CONTRIBUTIONS FROM THE MUSEUM OF PALEONTOLOGY
(*Continuation of Contributions from the Museum of Geology*)
UNIVERSITY OF MICHIGAN

VOL. V, No. 10, pp. 171–270 (16 pls., 1 map) JULY 1, 1939

TREPOSTOMATOUS BRYOZOA FROM THE TRAVERSE GROUP OF MICHIGAN

BY
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UNIVERSITY OF MICHIGAN PRESS
ANN ARBOR

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Editor: EUGENE S. MCCARTNEY

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CONTENTS

INTRODUCTION

IN 1926 the Geological Survey of Michigan collected numerous Bryozoa from various exposures of the Traverse group in the Southern Peninsula of Michigan. This material was supplemented by additional fossils collected earlier by Rominger and Grabau, and later by the Museum of Paleontology of the University of Michigan. The Cryptostomata have been studied and described by Deiss (1932, pp. 233–275) and McNair (1937, pp. 103–170). Two major groups, the Trepostomata and the Fistuliporidae, remain. This paper presents the results of a study of the Trepostomata, which now comprise seventy new and five previously described species belonging to nineteen genera, of which eleven are new.

Less has been written concerning Trepostomata from the Devonian than from any other period. The morphology and taxonomy of Ordovician and Silurian Bryozoa have been discussed thoroughly by Ulrich and Bassler. Carboniferous and Permian genera have been fairly well defined by Bassler, Ulrich, Lee, and Girty. Of the seventy-one genera listed as valid by Bassler (1934b, pp. 17–19) only two may have ranged from early to late Paleozoic, three are restricted to Devonian, seventeen are known from post-Devonian, and forty-nine from Devonian or earlier strata.

ACKNOWLEDGMENTS

This study was made possible by Professor E. C. Case, who generously lent the collections of Devonian Trepostomata in the Museum of Paleontology of the University of Michigan. Professor G. M. Ehlers provided additional specimens, supplied essential stratigraphic information, and read the manuscript.

Dr. R. S. Bassler placed at the writer's disposal the bryozoan collections in the United States National Museum and granted permission to describe several specimens collected by Rominger from the Traverse rocks of Michigan. He also gave unreservedly of his time and knowledge of the Trepostomata in verifying the results of this study, made valuable suggestions concerning the morphology and relationships of Devonian genera, offered much helpful advice for preparation of illustrations, and criticized the plates.

Throughout the preparation of this study the writer has enjoyed the constant encouragement and advice of Professor Charles Deiss, of Montana State University, who has shown a keen interest in the work and given untiring help and criticism in preparing the manuscript and plates.

Professor W. H. Shideler, of Miami University, lent a collection of Ordovician Trepostomata for comparative study and gave helpful suggestions on the morphology of the Trepostomata. Professor A. H. McNair, of Dartmouth College, offered valuable stratigraphic information.

Montana State University provided laboratory facilities and stenographic service.

To each of these men and institutions the writer is deeply indebted and here extends her appreciation and thanks.

RÉSUMÉ OF PREVIOUS STUDIES

The literature on Devonian Trepostomata is meager in comparison with that of the Ordovician, the Silurian, and the Carboniferous.

Hall, Winchell, Rominger, Nicholson, and Ulrich described many Devonian species from New York and a few from scattered localities. As neither Winchell nor Hall used thin sections for study, their work is inadequate. Devonian Trepostomata were described by Bassler in 1911 and by Ulrich and Bassler in 1913 from Wisconsin and Maryland respectively. Few species have been described by other workers.

A review of the literature shows that the Trepostomata from the Traverse of Michigan have received scant attention.

Winchell (1866, pp. 88–90) described, but did not figure, three species, which appear to be Trepostomata from the Petoskey region. Of these *Callopora punctillata* was assigned to *Lioclema* by Nickles and Bassler (1900, p. 306), and the generic identities of *Chaetetes hamiltonensis* and *Chaetetes microscopica* are still undetermined. Because the descriptions are inadequate and the types are unsectioned, other specimens cannot be identified with Winchell's species.

Ulrich (1890, pp. 408, 433) published two species from the Alpena region: *Monticulipora winchelli*, now assigned to *Atactotoechus*, gen. nov., and *Batostomella obliqua*, which has been selected as the genotype of *Eridotrypella*, gen. nov.

Rominger (1892, p. 60) mentioned the occurrence of *Monotrypa tennis* (*sic*) (Hall) in the Devonian at Long Lake, near Alpena.

James (1895, p. 87) described *Monticulipora hamiltonense* from the Alpena region. Nickles and Bassler (1900, p. 329) list this species as a synonym of *Monticulipora winchelli* Ulrich.

Bassler (1911b, p. 61) described *Orbignyella tenera* from the Petoskey region. This species is now assigned to *Anomalotoechus*, gen. nov.

Pohl (1930, p. 31) listed *Monotrypella ohioensis* Stewart as a species common to the Traverse of Ohio and the Bell shale of Michigan. Stewart's species is now assigned to *Leptotrypella*.

SPECIES	Bell shale, lower part; loc. 31	Bell shale, upper part; loc. 38	Ferron Point formation, lower part; loc. 38	Ferron Point formation, upper part; loc. 49	Ferron Point formation; loc. 29	Genshaw formation; loc. 14 of A. W. Grabau	Genshaw formation; loc. 50	Genshaw formation; Long Lake, near Alpena (locality of Carl Rominger)	Alpena limestone, upper part; loc. 40	Dock Street clay; loc. 53
Anomalotoechus tuberatus, sp. nov.....		+								
typicus, sp. nov..................					+					
Atactotoechus bifoliatus, sp. nov.......										+
casei, sp. nov....................										
creber, sp. nov...................										
limbatus, sp. nov.................										
spissus, sp. nov..................										
typicus, sp. nov..................										
winchelli (Ulrich)................										
Calacanthopora prima, sp. nov........										
Chondraulus densus, sp. nov..........										
granosus, sp. nov................		+								
petoskeyensis, sp. nov............										
Cyclopora ? lunata, sp. nov............			+							
Cyphotrypa ? maculosa, sp. nov........						+				
traversensis, sp. nov.............				+		+				
? unica, sp. nov..................	?+			+						
Discotrypa vera, sp. nov..............	+									
Dyoidophragma serratum, sp. nov.....										?+
typicale, sp. nov................										
Eostenopora compressa, sp. nov........		+								
picta, sp. nov...................		+							+	
primiformis, sp. nov.............										+
tenuimuralis, sp. nov............	+	+								
? villosa, sp. nov................		+								
Eridocampylus aculeatus, sp. nov......										
anceps, sp. nov..................				+						
laxatus, sp. nov.................		?+	+							
mollis, sp. nov..................										
multitabulatus, sp. nov...........				+						
obliquus, sp. nov................				?+						+
summus, sp. nov.................										
ulrichi, sp. nov..................				+						
Eridotrypella brevis, sp. nov..........	+				+					
devonica, sp. nov...............										
granosa. sp. nov................				+						
hybrida, sp. nov.................										

CHART

SPECIES	Norway Point formation; loc. 46	Norway Point formation; loc. 47	Potter Farm formation, lower part; loc. 68	Potter Farm formation; loc. 37	Potter Farm formation; loc. 42	Partridge Point formation; loc. 35	Gravel Point stage (formation), lower part; Petoskey (locality of Carl Rominger)	Gravel Point stage (formation); bed 3, zone 6 ("upper blue shale"); loc. 9	Gravel Point stage (formation); bed 3, zone 6 ("upper blue shale"); loc. 17	Petoskey formation, lower part; loc. 12
Anomalotoechus tuberatus, sp. nov.										
typicus, sp. nov.										
Atactotoechus bifoliatus, sp. nov.										
casei, sp. nov.									+	
creber, sp. nov.		+								
limbatus, sp. nov.								+		
spissus, sp. nov.	+	+								
typicus, sp. nov.	+	+								
winchelli (Ulrich)		+								
Calacanthopora prima, sp. nov.								+		
Chondraulus densus, sp. nov.				+						
granosus, sp. nov.										
petoskeyensis, sp. nov.							+			
Cyclopora ? lunata, sp. nov.										
Cyphotrypa ? maculosa, sp. nov.										
traversensis, sp. nov.										
? unica, sp. nov.						?+				
Discotrypa vera, sp. nov.										
Dyoidophragma serratum, sp. nov.		+								
typicale, sp. nov.								+		
Eostenopora compressa, sp. nov.										
picta, sp. nov.										
primiformis, sp. nov.										
tenuimuralis, sp. nov.										
? villosa, sp. nov.										
Eridocampylus aculeatus, sp. nov.								+		
anceps, sp. nov.										
laxatus, sp. nov.										
mollis, sp. nov.			+							
multitabulatus, sp. nov.										
obliquus, sp. nov.		+							?+	
summus, sp. nov.									+	
ulrichi, sp. nov.										
Eridotrypella brevis, sp. nov.										
devonica, sp. nov.				+	+					
granosa, sp. nov.	+									
hybrida, sp. nov.								+		

SPECIES	Bell shale, lower part; loc. 31	Bell shale, upper part; loc. 38	Ferron Point formation, lower part; loc. 38	Ferron Point formation, upper part; loc. 49	Ferron Point formation; loc. 29	Genshaw formation; loc. 14 of A. W. Grabau	Genshaw formation; loc. 50	Genshaw formation; Long Lake, near Alpena (locality of Carl Rominger)	Alpena limestone, upper part; loc. 40	Dock Street clay; loc. 53
Eridotrypella minuta, sp. nov..........					+					
obliqua (Ulrich)................			?+	+						
simplex, sp. nov................		?+		+	?+					
sinuosa, sp. nov.................										
spinifera, sp. nov................		+			?+					
valida, sp. nov..................		+		+	+					
vilis, sp. nov...................										
Leptotrypa? nicholsoni, sp. nov.......			+							
? spinifera, sp. nov..............				+						
Leptotrypella aequabilis, sp. nov.......	+		+	+		+				
gemmata, sp. nov...............		+								
magninodosa, sp. nov............				+		+				
moniliformis (Nicholson).........										+
ohioensis (Stewart).............	+	+				+				
parva, sp. nov...................										
pellucida, sp. nov...............				+		+				
undans, sp. nov.................				+		?+				
varia, sp. nov..................		+				?+				
Liociema alpenense, sp. nov..........			?+						+	
attenuatum, sp. nov.............										
incompositum, sp. nov...........										
passitabulatum, sp. nov..........										
traversense, sp. nov.............				+		+				
Microcampylus angularis, sp. nov......						+				
granosus, sp. nov...............										
minutus, sp. nov................									+	
multitabulatus, sp. nov..........						+				
ovatus, sp. nov.................				+		?+				
tenuis, sp. nov..................						?+				
traversensis, sp. nov............				+		+				
typicus, sp. nov.................				+		?+				
Stenoporella? devonica, sp. nov........		+								
Stereotoechus typicus, sp. nov.........										
Stigmatella alpenensis, sp. nov.........							+			
hybrida, sp. nov................		+								
Trachytoechus romingeri, sp. nov......								+		
typicus, sp. nov............		+								

(*Concluded*)

SPECIES	Norway Point formation; loc. 46	Norway Point formation; loc. 47	Potter Farm formation, lower part; loc. 68	Potter Farm formation; loc. 37	Potter Farm formation; loc. 42	Partridge Point formation; loc. 35	Gravel Point stage (formation), lower part; Petoskey (locality of Carl Rominger)	Gravel Point stage (formation); bed 3, zone 6 ("upper blue shale"); loc. 9	Gravel Point stage (formation); bed 3, zone 6 ("upper blue shale"); loc. 17	Petoskey formation, lower part; loc. 12
Eridotrypella minuta, sp. nov......										
obliqua (Ulrich).............					?+					?+
simplex, sp. nov............	+							+	+	
sinuosa, sp. nov..............									+	
spinifera, sp. nov............										
valida, sp. nov..............										
vilis, sp. nov................								+	?+	
Leptotrypa ? nicholsoni, sp. nov...										
? spinifera, sp. nov...........										
Leptotrypella aequabilis, sp. nov...		+								
gemmata, sp. nov............										
magninodosa, sp. nov.........										
moniliformis (Nicholson).....										
ohioensis (Stewart)..........										
parva, sp. nov..............								+		
pellucida, sp. nov............										
undans, sp. nov..............										
varia, sp. nov................										
Lioclema alpenense, sp. nov.......										
attenuatum, sp. nov..........			+							
incompositum, sp. nov........						+				
passitabulatum, sp. nov.......									+	
traversense, sp. nov..........		+	?+					+	?+	
Microcampylus angularis, sp. nov..										
granosus, sp. nov............								+	+	
minutus, sp. nov.............										
multitabulatus, sp. nov.......										
ovatus, sp. nov..............										
tenuis, sp. nov...............			+					?+		
traversensis, sp. nov..........								?+		
typicus, sp. nov..............										
Stenoporella ? devonica, sp. nov....										
Stereotoechus typicus, sp. nov.....	+	+						+		
Stigmatella alpenensis, sp. nov.....										
hybrida, sp. nov.............										
Trachytoechus romingeri, sp. nov.										
typicus, sp. nov..............										

Of the species previously reported from Traverse strata only three were identified in the collections studied: *Atactotoechus winchelli* (Ulrich), *Eridotrypella obliqua* (Ulrich), and *Leptotrypella ohioensis* (Stewart).

CORRELATIONS BASED ON EVIDENCE FROM TREPOSTOMATA

The species described in this paper are known only from the Traverse of Michigan, except *Leptotrypella ohioensis* (Stewart), from the Silica shale of northwestern Ohio, and *Leptotrypella moniliformis* (Nicholson), from the Hamilton of Ontario. Although a number of the same Devonian genera are present in Iowa, Maryland, Ohio, Ontario, New York, and Michigan, species are not identical. *Leptotrypella ohioensis* (Stewart) in the Bell shale and *Leptotrypella moniliformis* (Nicholson) in the Dock Street clay indicate a temporal correlation of the Traverse rocks in the Alpena region with the Devonian of Ontario and northwestern Ohio.

As is indicated in the faunal chart, fifty-four of the seventy-four species of Trepostomata described are known from single localities. Most of the remaining twenty species are confined to one formation or parts of two contiguous formations. The few long-range species include *Leptotrypella aequabilis*, sp. nov., which is found in the Bell shale, Ferron Point, Genshaw, and Norway Point formations; *Lioclema traversense*, sp. nov., in the Ferron Point, Genshaw, Norway Point, Gravel Point, and, doubtfully, Potter Farm formations; and *Eridotrypella simplex*, sp. nov., in the Ferron Point, Norway Point, Gravel Point formations, and doubtfully in the Bell shale.

