others the transversely fibrous pillars have the median dark line. Several sections show the peripheral vacuoles characteristic of the genus.

Tangential section: In the middle of a branch, the deep tangential section shows the peripheral vacuoles as narrow galleries converging upward; near the edge of the branch the vacuoles are narrow and elongate vertically. The tissue is fibrous, with the fibers in whorls around the vacuoles and in radial whorls between the vacuoles.

Remarks.—Except for the shape of the coenosteum, *Amphipora nattressi* has no generic similarity to the genus *Idiostroma*. It lacks the perfect laminae, the definite long, radial pillars and small, round vacuoles found in the tissue of that genus. It differs from *A. ramosa* in the greater amount of tissue and smaller amount of gallery space. The frequent and irregular branching is unknown in any other species of *Amphipora,* but the "dense character of the tissue" (Grabau, 1910, p. 94) is greater than that for *A. ramosa,* and for most other described species of *Amphipora,* although rather dense tissue is illustrated for *Amphipora uralensis* Yavorsky (1957, Pl. 37, Figs. 1–2), and for "*Amphora ramosa* Phillips" by Yavorsky (1957, Pl. 41, Figs. 1–9). *A. nattressi* also resembles "*Stachyodes*" *odinekensis* Yavorsky (1957, Pl. 33, Figs. 1–9), which the present authors would place in *Amphipora. A. nattressi* also resembles *Paramphipora devonica* Yavorsky (1957, Pl. 39, Figs. 19–20), which genus Yavorsky separated (1955, p. 154) from *Amphipora* because of the lack of the dark line in the tissue (the dark line is not discernible in Yavorsky's figures of *Amphipora* either, but it must have been apparent under the microscope). The dark median line of the fibrous tissue of *A. nattressi* does not appear in most of the tissue in many sections, but it is so plain in some parts of the same sections as to place the species in *Amphipora.*

A. nattressi is readily distinguished from *A. ramosa* of the Amherst-

burg or Lucas dolomite, which Grabau included in the same species (Pl. 8, Figs. 2–3), by the larger size of the branches, frequent and irregular branching, and in sections by the more dense tissue and obscure dark line in the skeletal elements.

Types and Occurrence.—Specimen No. 14039 (slide W3–5), which Grabau illustrated in Pl. 9, Fig. 7 of his 1910 paper, is here chosen as a lectotype. Specimen No. 14038, Pl. 9, Figs. 5–6, of Grabau's paper, 14042A (slide W3–6) and 14042B–L, topotypes collected by Grabau, are designated paralectotypes.

Numerous specimens of *A. nattressi* are present in three pieces of limestone, collected by G. M. Ehlers from the type locality. From these pieces of rock we have seven thin sections that show very well preserved skeletal structures of 24 specimens. All specimens in the pieces of limestone are here designated paralectotypes; they are filed under Nos. 34916A (slides W3–7, 8, 9), 34916B (slides W3–10, 11), and 34916C (slides W3–12, 13).

All above mentioned types were obtained from the typical Anderdon limestone of Locality B, the "Anderdon quarry," 1¼ miles northeast of Amherstburg, Ontario.

Grabau (1910, p. 94) mentioned the occurrence of *Idiostroma cylindrica* mss., "from the upper Traverse rocks of the Alpena region." That species has never been described and we do not have his specimens. We have specimens of *Amphipora* from the Potter Farm formation of the Traverse group exposed on the west side of Alpena, Michigan; these are very much like *A. nattressi,* although much higher in the Middle Devonian. Since there are several other genera of ramose stromatoporoids in the Potter Farm formation, there is no way of determining what form Grabau had in mind.

Genus *Stachyodes* Bargatzky 1881

Stachyodes Bargatsky, 1881, p. 688; Nicholson, 1886, pp. 107–108; 1892, pp. 221–23; Kühn, 1942, pp. 250–51; Lecompte, 1952, pp. 298–302; Galloway, 1957, pp. 444-45; Yavorsky, 1957, p. 58.

Type species.—Monotypic: *Stachyodes verticillata* (McCoy) = *Stromatopora* (*Caunopora*) *verticillata* McCoy, 1855, p. 66, Text-Figs. *a–b,* p. 67 = *Stachyodes ramosa* Bargatsky, 1881, p. 688.

Middle and Upper Devonian; Europe, about 18 species; America, one species.

Diagnosis.—Coenosteum ramose, with tabulate axial tube or tubes with branches, without peripheral vacuoles. Laminae and short pillars discernible in peripheral region, fused, without dark median line. Tissue porous; pores parallel to axis in the axial region, perpendicular to the surface in

the outer region. The single axial tube has branches, much like typical astrorhizae.

Remarks.—Typical species of *Stachyodes* have very porous tissue from axis to periphery; "neither radial pillars nor concentric laminae being recognizable as distinct structures" (Nicholson, 1892, p. 222). Two of Lecompte's species (1952, Pls. 61–65), *S. radiata* and *S. costulata,* show definite laminae and interlaminar spaces largely filled with tissue. Yavorsky's five species (1957, Pls. 30–33), from the Upper Devonian of Russia, all have porous tissue but only vaguely indicated laminae and pillars.

The axial tube with branches, which nearly all species possess, may well be an astrorhizal tube and branches, as Lecompte (1952, p. 298) insisted. Since the presence of astrorhizae is only a specific character, never a generic one (Galloway, 1957, p. 381), there may be species of *Stachyodes* without the axial or astrorhizal tube, as described for the following species, and there may, therefore, be species of the other genera of the family Idiostromatidae, which have no axial canal.

Stachyodes paralleloporoides Lecompte

(Pl. XII, Figs. 1*a–d,* 2)

Stachyodes paralleloporoides Lecompe, 1952, pp. 308–309, Pl. 63, Fig. 3; Pl. 64, Figs. 1–2.

Description.—The following description is based on specimens obtained by G. M. Ehlers from the upper part of the Middle Devonian Bois Blanc formation near Mackinaw City, Michigan.

Coenosteum: Branches subcylindrical, undulating, 5 to 8 mm. in diameter, 15 to 25 mm. long, not branching. Surface is nearly smooth, mostly covered with calcareous shale. No indication of an axial tube.

Cross section: The axial region has many round galleries, but no single axial tube, and therefore no lateral branches of tubes. The galleries are round, 0.1 to 0.2 mm. in diameter, with thin dark walls; the walls in turn are thickened by tissue with conspicuous, vertical pores, 0.03 to 0.05 mm. in diameter. One specimen does not show the pores in the walls of the axial galleries. In the submature and mature regions of the rami the laminae are thick, parallel, with short thick pillars. The laminae and pillars are amalgamated and are pierced by small pores, 0.03 mm. in diameter, at right angles to the surface; the pores appear to be composed of superposed maculae, much as in the genus *Parallelopora.*

Vertical section: In the axial zone the galleries are long, tabulate, and gradually turned into the outer region. The dark wall of the tubes and the thickened tissue are apparent, but the pores are obscure. The mature or outer region shows the thick porous laminae and the short thick pillars, and that the pores in both laminae and pillars are at right angles to the

surface. Galleries are oval and elongate, many with curved dissepiments.

Tangential section: The tissue of both laminae and pillars is amalgamated and conspicuously porous. The galleries occupy about half the field, and they have numerous curved dissepiments.

Remarks.—The Michigan specimens of *Stachyodes paralleloporoides* are very similar to the Belgian ones, except for the lack of an axial tube. One of Lecompte's illustrations (1952, Pl. 64, Fig. 2*b*, bottom of figure) shows a cross section with many small tubes instead of one large axial tube.

Types and Occurrence.—Hypotypes No. 34918A (slide W3–14) and No. 34918B (slide W3–15). Species is common in upper part of Middle Devonian Bois Blanc formation, unit 21 of rock section, exposed at Locality D and described by G. M. Ehlers (1945, p. 100). The hypotypes were found with *Clavidictyon millcreekense* Galloway and Ehlers, sp. nov. *Stachyodes paralleloporoides*, apparently, does not have the epitheca of that species.

The specimens of *Stachyodes paralleloporoides* from Michigan are of lower Middle Devonian age whereas those from Belgium are lower Upper Devonian.

Genus *Clavidictyon* Sugiyama 1939

A description of the genus *Clavidictyon* is given in Part I.

Clavidictyon millcreekense Galloway and Ehlers, sp. nov.

(Pl. XII, Figs. 3*a–e*, 4–6)

Description.—The description is based on specimens obtained by G. M. Ehlers from the upper part of the Middle Devonian Boic Blanc formation near Mackinaw City, Michigan.

Coenosteum: Coenosteum consists of small, ramose branches, 3 to 5 mm. in diameter, 10 to 20 mm. long, not branching. Surface in general smooth; epitheca with annular growth lines; where weathered, the surface shows round papillae. No axial tube apparent, mamelons or astrorhizae lacking.