Eridotrypella simplex, sp. nov., *Lioclema traversense*, sp. nov., and *Stereotoechus typicus*, sp. nov., are the only species definitely known to occur in both the Charlevoix–Petoskey and the Alpena regions. The first two are long-range species. *Stereotoechus typicus*, on the other hand, was found only in the Norway Point and Gravel Point formations. Consequently species of Trepostomata offer no evidence for correlating formations on the eastern and western sides of the Southern Peninsula. Three genera, however, suggest a correlation. *Dyoidophragma* and *Stereotoechus*

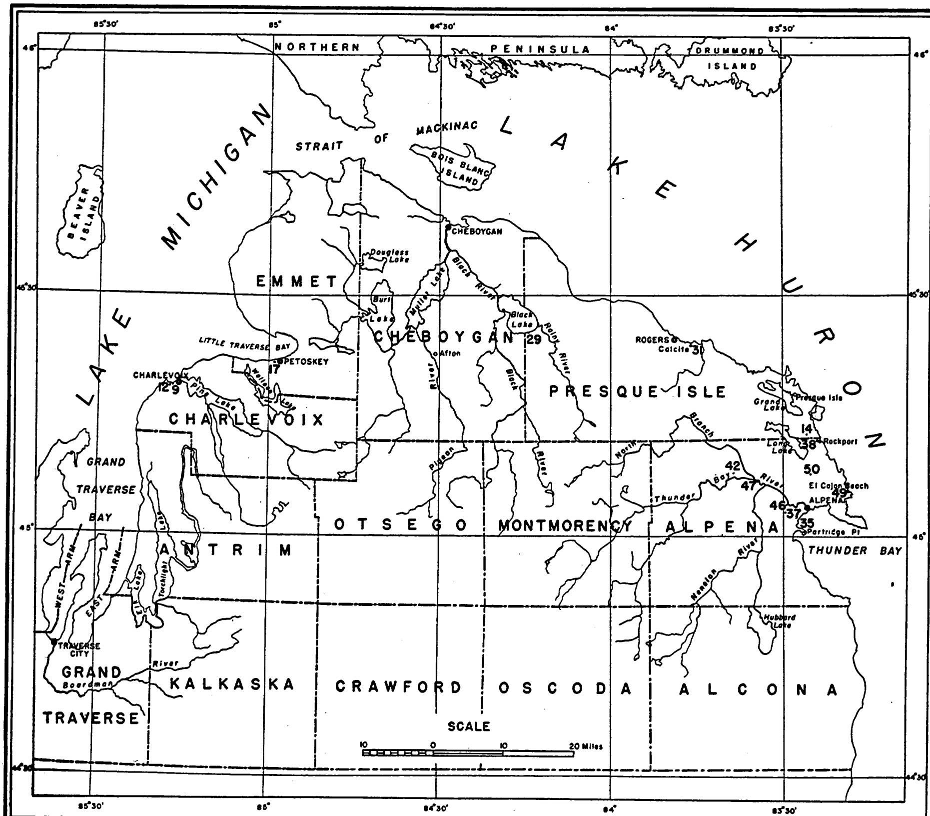

FIG. 1. Index map of fossil localities
(Localities 40, 53, and 68 are within Alpena.)

occur in the Norway Point formation and in the "upper blue shale" of the Gravel Point formation. *Atactotoechus* is represented by two species from the "upper blue shale" of the Gravel Point formation, four from the Norway Point formation, and one from the Dock Street clay. The fact that *Atactotoechus, Dyoidophragma,* and *Stereotoechus* do not occur below the Dock Street clay in the Alpena region and are not known from the Afton–Black Lake region, but are present in the upper part of the Gravel Point formation in the Charlevoix–Petoskey region, seems to substantiate the conclusions of McNair (1937, p. 163) that the Traverse of the Charlevoix–Petoskey region is represented in the Alpena region by strata younger than the Alpena limestone.

REGISTER OF FOSSIL LOCALITIES

Species of Trepostomata described in this paper were collected from the localities indicated on the accompanying map (Fig. 1). With the exception of locality 14 of Grabau (1902, p. 175) all locality numbers were assigned in the course of field studies made by the Michigan Geological Survey expedition of 1926 or by the Museum of Paleontology of the University of Michigan. The localities at which Rominger collected two of the species described are not definitely known. The precise geographic location of the other Traverse exposures is given in the following register:

LOCALITY

9 Abandoned quarry No. 1 of Charlevoix Rock Products Co., SE. ¼ SE. ¼ Sec. 28, T. 34 N., R. 8 W., about three quarters of a mile west of Charlevoix city line.

12 Abandoned quarry No. 2 of Charlevoix Rock Products Co., SW. ¼ Sec. 28, T. 34 N., R. 8 W., about a quarter of a mile southwest of locality 9.

14 (Locality of A. W. Grabau.) Rabiteau farm, NW. ¼ Sec. 35, T. 33 N., R. 8 E., Presque Isle County.

17 Antrim Lime Co. quarry, western part of Petoskey, SE. ¼ Sec. 1, T. 34 N., R. 6 W., Emmet County.

29 Abandoned quarry on shore of Black Lake, half a mile west of Onaway State Park, Sec. 7, T. 35 N., R. 2 E., Presque Isle County.

31 Quarry of Michigan Limestone and Chemical Co., near Rogers City, Presque Isle County.

35 Partridge Point, on Thunder Bay, Lake Huron, about four miles south of Alpena.

37 Shallow abandoned quarry a few hundred feet north of U.S. Highway No. 23 in SE. ¼ SW. ¼ Sec. 19, T. 31 N., R. 8 E., about two miles west of Alpena.

38 Abandoned quarry of Kelly Island Lime and Transport Co., Rockport, Sec. 6, T. 32 N., R. 9 E., Alpena County.

40 Quarry of Michigan Alkali Co. at Alpena.

42 Hillside along Long Rapids road about half a mile east of west line of Sec. 31, T. 32 N., R. 7 E., nearly at Orchard Hill, Alpena County.

46 Shale bank on south side of Thunder Bay River, approximately one mile east of Four Mile Dam, Alpena County.

47 Shale bank on south side of Thunder Bay River, at Seven Mile Dam, Sec. 1, T. 32 N., R. 7 E., Alpena County.

49 Abandoned quarry of El Cajon Portland Cement Co. at El Cajon Beach, Sec. 10, T. 31 N., R. 9 E., Alpena County.

50 Point on Wessel road approximately six miles north of Alpena, 1½ miles north of township line.

53 Quarry of Thunder Bay Quarries Co. at Alpena.

68 Small abandoned shale pit in the Alpena Cemetery in SW. ¼ Sec. 21, T. 31 N., R. 8 E., about one mile west of center of Alpena.

TAXONOMY AND RELATIONSHIPS OF DEVONIAN TREPOSTOMATA

Devonian Trepostomata have not received so careful morphologic and systematic study as have Ordovician, Silurian, and Carboniferous forms upon which the existing classification was established. Ulrich and Bassler (1904, p. 43), in their *Revision of the Paleozoic Bryozoa,* stated that Devonian Trepostomata are difficult to classify, but made a few suggestions as to the systematic position of this group. Since 1904 the problem has received little attention. This study of Trepostomata from the Traverse group of Michigan has resulted in several modifications of the old classification, which for two reasons was inadequate:

(1) Few Devonian Trepostomata have been described except those superficially treated by Hall. Of the seventy-one genera listed as valid by Bassler (1934b, pp. 17–19) seventeen were believed to contain Devonian species. Of these seventeen genera only five (*Callotrypa, Diplostenopora, Leptotrypella, Petalotrypa,* and *Trematella*) were defined upon Devonian genotypes, the other

twelve being from the Ordovician, the Silurian, or the Carboniferous periods. Consequently Devonian species have been doubtfully and at times erroneously assigned to some of these genera.

(2) The relationships of numerous Devonian forms are obscure. Characters diagnostic of the families Prasoporidae, Heterotrypidae, Amplexoporidae, and Batostomellidae intermingle. If specimens possess structures diagnostic of more than one genus or family, students may interpret differently the relative importance of such characteristics. In this way closely allied species may be referred to different genera, families, or even suborders.

Devonian Trepostomata form two natural groups. The first, apparently senescent, is allied to Ordovician and Silurian Heterotrypidae, Prasoporidae, Amplexoporidae, Halloporidae, and Trematoporidae. The second group, possibly primitive, is allied to the Carboniferous Batostomellidae. Few Devonian species, however, can be assigned to genera typical of the Ordovician and the Silurian or of the Carboniferous, because the classification was established largely for pre- and post-Devonian Trepostomata and made no provision for bryozoans which are apparently either racially senescent representatives of Ordovician and Silurian genera or primitive generalized forms allied or ancestral to Mississippian and Pennsylvanian genera. Strongly thickened walls, zones of intermittent thickening, thick laminated diaphragms, and loss of mesopores are characters produced by excessive deposition of calcite, apparently a phylogenetic tendency, which was also observed by Lang (1919, p. 105) in the Cheilostomata. Such characters occur in many Devonian species allied to the early Paleozoic Heterotrypidae, Prasoporidae, and Amplexoporidae. Strongly thickened and beaded walls are characteristic of many genera of Carboniferous Batostomellidae, and likewise seem to have been produced by excessive calcification. On the other hand, Devonian Batostomellidae frequently have uniformly thickened walls, well-developed mesopores, and complete diaphragms, which are generalized characters typical of racially primitive stocks. Consequently these forms may be considered ancestral to Carboniferous genera. Such primitive and senescent characters have been used indiscriminately in defining Ordovician and Silurian as well as Carboniferous genera.

Devonian forms having unusual combinations of family and generic characters could not be assigned to earlier or later genera unless the older definitions should be modified. Such revision would only result in confusion and diminish the value of Trepostomata for stratigraphic purposes. Consequently the new family Atactotoechidae and eleven new genera had to be defined. Most of the Middle Devonian Trepostomata can be assigned to three families, the Heterotrypidae, the Atactotoechidae, and the Batostomellidae, but the systematic relationships of a few genera are so involved that additional study may necessitate some taxonomic changes.

Of the six families which attained their maximum in the Ordovician and the Silurian, the Constellaridae and the Prasoporidae are unknown in Devonian strata, and a few species appear to belong to *Hallopora* Bassler of the Halloporidae, *Monotrypa* Nicholson and *Stromatotrypa* Ulrich of the Trematoporidae, and *Discotrypa* Ulrich, *Petalotrypa* Ulrich, and *Rhombotrypa* Ulrich and Bassler of the Amplexoporidae.

In contrast, the family Heterotrypidae contains more individuals than any other group of Trepostomata. Some of these specimens belong to typical Eopaleozoic genera — *Cyphotrypa* Ulrich and Bassler, *Leptotrypa* Ulrich, *Stigmatella* Ulrich and Bassler, and, doubtfully, *Dekayia* Milne-Edwards and Haime — but most are species of genera known only from the Devonian — *Leptotrypella* Vinassa de Regny, *Eridocampylus*, gen. nov., and *Eridotrypella*, gen. nov. These three genera differ from Ordovician and Silurian Heterotrypidae in having strongly thickened walls in the mature zone, no mesopores, and, in some species, intermittently thickened walls, characters which indicate excessive calcification. *Leptotrypella* appears to have been derived from *Heterotrypa*. Species of *Eridotrypella* intergrade with those of *Leptotrypella* and *Eridocampylus*.

The term "heterophragm" is proposed for small cystoid structures which project from the zooecial walls and are composed of strongly thickened laminated tissue similar to and continuous with that of the walls. The upper surface may be either smooth or corrugated. Heterophragms resemble in shape the open cystiphragms present in some Prasoporidae, but differ in that the cysts are composed of much thicker tissue, attached to the walls through a smaller space (generally less than one eighth of the zooecial diameter), and never superimposed to form a series of vesicles. Heterophragms are diagnostic of four Devonian genera: *Eridocampylus* of the Heterotrypidae; *Trachytoechus*, gen. nov., and an undescribed genus of the Batostomellidae; and another undescribed genus of the Trematoporidae.

The family Atactotoechidae is established for the new Devonian genera, *Anomalotoechus* and *Atactotoechus*, which are allied to Ordovician and Silurian Trepostomata, but have structures diagnostic of several different families. Although the presence of cystiphragms obviously suggests a relationship with the Prasoporidae, the walls of the Atactotoechidae are irregularly or intermittently thickened, and may be similar in structure to those of the Batostomellidae, the Heterotrypidae, or the Amplexoporidae. Such variation in wall structure within a group characterized by other unusually homogeneous characters precludes assigning these genera to any previously defined family. As characters diagnostic of the families Prasoporidae, Heterotrypidae, Batostomellidae, and Amplexoporidae intermingle in the Atactotoechidae, the systematic relationships of these Devonian Trepostomata are most obscure. The fact that cystiphragms occur in all members of the group, regardless of the type of wall structure, implies that the Atactotoechidae were derived from Eopaleozoic Prasoporidae. Further, the intermittently or irregularly thickened walls indicate phylogenetic senescence. Therefore the Devonian Atactotoechidae may represent the ultimate result of prasoporid evolution.

Although the family Batostomellidae reached its maximum development in the Carboniferous, genera of this family constitute an important element in Devonian trepostomatous faunas. The few Devonian species reported by earlier workers were assigned to *Batostomella* Ulrich, *Bythopora* Miller and Dyer, *Callotrypa* Hall and Simpson, *Diplostenopora* Ulrich and Bassler, *Lioclema* Ulrich, and *Trematella* Hall. Relatively few Batostomellidae are known from the Ordovician and the Silurian. Species of *Lioclema* and *Batostomella* are described from both pre- and post-Devonian rocks, *Bythopora* and *Callotrypa* are reported from Devonian or older strata, and *Diplostenopora* and *Trematella* from the Devonian only.

Seven new genera, *Calacanthopora, Chondraulus, Dyoidophragma, Eostenopora, Microcampylus, Stereotoechus,* and *Trachytoechus,* are defined to accommodate Devonian species which cannot be assigned to any described genera, but which appear to be allied to some genera now included in the Batostomellidae. Unfortunately, this family contains a heterogeneous assemblage of genera. Revision of the Batostomellidae will probably result in the separation of most of these genera into three sections of at least subfamily rank and the assignment of a few genera to other families. As these taxonomic changes cannot be made until the Carboniferous Trepostomata are studied and evaluated, the new Devonian genera are assigned to the Batostomellidae because this family contains structurally similar forms.

Lioclema is well represented in Devonian strata, but as yet no species of the many allied genera described from the Carboniferous have been reported. The new genus *Calacanthopora* is closely related, however, to *Dyscritella* Girty and undoubtedly belongs to the "*Lioclema*" section of the Batostomellidae.

Dyoidophragma, Eostenopora, and *Stereotoechus* indisputably are members of the stenoporoid section. These three genera are characterized by moderately numerous complete diaphragms and walls more uniform in thickness than those of Carboniferous stenoporoids. *Dyoidophragma* is apparently ancestral to *Stenophragma. Eostenopora* and *Stereotoechus* are close to structural types now included in *Stenopora* auct. (p. 242).

The aberrant genus *Trachytoechus* is a doubtful member of this group. Its irregularly thickened walls and acanthopores suggest those of some stenoporoids, and species are close to *Eostenopora ? villosa,* sp. nov. The wall structure of *Trachytoechus,* however, is similar to that of Devonian specimens now assigned to *Monotrypa. Chondraulus,* another genus of uncertain relationships, resembles the typical Devonian stenoporoid *Eostenopora* in having intermittently thickened walls and acanthopores similar in structure and distribution, but differs in having the walls of both zooecia and acanthopores composed of extremely granular tissue. Such granularity is also characteristic of the zooecial walls in *Stenoporella* Bassler. Thus *Chondraulus* seems to be intermediate between *Eostenopora* and *Stenoporella.*

Microcampylus is more closely allied to the "*Batostomella*" section than to the "*Stenopora*" section of the Batostomellidae. This new genus resembles *Batostomella* in having walls and acanthopores of similar structure, well-developed mesopores, and relatively few complete diaphragms, but differs in having numerous minute mural spines similar to those diagnostic of *Stenoporella.* Strangely, *Stenoporella? devonica*, sp. nov., which has moderately numerous complete diaphragms as well as mural spines but lacks mesopores is intermediate between *Microcampylus* and Mississippian species of *Stenoporella.* Consequently *Microcampylus* establishes a link between the "*Stenopora*" and the "*Batostomella*" sections of the Batostomellidae.

DESCRIPTIONS OF FAMILIES, GENERA, AND SPECIES

The types of species described in this paper are preserved in the Museum of Paleontology of the University of Michigan.

Order TREPOSTOMATA Ulrich

Family **ATACTOTOECHIDAE,** fam. nov.

Definition. — Zoaria multiform. Walls usually amalgamate, occasionally integrate, irregularly or intermittently thickened; structure laminated in zones of thickening, granular in thin-walled parts of zoarium. Cystiphragms present in mature zone. Diaphragms and cystiphragms generally more numerous opposite zones of wall thickening. Mesopores absent. Acanthopores often absent; when present, composed of nongranular laminated tissue.

Remarks. — The family Atactotoechidae includes several Devonian Trepostomata previously assigned doubtfully to *Monticuliporella* Bassler, 1934 [*Monticulipora* auct.], and *Orbignyella* Ulrich and Bassler, 1904. The presence of cystiphragms suggests relationship with genera of early Paleozoic Prasoporidae. Comparison of the wall structure characteristic of the two families shows, however, that the Devonian forms are generically different and cannot be included in the family Prasoporidae. The irregular granularity of the thickened walls in the mature zone of *Monticuliporella* distinguishes it from genera of the Atactotoechidae, in which the thickened walls are always laminated. The Atactotoechidae were possibly derived from *Orbignyella.* In the genotype, *O. sublamellosa* Ulrich and Bassler, 1904, and other Ordovician and Silurian species, the walls are filled with a granular deposit which obscures the laminated structure. The walls of some zooecia in *O. sublamellosa* are intermittently thickened and occasionally beaded, but this character is not constant or diagnostic of the genus. The new genus *Anomalotoechus* is established for Devonian Trepostomata which resemble *Orbignyella,* but differ in that the walls are composed of clear nongranular tissue. The dark dividing line in the walls of a few species of *Atactotoechus,* gen. nov., is a characteristic of integrate Trepostomata, and is not to be confused with the granular deposit in the walls of the amalgamate genus *Orbignyella.*

Wall structure is probably the most reliable character for separating trepostomatous families. The Devonian forms included in the Atactotoechidae comprise a homogeneous family, which is established to accommodate genera and species possessing characters of four families of Eopaleozoic Trepostomata. Although the amalgamate intermittently thickened walls of some forms and the integrate walls of others suggest relationships with the Batostomellidae, the Heterotrypidae, and the Amplexoporidae, cystiphragms indicate derivation from the Prasoporidae.

The family Atactotoechidae now contains *Anomalotoechus* and *Atactotoechus.* Two other undescribed genera are known.

Genus **ANOMALOTOECHUS,** gen. nov.

Definition. — Zoarium ramose, incrusting, or massive. Walls irregularly thickened, thickening not developed at regular intervals in zoarium; structure granular in thin parts, laminated, clear, nongranular in thickened parts. Diaphragms straight or curved. Cystiphragms usually not well defined. Diaphragms and cystiphragms more closely arranged in thick-walled parts of zooecia, zonal crowding generally absent. Mesopores absent. Acanthopores numerous, well defined, laminated.

Genotype. — *Anomalotoechus typicus*, sp. nov.

Name. — ἀνώμαλος, "uneven"; τοῖχος, "wall."

Remarks. — *Anomalotoechus* differs from *Atactotoechus*, gen. nov., in the absence or the paucity of zones of periodically thickened walls and of crowded bands of diaphragms and cystiphragms, and in having numerous well-defined acanthopores; and from *Orbignyella* Ulrich and Bassler in having irregularly thickened walls composed of nongranular tissue.

Orbignyella tenera Bassler (1911b, p. 61), *Monticulipora monticula* White (1876, p. 27), which was assigned to *Orbignyella* by Bassler (1911b, p. 61), and probably *Monticulipora* (?) *marylandensis* Ulrich and Bassler (1913b, p. 123) are species of *Anomalotoechus.* Other undescribed species in the United States National Museum are known from the Prout limestone west of Sandusky, Ohio, and from the Ludlowville near Arkona, Ontario.

Anomalotoechus tuberatus, sp. nov.

(Pl. I, Figs. 1–3)

Description. — Zoarium incrusting; 0.4 to 1 mm. or more in thickness. Prominent conical monticules composed of larger zooecia 3 mm. apart, measured from center to center.

Zooecia polygonal; average diameter of intermonticular zooecia 0.23 mm.; eight in 2 mm.; diameter of monticular zooecia 0.3 mm. or more; six and one half or seven in 2 mm., counting from center of monticule. Walls strongly thickened in monticules, thin in intermonticular areas. Mesopores absent; occasionally a few small zooecia in monticules. Acanthopores laminated; central cavity usually filled with dense tissue near surface; in intermonticular areas located at junctions of zooecial walls, small, less numerous than zooecia; in monticules larger and occasionally inflecting zooecia.

Immature zone short, zooecia direct through most of length. Walls in mature zone slightly irregular. Cystiphragms and straight or curved diaphragms one-third to one-half tube diameter apart in mature zone.

Remarks. — *Anomalotoechus tuberatus* is readily distinguished from other species of *Anomalotoechus* by its prominent monticules, thin incrusting zoarium, and more regularly thickened zooecial walls.

Holotype. — No. 19802.

Occurrence. — Bell shale; locality 38.

Anomalotoechus typicus, sp. nov.

(Pl. I, Figs. 4–7)

Description. — Zoarium composed of solid or hollow branches 5 to 10 mm. in diameter. Surface not marked by maculae, monticules, or groups of larger zooecia.

Zooecia polygonal or subpolygonal; of two sizes, diameter of small zooecia 0.15 to 0.2 mm., of large ones, 0.3 mm.; arrangement of large and small zooecia haphazard, grouping not observed; seven or eight in 2 mm. Mesopores absent. Acanthopores well defined, composed of laminated tissue; central cavity obscured by dense deposit at surface; those associated with large zooecia larger than acanthopores near small zooecia, moderately numerous, generally at or near junctions of zooecial walls.

Zooecia perpendicular to surface in mature zone. Walls irregularly thickened, occasionally beaded, thin at periphery, amalgamate, composed of nongranular laminated tissue. Straight complete diaphragms or poorly defined cystiphragms in mature zone; distribution variable, one or two in space equal to one tube diameter, more closely arranged in thick-walled parts of zooecia.

Remarks. — *Anomalotoechus typicus* differs from *A. tener* (Bassler) in having a ramose zoarium and larger zooecia; and from *A. monticulus* (White) in having a ramose zoarium, more and larger acanthopores, and fewer diaphragms. The incrusting zoarium and the prominent monticules composed of larger zooecia distinguish *A. tuberatus*, sp. nov., from *A. typicus*.

Holotype. — No. 19801.

Occurrence. — Ferron Point formation; locality 29.

Genus **ATACTOTOECHUS**, gen. nov.

Definition. — Zoarium ramose or massive. Walls intermittently thickened, thickened zones laminated, thin zones granular. Cystiphragms in mature and occasionally in immature zones, usually resemble slightly curved complete or incomplete diaphragms, but, occasionally, cysts are closed. Diaphragms and cystiphragms more numerous opposite thick-walled parts of zooecia. Intermittent thickening is a regular feature of zoarial growth, hence crowded bands of diaphragms and cystiphragms developed at intervals. Mesopores absent, but small zooecia occasionally present. Acanthopores laminated, few or absent, usually restricted to monticules or groups of larger zooecia.

Genotype. — *Atactotoechus typicus*, sp. nov.

Name. — ἄτακτος, "irregular"; τοῖχος, "wall."

Remarks. — Integrate species of *Atactotoechus* resemble species of *Amplexopora* Ulrich in the structure of the walls and the absence of mesopores, but differ in the absence or the slight development of acanthopores, the presence of cystiphragms, and the intermittent thickening of the walls. Amalgamate species of *Atactotoechus* are similar to species of *Eostenopora*, gen. nov., in the intermittently thickened walls and the arrangement of diaphragms, but differ in the almost complete absence of acanthopores and the presence of cystiphragms in the mature zone. The fact that some species of *Atactotoechus* have integrate and others amalgamate walls does not seem to be an adequate reason for placing in different families forms having other homogeneous structural characters.

Atactotoechus is compared with *Anomalotoechus*, gen. nov., on page 188.

Monticulipora winchelli Ulrich (1890, p. 408), *Chaetetes furcatus* Hall (1876, Pl. XXXVII, Figs. 1–5; Pl. XXXVIII, Figs. 6–9), and *C. fruticosus* Hall (1876, Pl. XXXVIII, Figs. 1–5) are now assigned to *Atactotoechus*.

Atactotoechus bifoliatus, sp. nov.

(Pl. I, Figs. 8–11)

Description. — Zoarium small bifoliate mass. Groups of large zooecia usually elevated into low monticules 3 to 4 mm. apart, measured from center to center.

Zooecia polygonal; average diameter of intermonticular zooecia 0.2 mm.; eight in 2 mm.; diameter of monticular zooecia 0.3 to 0.35 mm.; six in 2 mm., measured from center of monticule. Walls thin. Mesopores absent. Acanthopores not observed in tangential sections, but on surface of zoarium inconspicuous spines are observable at junctions of zooecial walls in monticules.

Zooecia direct from median lamina to surface, except where gently curved near edge of zoarium. Immature zone short, usually undifferentiated from mature zone. Walls thin, thickened at irregular intervals. Diaphragms more numerous than well-defined cystiphragms. Diaphragms straight or curved, complete or incomplete, one or two in thin-walled parts of zooecia in space equal to one tube diameter, three or four opposite thick-walled parts of zooecia. Bands of closely arranged diaphragms and cystiphragms less conspicuous in *Atactotoechus bifoliatus* than in other species of genus because immature region is short and walls are thickened irregularly instead of being in well-defined zones extending through zoarium at uniform intervals.

Remarks. — *Atactotoechus bifoliatus* differs from other species in the bifoliate zoarium. Except for the zoarium, *A. bifoliatus* resembles *A. casei,* sp. nov., in having a short immature and a long mature zone, amalgamate walls, and no acanthopores, but differs in having smaller zooecia in the monticules, more granular walls, and less-pronounced intermittent thickening.

Holotype. — No. 19803.

Occurrence. — Dock Street clay; locality 53.

Atactotoechus casei, sp. nov.

(Pl. II, Figs. 1–3)

Description. — Zoarium massive. Low monticules composed of groups of larger zooecia 4 to 5 mm. apart, measured from center to center.

Zooecia polygonal; average diameter of smaller zooecia 0.2 mm.; eight or nine in 2 mm.; maximum diameter of larger ones 0.4 mm.; six in 2 mm., measured from center of monticule. Walls of monticular zooecia two to four times thicker than walls of intermonticular zooecia. Mesopores absent; small zooecia occasionally present. Acanthopores absent.

Mature region long. Walls amalgamate, thin, irregularly thickened; thick-walled zones composed of laminated tissue separated by thin granular walls. Cystiphragms present, closely arranged throughout mature zone, crowded in thick-walled parts of zooecia. In some zooecia straight diaphragms one-third to one-fourth tube diameter apart, in others incomplete curved diaphragms or typical closed cystiphragms on one side of tube and straight diaphragms on other side.

Remarks. — *Atactotoechus casei* differs from *A. creber*, sp. nov., and *A. limbatus*, sp. nov., in having a massive zoarium. *A. winchelli* (Ulrich) resembles *A. casei* in mode of growth, but has integrate walls, vague acanthopores, less closely arranged diaphragms and cystiphragms, and less-pronounced intermittent thickening.

Holotype. — No. 19804.

Occurrence. — Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 17.

Atactotoechus creber, sp. nov.

(Pl. II, Figs. 8–11)

Description. — Zoarium ramose; diameter of subtriangular branches 20 to 25 mm. Slightly elevated groups of larger zooecia generally 3 mm. apart, measured from center to center.

Zooecia polygonal; diameter of smaller zooecia 0.2 to 0.25 mm.; eight in 2 mm.; diameter of larger ones approximately 0.3 mm.;

six and one half or seven in 2 mm., measured from center of group. Walls thin, amalgamate. Acanthopores few, vague, observed as inconspicuous spines at junctions of zooecial walls on surface.

Zooecia direct, bend gradually from immature to mature zone. Walls slightly thickened at wide intervals in immature region; thickenings more conspicuous, longer, and more frequent in mature zone. Cystiphragms few, restricted to mature zone. Diaphragms straight or curved, in axial region one to three in thick-walled part of zooecium, increasingly numerous as tubes bend toward periphery, in transition zone one to one and one-half tube diameters apart, in mature zone usually one-third tube diameter apart. Diaphragms and cystiphragms more closely arranged in zones of wall thickening, four or more in space equal to one tube diameter; crowded bands of diaphragms and cystiphragms conspicuous in longitudinal sections.

Remarks. — The close arrangement of diaphragms and cystiphragms throughout the mature zone is the most diagnostic character of this species. The ramose zoarium, the greater number of diaphragms, particularly in zones of wall thickening, the presence of vague acanthopores, and the less-marked difference in size of zooecia in monticules and intermonticular areas distinguish *Atactotoechus creber* from *A. casei,* sp. nov. *A. creber* differs from *A. spissus,* sp. nov., in having amalgamate walls and diaphragms restricted to zones of wall thickening in the axial region and more closely arranged and numerous in the mature region. Diaphragms are also numerous in the mature zone of *A. typicus,* sp. nov., and *A. winchelli* (Ulrich), but both these species are integrate.

Holotype. — No. 19805.

Occurrence. — Norway Point formation; locality 47.

Atactotoechus limbatus, sp. nov.

(Pl. II, Figs. 4–7)

Description. — Zoarium ramose; average dimensions of flattened branches 10 by 20 mm. Groups of larger and thicker-walled zooecia 3 to 4 mm. apart, measured from centers, generally elevated into low monticules.

Zooecia polygonal; average diameter of small ones 0.22 mm.;

eight or nine in 2 mm.; average diameter of large ones 0.28 mm.; six and one half in 2 mm., counting from center of monticule. Few abnormally small zooecia in monticules. Walls typically heterotrypid in structure, thin in intermonticular areas, much thicker in monticules. Minute hollow acanthopores at junctions of zooecial walls in intermonticular areas, larger in monticules.

Zooecia bend gradually from axial region to periphery, usually direct in short mature zone. Walls intermittently thickened in both immature and mature regions; thin, granular in immature region, considerably thickened and distinctly laminated in mature region. Diaphragms thin, straight or slightly curved in immature zone; both thick cystiphragms and thin, straight, complete or incomplete diaphragms in mature zone. One or two diaphragms in each zooecium just behind or opposite wall thickenings in immature zone; diaphragms and cystiphragms gradually become more numerous, usually one tube diameter apart in transition zone; two to four diaphragms in space equal to one tube diameter in short thick-walled mature zone; at least one thick laminated diaphragm or cystiphragm in outer mature zone of each zooecium.

Remarks. — Distinguishing characters of this species are the heterotrypid wall structure, the moderately numerous acanthopores, the extremely wide axial zone, and the conspicuous development of diaphragms and cystiphragms in a narrow band near the periphery. *Atactotoechus limbatus* differs from *A. casei*, sp. nov., in having an extremely short mature zone, acanthopores, fewer diaphragms, fewer well-defined cystiphragms, and smaller zooecia in the monticules; from *A. spissus*, sp. nov., in having fewer and less regularly arranged diaphragms in the immature zone, a shorter mature zone, larger acanthopores in the monticules, and amalgamate walls; and from *A. typicus*, sp. nov., and *A. creber*, sp. nov., in having a shorter mature zone and fewer diaphragms.

Holotype. — No. 19806.

Occurrence. — Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9.

Atactotoechus spissus, sp. nov.

(Pl. III, Figs. 1–4)

Description. — Zoarium ramose; maximum diameter 15 mm. Groups of larger zooecia usually slightly elevated, 3 mm. apart, measured from center to center.

Zooecia polygonal; diameter of average zooecia 0.2 to 0.25 mm.; seven or eight in 2 mm.; diameter of large ones approximately 0.3 mm.; usually six and one half or seven in 2 mm., measured from center of group of large zooecia. Walls moderately thick, integrate. Acanthopores small, inconspicuous, superficial, moderately numerous, usually near junctions of zooecial walls in sections close to surface.

Zooecia bend gradually from axial region to periphery, perpendicular to surface. Walls periodically thickened at wide intervals; structure of outer mature zone reproduced in wall thickenings of axial region. Thin straight or curved diaphragms one and one-half to two tube diameters apart in axial region except in zones of thickened walls, where four thicker diaphragms or cystiphragms usually occur in space equal to one tube diameter. Thin diaphragms and cystiphragms approximately one tube diameter apart in thin-walled parts of zooecia, three to five thick diaphragms and cystiphragms in space equal to one tube diameter in thick-walled zones in mature region.