Cross section: Axial region shows several round galleries in a ground mass of thick pillars. Some galleries have curved tabulae. The tissue is both flocculent and porous, floccules from 0.04 to 0.07 mm. in diameter, and separated by light-colored tissue in which there are pores, 0.03 mm. in diameter. Outer region is much the same as the axial region, with round, oval and elongate galleries up to the edge; in some places there is a thin, compact epitheca at the surface. There are no definite laminae.

Vertical section: The galleries are nearly vertical in the axial region, but bend gradually and approach the surface obliquely. The galleries do

not open at the surface, which has a thin epitheca. Inside the epitheca there is a thin, vertical vacuity, much as in *Amphipora*. Many galleries have straight or curved tabulae. The tissue is thick, with large, flocculent maculae, separated by light-colored tissue and vertical pores. There are no determinable laminae in any of the sections; the structures are mostly short pillars.

Tangential section: Flocculent tissue makes up most of the section. The floccules are separated by light-colored tissue but pores rarely are seen. The oblique galleries have a few tabulae, and stop in the vacuity below the epitheca. The epitheca is from 0.07 to 0.18 mm. thick, and composed of flocculent tissue.

Preservation.—The specimens are infiltrated with calcium carbonate; they were buried in lime mud and are well preserved.

Remarks.—*Clavidictyon millcreekense* differs from *C. kegomicense,* described in Part I of this paper, in having tissue in the axial region and a thinner cortical region.

Types and Occurrence.—Holotype No. 34918C (slide W3–16); paratypes 34918D (slide W3–17), 34918E (slide W3–18), and 34918F. The types and other specimens of the species are common in upper part of Middle Devonian Bois Blanc formation, unit 21 of rock section, exposed at Locality D and described by G. M. Ehlers (1945, p. 100). They occur with many specimens of *Stachyodes paralleloporoides* Lecompte, from which they cannot be distinguished except by the study of thin sections; *C. millcreekense* has an epitheca, a structure which apparently is lacking in *Stachyodes paralleloporoides.*

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EXPLANATION OF PLATE I

PAGE

Stromatopora monticulifera Winchell 51

FIG. 1*a*. Surface of lectotype, showing mamelons and papillae, but only faint astrorhizae. No. 32409A. Gravel Point formation; Locality 14. × 1.

FIG. 1*b*. Vertical section of lectotype, showing laminae, microlaminae, mamelon with round astrorhizal canals, small galleries, thin psuedozooidal tubes, obscure dark long pillars, and maculate tissue. Slide W1–1. × 10.

FIG. 1*c*. Vertical section of lectotype, between mamelons, showing laminae, obscure pillars, small galleries, small astrorhizal canals, pseudozooidal tubes, and maculate tissue. Slide W1–1. × 10.

FIG. 1*d*. Tangential section of lectotype, showing mamelon with astrorhizae, confluent galleries, round pseudozooidal tubes, round pillars, and maculate tissue. Slide W1–2. × 10.

FIG. 2. Surface of paralectotype, showing astrorhizae on the mamelons and papillae. No. 32409B. Gravel Point formation; Locality 14. × 1.2.

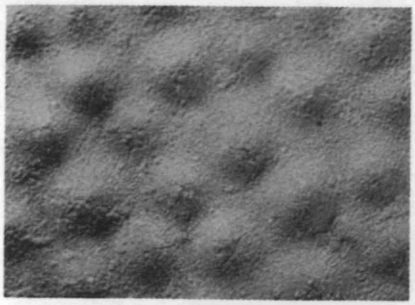
Parallelopora winchelli Galloway and Ehlers, sp. nov. 57

FIG. 3*a*. Surface of holotype, showing conical mamelons with astrorhizae and flat spaces between. No. 40243A. Gravel Point formation; Locality 14*e*. × 1.

FIG. 3*b*. Vertical section of holotype, showing laminae, microlaminae, superposed pillars, maculae arranged more or less vertically, galleries, astrorhizal canals, and pseudozooidal tubes; also mamelon at right. Slide W1–10. × 10.

FIG. 3*c*. Tangential section of holotype, showing mamelon column, maculate tissue, confluent pillars and galleries, astrorhizal canals, and small pseudozooidal tubes. Slide W1–10. × 10.

PLATE I



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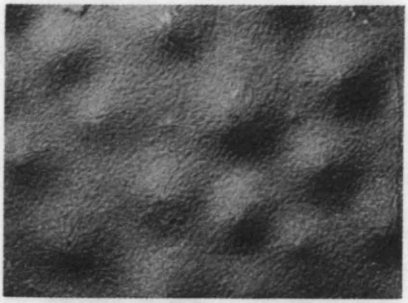

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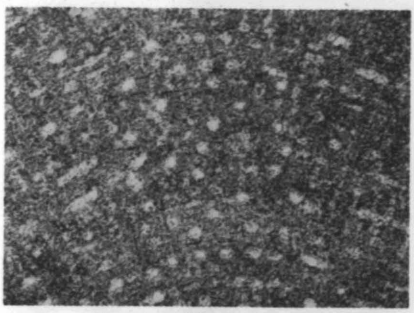

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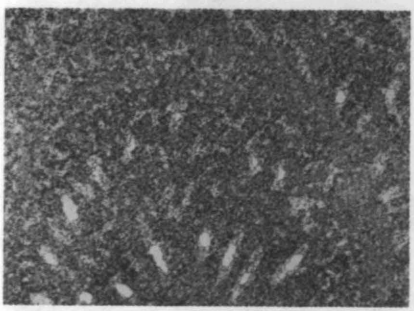

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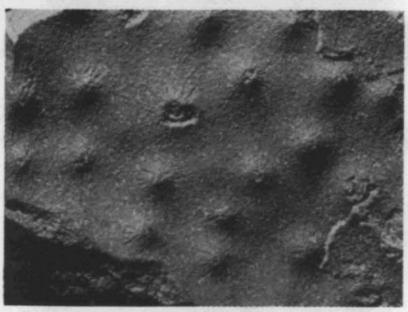

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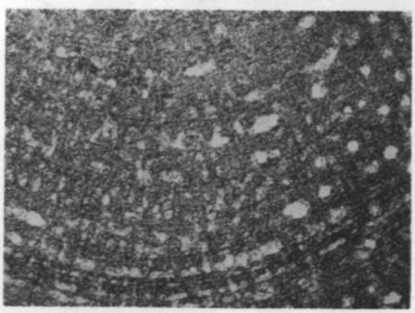

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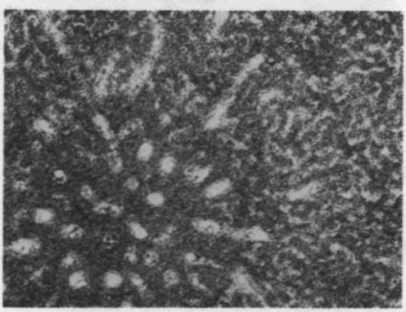

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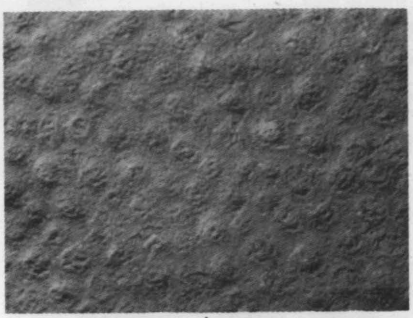
PLATE II



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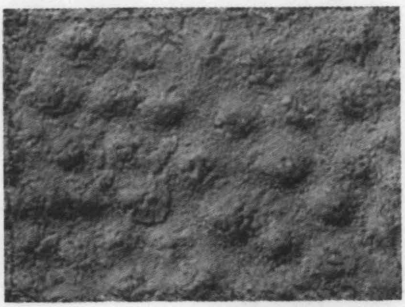

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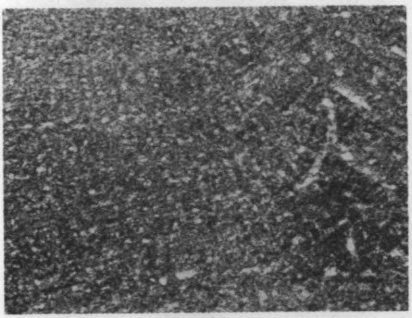

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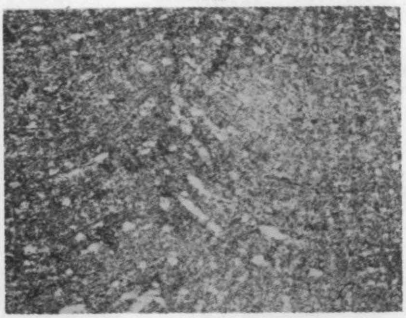

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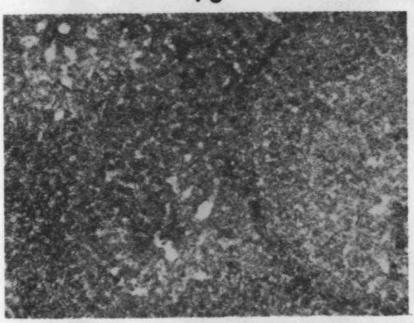