Remarks. — Characteristic features of *Atactotoechus spissus* are the numerous diaphragms in the axial region and the conspicuous thick diaphragms and cystiphragms, which are more numerous and uniformly developed than in any other species of the genus. The differences between *A. spissus*, *A. creber*, sp. nov., *A. limbatus*, sp. nov., and *A. typicus*, sp. nov., are discussed in the remarks on pages 193, 194, and 196. *A. spissus* differs from *A. casei*, sp. nov., in having integrate walls, acanthopores, thick diaphragms, less well developed cystiphragms, and monticular and intermonticular zooecia of more uniform size. See page 198 for comparison of *A. winchelli* (Ulrich) with *A. spissus*.

Holotype. — No. 19807; figured specimen No. 19808.

Occurrence. — Norway Point formation; localities 46 and 47.

Atactotoechus typicus, sp. nov.

(Pl. III, Figs. 5–11)

Description. — Zoarium subfrondescent; average thickness 15 to 20 mm. Groups of larger zooecia elevated into strong monticules 2 to 4 mm. apart, measured from center to center.

Zooecia polygonal; diameters average 0.22 mm. in intermonticular areas; eight in 2 mm.; diameter of largest monticular zooecia 0.4 mm. or more; six in 2 mm., counting from center of monticule. Walls integrate, moderately thick. Mesopores absent; minute zooecia occasionally present. Acanthopores few, usually small, located at junctions of zooecial walls near surface, few larger ones in monticules.

Zooecia bend gradually from axial to mature region, perpendicular to periphery throughout most of mature zone. Walls thin and granular in immature region and in mature region between zones of wall thickening. Thickened parts of walls laminated and integrate. Diaphragms few in axial region; straight or curved diaphragms increase in frequency from younger part of axial region to periphery. Cystiphragms and straight or curved, complete or occasionally incomplete diaphragms numerous in mature zone, often thick and conspicuously laminated in zones of wall thickening. Diaphragms and cystiphragms approximately one tube diameter apart in older part of mature region; one-third to one-half tube diameter apart in zones of wall thickening and in outer mature region. Mature zone usually longer beneath monticules (Pl. III, Fig. 11).

Remarks. — The strong monticules and the longer mature region developed beneath monticules are the most easily recognized characters of *Atactotoechus typicus.* Integrate walls are also characteristic of *A. spissus,* sp. nov., and *A. winchelli* (Ulrich). *A. typicus* differs from *A. spissus* in having fewer diaphragms in the immature region, but more numerous and closely arranged diaphragms and cystiphragms in the mature region and larger monticular zooecia; from *A. winchelli,* in having a subfrondescent zoarium, prominent monticules, and crowded diaphragms in the mature region; and from *A. bifoliatus,* sp. nov., *A. casei,* sp. nov., *A. limbatus,* sp. nov., and *A. creber,* sp. nov., in the integrate walls.

Holotype. — No. 19809; figured specimen No. 19810.
Occurrence. — Norway Point formation; localities 46 and 47.

Atactotoechus winchelli (Ulrich)

(Pl. IV, Figs. 7–9)

1890. *Monticulipora winchelli* Ulrich, Geol. Surv. Ill., Vol. VIII, p. 408, Pl. XLV, Figs. 6–6a.
1895. *Monticulipora hamiltonense* J. F. James, Journ. Cincinnati Soc. Nat. Hist., Vol. XVIII, p. 87.

Original description. — "Zoarium consisting of a number of superimposed layers, the whole from two to twelve mm. in thickness, the layers from one-half to two mm. thick. Under surface provided with a coarsely wrinkled epitheca. Upper surface showing slightly elevated clusters of larger cells, about 4 mm. apart, measuring from center to center. Walls of zooecia rather thin. Zooecia angular, irregularly hexagonal, those of the normal size seven or eight in 2 mm., those in the clusters from one-third to one-half larger. Apertures angular. Cystiphragms closely set, very large, leaving but a small visceral cavity; occasionally infundibular. Acanthopores apparently wanting.

"Owing to the large crescentic shape and closeness of the cystiphragms, vertical sections present appearances which at first sight are very puzzling. The tubes seem to be tabulated very differently. This is due to the shape of the cystiphragms and their not being arranged in the same way in all the tubes. A vertical section of the zoarium cuts a few tubes through the center but most of them at a greater or less distance from it. Only when the section passes through the extremely small visceral cavity is the usual overlapping appearance of cystiphragms shown, and the narrow visceral cavity seen to be crossed by diaphragms. When the section does not pass through the visceral cavity, and it rarely does, the diaphragms seem curved or horizontal and to extend clear across the tube. The appearance presented by cutting through an infundibular cystiphragm is shown at the top of the third tube from the right, in figure 6a of plate XLV.

"The general features of the zoarium are decidedly like those of several Lower Silurian species of the genus. The large size of the cystiphragms, the consequent slenderness of the visceral cavity, and the apparent absence of acanthopores are marked peculiarities of the species.

"Position and locality: — Hamilton group, Thunder Bay, Mich."

Remarks. — *Monticulipora winchelli* Ulrich is an integrate species of *Atactotoechus.* Ulrich's original figures are inadequate. The hypotype (Pl. IV, Figs. 7–9) corresponds closely with the original description and with thin sections of the types in the United States National Museum. Zones of wall thickening are inconspicuous, but are indicated by bands of more closely arranged diaphragms. Vague superficial acanthopores are observable at the junctions of zooecial walls in tangential sections near the periphery.

Atactotoechus winchelli (Ulrich) has thinner walls and less conspicuous intermittent wall thickenings than have other species of the genus, except, possibly, *A. bifoliatus,* sp. nov. The walls of *A. bifoliatus,* however, are amalgamate, variation between the size of zooecia in the monticules and intermonticular areas is greater, and the zoarium is bifoliate. The differences between *A. winchelli* and *A. typicus,* sp. nov., are given on page 196. *A. winchelli* differs from *A. casei,* sp. nov., in having integrate walls, more widely separated diaphragms in the thin-walled parts of the zooecia, and monticular and intermonticular zooecia of more uniform size; from *A. spissus,* sp. nov., in having only thin and less closely arranged diaphragms and cystiphragms in the mature zone, a massive zoarium, and slightly thicker walls; and from *A. creber,* sp. nov., in having a massive zoarium, integrate walls, and fewer diaphragms.

Hypotype. — No. 19811.

Occurrence. — Norway Point formation; locality 47.

FAMILY HETEROTRYPIDAE ULRICH

1890. *Heterotrypidae* Ulrich, Geol. Surv. Ill., Vol. VIII, p. 371.
1900. *Heterotrypidae* Nickles and Bassler, Bull. U. S. Geol. Surv., No. 173, p. 31.
1904. *Heterotrypidae* Ulrich and Bassler, Smithsonian Misc. Coll., Vol. XLVII, p. 23.
1911. *Heterotrypidae* Bassler, U. S. Nat. Mus., Bull. 77, p. 204.

Definition from Bassler, 1911. — "The Heterotrypidae are amalgamate Trepostomata differing from the Monticuliporidae in having straight diaphragms instead of the curved cystiphragms. Clearly defined, frequently large, typical acanthopores are developed in every member of the family. Although the walls of adjoining zooecia are fused, this double wall persists as a distinct but thin unit which has a clean-cut individuality, as shown in sections."

Remarks. — Ulrich and Bassler (1904, p. 23) described the wall structure of the Heterotrypidae as follows: "As seen in tangential sections of well preserved specimens, the wall separating adjacent zooids consists (1) of a moderately wide, light-colored, transversely dotted or lined, central band, which represents the amalgamated original walls, and (2), bordering it on each side, a concentrically laminated, secondary deposit." This characteristic structure has proved to be an excellent criterion for identifying genera belonging to the family. More than half the typical specimens from Michigan sectioned for this study are assigned to four described and two new genera.

Genus CYPHOTRYPA Ulrich and Bassler

1904. *Cyphotrypa* Ulrich and Bassler, Smithsonian Misc. Coll., Vol. XLVII, p. 29.

Original definition. — "Massive *Heterotrypidae.* Zooecial walls thin, amalgamated, the central portion light-colored; tubes prismatic, with numerous well-developed diaphragms; mesopores wanting, acanthopores well developed."

Genotype. — *Leptotrypa acervulosa* Ulrich (1895, p. 318, Pl. XXVII, Figs. 24–25).

Cyphotrypa? maculosa, sp. nov.

(Pl. V, Figs. 17–18)

Description. — Zoarium composed of one or more incrusting layers; average thickness of layers 1 to 2 mm., of zoarium 3 mm. Monticules subsolid, composed of small thick-walled tubes, 3 mm. apart, measured from center to center.

Zooecia subpolygonal, larger near monticules; diameter 0.21

to 0.28 mm.; seven or eight in 2 mm. Walls greatly thickened in monticules. Mesopores absent. Small tubes in monticules probably modified zooecia. Acanthopores small and laminated, relatively few in intermonticular areas, moderately numerous in monticules.

Mature region short. Walls usually strongly thickened throughout length of zooecia. Diaphragms straight or occasionally curved, one-third to one tube diameter apart.

Remarks. — Assignment of *Cyphotrypa? maculosa* to the genus is doubtful because the zooecial walls are relatively thick. Subsolid monticules are typical of *Atactopora* Ulrich, 1879, but diaphragms are too numerous and acanthopores too few to warrant placing this species in that genus. *C.? maculosa* is the only species in the collection in which subsolid monticules are developed. It differs also from *C. traversensis*, sp. nov., in having fewer acanthopores and more closely arranged diaphragms. *C.? maculosa* is compared with *C.? unica*, sp. nov., on page 202.

Holotype. — No. 19812.

Occurrence. — Genshaw formation; locality 14 of A. W. Grabau.

Cyphotrypa traversensis, sp. nov.

(Pl. IV, Figs. 10–12)

Description. — Zoarium a low conical subcircular mass; average diameter 30 mm.; maximum thickness 9 mm. Epizoarium concentrically wrinkled. Groups of large zooecia present but not elevated into monticules; 3 to 3.5 mm. apart, measured from center to center.

Zooecia polygonal; diameter of ordinary tubes 0.21 to 0.25 mm.; nine in 2 mm.; diameter of large ones 0.3 to 0.35 mm.; maximum length 0.49 mm.; seven in 2 mm., counting from center of group. Mesopores absent; small zooecia occasionally present. Acanthopores well defined, small; some inflect zooecia; developed at or near junctions of zooecial walls.

Zooecia perpendicular to surface through most or all of length. Walls thin; slight irregular thickening occasionally developed; abnormally thickened near beginning of mature zone in medial part of zoarium. Diaphragms well defined, variably spaced, usually one to two tube diameters apart, except in youngest part of mature zone, where one or two occur in space equal to one tube diameter.

Remarks. — The irregularly thickened walls of this species are similar to those in *Stigmatella* Ulrich and Bassler, but the diaphragms are too numerous and strong to permit including *Cyphotrypa traversensis* in that genus. *C. corrugata* (Weller), described by Ulrich and Bassler (1913a, p. 269, Pl. XLII, Figs. 5–9) from Maryland, is either the same as *C. traversensis* or a closely allied species. *C. corrugata* Ulrich and Bassler is obviously different from *Monotrypa corrugata* Weller (1903, p. 223, Pl. XVIII, Figs. 1–5).

Cyphotrypa traversensis resembles *Stigmatella alpenensis*, sp. nov., in size of zooecia, form of zoarium, and number and size of acanthopores, but differs in having more closely arranged and numerous diaphragms.

Holotype. — No. 19813.

Occurrence. — Genshaw formation; locality 14 of A. W. Grabau. Ferron Point formation; locality 49.

Cyphotrypa? unica, sp. nov.

(Pl. V, Figs. 11–14)

Description. — Zoarium composed of one or two incrusting layers, each about 1 mm. in thickness. Conspicuous monticules 3 mm. apart, measured from center to center.

Zooecia polygonal; average diameter 0.25 to 0.3 mm.; six or seven in 2 mm. Mesopores absent. Acanthopores large, particularly prominent in monticules; central tubes filled with dense concentrically laminated deposits near surface; acanthopores thin-walled tubes approximately 0.07 mm. in diameter in deep tangential sections, often inflect zooecia (Pl. V, Fig. 13); developed at or near junctions of zooecial walls.

Zooecia direct, immature zone short. Walls moderately thick in mature zone. Diaphragms well defined, thin, average three to a zooecium, approximately one tube diameter apart.

Remarks. — This species is placed in *Cyphotrypa* instead of

Leptotrypa because the numerous acanthopores are strong and the diaphragms are moderately abundant for an incrusting form. A comparable species, *Leptotrypa? spinifera*, sp. nov., has prominent acanthopores, but so few diaphragms that it cannot be included in *Cyphotrypa*. The much thinner zoarium, the absence of monticules, the thicker walls, and the regular distribution of acanthopores are other characters which distinguish *L.? spinifera* from *Cyphotrypa? unica*. *C.? unica* differs from *C.? maculosa*, sp. nov. (also an incrusting species), in the absence of subsolid monticules and in having fewer diaphragms and more and larger acanthopores.

Holotype. — No. 19814.

Occurrence. — Ferron Point formation; locality 49. Doubtfully present in Bell shale at locality 31 and in Partridge Point formation at locality 35.

Genus **ERIDOCAMPYLUS**, gen. nov.

Definition. — Zoarium ramose. Wall structure heterotrypid-amalgamate; transverse rows of granules well defined. Walls gradually thickened from beginning of mature zone to surface. Zooecia oblique in immature zone, gradually bent toward surface in mature zone, nearly direct in peripheral region. Diaphragms in mature zone only, more closely arranged in early mature or transition region. Heterophragms in mature zone; upper surface smooth. Mesopores absent. Acanthopores usually granular, present near junctions of zooecial walls.

Genotype. — *Eridocampylus ulrichi*, sp. nov.

Name. — ἔρις, ἔριδος, "dispute"; καμπύλος, "hooked."

Remarks. — *Eridocampylus* is established for heterotrypid species resembling those of *Eridotrypella* in structure of walls and acanthopores and in arrangement of diaphragms, but having a sufficient number of smooth heterophragms to make these structures an obvious feature in longitudinal sections. Some of the specimens assigned to *Eridotrypella* have heterophragms. These structures, however, are so few or so poorly defined that observed occurrences apparently depend upon the coincidence that longitudinal sections cut a few zooecia containing heterophragms or a deposit resembling them. The fact that heterophragms may be present indicates that species of the two genera intergrade.

Eridocampylus aculeatus, sp. nov.

(Pl. VII, Figs. 1–3)

Description. — Zoarium ramose; average diameter 5 mm. Slightly elevated groups of larger zooecia generally 3 mm. apart, measured from center to center.

Zooecia subpolygonal or round; often inflected; diameter of ordinary zooecia 0.21 mm.; six to six and one half in 2 mm.; diameter of monticular zooecia 0.28 to 0.3 mm.; five to five and one half in 2 mm., measured from center of group of large zooecia. Few small tubes in monticules. Walls moderately thick; small granules arranged in transverse rows in medial band. Acanthopores composed of laminated tissue, usually solid at surface, large, numerous, located near junctions of zooecial walls.

Zooecia oblique in immature and early mature zones, abruptly bent in medial mature zone, perpendicular to surface in peripheral region. Thin crenulated walls of axial region gradually thickened from transition to mature zone. Two or three diaphragms approximately one tube diameter apart in transition, absent in late mature region. Heterophragms always present but not abundant.

Axial ratio 0.7 : 1.

Remarks. — Diagnostic characters of *Eridocampylus aculeatus* are the strong acanthopores, the restriction of diaphragms to the transition zone, and the short mature zone, in which zooecia are strongly bent toward the periphery. The most obvious difference between *E. aculeatus* and other species is the laminated structure of the relatively large acanthopores. *E. aculeatus* resembles *E. ulrichi*, sp. nov., *E. mollis*, sp. nov., and *E. laxatus*, sp. nov., in having a short mature region in which the tubes are usually strongly bent toward the periphery. *E. aculeatus* differs from *E. ulrichi* in having large laminated acanthopores and in lacking diaphragms in the younger mature zone; from *E. mollis* in having a larger zoarium, less granular walls, and laminated acanthopores; and from *E. laxatus* in having laminated acanthopores and zooecia which are not conspicuously expanded in the mature zone.

Holotype. — No. 19815.

Occurrence. — Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9.

Eridocampylus anceps, sp. nov.