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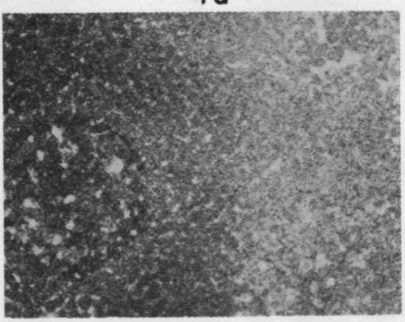

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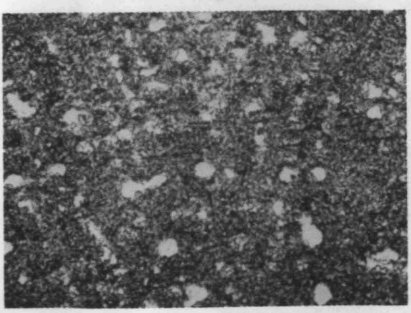

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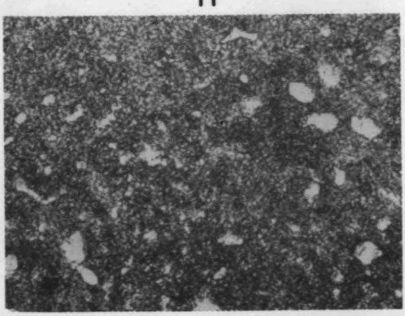


1h

EXPLANATION OF PLATE II

PAGE

Stromatopora pustulifera Winchell 54

FIG. 1*a*. Surface of holotype, showing mamelons, most with broken summits. No. 32398. Petoskey formation; Locality 18. × 1.2.

FIG. 1*b*. Surface of holotype, showing mamelons and small, imperfect astrorhizae. × 1.8.

FIG. 1*c*. Vertical section of holotype, showing laminae, microlaminae, a mamelon with oblique astrorhizal canals and short axial tube, maculate, amalgamate tissue, oval galleries, and pseudozooidal tubes with thin pillars between. Slide W1–18. × 10.

FIG. 1*d*. Vertical section from another part of holotype and cut thinner than slide W1–18, showing microlaminae, pseudozooidal tubes, and maculae, somewhat better. Slide W1–19. × 10.

FIGS. 1*e–f*. Tangential sections of holotype, showing mamelons, imperfect astrorhizae, roundish and confluent pillars, joining galleries, pseudozooidal tubes, and maculate, amalgamate tissue. Slide W1–22. × 10.

FIG. 1*g*. Vertical section of holotype, showing amalgamate tissue, microlaminae, maculae, superposed galleries, and indistinct pillars. Slide W1–20. × 20.

FIG. 1*h*. Tangential section of holotype, showing amalgamate, maculate tissue, partly recrystallized, mamelons, imperfect astrorhizae, galleries, and small pseudozooidal tubes. Slide W1–23. × 20.

EXPLANATION OF PLATE III

PAGE

Trupetostroma nux (Winchell) 59

FIG. 1*a*. Vertical section, prepared by Winchell, of lectotype, showing abraded surface, case-hardened margin, latilaminae and mamelons. Microlaminae, laminae, superposed pillars, open galleries, astrorhizal tubes and mamelon columns are clearly seen on specimen with a 10× lens. No. 32414. Petoskey formation; Locality 18. × 1.

FIG. 1*b*. Vertical section of lectotype, showing microlaminae, laminae, one mamelon, superposed pillars and galleries, astrorhizal canals, vacuoles, and vertical pores. Slide W2–5. × 10.

FIG. 1*c*. Tangential section of lectotype, showing mamelons, anastomosing pillars and galleries, astrorhizal canals, and vacuolate and porous tissue. Slide W2–6. × 10.

FIGS. 2–6. Paralectotypes, six waterworn specimens; two cut specimens, Fig. 2, are enclosed in lithified calcareous silt. Nos. 32417A (Fig. 3), 32417D (Fig. 5), 32417E (Fig. 2, two specimens), 32417F (Fig. 4), and 32417G (Fig. 6). Petoskey formation; Locality 18. × ⅔.

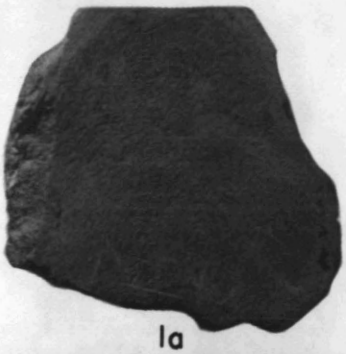
FIG. 7*a*. Specimen, worn into a pebble by wave action in Middle Devonian Petoskey time, showing smoothed surface, case-hardened rind 10 mm. thick, and mamelons where rind has been removed. Topotype, Indiana University, Paleontological Collection. Petoskey formation; Locality 18. × ⅔.

FIG. 7*b*. Inner surface of same specimen (Fig. 7*a*), showing mamelons, radiating open galleries, and tabulate astrorhizal canals. Inside of coenosteum has not been infiltrated and is much as in life, but without soft parts. × 6.

FIG. 7*c*. Vertical section of same specimen (Fig. 7*a*), showing laminae, microlaminae, superposed pillars and galleries, a mamelon column, scattered astrorhizal canals that are much larger than the galleries and vacuoles and pores. Topotype, Indiana University, Paleontological Collection, slide No. 306—64. × 10.

FIG. 7*d*. Tangential section of same specimen (Fig. 7*a*), showing radiating galleries in mamelons, scattered large astrorhizal canals, confluent pillars, vacuoles, and pores (smaller than vacuoles), and specks, simulating maculae. Topotype, Indiana University, Paleontological Collection, slide No. 306—67. × 10.

PLATE III



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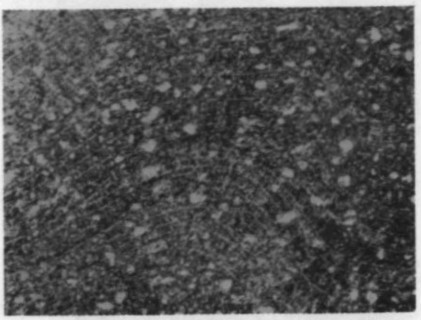

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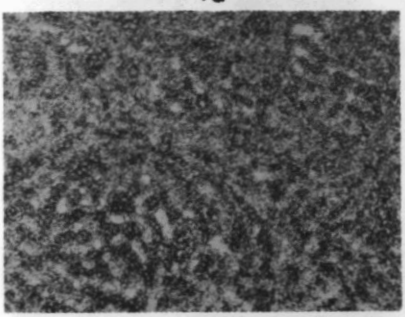

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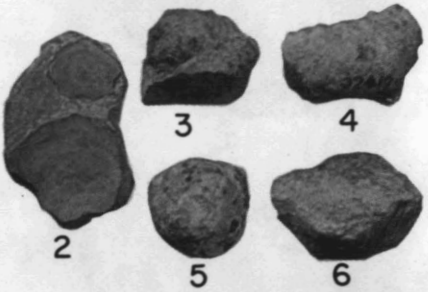

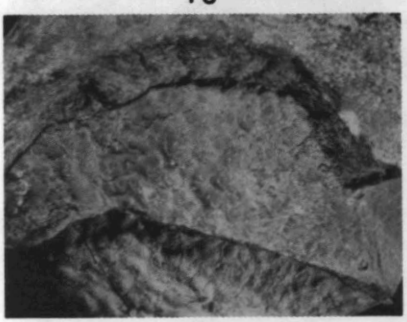

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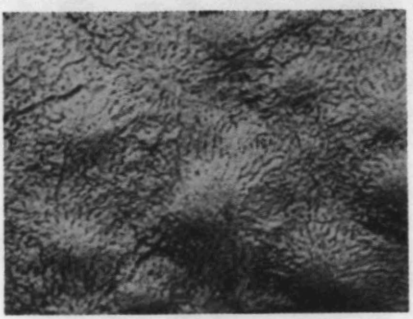

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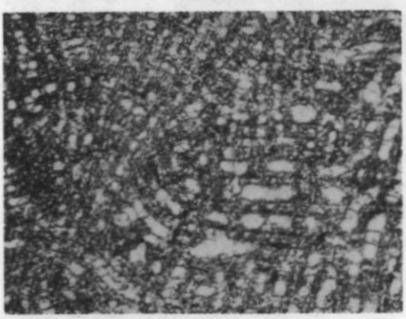

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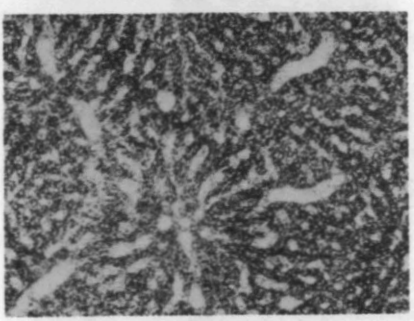

7d

PLATE IV

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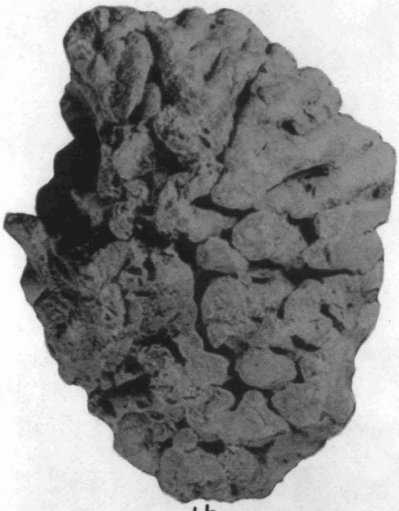

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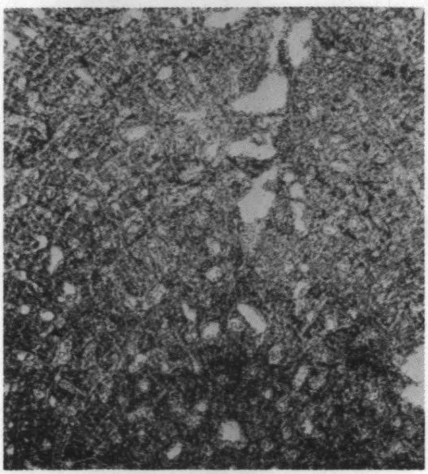

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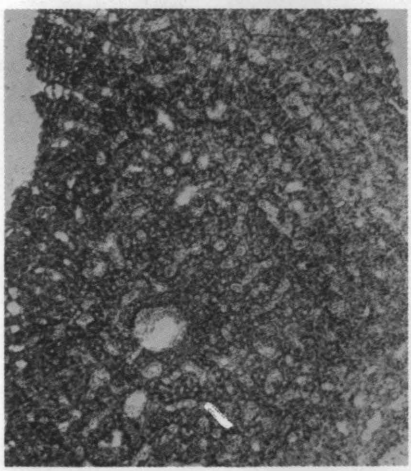
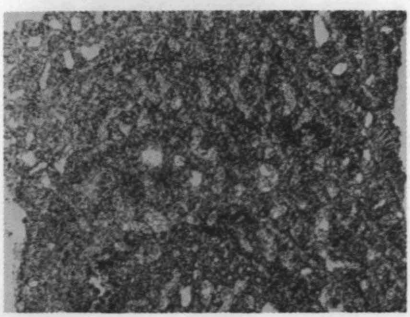


1d



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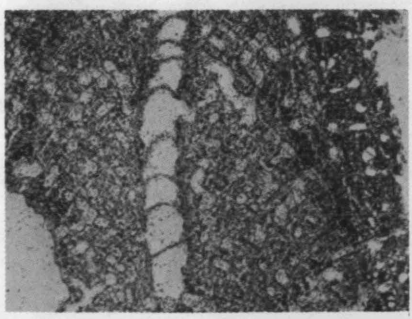


2

EXPLANATION OF PLATE IV

PAGE

Idiostroma caespitosum (Winchell) 63

FIG. 1*a*. Upper surface of lectotype. No. 32401A. Petoskey formation; Locality 18. × ⅔.

FIG. 1*b*. Lower surface of lectotype. × ⅔.

FIG. 1*c*. Vertical section of lectotype, showing intermittent character of axial tube, arching laminae, vacuoles, indistinct superposed pillars, and transversely porous tissue. Slide W2–17. × 10.

FIG. 1*d*. Cross section of lectotype at place of branching, showing axial tube at one side of axis, axial zone with round and diverse vacuolate laminae, superposed pillars and galleries. Upper left corner figured by Galloway, 1957, Pl. 31, Fig. 12 (No. "32701" in explanation of Fig. 12 should read 32401). Slide W2–17. × 10.

FIG. 1*e*. Deep tangential section of lectotype, showing arching vacuolate laminae, vacuolate pillars, and pillars and galleries elongate vertical to branch. Slide W2–17. × 10.

FIG. 2. Vertical section of paralectotype, showing tabulate axial tube, vacuolate axial zone, laminae, pillars, superposed galleries and pillars, and vacuolate and transversely porous interlaminar tissue. No. 32401B (slide W2–19). Petoskey formation; Locality 18. × 10.

EXPLANATION OF PLATE V

PAGE

Idiostroma roemeri Nicholson 67

FIG. 1*a*. Side view of hypotype, a nearly complete coenosteum. No. 32408. Petoskey formation; Locality 18. × ⅔.

FIG. 1*b*. Vertical section of branch of same hypotype, showing axial tube, strong concentric laminae, strong pillars, superposed galleries mostly filled with vacuolate secondary tissue which is transversely porous in some places. Slide W2–22. × 10.

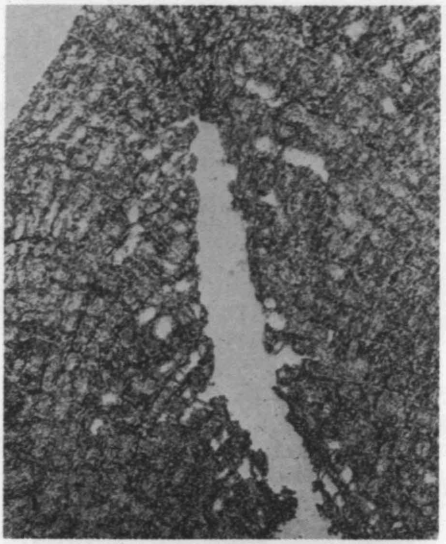
FIG. 1*c*. Cross section of same hypotype, showing axial and accessory tubes, narrow axial zone, latilaminae, and superposed galleries and pillars, laminae in submature and mature regions, and vacuolate tissue. Slide W2–24. × 6.

FIG. 1*d*. Tangential section of same hypotype, showing accessory axial tube, round and joining galleries and pillars, and vacuolate tissue. Slide No. W2–24. × 10.

FIG. 2. Polished section of one side of another hypotype, showing latilaminae, laminae, and superposed pillars; reversed side shows eight small branches, some with axial tubes. No. 32406. Petoskey formation; Locality 18. × 1.1.

PLATE V

1a



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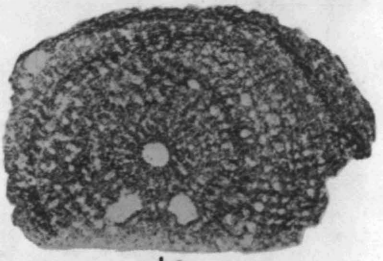

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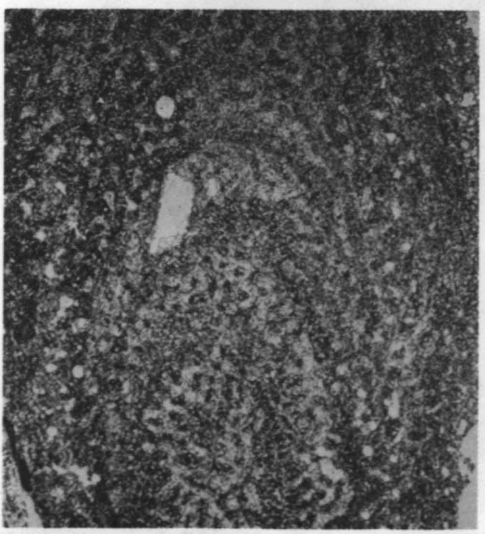
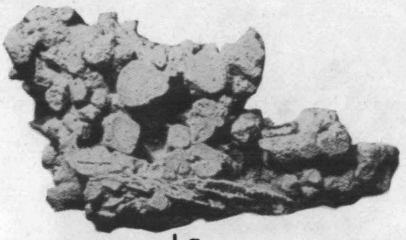


1d

2

PLATE VI



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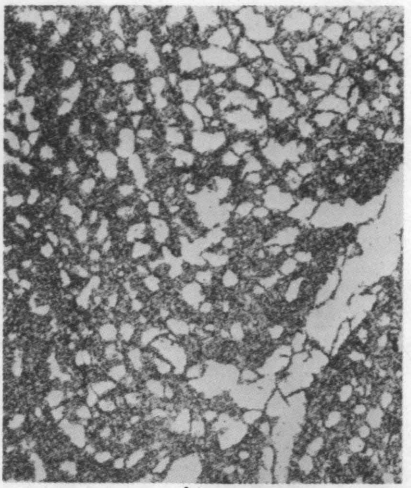