(Pl. VII, Figs. 10–11)

Description. — Zoarium ramose; average diameter 8 mm. Slightly elevated monticules composed of larger and thicker-walled zooecia 3 mm. apart, measured from center to center.

Zooecia subpolygonal to circular; average diameter of ordinary zooecia 0.17 mm.; range in diameter in monticules from 0.14 mm. to 0.21 mm.; seven to eight in 2 mm. Walls thick, minutely granular; width equal to or greater than zooecial diameters in monticules. Few small zooecia in monticules. Acanthopores are poorly defined, large granular spots near junctions of many zooecial walls.

Zooecia bent approximately 50 degrees toward periphery at beginning of mature zone, nearly perpendicular to surface. Walls thin and crenulated in axial zone, conspicuously, often irregularly, thickened and extremely granular in mature zone. Two or three diaphragms in transition zone, one to three in mature zone of each zooecium. Few heterophragms in early mature zone.

Axial ratio 0.6 : 1.

Remarks. — The conspicuously thickened and minutely granular walls, the longer mature zone, and the relatively abundant well-defined diaphragms of the transition and mature zones are the distinguishing characters of *Eridocampylus anceps*. *E. multitabulatus*, sp. nov., is compared with *E. anceps* on page 207. *E. anceps* differs from *E. obliquus*, sp. nov., in having direct zooecia, a smaller axial ratio, more diaphragms, fewer heterophragms, and thicker walls. *Eridotrypella devonica*, sp. nov., resembles *Eridocampylus anceps* in having thick, minutely granular walls, large granular acanthopores, and, in some specimens, occasional heterophragms (Pl. VI, Fig. 13), but differs in having oblique zooecia and few heterophragms.

Holotype. — No. 19816.

Occurrence. — Ferron Point formation; locality 49.

Eridocampylus laxatus, sp. nov.

(Pl. VII, Figs. 8–9)

Description. — Zoarium ramose; average diameter 5 mm. Groups of larger zooecia usually 3 mm. apart, measured from center to center.

Zooecia polygonal; diameter of average zooecia 0.21 to 0.23 mm.; few larger ones 0.28 mm. in diameter; six to seven in 2 mm. Small tubes occasionally present. Walls thick; medial band between ordinary zooecia minutely granular, between larger zooecia crossed by transverse rows of granules. Granular, inconspicuous acanthopores near junctions of zooecial walls.

Zooecia bend abruptly through angle of 40 to 50 degrees in midmature zone, slightly oblique in peripheral region. Zooecia gradually expand from transition zone to periphery; diameter in late mature zone approximately twice that of tubes in axial region. Thin crenulated walls of axial region gradually thickened from transition to bend in mature region; walls thick, minutely granular in late mature zone. Two to four diaphragms in transition and early mature zones of each zooecium. Few heterophragms in late mature zone.

Axial ratio ranges from 0.75 : 1 to 0.8 : 1.

Remarks. — The conspicuous expansion of the zooecia and their abrupt bend in the midmature region are the important specific characters. *Eridocampylus laxatus* differs from *E. ulrichi,* sp. nov., in having thicker walls and expanded zooecia in the mature region, and irregularly arranged, usually indistinct, granules in the zooecial walls; and from *E. mollis,* sp. nov., in having thinner walls, less well defined granules, inconspicuous acanthopores, a larger zoarium, and expanded zooecia. *E. laxatus* is compared with *E. aculeatus,* sp. nov., on page 203.

Holotype. — No. 19817.

Occurrence. — Ferron Point formation and doubtfully Bell shale; locality 38.

Eridocampylus mollis, sp. nov.

(Pl. VIII, Figs. 7–8)

Description. — Zoarium ramose; diameter approximately 3 mm. Groups of larger thicker-walled zooecia usually 3 mm. apart, measured from center to center.

Zooecia subpolygonal; diameter of ordinary zooecia 0.17 mm.; usually eight in 2 mm.; diameter of larger ones 0.21 to 0.28 mm.; six or seven in 2 mm., counting from center of group. Walls thick, average width equal to half diameter of smaller zooecia, width equivalent to or greater than zooecial diameters in center of groups of large zooecia. Transverse rows of granules conspicuous in medial band separating laminated deposits lining zooecia. Small tubes few. Acanthopores granular, located near junctions of zooecial walls, inconspicuous because of strong development of smaller granules.

Zooecia oblique in axial and transition zones, bent through arc of 40 to 50 degrees in early mature zone, slightly oblique at periphery. Walls crenulated in immature zone, slightly thickened from beginning of transition to bend in zooecia, conspicuously thickened in late mature region. Rows of granules perpendicular to surface well defined in longitudinal sections through mature zone. Two to four diaphragms in transition, generally absent in outer mature region. Heterophragms always present but not numerous.

Axial ratio 0.8 : 1.

Remarks. — The small ordinary zooecia, the conspicuously thickened walls in the center of groups of large zooecia, the well-defined granules, and the abruptly bent zooecia of the short mature zone are diagnostic characters of this species. Comparisons of *Eridocampylus mollis* with *E. aculeatus*, sp. nov., and *E. laxatus*, sp. nov., are given on pages 203 and 205. *E. mollis* differs from *E. ulrichi*, sp. nov., in having a smaller zoarium, thicker walls, larger poorly defined acanthopores, and more granules in the walls.

Holotype. — No. 19819.

Occurrence. — Potter Farm formation; locality 68.

Eridocampylus multitabulatus, sp. nov.

(Pl. VIII, Figs. 13–14)

Description. — Zoarium ramose; average diameter 10 mm. Slightly elevated groups of larger, thicker-walled zooecia 3 mm. apart, measured from center to center.

Zooecia subpolygonal to circular; diameter of average zooecia 0.21 mm.; seven to eight in 2 mm.; diameter of large ones 0.28 to 0.3 mm., occasionally more; six to seven in 2 mm., counting from center of group of large zooecia. Small tubes usually confined to monticules. Walls moderately thick, conspicuously so in center of groups of large zooecia. Medial band of walls occupied by closely arranged transverse rows of granules. Small granular acanthopores at junctions of zooecial walls.

Oblique zooecia of axial zone bend through arc of 30 to 40 degrees in early mature region, oblique to surface at periphery. Walls coarsely crenulated in axial zone, gradually thickened in short transition, conspicuously and occasionally irregularly thickened in late mature zone. Diaphragms present from transition through entire mature zone, seven or eight in each zooecium, approximately one tube diameter apart. Heterophragms occasionally present, usually large, resembling cystiphragms or curved diaphragms.

Axial ratio 0.7 : 1.

Remarks. — The diagnostic characters of *Eridocampylus multitabulatus* are the long mature region, the numerous evenly spaced diaphragms, the large heterophragms, and the well-developed granules. *E. multitabulatus* differs from *E. anceps,* sp. nov., in having more diaphragms, thinner walls, larger heterophragms, and transverse rows of granules in tangential sections of walls; and from *E. summus,* sp. nov., in having more diaphragms and fewer heterophragms. *E. obliquus,* sp. nov., is compared with *E. multitabulatus* on page 208.

Holotype. — No. 19820.

Occurrence. — Ferron Point formation; locality 49.

Eridocampylus obliquus, sp. nov.

(Pl. VIII, Figs. 9–10)

Description. — Zoarium irregularly ramose; diameter 6 to 7 mm. Groups of thicker-walled zooecia usually elevated into monticules. Distance between monticules variable.

Zooecia subpolygonal; usually elongate in tangential sections; diameter of average zooecia 0.2 to 0.25 mm., occasionally 0.28 mm.; six or seven in 2 mm. Small zooecia rarely developed. Walls moderately thick; central band conspicuously granular; granules arranged in transverse rows. Acanthopores granular and inconspicuous because of extreme development of small granules in walls, usually near junctions of zooecial walls.

Zooecia oblique, slightly bent toward periphery in mature region; acute angle of 30 to 40 degrees between zooecial walls and periphery. Crenulated walls of immature zone gradually thicken through transition zone into mature zone. Two diaphragms usually present in transition zone, one to three additional diaphragms in mature zone, usually more than one tube diameter apart. Heterophragms moderately numerous in mature zone.

Axial ratio ranges from 0.6 : 1 to 0.8 : 1.

Remarks. — The pronouncedly oblique zooecia, the granular walls, and the diaphragms in the mature zone as well as the transition zone are diagnostic characters of *Eridocampylus obliquus.* This species differs from *E. summus,* sp. nov., in having fewer heterophragms, more diaphragms, and more oblique zooecia; and from *E. multitabulatus,* sp. nov., in having oblique zooecia, fewer diaphragms, and more heterophragms. *E. obliquus* is compared with *E. anceps,* sp. nov., and *Eridotrypella devonica,* sp. nov., on pages 204 and 213.

Holotype. — No. 19818.

Occurrence. — Norway Point formation; locality 47. Dock Street clay; locality 53. Doubtfully present in Ferron Point formation at locality 49 and in Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl, at locality 17.

Eridocampylus summus, sp. nov.

(Pl. VIII, Figs. 11–12; Pl. IX, Fig. 3)

Description. — Zoarium ramose; diameter 6 to 7 mm.

Zooecia polygonal to elongate-oval; diameter 0.14 to 0.21 mm., occasionally 0.25 mm.; eight or nine in 2 mm. Walls moderately thick, granular. Acanthopores granular, prominent, numerous, often inflect zooecia, form distinct nodes at junctions of zooecial walls on surface of zoarium.

Zooecia bend gradually toward periphery from axial region, slightly oblique in mature zone. Walls crenulated in axial zone, gradually thickened in short transition zone, irregularly and, occasionally, intermittently thickened in long mature zone. Generally two diaphragms in transition zone, and one or two more in younger mature zone. Heterophragms extremely numerous throughout mature zone, usually small and strongly curved, occasionally large and irregularly curved.

Remarks. — The unusually numerous heterophragms distinguish *Eridocampylus summus* from other described species of the genus. Further distinctive characters are the long mature region, the fewness of the diaphragms, which are usually confined to the transition zone, and the prominent granular acanthopores inflecting the zooecia.

Holotype. — No. 19821.

Occurrence. — Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 17.

Eridocampylus ulrichi, sp. nov.

(Pl. VIII, Figs. 1–6)

Description. — Zoarium ramose; diameter 5 to 6 mm. Groups of larger, thicker-walled zooecia 3 to 4 mm. apart, measured from center to center; often elevated into monticules.

Zooecia subpolygonal; diameter of average zooecia 0.21 mm.; seven in 2 mm.; diameter of large ones 0.3 mm. or more. Small tubes few. Walls moderately thick; medial band crossed by transverse rows of granules in outer mature zone. Acanthopores granular, small, located at junctions of zooecial walls.

Zooecia oblique from axial region into early mature zone, bent through arc of 30 to 50 degrees, nearly direct in late mature region. Walls crenulated in immature zone, gradually thickened from beginning of transition zone to bend in tubes, thick, granular, but clearly laminated in mature zone. Two or three diaphragms in transition region, usually absent in late mature region. Small thick heterophragms and larger thin irregularly curved diaphragms or cystiphragms moderately numerous in mature region.

Axial ratio averages 0.75 : 1.

Remarks. — *Eridocampylus ulrichi* is one of four species having a short mature zone and zooecia bent rather abruptly in the early mature region. It is compared with *E. aculeatus*, sp. nov., *E. laxatus*, sp. nov., and *E. mollis*, sp. nov., on pages 203, 205, and 206. *E. ulrichi* is characterized by nearly direct zooecia in the mature zone, relatively thinner walls, and small but distinct granular acanthopores.

Holotype. — No. 19879; paratype No. 19880.

Occurrence. — Ferron Point formation; locality 49.

GENUS **ERIDOTRYPELLA,** gen. nov.

Definition. — Zoarium ramose. Wall structure heterotrypid-amalgamate; transverse rows of granules well defined. Walls thin, usually crenulated in immature region, gradually thickened from beginning of mature zone to surface. Zooecia oblique, slightly bent toward surface in mature zone. Diaphragms absent in immature zone, several closely arranged in early mature zone of each zooecium, usually absent near periphery. Mesopores absent. Acanthopores granular.

Genotype. — *Batostomella obliqua* Ulrich (1890, p. 433, Pl. XLVI, Figs. 2–2c).

Remarks. — The Devonian "Eridotrypas" form a homogeneous group having heterotrypid wall structure. Species intergrade with those of *Eridocampylus*, gen. nov., and *Leptotrypella* Vinassa de Regny. *Eridotrypella* is established to accommodate species which possess many characters diagnostic of *Eridotrypa* Ulrich, 1895, but which differ in having wall structure typical of the Heterotrypidae instead of the Batostomellidae. When Ulrich (1895, p. 265) defined *Eridotrypa*, he wrote: "The systematic position of the genus, though in a measure doubtful, is probably intermediate between *Homotrypa* (compare *H. similis* Foord) of the *Monticuliporidae*, and *Bythopora*, Miller and Dyer, of the *Batostomellidae*. Because of the absence of cystiphragms it will be best to embrace the genus provisionally in the latter family." In the genotype, *Eridotrypa mutabilis* Ulrich (1895, p. 265, Pl. XXVI, Figs. 20–32), the walls are similar to those in several other genera now included in the Batostomellidae; however, the characters originally designated as diagnostic of the genus (a ramose zoarium, oblique zooecia, granular acanthopores, and closely arranged diaphragms in the early mature zone) were probably developed in genera belonging to different families.

The following species are now assigned to *Eridotrypella:*

appressa (Ulrich) 1890
brevis, sp. nov.
devonica, sp. nov.
granosa, sp. nov.
hybrida, sp. nov.
minuta, sp. nov.
obliqua (Ulrich) 1890
parvulipora (Ulrich and Bassler) 1913
simplex, sp. nov.
sinuosa, sp. nov.
spinifera, sp. nov.
valida, sp. nov.
vilis, sp. nov.

Eridotrypella brevis, sp. nov.

(Pl. V, Figs. 15–16)

Description. — Zoarium ramose; maximum diameter 4 mm. Slightly elevated groups of larger zooecia 2.5 to 3 mm. apart, measured from center to center.

Zooecia elongate-subpolygonal; diameter of ordinary zooecia 0.21 to 0.3 mm.; seven or eight in 2 mm. Smaller tubes few. Acanthopores small and inconspicuous, composed of nongranular laminated tissue, located near junctions of zooecial walls, never numerous.

Zooecia oblique to surface through most of length, abruptly bent in outer portion of short mature zone, slightly oblique in peripheral region. Walls uncrenulated in immature zone, moderately thickened in mature zone. Diaphragms thick; laminae prolonged as deposit lining zooecia; one or two in transition.

Axial ratio 0.8 : 1.

Remarks. — *Eridotrypella brevis, E. spinifera,* sp. nov., and *E. valida,* sp. nov., resemble *Leptotrypella* in structure of walls and acanthopores, but are assigned to *Eridotrypella* because the diaphragms are restricted to the transition between immature and mature zones, the zooecia are oblique, and the acanthopores are relatively small. Characters which distinguish these three species from other described species of *Eridotrypella* are the uncrenulated walls in the axial region, the absence of transverse rows of granules in the medial band of zooecial walls in the mature zone, and the laminated acanthopores. *Eridotrypella brevis* differs from *E. spinifera,* sp. nov., in having only one or two instead of three or four diaphragms in each zooecium, a shorter mature zone, and fewer acanthopores; and from *E. valida,* sp. nov., in having fewer diaphragms, a shorter mature zone, and thinner walls.

Holotype. — No. 19822.

Occurrence. — Bell shale; locality 31. Ferron Point formation; locality 29.

Eridotrypella devonica, sp. nov.

(Pl. VI, Figs. 11–13)

Description. — Zoarium ramose; diameter 7 mm.

Zooecia oval to elliptical; length approximately twice width, short diameter 0.09 to 0.14 mm., long diameter 0.19 to 0.21 mm.; six or seven in 2 mm. Walls thick, occasionally exceeding diameters of zooecia. Mesopores absent; few small zooecia present. Acanthopores granular, vaguely defined, large, located near junctions of zooecial walls. Many small granules arranged in transverse rows.