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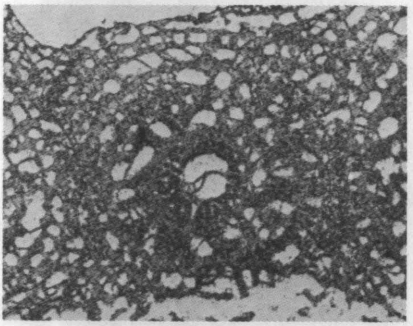
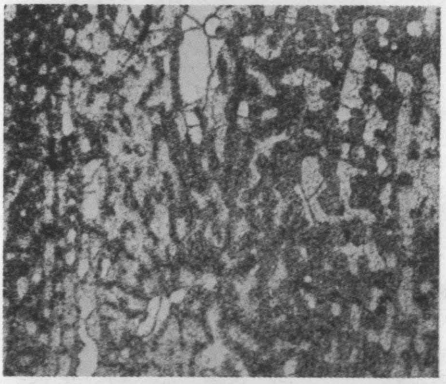


1c

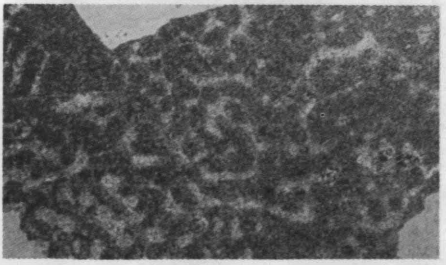
2a

3



2b

2d



2c

EXPLANATION OF PLATE VI

PAGE

Dendrostroma petoskeyense Galloway and Ehlers, sp. nov. 69

FIG. 1*a*. Top view of holotype (one of Winchell's syntypes of *Idiostroma caespitosum*), showing variation in size of branches, and axial tubes and short pillars. No. 32402B. Petoskey formation; Locality 18. × ⅔.

FIG. 1*b*. Vertical section of two diverging branches of holotype, showing axial tube, laminae and short pillars (both transversely porous), galleries, and dissepiments. Slide W2–25. × 10.

FIG. 1*c*. Cross section of three contiguous branches of holotype. showing axial tube, annular laminae thinning toward the surface, short pillars, transversely fibrous tissue, and dissepiments. Slide W2–25. × 10.

Dendrostroma fibrosum Galloway, sp. nov. 71

FIG. 2*a*. View of holotype, Indiana University, Paleontological Collection. Petoskey formation; Locality 21. × 1.

FIG. 2*b*. Vertical section of holotype, showing small tabulate axial tube, dissepiments, fibrous laminae, and short fibrous pillars. Indiana University, Paleontological Collection, slide No. 282—86. × 10.

FIG. 2*c*. Tangential section of holotype, showing laminae and pillars joining and composed of similar transversely and radially fibrous tissue. Slide No. 282—86. × 10.

FIG. 2*d*. Part of cross section of holotype, showing small axial tube with branches, thick annular laminae, short thick pillars, both transversely fibrous. Slide 282—86. × 10.

FIG. 3. View of paratype, Indiana University, Paleontological Collection, Slide No. 282—87. × 1.

EXPLANATION OF PLATE VII

PAGE

Stromatoporella elevata Parks 75

FIG. 1*a*. Surface of hypotype, showing pustules, many broken. No. 14310. Gravel Point formation; location, 1½ miles east of Locality 14. × 1.

FIG. 1*b*. Vertical section of hypotype, showing thick, porous laminae, some rising into ring pillars. Hypotype is attached to a part of a greatly recrystallized shell of an orthoconic cephalopod; position of shell is indicated in illustration by a wide, light-colored band below the stromatoporoid. Slide W2–24. × 10.

FIG. 1*c*. Tangential section of hypotype, showing porous laminae, tubercles, large ring pillars, and anastomosing galleries and pillars. Slide W2–24. × 10.

Stromatoporella mudlakensis Galloway, sp. nov. 77

FIG. 2*a*. View of holotype. Indiana University, Paleontological Collection. No. 4641A. Petoskey formation; Locality 21. × 1.

FIG. 2*b*. Vertical to partly oblique section of holotype, showing thin, porous laminae and pillars in axial region. In the outer region the laminae are thick and coarsely porous; abundant ring pillars are formed by upturns of the laminae to which they are attached; some curved dissepiments. Indiana University, Paleontological Collection, slide 282—82. × 10.

FIG. 3. View of paratype. Same depository, formation, and locality as holotype. No. 4641B. × 1.

FIG. 4*a*. View of another paratype. Same depository, formation, and locality as holotype. No. 4641C. × 1.

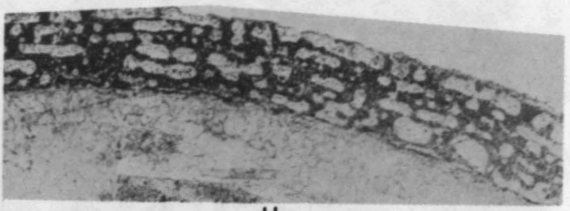
FIG. 4*b*. Tangential section of paratype No. 4641C, showing porous laminae, porous ring pillars, and nonporous ring pillars. Slide 282—83. × 10.

FIG. 5*a*. View of another paratype. Same depository, formation, and locality as holotype, No. 4641D. × 1.

FIG. 5*b*. Cross section of paratype No. 4641D, showing thin, porous structures in axial region, and thick, porous laminae, short thick porous pillars and ring pillars, and thick fibrous pillars. Slide 306—82. × 10.

PLATE VII

1a



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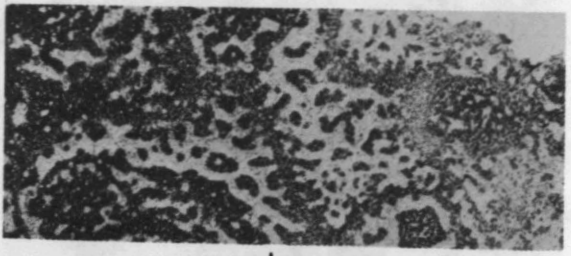


1c

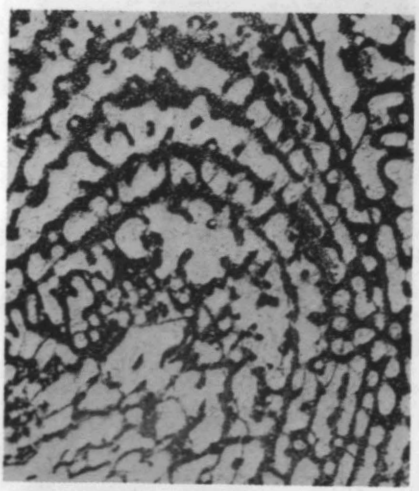
2a

3

4a

5a

4b



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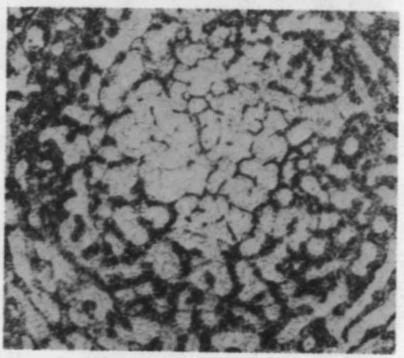
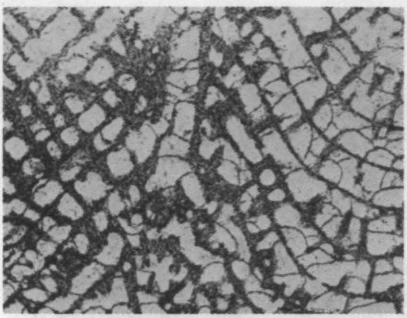


5b

PLATE VIII



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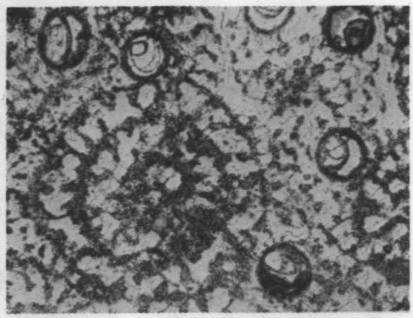

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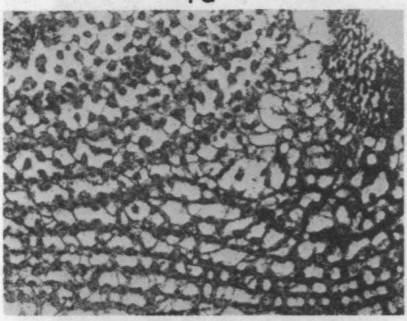

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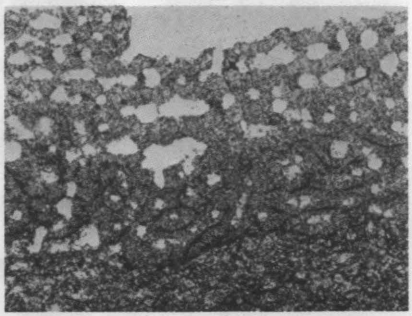

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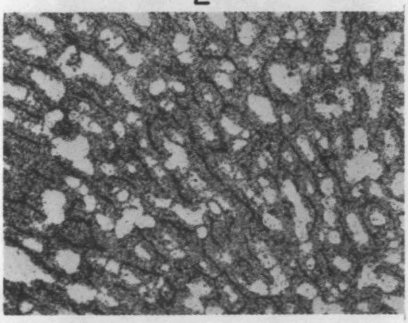

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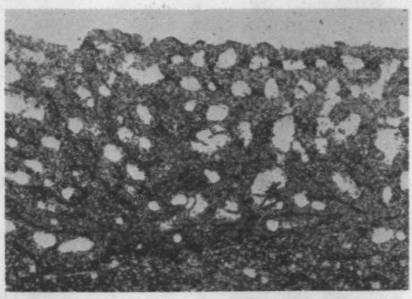

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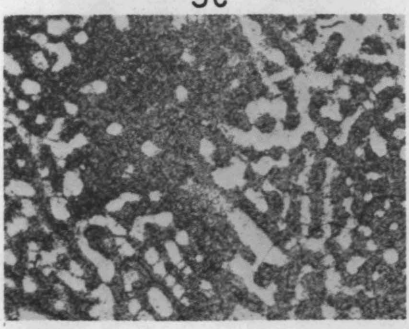

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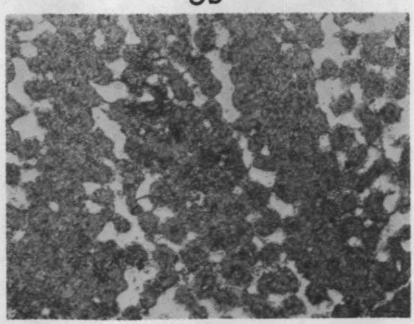


4

EXPLANATION OF PLATE VIII

PAGE

Anostylostroma arvense (Parks) 82

FIG. 1*a*. Vertical section of a hypotype, showing a mamelon with axial tabulate tube, regular laminae, short pillars, some superposed much as in *Gerronostroma*, and numerous curved dissepiments. No. 36086 (slide W4–8). Amherstburg or Lucas dolomite; Locality A. × 10.

FIG. 1*b*. Tangential section of same hypotype, showing mamelons, annuli of laminae, round pillars, and many specimens of the symbiotic coral *Syringopora*. Astrorhizae are lacking. Slide W4–9. × 10.

FIG. 2. Tangential section of another hypotype, showing round pillars, thick laminae, and curved dissepiments. Note repair tissue in upper right corner. No. 36079 (slide W4–4). Amherstburg or Lucas dolomite; Locality A. × 10.

Stictostroma anomalum Galloway and Ehlers, sp. nov. 85

FIG. 3*a*. Vertical section of holotype through basal latilamina, showing peritheca of pillars with transverse fibers and dark median line; the upper layer of 4 to 6 thick laminae and short pillars is vertically fibrous without dark median line. No. 36077B; slide W4–10. Amherstburg or Lucas dolomite; Locality A. × 10.

FIG. 3*b*. Vertical section of holotype, showing laminae which are transversely fibrous and continue downward into the short pillars. Slide W4–10. × 10.

FIG. 3*c*. Tangential section of holotype, showing oblique pillars of the peritheca, which are transversely fibrous with dark median line, and dissepiments in some of the galleries. Slide W4–11. × 10.

FIG. 3*d*. Tangential section of holotype at junction of peritheca and laminae, showing pillars of the peritheca, and thick, transversely fibrous laminae and round pillars of the first normal layer of structures. Slide W4–11. × 10.

FIG. 4. Tangential section of a specimen similar to the holotype, from the same formation and locality, and cut in the normal layer of the coenosteum, showing large round pillars, thick laminae, and joining galleries, some with dissepiments. Paratype No. 36078; slide W4–13. × 10.

EXPLANATION OF PLATE IX

PAGE

Stictostroma anomalum Galloway and Ehlers, sp. nov. 85

FIG. 1*a*. Vertical section of paratype, showing thick transversely fibrous laminae that bend up into the short pillars, oval galleries, astrorhizal canals larger than the galleries, few dissepiments, mamelon with short axial tube, and latilaminae 3 mm. thick. Paratype No. 36085; slide W4–14. Amherstburg or Lucas dolomite; Locality A. × 10.

FIG. 1*b*. Tangential section of same paratype, showing mamelon with axial tube and radial astrorhizal canals, thick fibrous laminae, round pillars, incipient ring pillars in the mamelon, and dissepiments. Slide W4–15. × 10.

Stictostroma anderdonense Galloway and Ehlers, sp. nov. 88

FIG. 2*a*. Vertical section of holotype, showing closely spaced laminae arching over a short mamelon, above which are more distantly spaced laminae and short straight and curved pillars that grade into dissepiments. No. 14309 (Grabau specimen, 1910, Pl. 9, Figs. 1–2); slide W4–16. Anderdon limestone; Locality B. × 10.

FIG. 2*b*. Vertical section of holotype, from same slide, showing abrupt change from straight laminae and short pillars to cystose laminae and long oblique pillars. Slide W4–16. × 10.

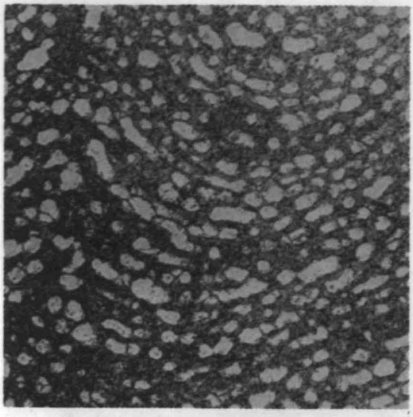
FIG. 2*c*. Tangential section of holotype, showing a low mamelon with distantly spaced laminae and small imperfect astrorhiza; pillars and galleries round and irregular; tissue fibrous and granular, partly recrystallized. Slide W4–17. × 10.

*Stromatopora galloway*i Fritz and Waines 90

FIG. 3*a*. Vertical section of hypotype, showing typical amalgamate tissue with obscure laminae and pillars, but finely maculate; small irregular galleries, large astrorhizal canals with tabulae, and thin pseudozooidal tubes with rare tabulae. No. 14062 (Grabau's specimen, 1910, Pl. 8, Fig. 1); slide W4–18. Amherstburg or Lucas dolomite; Locality A. × 10.

FIG. 3*b*. Tangential section of same specimen, showing amalgamate maculate tissue, small anastomosing galleries that separate roundish pillars between small round pseudozooidal tubes, and radiating astrorhizal canals. Slide W4–19. × 10.

PLATE IX



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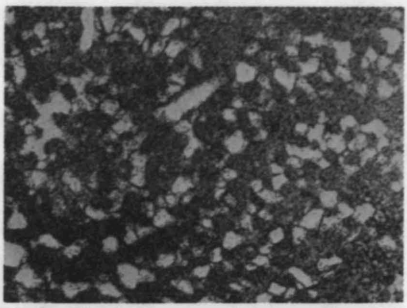
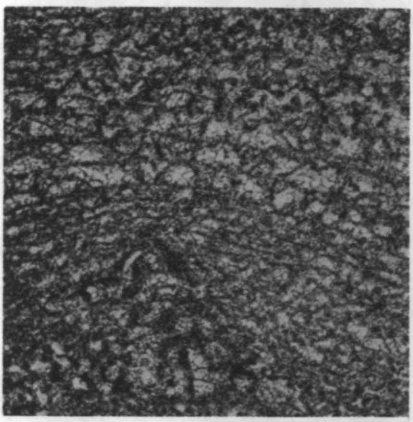


1b



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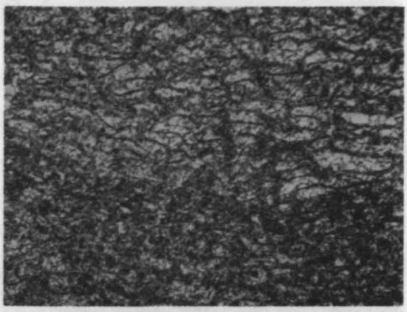

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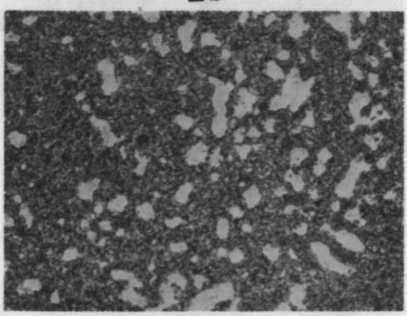

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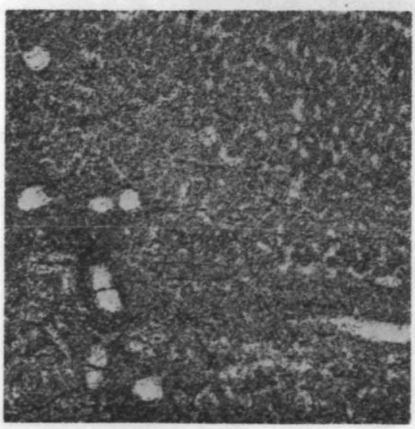