Zooecia oblique to surface throughout entire length. Acute angle between zooecium and surface 35 to 40 degrees. Walls thin and crenulated in axial region, greatly thickened in mature zone. Diaphragms clearly defined, average of four in transition and early mature zones, one or two tube diameters apart.

Axial ratio 0.7 : 1.

Remarks. — Some specimens identified as *Eridotrypella devonica* possess a few small heterophragms (Pl. VI, Fig. 13). Although these structures are not sufficiently numerous to justify assigning the specimens to *Eridocampylus*, their presence suggests a close relationship between the two genera. *Eridotrypella devonica* resembles *Eridocampylus obliquus*, sp. nov., in having extremely oblique zooecia and granular walls and acanthopores, but differs in having few if any heterophragms, thicker walls, and more regular tabulation. *Eridotrypella devonica* resembles *E. appressa* (Ulrich) (1890, p. 453, Pl. XLVI, Figs. 1–1e) in degree of obliquity of zooecia, but differs in having smaller elongate oval zooecia, thicker walls in the mature zone, vaguely defined but relatively large acanthopores in addition to granules, and usually more diaphragms.

Holotype. — No. 19823; figured specimen No. 19824.

Occurrence. — Potter Farm formation; localities 37 and 42.

Eridotrypella granosa, sp. nov.

(Pl. VI, Figs. 1–3)

Description. — Zoarium flattened-ramose; short diameter 3 to 5 mm., long diameter 8 to 10 mm. Groups of larger and thicker-walled zooecia 2 to 3 mm. apart, measured from center to center.

Zooecia subpolygonal or round; diameter of average zooecia 0.17 mm.; seven or eight in 2 mm.; diameter of large zooecia 0.21 to 0.28 mm. Small tubes few. Width of walls often equal to diameter of zooecia; laminated linings of zooecia separated by wide and extremely granular band; granules arranged in transverse rows near periphery, no definite arrangement in deeper sections. Acanthopores vague granular spots at junctions of zooecial walls.

Zooecia abruptly bent toward surface in transition zone, nearly direct in mature zone. Walls thin and crenulated in axial region, strongly thickened and granular in mature zone. In longitudinal sections cutting flat surface of walls, streaks of granules oriented perpendicular to surface. Diaphragms well defined, not thick, number varies, one or two in transition region and one or two in late mature region.

Remarks. — The distinguishing characters of *Eridotrypella granosa* are strongly thickened walls of the nearly direct zooecia in the mature zone, the numerous conspicuous granules in the walls, and the diaphragms in the extreme mature as well as the transition region. *E. granosa* differs from *E. obliqua* (Ulrich) in having much thicker walls and more and stronger granules; from *E. devonica*, sp. nov., in having nearly direct zooecia in the mature zone, fewer diaphragms in the transition and early mature region, and subcircular zooecia; and from *E. hybrida*, sp. nov., *E. sinuosa*, sp. nov., *E. vilis*, sp. nov., and *E. simplex*, sp. nov., in having thicker walls, more direct zooecia in the mature zone and a few diaphragms in the late mature region.

Holotype. — No. 19825.

Occurrence. — Ferron Point formation; locality 49. Norway Point formation; locality 46.

Eridotrypella hybrida, sp. nov.

(Pl. V, Figs. 1–2)

Description. — Zoarium flattened-ramose; diameter 3 by 6 mm.

Zooecia elongate; subpolygonal to oval; 0.14 to 0.17 mm. in width, 0.25 to 0.28 mm. in length; six in 2 mm., measured longitudinally, eight in 2 mm., diagonally. Small tubes few. Walls moderately wide; structure heterotrypid; medial band slightly granular. Acanthopores granular; central tube occasionally distinguishable; numerous, usually near junctions of zooecial walls.

Zooecia slightly bent toward surface in early mature region, oblique in outer mature zone. Mature zone relatively long; walls thickened and granular. Two or three thin diaphragms in transition and early mature zones; usually one tube diameter apart. Heterophragms occasionally present.

Remarks. — Although a few vague heterophragms are developed in specimens of *Eridotrypella hybrida,* these structures are neither sufficiently well marked nor constantly developed to justify assigning the species to *Eridocampylus,* gen. nov. *Eridotrypella hybrida* differs from *E. devonica,* sp. nov., in having thinner and less granular walls, fewer diaphragms, and a smaller zoarium; from *E. obliqua* (Ulrich) in having more numerous and prominent acanthopores, less regular walls, and more oblique zooecia; from

E. simplex, sp. nov., in having more diaphragms and a longer mature zone; and from *E. valida,* sp. nov., and *E. spinifera,* sp. nov., in having thinner walls, more oblique zooecia, a longer mature zone, and no thick diaphragms.

Holotype. — No. 19826.

Occurrence. — Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9.

Eridotrypella minuta, sp. nov.

(Pl. VI, Figs. 9–10)

Description. — Zoarium ramose; average diameter slightly more than 1 mm.

Zooecia elongate-polygonal; 0.21 to 0.28 mm. in length; five to seven in 2 mm. Walls thick and minutely granular. Mesopores absent; small zooecia occasionally present. Acanthopores absent.

Zooecia slightly bent in transition zone; oblique throughout mature zone. Walls uncrenulated in immature region, gradually thicken toward periphery in mature zone. Two diaphragms a tube diameter or more apart in early mature region.

Axial ratio 0.7 : 1.

Remarks. — *Eridotrypella minuta* is distinguished from *E. obliqua* (Ulrich) by its extremely small zoarium, the absence of acanthopores, and the more elongate zooecia; and from other described species of *Eridotrypella* by the small size of its zoarium and the absence of acanthopores.

Holotype. — No. 19827.

Occurrence. — Ferron Point formation; locality 29.

Eridotrypella obliqua (Ulrich)

(Pl. VI, Figs. 4–8)

1890. *Batostomella obliqua* Ulrich, Geol. Surv. Ill., Vol. VIII, p. 433, Pl. XLVI, Figs. 2–2c.
1895. *Eridotrypa obliqua* Ulrich, Geol. of Minnesota, Vol. III, Part I, p. 265.
1900. *Eridotrypa? obliqua* Nickles and Bassler, Bull. U. S. Geol. Surv., No. 173, p. 238.

Original description. — "Zoarium dendroidal, consisting of dichotomously and otherwise branching stems, of an average thickness of six mm. Surface marked with low rounded tubercles composed of larger sized cell apertures; centers of clusters 2.5 mm. apart. Zooecial tubes slightly tortuous, opening very obliquely upon the surface, their walls thin and somewhat flexuous in the axial region, rather thick in the cortical zone. Both tangential and vertical sections show that the central portion of the wall is granular. Apertures angular, elongate, owing to their obliquity, those occupying the monticules especially so, about seven in 2 mm. measuring lengthwise. Mesopores few or wanting. Two or three diaphragms developed just before the tubes enter the peripheral region. A few faint and small acanthopores appear to be present in tangential sections; not observed on the surface.

"The great obliquity of the tubes, the absence, more or less complete, of mesopores, and the angular elongated apertures are the most distinctive characters of this form.

"Position and locality: Hamilton group, Alpena, Michigan."

Remarks. — *Eridotrypella obliqua* (Ulrich) is the most abundant species in the collection of Michigan Trepostomata.

In addition to the characters described by Ulrich these specimens have heterotrypid wall structure. At the extreme periphery the walls are composed of laminated zooecial deposits separated by a wide band of amalgamate tissue which contains transverse rows of granules. In tangential sections cut slightly deeper the transverse rows of granules are not present, although the laminated zooecial deposits and the amalgamate medial band are distinguishable. The granular acanthopores are also more prominent in the outer region.

Hypotypes. — Nos. 19828 and 19829.

Occurrence. — Ferron Point formation; localities 38 and 49. Doubtfully present in Potter Farm formation at locality 42 and in Petoskey formation at locality 12.

Eridotrypella simplex, sp. nov.

(Pl. VI, Figs. 14–15)

Description. — Zoarium ramose; average diameter 5 mm. Slightly elevated monticules 3.5 to 4 mm. apart, measured from center to center.

Zooecia elongate-subpolygonal; oval in tangential sections; diameter of ordinary zooecia 0.25 to 0.35 mm.; diameter of largest monticular zooecia 0.42 mm.; six or seven in 2 mm. Walls moderately thick, minutely granular. Mesopores absent. Granular acanthopores near junctions of zooecial walls.

Zooecia oblique, straight throughout entire length. Walls coarsely crenulated in axial region, gradually thicken from transition to periphery, finely granular. One thin diaphragm in transition zone of each zooecium.

Axial ratio ranges from 0.8 : 1 to 0.9 : 1.

Remarks. — The diagnostic characters of *Eridotrypella simplex* are the extreme simplicity of structure, the obliquity of zooecia, the shortness of the mature zone, and the fewness of the diaphragms. *E. simplex* differs from *E. devonica*, sp. nov., in having a shorter mature zone, thinner walls, and fewer diaphragms; from *E. brevis*, sp. nov., in having oblique zooecia, thinner walls in the mature zone, crenulated walls in the immature zone, and thin diaphragms; and from *E. obliqua* (Ulrich) in having oblique zooecia, thinner walls, and fewer diaphragms.

Holotype. — No. 19830.

Occurrence. — Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; localities 9 and 17. Ferron Point formation; locality 49. Norway Point formation; locality 46. Doubtfully present in Bell shale at locality 38 and in Ferron Point formation at locality 29.

Eridotrypella sinuosa, sp. nov.

(Pl. VI, Figs. 16–17)

Description. — Zoarium flattened-ramose; diameter 3 or 4 by 7 mm. Groups of thicker-walled zooecia present in monticules usually 3 mm. apart, measured from center to center.

Zooecia elongate-polygonal; irregularly oval in sections; diameter 0.21 to 0.28 mm.; six in 2 mm. Few small tubes associated with larger zooecia. Walls of ordinary zooecia moderately thick, conspicuously thickened in monticules; medial band crossed by transverse rows of granules. Acanthopores unusually well defined; central tube occasionally observed, but usually filled by dense deposit near surface; large, often inflect zooecia, located near junctions of zooecial walls.

Zooecia bent through arc of 10 to 15 degrees in outer mature zone, oblique at periphery. Walls coarsely crenulated in immature zone, gradually thickened from beginning of mature zone to periphery, flexuous in mature region; structure granular. Diaphragms thin, one or two in each zooecium proximal to thickening of walls in early mature zone.

Axial ratio of short diameter 0.5 : 1.

Remarks. — The distinctive characters of *Eridotrypella sinuosa* are the oblique and flexuous zooecial walls, the few diaphragms, and the extremely numerous granules. *E. sinuosa* differs from *E. devonica*, sp. nov., in having fewer diaphragms, a shorter mature zone, and laminated acanthopores; from *E. simplex*, sp. nov., in having thicker and more granular walls, more, larger, and laminated acanthopores, and a longer less-oblique mature zone; and from *E. vilis*, sp. nov., in having well-defined acanthopores, thicker walls, and fewer diaphragms, which are restricted to the transition zone.

Holotype. — No. 19831.

Occurrence. — Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 17.

Eridotrypella spinifera, sp. nov.

(Pl. VII, Figs. 6–7)

Description. — Zoarium ramose; average diameter 4 mm. Groups of larger zooecia elevated into low monticules 3 mm. apart, measured from center to center.

Zooecia subpolygonal; diameter of ordinary zooecia 0.21 to 0.25 mm.; seven, measured diagonally, or six measured longitudinally, in 2 mm.; diameter of monticular zooecia 0.28 to 0.35 mm.; usually six in 2 mm., measured from center. Few small tubes in monticules. Acanthopores well defined, laminated, of moderate size, numerous, usually near junctions of zooecial walls.

Zooecial walls uncrenulated and nearly vertical in axial region, abruptly bent between axial and mature zones, nearly direct in mature zone. Walls minutely granular, approximately 0.07 mm. in thickness in mature zone. One or two thin diaphragms in each tube at transition; one or two thick diaphragms usually near bend in zooecium or in early mature zone, 0.1 to 0.14 mm. apart; occasional diaphragm strongly curved, complete or incomplete, resembles cystiphragm.

Axial ratio 0.75 : 1.

Remarks. — *Eridotrypella spinifera* is discussed and compared with *E. brevis*, sp. nov., on page 212. *E. spinifera* differs from *E. valida*, sp. nov., in having more and larger acanthopores and thinner walls. The nongranular heterotrypid wall structure and the unusually strong acanthopores readily separate this species from others.

Holotype. — No. 19832.

Occurrence. — Bell shale; locality 38. Doubtfully present in Ferron Point formation; locality 29.

Eridotrypella valida, sp. nov.

(Pl. VII, Figs. 12–14)

Description. — Zoarium ramose; average diameter 5 mm. Groups of larger zooecia usually not elevated; 3 mm. apart, measured from center to center.

Zooecia subpolygonal, occasionally oval in tangential section; ordinary zooecia 0.21 to 0.25 mm. in diameter; six or seven in 2 mm.; large zooecia 0.28 to 0.35 mm. in diameter. Walls thick, finely granular; wide medial band between laminated zooecial deposits. Small tubes few. Acanthopores few, usually vague, slightly granular; central tube and concentric laminae occasionally distinguishable.

Zooecia bent abruptly at beginning of mature zone, nearly direct in short mature zone. Walls uncrenulated in axial region, conspicuously thickened and finely granular in mature zone. Two or three thin diaphragms usually present in each zooecium behind bend into mature zone, one or two unusually thick diaphragms at bend and in early mature region. Curved diaphragms resembling cystiphragms similar to those in *E. spinifera*, sp. nov.

Thick diaphragms contribute to laminated zooecial linings, as in several species of *Leptotrypella* (Pl. VII, Fig. 14).

Axial ratio 0.6 : 1.

Remarks. — Diagnostic characters of *Eridotrypella valida* are the unusually thick walls, the thick diaphragms in the early mature region, and the almost complete absence of acanthopores. Comparisons with *E. brevis*, sp. nov., and *E. spinifera*, sp. nov., are given on pages 212 and 219. *E. valida* differs from *E. devonica*, sp. nov., in having a shorter and less oblique mature zone, thick diaphragms, and subpolygonal zooecia; and from *E. obliqua* (Ulrich) in having more direct zooecia in the mature zone, more and thicker diaphragms, and no granules in the walls.

Holotype. — No. 19833.

Occurrence. — Bell shale, locality 38. Ferron Point formation; localities 29 and 49.

Eridotrypella vilis, sp. nov.

(Pl. VII, Figs. 4–5)

Description. — Zoarium flattened-ramose; average dimensions 3 by 7 mm. Groups of larger zooecia usually 3.5 mm. apart, measured from center to center.

Zooecia subpolygonal, oval in tangential sections; diameter of ordinary zooecia 0.21 to 0.25 mm., of large tubes 0.28 to 0.3 mm.; six or seven in 2 mm. Few small tubes associated with large zooecia. Walls thick, crossed by transverse rows of granules. Acanthopores granular, occasionally showing hollow central tube, of moderate size, located near junctions of zooecial walls.

Zooecia oblique, slightly bent toward surface at a point one-half or one-third length of mature region from periphery. Walls in immature zone thin and crenulated, in mature zone thick and granular. Diaphragms thin but well defined, one to three, occasionally four, in transition and mature zones.

Axial ratio of short diameter 0.6 : 1.

Remarks. — *Eridotrypella vilis* differs from *E. hybrida*, sp. nov., in having thicker and more granular walls, a shorter mature zone, fewer diaphragms, and zooecia which bend toward the periphery in the outer mature zone instead of in the transition zone; and from *E. simplex*, sp. nov., in having more diaphragms, less oblique zooecia, and thicker, more granular walls. *E. sinuosa*, sp. nov., is compared with *E. vilis* on page 218.

Holotype. — No. 19834.

Occurrence. — Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9, and doubtfully at locality 17.