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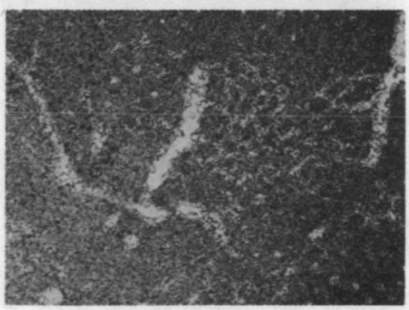
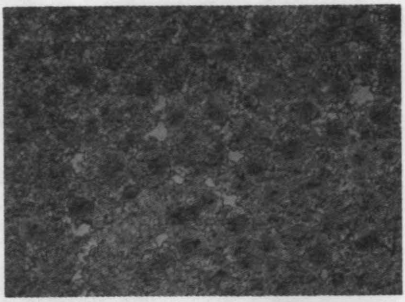


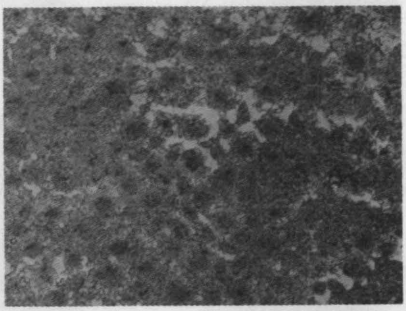
3b

PLATE X

1a

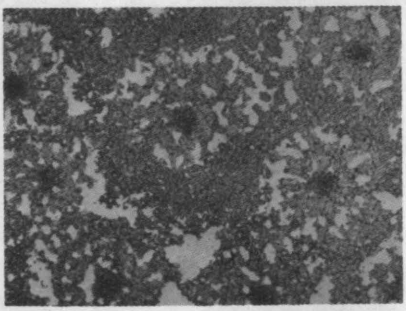


1b



2b

2a



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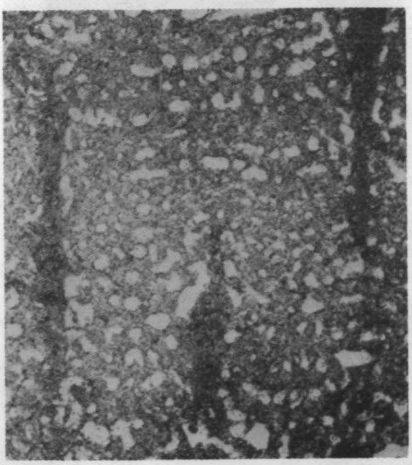
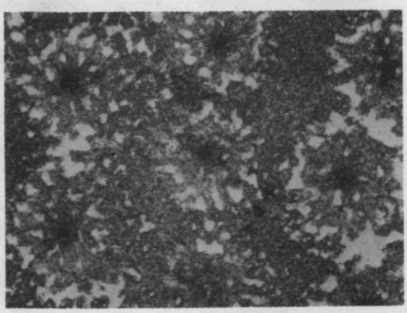


4a



4b

EXPLANATION OF PLATE X

PAGE

Syringostroma aurora Parks 92

FIG. 1*a*. Vertical section of hypotype, showing latilaminae, thick laminae, conspicuous long pillars, but no mamelons or astrorhizae, and finely maculate amalgamate tissue. No. 14075 (Grabau's specimen, 1910, Pl. 9, Fig. 3); slide W4–20. Anderdon limestone; Locality B. × 10.

FIG. 1*b*. Tanegntial section of same specimen, showing amalgamate tissue and large round pillars, but no mamelons or astrorhizae. The small galleries are partly filled with calcite. Slide W4–21. × 10.

Syringostroma aurorella Fritz and Waines 93

FIG. 2*a*. Vertical section of hypotype, showing thick laminae, long pillars, small galleries, and astrorhizal canals. No. 14057 (Grabau's specimen, 1910, Pl. 9, Fig. 4); slide W4–22. Anderdon limestone; Locality B. × 10.

FIG. 2*b*. Tangential section of same specimen, showing small galleries, large pillars, and a few astrorhizal canals. Slide W4–23. × 10.

Syringostroma sherzeri (Grabau) 95

FIG. 3. Tangential section of lectotype, showing mamelon columns, each with large axial pillar. No. 13093 (Grabau's specimen, 1910, Pl. 8, Figs. 4–5); slide W5–1. Amherstburg or Lucas dolomite; Locality A. × 10.

FIG. 4*a*. Vertical section of paralectotype, showing mamelon columns with large axial pillars, thick laminae, short pillars, oval and irregular galleries, and a few astrorhizal canals. No. 13095; slide W5–3. Same formation and locality as lectotype. × 10.

FIG. 4*b*. Tangential section of same specimen, showing mamelon columns each with a large axial pillar, radiating short pillars, thick laminae, irregular galleries, and maculate tissue. Section does not show the rare astrorhizae. Slide W5–3. × 10.

EXPLANATION OF PLATE XI

PAGE

Amphipora ramosa (Phillips) 98

FIG. 1*a*. Five cross sections and two oblique sections of coenostea contained in a slide made from a rock specimen figured by Grabau, 1910, Pl. 8, Fig. 2. Sections show axial tubes, loose texture, pillars of transversely fibrous tissue with dark median line, and peripheral vesicles. Hypotypes (several specimens in rock) No. 14040; slide W3–1. Amherstburg or Lucas dolomite; Locality A. × 10.

FIG. 1*b*. Cross section and part of two tangential sections of hypotypes under No. 14040, showing axial tube, loose texture, small peripheral vacuoles, and fibrous tissue with dark median line. Slide W3–2. × 10.

Amphipora nattressi (Grabau) 99

FIG. 2*a*. Side view of lectotype, figured by Grabau, 1910, Pl. 9, Fig. 7. No. 14039. Anderdon limestone; Locality B. × 1.

FIG. 2*b*. Cross section of lectotype, showing no axial tube, large amount of fibrous tissue, peripheral vesicles characteristic of the genus *Amphipora,* and obscure laminae and pillars. Slide W3–5. × 10.

FIG. 3. Side view of paralectotype, figured by Grabau, 1910, Pl. 9, Fig. 5. No. 14038. Anderdon limestone; Locality B. × 1.

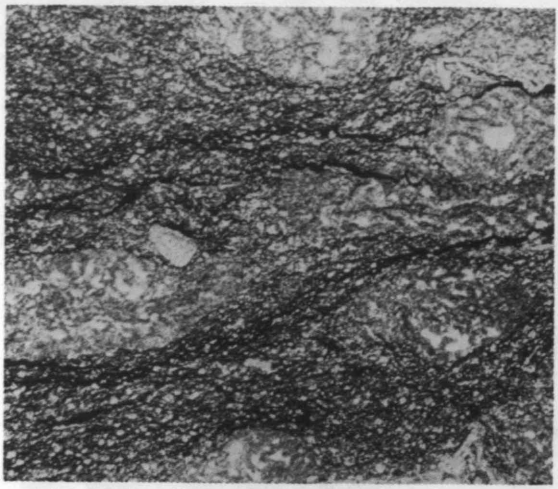
FIGS. 4*a,* 5–7. Four topotypes, showing irregularity of branching. Collected by Grabau. Nos. 14042A–D. Same formation and locality as lectotype. × 1.

FIG. 4*b*. Cross section of one of Grabau's topotypes through stem and longitudinal section of branch, showing large amount of fibrous tissue and small galleries and peripheral vacuoles. No. 14042A, illustrated in Figure 4*a;* slide W3–6. × 10.

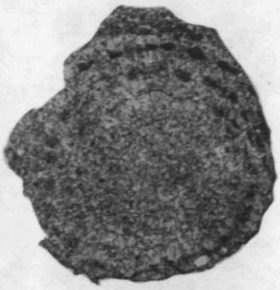
FIG. 4*c*. Section parallel to axis of same topotype, showing large proportion of tissue, small galleries, small peripheral vesicles, vague lamellae and pillars, and fibrous tissue. Slide W3–6. × 10.

FIG. 8. Cross section of a topotype, collected by G. M. Ehlers, showing axial tube, large amount of fibrous tissue, some of which has dark median line, small galleries, and peripheral vacuoles. No. 34916B; slide W3–10. Same formation and locality as lectotype. × 10.