Genus LEPTOTRYPA Ulrich

1883. *Leptotrypa* Ulrich, Journ. Cincinnati Soc. Nat. Hist., Vol. VI, p. 158.
1900. *Leptotrypa* Nickles and Bassler, Bull. U. S. Geol. Surv., No. 173, p. 31.
1904. *Leptotrypa* Ulrich and Bassler, Smithsonian Misc. Coll., Vol. XLVII, pp. 24, 28.
1911. *Leptotrypa* Bassler, U. S. Nat. Mus., Bull. 77, p. 207.

Definition from Bassler, 1911. — "Heterotrypidae with the zoarium of thin, evenly spread, parasitic expansions with thin-walled, polygonal zooecia, no mesopores, few diaphragms, and very small acanthopores, which are never abundant."

Genotype. — *Leptotrypa minima* Ulrich (1883, p. 159, Pl. VI, Figs. 2–2b).

Leptotrypa? nicholsoni, sp. nov.

(Pl. V, Figs. 6–8)

Description. — Zoarium incrusting; maximum thickness of lamina 0.6 mm. No maculae, monticules, or groups of larger zooecia.

Zooecia polygonal, occasionally quadrate; 0.18 to 0.21 mm. in diameter; nine or ten in 2 mm. Walls thin, occupied by granules. Mesopores absent. Acanthopores small, well defined, usually near junctions of zooecial walls.

Zooecia direct. Walls slightly thickened in mature zone. One or two diaphragms in mature zone of each zooecium.

Remarks. — The thin zoarium and the small thin-walled zooecia distinguish *Leptotrypa? nicholsoni* from associated heterotrypid Trepostomata.

The thin incrusting zoarium and the uniform size and shape of the zooecia at first suggested that this form was *Chaetetes quadrangularis* Nicholson (1874, p. 58), assigned by Ulrich (1890, p. 455) to *Leptotrypa.* In the United States National Museum are many incrusting Trepostomata from the Hamilton of Thedford, Ontario. These specimens were examined in an attempt to establish a neotype for Nicholson's species. According to the original description, "*Chaetetes quadrangularis* is found commonly encrusting *Heliophyllum Halli* and *Cystiphyllum vesiculosum*, and often forming expansions of considerable extent." The specimens incrusting corals do not have sufficiently thin zoaria or sufficiently small zooecia to enable one to identify them with *C. quadrangularis*. Further, sections showed they are integrate Trepostomata and therefore cannot be assigned to *Leptotrypa*. As the generic position of *Chaetetes quadrangularis* is unknown, specimens should not be assigned to *Leptotrypa quadrangularis* (Nicholson).

Holotype. — No. 19835.

Occurrence. — Ferron Point formation; locality 38.

Leptotrypa? spinifera, sp. nov.

(Pl. V, Figs. 3–5)

Description. — Zoarium incrusting; 0.4 to 0.6 mm. in thickness. Groups of larger zooecia 3 or 4 mm. apart, measured from center to center, not elevated into monticules.

Zooecia polygonal; ordinary zooecia 0.2 to 0.28 mm. in diameter; seven in 2 mm.; larger zooecia 0.28 to 0.3 mm. in diameter; six in 2 mm., counting from center of a group. Minute zooecia few. Acanthopores well defined, of moderate size, approximately as numerous as zooecia, located near junctions of zooecial walls.

Zooecia direct. Walls thicken gradually toward surface. One or, occasionally, two well-defined diaphragms in early mature region of each zooecium.

Remarks. — *Leptotrypa? spinifera* is doubtfully assigned to *Leptotrypa* because the acanthopores are relatively strong. Diaphragms are not sufficiently numerous to justify assigning the species to *Cyphotrypa*. *L.? spinifera* is compared with *Cyphotrypa? unica*, sp. nov., on page 202. Larger acanthopores, groups of large zooecia, and thicker walls distinguish *L.? spinifera* from *L.? nicholsoni*, sp. nov.

Holotype. — No. 19836.

Occurrence. — Ferron Point formation; locality 49.

GENUS LEPTOTRYPELLA VINASSA DE REGNY

1920. *Leptotrypella* Vinassa de Regny, Atti Soc. italiana sci. nat., Vol. LIX, p. 222.

Original definition. — "*Leptotrypa pariete incrassata.*"

Genotype. — *Chaetetes barrandei* Nicholson (1874, p. 57, Pl. IV, Fig. 7c).

The original definition of *Leptotrypella* is inadequate, but the genotype designated possesses structures characteristic of a group of Devonian Heterotrypidae, and Bassler (1934b, p. 138) has recognized the validity of the genus. The emended definition given here is based upon topotypes of *Leptotrypella barrandei* (Nicholson), other previously described species belonging to the genus, and several new species from the Traverse group of Michigan.

Emended definition. — Zoarium usually ramose. Walls moderately thick, nongranular; laminated zooecial deposits separated by amalgamate medial band. Zooecia polygonal. Diaphragms complete, usually numerous in mature zone, often thick and merging into laminated wall tissue. Mesopores absent; minute zooecia occasionally present. Acanthopores well defined, generally numerous, but nearly absent in a few species, always present and usually stronger within groups of larger zooecia or monticules.

Remarks. — *Leptotrypella* differs from *Heterotrypa* Nicholson in lacking mesopores; from *Dekayella* Ulrich in lacking mesopores and in having the larger acanthopores confined to the monticules; and from *Cyphotrypa* Ulrich and Bassler in having a ramose zoarium, thick walls, and acanthopores of two sizes. *Leptotrypella* is also related to *Eridotrypella,* gen. nov., but differs in having well-developed laminated acanthopores, direct zooecia, and diaphragms throughout the mature zone. Several species now assigned to *Eridotrypella* possess the wall and acanthopore structure of *Leptotrypella* (p. 212). These transitional species are retained in *Eridotrypella* because the diaphragms are restricted to the transition zone.

Vinassa de Regny (1920, p. 222) assigned *Atactopora angularis* Ulrich and Bassler, 1904, and *Amplexopora ampla* Ulrich and

Bassler, 1904, to *Leptotrypella.* These two bryozoans are valid species of *Atactopora* and *Amplexopora,* respectively, and cannot be retained in *Leptotrypella.*

The species now assigned to *Leptotrypella* are:

aequabilis, sp. nov.	*parva,* sp. nov.
barrandei (Nicholson) 1874	*pellucida,* sp. nov.
gemmata, sp. nov.	*spinulifera* (Fritz) 1930
magninodosa, sp. nov.	*undans,* sp. nov.
moniliformis (Nicholson) 1874	*varia,* sp. nov.
ohioensis (Stewart) 1927	

Leptotrypella aequabilis, sp. nov.

(Pl. IX, Figs. 6–7)

Description. — Zoarium ramose; average maximum diameter 10 mm. Monticules composed of groups of larger zooecia 2 to 2.5 mm. apart, measured from center to center.

Zooecia subpolygonal, occasionally inflected by acanthopores; ordinary zooecia 0.2 to 0.25 mm. in diameter; seven to eight in 2 mm.; large zooecia 0.3 mm. or more in diameter; six to six and one half in 2 mm., measured from center of monticule. Walls thick; light-colored divisional band nongranular. Small tubes occasionally present. Acanthopores laminated, of moderate size, few larger ones in monticules, located near junctions of zooecial walls.

Zooecia abruptly bent at beginning of mature zone, perpendicular to surface in mature zone. Walls thin and uncrenulated in immature zone, uniformly thickened in mature zone. Diaphragms well defined but not thick, generally seven or eight in mature region of each zooecium, approximately one tube diameter apart.

Axial ratio 0.4 : 1.

Remarks. — *Leptotrypella aequabilis* differs from *L. pellucida,* sp. nov., in having well-defined and numerous acanthopores, larger zooecia, slightly thinner walls, and few if any thick diaphragms; from *L. moniliformis* (Nicholson) in having smaller zooecia, which are perpendicular to the surface throughout the mature zone; from *L. varia,* sp. nov., in having thinner and uniformly thickened walls in the mature zone, few if any thick diaphragms, and larger zooecia; and from *L. magninodosa,* sp. nov., in having smaller acanthopores, thinner walls, and larger zooecia.

Holotype. — No. 19837.

Occurrence. — Ferron Point formation; localities 38 and 49. Bell shale; locality 31. Genshaw formation; locality 14 of A. W. Grabau. Norway Point formation; locality 47.

Leptotrypella gemmata, sp. nov.

(Pl. X, Figs. 7–8)

Description. — Zoarium ramose; average diameter 3 mm. Monticules composed of thicker-walled zooecia, 3 mm. apart, measured from center to center.

Zooecia polygonal; average diameter 0.2 mm.; seven in 2 mm. Walls thick in monticules, much thinner in intermonticular areas. Small tubes few. Acanthopores large, closed at surface by dense laminated deposit; central tubes unusually large and well defined in longitudinal sections. Acanthopores numerous, developed near junctions of zooecial walls.

Zooecia bend gradually from axial zone to periphery, nearly perpendicular to surface in outer mature zone. Walls thin and uncrenulated in axial region, uniformly thickened in short mature zone. Diaphragms thick in oldest part of mature zone, thinner in younger parts of zooecia, two or three in each zooecium, one or two tube diameters apart.

Axial ratio 0.5 : 1.

Remarks. — The unusually large acanthopores and the short mature zone are the most diagnostic characters of *Leptotrypella gemmata.* This species resembles *L. ohioensis* (Stewart) in having a comparable mature zone, but differs in having a smaller zoarium, a smaller axial ratio, fewer diaphragms, and larger acanthopores; and from *L. magninodosa,* sp. nov., in having smaller acanthopores, particularly in the monticules, fewer diaphragms, regularly thickened walls, a shorter mature zone, and a smaller zoarium.

Holotype. — No. 19843.

Occurrence. — Bell shale; locality 38.

Leptotrypella magninodosa, sp. nov.

(Pl. IX, Figs. 8–9)

Description. — Zoarium ramose; maximum diameter 6 mm. Slightly elevated monticules composed of thick-walled zooecia 2 mm. or more apart, measured from center to center.

Zooecia irregularly subpolygonal, occasionally inflected; average diameter 0.2 mm.; eight in 2 mm. Walls thick, particularly in monticules. Small zooecia moderately numerous. Acanthopores large; central tubes usually filled by laminated deposit near surface; in monticules usually two or three times the size of those in intermonticular areas; located at junctions of zooecial walls.

Zooecia bend gradually outward from axial region, perpendicular to surface in outer mature zone. Walls thin and crenulated in immature region, irregularly thickened in mature zone. Diaphragms well defined, not conspicuously thickened, seven or eight usually present in mature region of zooecium, approximately one tube diameter apart.

Axial ratio 0.4 : 1.

Remarks. — The large size of the acanthopores and the irregularly thickened walls are the most diagnostic characters of *Leptotrypella magninodosa.* This species differs from *L. moniliformis* (Nicholson) in having much larger acanthopores, thicker walls, and smaller zooecia. *L. magninodosa* is compared with *L. aequabilis,* sp. nov., *L. gemmata,* sp. nov., and *L. varia,* sp. nov., on pages 225 and 232.

Holotype. — No. 19838.

Occurrence. — Genshaw formation; locality 14 of A. W. Grabau. Ferron Point formation; locality 49.

Leptotrypella moniliformis (Nicholson)

(Pl. IX, Figs. 10–11)

1874. *Chaetetes moniliformis* Nicholson, Geol. Mag., New Ser., Decade II, Vol. I, p. 57, Pl. IV, Figs. 7a–7b.

1881. *Monticulipora (Heterotrypa) moniliformis* Nicholson, Genus Monticulipora, p. 137, Pl. I, Figs. 1–1c.

1882. *Amplexopora moniliformis* Ulrich, Journ. Cincinnati Soc. Nat. Hist., Vol. V, p. 255.

1900. *Heterotrypa? moniliformis* Nickles and Bassler, Bull. U. S. Geol. Surv., No. 173, p. 289.

Description from Nicholson, 1881. — "Corallum dendroid, the branches usually having a diameter of from three to five lines, or occasionally more. The surface may be nearly smooth, but is usually provided with bluntly rounded tubercles or monticules, which seem to be composed of corallites of a very slightly larger size than the average. The calices are polygonal, and the thick walls between them exhibit at all their angles of junction well-marked blunt spines, which, in slightly worn examples, produce a very characteristically rough superficial aspect. The walls of the corallites are completely amalgamated, and are mostly of tolerably equal dimensions, averaging 1–70th to 1–60th inch in diameter, though occasional smaller corallites are intercalated among them. There is also a great number of thick-walled hollow spines ('spiniform corallites'), which are of unusually large size, and are placed at almost all the angles of the junction of the normal corallites, as well as often in the substance of their walls. The tabulae are complete, horizontal, or slightly curved, from 1–100th to 1–80th inch apart . . . .

"As regards the internal structure of the corallum, thin tangential sections show a seeming entire amalgamation of the walls of the corallites, not the slightest trace of any line of demarcation between adjoining tubes being recognizable. The corallites are as a whole very uniform in size, and are polygonal or sub-polygonal in shape. Small corallites, in limited number, are usually intercalated among the larger tubes; but the amount of these varies even in different parts of the same section, and as they show no peculiarities of structure, they are apparently merely young tubes. At almost all the angles of junction of the large tubes, however, and commonly in the thickness of their lateral walls, are developed large hollow spines ('spiniform corallites'), which exhibit a central dark or light space surrounded by a conspicuous thickened wall. The upper ends of these peculiar structures project as intercalicine spines upon the surface, and I have not been able to detect that they are open above; though they are clearly hollow, and they can often be traced in the longitudinal sections as distinct tubular cavities in the axis of the thickened wall of the corallites.

"Longitudinal sections show that the corallites in the axis of the branches are thin-walled, with comparatively few tabulae. In the outer part of their course, however, where they bend outwards to reach the surface, they become thickened, and the walls assume the peculiar fibrous aspect characteristic of all those *Monticuliporae* in which a complete amalgamation of the corallites occurs. In this part of their course, also, the tabulae increase considerably in number; but they are never very closely arranged, and they are always complete."

Remarks. — In the specimen identified as *Leptotrypella moniliformis* (Nicholson) the average diameter of the smaller zooecia is 0.3 mm., of the larger 0.4 to 0.5 mm.; five or six in 2 mm., counting from the center of a group of larger zooecia. Clusters of larger zooecia are usually 3 mm. apart, measured from center to center, and slightly if at all elevated. The thickness of the walls, the size and number of acanthopores, and the structure and distribution of diaphragms in the figured hypotype are similar to Nicholson's figures in the "Genus Monticulipora" (1881, Pl. I, Figs. 1b–1c).

Hypotype. — No. 19839.

Occurrence. — Hamilton; Thedford, Ontario. Dock Street clay; locality 53.

Leptotrypella ohioensis (Stewart)

(Pl. IX, Figs. 1–2)

1927. *Monotrypella ohioensis* Stewart, Geol. Surv. Ohio., Fourth Ser., Bull. 32, p. 29, Pl. II, Figs. 7–10.

Original description. — "Zoarium ramose, often in discoidal masses from which several branches diverge. Zooecial apertures angular, irregular in shape and size, from 5 to 7 in 2 mm. Mesopores wanting, the small angular cells seen in tangential sections being young zooecia. Cell tubes polygonal, frequently becoming narrower where new zooecia are introduced, diverging gently from the axis until the mature region is reached and then turning abruptly to meet the surface at right angles. Diaphragms wanting in axial region, quite closely disposed in mature part where they are usually horizontal although some oblique ones also occur. Towards the peripheral margin the walls become thicker."

Revised description. — Zoarium ramose; average diameter of branches 5 mm. Groups of larger zooecia 3 mm. apart, generally not elevated.

Zooecia subpolygonal; diameter of ordinary zooecia 0.21 to 0.25 mm.; seven or eight in 2 mm.; diameter of large ones 0.35 to 0.42 mm. Walls approximately same thickness in all parts of zoarium. Few small tubes associated with large zooecia. Acanthopores well defined, of moderate size, usually near junctions of zooecial walls.

Zooecia bend gradually from immature into mature zone, nearly perpendicular to surface in outer mature region. Walls thin and uncrenulated in immature zone, moderately and occasionally irregularly thickened in mature zone. Diaphragms clearly defined, occasionally thick, four or five in mature part of each zooecium, one-half to one tube diameter apart.