PLATE XI

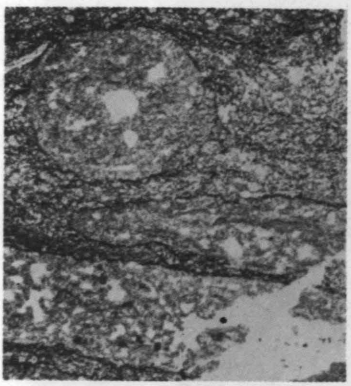


1a



2b

4b



1b

2a

3

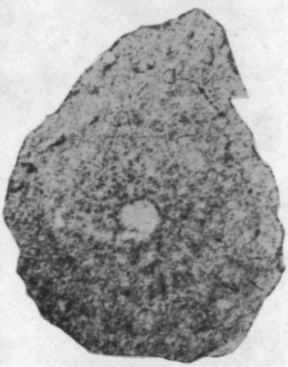
4a

5

4c

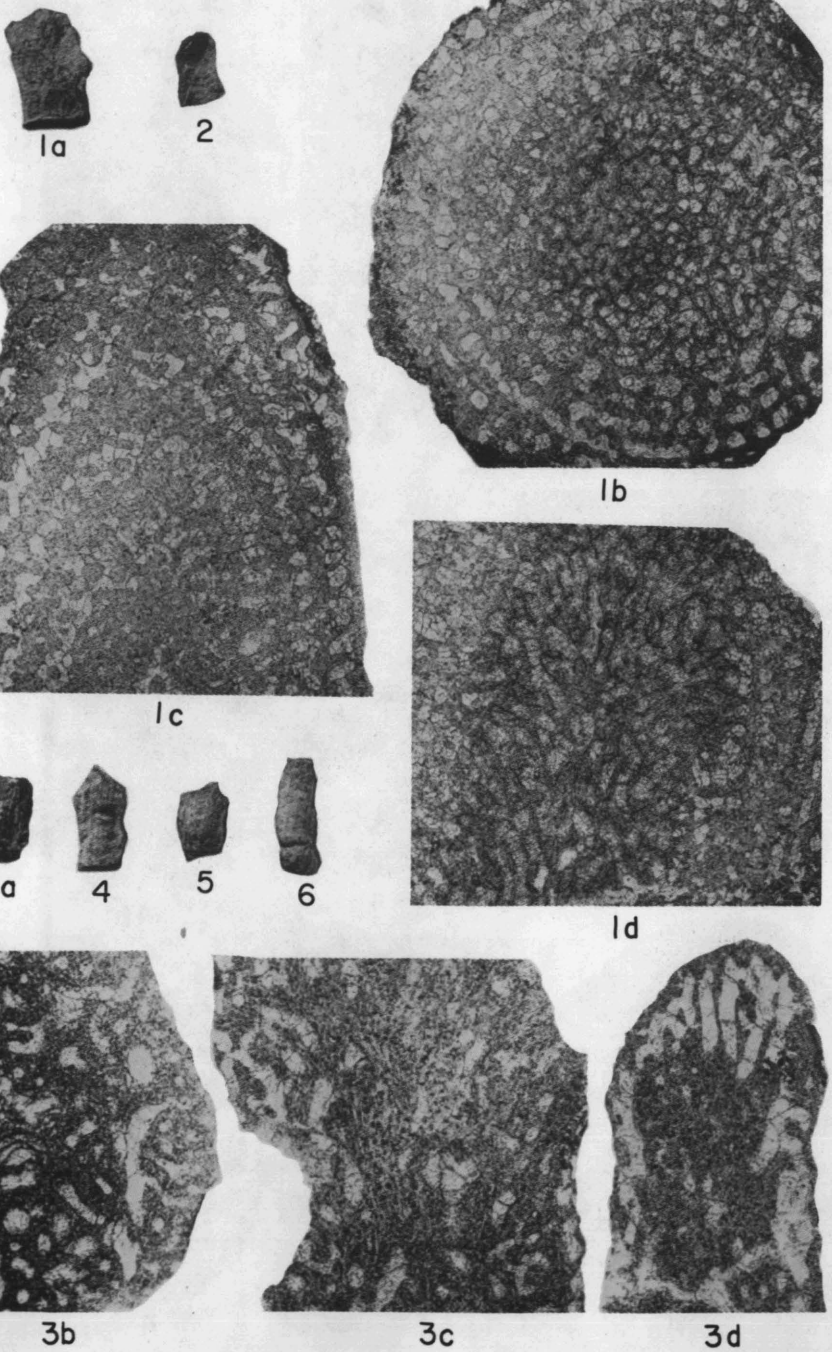
6

7



8

PLATE XII



EXPLANATION OF PLATE XII

PAGE

Stachyodes parallelporoides Lecompte 102

FIGS. 1*a*, 2. Views of two hypotypes. No. 34918A, Fig. 1*a* and No. 34918B, Fig. 2. Bois Blanc formation; Locality D. × 1.

FIG. 1*b*. Cross section of hypotype, No. 34918A, showing round vertical galleries, dark walls and small vertical pores in axial region; thick laminae and pillars in peripheral zone with pores at right angles to surface. Slide W3–14. × 10.

FIG. 1*c*. Tangential section of same hypotype, showing joined laminae and pillars, full of pores simulating maculae, and irregular and joining galleries with many curved dissepiments. No. 34918A; slide W3–14. × 10.

FIG. 1*d*. Vertical section of same hypotype, showing axial tubes with porous walls, thick laminae and short thick pillars in outer regions, with pores vertical to the surface. No. 34918A; slide W3–14. × 10.

Clavidictyon millcreekense Galloway and Ehlers, sp. nov. 103

FIGS. 3*a*, 4–6. Side views of holotype, No. 34918C, Fig. 3*a*, and paratypes Nos. 34918D–F, Figures 4–6. Bois Blanc formation; Locality D. × 1.

FIGS. 3*b–c*. Incomplete cross sections of holotype, showing thick vertical pillars but no laminae, round, oval and irregular galleries, some with curved tabulae, porous and flocculent tissue. Slide W3–16. × 10.

FIG. 3*d*. Vertical section of holotype, showing diverging, tabulate galleries, tissue with floccules and vertical pores, and epitheca. Slide W3–16. × 10.

FIG. 3*e*. Tangential section of holotype, showing thick, flocculent and porous tissue, and long tabulate galleries terminating below the thin epitheca. Slide W3–16. × 10.

EXPLANATION OF PLATE XIII

PAGE

Clavidictyon kegomicense Galloway, sp. nov. 73

FIGS. 1*a*, 2–3. View of holotype, No. 4637A, and two paratypes, Nos. 4637B–C, and slides 306—83–84 in Indiana University Paleontological Collection. Petoskey formation; Locality 21. × 1.

FIG. 1*b*. Longitudinal section of holotype, showing axial zone with discontinuous irregular axial tubes, arching laminae with light-colored, median zone and flocculent zones on each side; cortical or mature zone of flocculent tissue, remnants of galleries, and obscure laminae and pillars. × 10.

FIG. 1*c*. Tangential section of holotype, showing thick, flocculent tissue and remnants of laminae, pillars, and galleries. × 10.

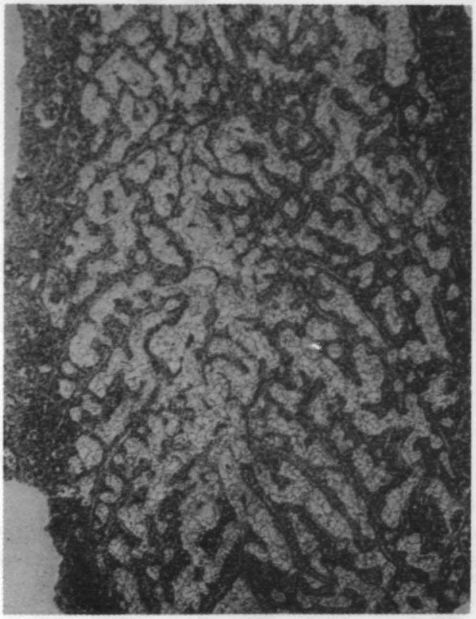
FIGS. 1*d–e*. Cross sections of holotype, showing wide axial zone without definite axial tube, joining pillars, laminae in outer zone, flocculent tissue, and roundish and irregular galleries. × 10.

Idiostroma caespitosum (Winchell) 63

FIG. 4. Side view of paralectotype, showing part of a coenosteum with several branches. No. 32405A. Petoskey formation; Locality 18. × 1.1.

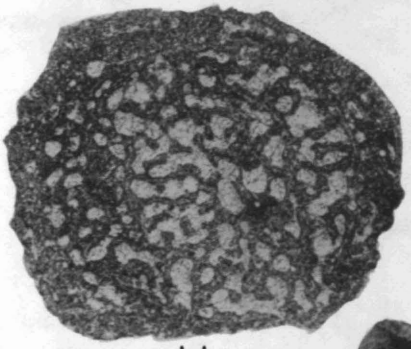
FIG. 5. Side view of another paralectotype, showing caespitose branching. No. 32402A. Same formation and locality as other paralectotype. × 0.6.

PLATE XIII

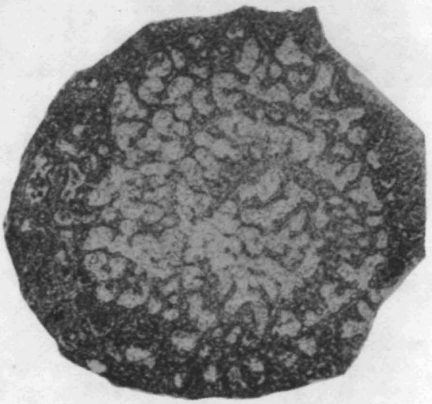


1b

1c



1d



1e

1a

4

3

2

5