Axial ratio 0.7 : 1.

Remarks. — The relatively short mature zone, the large axial ratio, the uncrenulated walls in the axial region, and the small but distinct acanthopores are diagnostic characters of *Leptotrypella ohioensis* (Stewart). Longitudinal sections of this species superficially resemble those of *L. gemmata*, sp. nov. (p. 225). *L. ohioensis* (Stewart) is readily distinguished from *L. undans*, sp. nov., by the smaller axial ratio, the more direct zooecia of the mature zone, the smaller acanthopores, and the uncrenulated walls in the immature zone.

Hypotype. — No. 19840.

Occurrence. — Silica shale; shale pit of Sandusky Cement Co., at Silica, Lucas County, Ohio. Bell shale; localities 31 and 38. Genshaw formation; locality 14 of A. W. Grabau.

Leptotrypella parva, sp. nov.

(Pl. IX, Figs. 4–5)

Description. — Zoarium ramose; average diameter 2 mm.

Zooecia subpolygonal; average diameter 0.14 to 0.16 mm.; ten in 2 mm. Small tubes few. Acanthopores small, composed of concentrically laminated tissue, usually near junctions of zooecial walls.

Zooecia gradually bend toward periphery in early mature zone, slightly oblique to surface. Walls thin and uncrenulated in axial region, uniformly thickened in mature zone. Diaphragms thin, well defined, usually one-third to one tube diameter apart in mature zone.

Axial ratio 0.45 : 1.

Remarks. — *Leptotrypella parva* differs from other species in the unusually small size of the zoarium, the zooecia, and the acanthopores.

Holotype. — No. 19841.

Occurrence. — Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9.

Leptotrypella pellucida, sp. nov.

(Pl. X, Figs. 9–10)

Description. — Zoarium ramose; average diameter 9 mm. Groups of larger thicker-walled zooecia 3 mm. apart, measured from center to center; slightly elevated if at all.

Zooecia subpolygonal or subcircular; average diameter 0.17 to 0.2 mm.; occasionally 0.28 mm.; seven or eight in 2 mm. In tangential sections wide unusually clear medial band separates laminated deposits lining zooecia. Few small tubes associated with groups of larger zooecia. Acanthopores extremely few, generally developed only in groups of larger zooecia.

Zooecia oblique in immature zone, perpendicular to surface throughout most of mature zone. Walls thin and crenulated in axial region; thickening slightly irregular in long mature zone. Two thick diaphragms usually present in each zooecium in oldest part of mature zone, and one or two near periphery. Thick diaphragms contribute to laminated deposit lining zooecia. Well-defined thinner diaphragms one-third to one tube diameter apart throughout mature zone.

Axial ratio ranges from 0.5 : 1 to 0.6 : 1.

Remarks. — The long mature zone, the numerous diaphragms, and the extremely few acanthopores are characters which distinguish *Leptotrypella pellucida* from most of the other species. *L. barrandei* (Nicholson) has a shorter mature zone, larger zooecia, thinner walls, fewer diaphragms, and well-defined small acanthopores. *L. pellucida* most closely resembles *L. spinulifera* (Fritz),[1] but is readily distinguished by the absence of prominent monticules. *L. pellucida* is compared with *L. aequabilis*, sp. nov., on page 224.

Holotype. — No. 19842.

Occurrence. — Ferron Point formation; locality 49. Genshaw formation; locality 14 of A. W. Grabau.

Leptotrypella undans, sp. nov.

(Pl. X, Figs. 4–6)

Description. — Zoarium ramose; average diameter 4 mm.

Zooecia subpolygonal or subcircular; diameter 0.15 to 0.2 mm.; seven or eight in 2 mm. Walls thick; medial band wide. Small tubes few. Acanthopores moderately large, clearly defined, located near junctions of zooecial walls.

Zooecia bend gradually from axial zone to periphery, slightly oblique in peripheral region. Walls thin and crenulated in immature zone, conspicuously thickened in short mature zone. Most diaphragms thick, two or three in mature region of each zooecium, approximately one tube diameter apart.

Axial ratio 0.8 : 1.

Remarks. — The diagnostic characters of *Leptotrypella undans* are an extremely short mature zone, a large axial ratio in comparison with those of other species, conspicuously thickened walls in the mature zone, and unusually well defined acanthopores. *L. undans* differs from *L. gemmata*, sp. nov., in having crenulated walls in the immature zone, thicker walls in the mature zone, less prominent acanthopores, and a greater axial ratio. It is compared with *L. ohioensis* (Stewart) on page 229.

Holotype. — No. 19844.

Occurrence. — Ferron Point formation; locality 49. Doubtfully present in Genshaw formation; locality 14 of A. W. Grabau.

[1] Fritz, 1930, p. 223, Pl. XII, Figs. 3–6.

Leptotrypella varia, sp. nov.

(Pl. X, Figs. 1–3)

Description. — Zoarium ramose; average diameter 5 mm. Groups of larger zooecia 3 mm. apart, measured from center to center, not elevated into monticules.

Zooecia polygonal or subpolygonal; diameter of ordinary zooecia 0.2 mm.; usually seven or eight in 2 mm.; diameter of large tubes 0.3 mm.; six or seven in 2 mm., counting from center of group. Laminated deposits lining zooecia unusually thick and separated by narrow medial band; conspicuous lines of dark tissue mark junctions of light-colored medial band and laminated deposits. Minute zooecia few. Acanthopores strong, occasionally inflect zooecia, located near junctions of zooecial walls.

Zooecia abruptly bent between axial and mature regions, perpendicular to periphery. Walls thin and uncrenulated in axial region, pronouncedly and irregularly thickened in mature zone. Diaphragms variable in structure, usually thick and contributing to conspicuous irregular thickening of walls, numerous, approximately one tube diameter apart in mature zone, six to nine diaphragms in each zooecium.

Axial ratio 0.4 : 1.

Remarks. — In tangential sections the unusually wide laminated zooecial deposits separated from the narrow medial band by lines of darker tissue and in longitudinal sections the marked irregularity of wall thickening are diagnostic characters of *Leptotrypella varia.* This species differs from *L. magninodosa,* sp. nov., in having thick diaphragms and smaller acanthopores.

Holotype. — No. 19845.

Occurrence. — Bell shale; locality 38. Doubtfully present in Genshaw formation; locality 14 of A. W. Grabau.

Genus STIGMATELLA Ulrich and Bassler

1904. *Stigmatella* Ulrich and Bassler, Smithsonian Misc. Coll., Vol. XLVII, p. 33.
1911. *Stigmatella* Bassler, U. S. Nat. Mus., Bull. 77, p. 210.

Original definition. — "Zoarium variable, ranging from incrusting to irregularly massive and ramose. Zooecia angular, rounded, or irregularly petaloid, the shape depending upon the presence (or absence) of mesopores and the number of acanthopores. Typically the zoarial surface exhibits at regular intervals maculae or spots composed of mesopores, although in some species the usual monticules or clusters of large cells occur. Acanthopores always present but variable in number, intermittent, developed chiefly in narrow zones, sometimes inconspicuous but more often so numerous as to give the surface a decidedly hirsute appearance. Mesopores, when present, developed in mature region only, their number being variable even for the same species.

"The zooecial tubes have thin walls in the axial region and these become but slightly thickened in the peripheral region where a few unusually delicate diaphragms are inserted. In vertical sections the walls exhibit at rather regular intervals in the peripheral region thickenings somewhat similar to those occurring in *Stenopora.* These thickenings occur approximately at the same height in the walls, and tangential sections through these zones give the full development of acanthopores. Minute structure of walls as shown in tangential sections, of the type that characterizes the *Heterotrypidae.*"

Genotype. — *Stigmatella crenulata* Ulrich and Bassler (1904, p. 34, Pl. IX, Figs. 1–4; Pl. XIV, Figs. 1–2).

Stigmatella alpenensis, sp. nov.

(Pl. IV, Figs. 4–6)

Description. — Zoarium a low conical mass; maximum thickness 7 mm. Groups of larger zooecia 4 to 5 mm. apart, measured from center to center, not elevated.

Zooecia subpolygonal; average diameter 0.2 mm.; usually nine in 2 mm.; large zooecia 0.25 to 0.3 mm. in diameter, associated with a few smaller tubes, averaging 0.15 mm. in diameter. Mesopores not observed in longitudinal sections. Acanthopores well defined, large, located near junctions of zooecial walls, occasionally inflect zooecia.

Zooecia normally direct from thin epizoarium to surface. Walls thin; periodic thickening irregularly developed; in some walls acanthopores persist for 2 mm., in others, thickening scarcely discernible or absent for long distances. Diaphragms straight, thin, one in a zooecium just behind wall thickenings, usually four or more tube diameters apart.

Remarks. — Most of the characters typical of *Stigmatella* are exhibited by this species, but the zonal development of intermittent wall thickening is less regular than usual and may be attributed to the form of the zoarium, which is thin at the edge and thick at the elevated central part. *Stigmatella alpenensis* is compared with *Stigmatella hybrida,* sp. nov., and with *Cyphotrypa traversensis,* sp. nov., on pages 234 and 201.

Holotype. — No. 19846.

Occurrence. — Genshaw formation; locality 50.

Stigmatella hybrida, sp. nov.

(Pl. V, Figs. 9–10)

Description. — Zoarium utricular; thickness of layers ranges from 0.6 to 2 mm. or more. Groups of larger zooecia approximately 4 mm. apart, measured from center to center, occasionally slightly elevated.

Zooecia polygonal; diameter of average zooecia 0.21 to 0.28 mm.; usually seven in 2 mm.; diameter of large zooecia 0.4 to 0.45 mm.; six in 2 mm., measured from center of group. Mesopores absent. Acanthopores obscure, small, generally present at junctions of zooecial walls, absent in areas where walls are not thickened.

Zooecia nearly direct. Walls thickened at intervals. Diaphragms straight or slightly curved, thin but well defined, developed in zones of wall thickening; generally two to four in a zooecium.

Remarks. — *Stigmatella hybrida* is not a typical species of the genus because the diaphragms are too strong and closely arranged in some zooecia, the acanthopores are poorly defined, and the zones of thickened walls are seldom well developed. *S. hybrida* seems to be intermediate between *Stigmatella* and *Cyphotrypa. S. hybrida* differs from *S. alpenensis,* sp. nov., in having a utricular zoarium, small and obscure acanthopores, and larger zooecia.

Holotype. — No. 19847; paratype No. 19848.

Occurrence. — Bell shale; locality 38.

FAMILY BATOSTOMELLIDAE ULRICH

1890. ***Batostomellidae*** **Ulrich, Geol. Surv. Ill., Vol. VIII, p. 375.**
1929. ***Batostomellidae*** **Bassler, Pal. Timor, Lief. XVI, p. 54.**

Definition from Bassler, 1929. — "Zoarium usually ramose but varying from thin incrusting expansions to bifoliate fronds and including all the different types of massive growths. Zooecia with thick walls in the mature region where they appear to be fused leaving the middle area clearer than the edges; diaphragms frequently absent but when present sometimes straight but often centrally perforated. Acanthopores and mesopores usually present, the former often greatly developed."

GENUS **CALACANTHOPORA,** gen. nov.

Definition. — Zoarium incrusting. Walls completely amalgamate, uniform in thickness. Diaphragms and mesopores absent. Acanthopores well defined, usually very large, numerous.

Genotype. — *Calacanthopora prima*, sp. nov.

Name. — *καλός*, "beautiful"; *ἄκανθα*, "thorn"; *πόρος*, "pore."

Remarks. — *Calacanthopora* is proposed to include Batostomellidae having thin incrusting zoaria, uniformly thickened walls, and numerous large acanthopores, but neither mesopores nor diaphragms. This new genus is apparently allied to the "*Lioclema*" group of Batostomellidae, but cannot be assigned to any of the described genera, since mesopores are absent. Although the absence of diaphragms and mesopores, and the very short zooecia indicate that *Calacanthopora* is allied to *Koninckopora* Lee, that genus has no acanthopores, and the genotype, *K. inflata* (de Koninck), figured by Lee (1912, Pl. XVI, Fig. 23), has periodically thickened walls. *Calacanthopora* is also allied to *Dyscritella* Girty, because both genera have uniformly thickened walls, numerous large acanthopores, and no diaphragms, but *Dyscritella* has mesopores.

Calacanthopora prima, sp. nov.

(Pl. XVI, Figs. 4–7)

Description. — Zoarium incrusting, extremely thin; 0.25 to 0.3 mm. in thickness. Slightly elevated monticules composed of larger zooecia 2 to 2.5 mm. apart, measured from center to center. Acanthopores project as prominent spines on surface of zoarium.

Zooecia subquadrangular to oval; average diameter 0.14 mm.; eleven to twelve in 2 mm.; diameter of monticular zooecia 0.2 to 0.25 mm. Walls moderately thick, completely amalgamate, nongranular. No mesopores or small tubes. Acanthopores well defined, composed of concentrically laminated tissue, solid at surface, variable in size, generally large and often inflecting zooecia, average four or five around a zooecium.

Zooecia direct; immature region not differentiated from mature. Walls uniformly thickened. Diaphragms absent.

Holotype. — No. 19849.

Occurrence. — Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9.

Genus **CHONDRAULUS**, gen. nov.

Definition. — Zoarium massive. Walls granular, amalgamate; laminated structure obscured by extreme granularity; intermittently thickened. Immature region short or poorly differentiated from mature region. Zooecia surrounded by minute tubules from beginning of mature region to surface of zoarium. Walls of tubules composed of granular laminated tissue; in tangential sections they appear as granular acanthopores surrounding zooecia, in longitudinal sections as granular streaks parallel with zooecial walls. Diaphragms thin, complete, moderately numerous. Mesopores absent, but smaller than average zooecia often numerous and resemble mesopores in tangential sections. Well-defined acanthopores at junctions of zooecial walls.

Genotype. — *Chondraulus granosus,* sp. nov.

Name. — **χονδρός**, "granular"; **αὐλός**, "tube."

Remarks. — At low magnification (× 20) the walls of this genus appear to be composed of a structureless granular deposit.

Examination of thin sections at high magnification (× 50), however, shows that the walls of both zooecia and minute tubules consist of regular laminae of dense, finely granular tissue (Pl. XII, Fig. 2).

Chrondraulus resembles *Eostenopora,* gen. nov., in having intermittently thickened walls, numerous acanthopores, and complete diaphragms, and is, therefore, assigned to the Batostomellidae. Although extremely granular wall structure is not characteristic of typical stenoporoids, the granularity of the tissue composing the zooecial walls in *Stenoporella* Bassler (p. 259) approaches that of *Chondraulus.*

Chaetetes ponderosus Rominger is a species of *Chondraulus.* In discussing this species Rominger (1892, p. 61) wrote: " . . . the intervening walls are stout, and not formed of a homogeneous mass of schlerenchyma, but obviously show their composition of a circle of solid vertical tissue columelles of alternately smaller and larger sizes. These columelles are intimately united with their side faces into closed channels with simple walls common to the contiguous cavities.

" . . . Cross sections of the columelles under the microscope appear exactly like intersected acanthopores, as they present themselves in tangential sections of some Monticulipora species, but none show a central perforation like some of these do in *Monticulipora.*"

Rominger's figures (Rominger, 1892, Pl. III, Figs. 4–8) of *Chondraulus ponderosus* not only fail to support this statement but show well-defined hollow acanthopores in both tangential and longitudinal sections.

Chondraulus densus, sp. nov.

(Pl. XII, Figs. 5–8)

Description. — Zoarium massive; average thickness 10 mm. Groups of larger zooecia 2 to 3 mm. apart, measured from center to center.

Zooecia subpolygonal; diameter of average zooecia 0.2 to 0.25 mm.; nine to ten in 2 mm.; diameter of large zooecia 0.28 to 0.35 mm., occasionally as much as 0.56 mm.; seven or eight in 2 mm., counting from center of group. Few smaller tubes 0.05 to 0.14 mm. in diameter, probably young zooecia, since mesopores are absent in longitudinal sections. Walls moderately thick, densely granular. Ten to fifteen granular acanthopores surround average zooecium, twenty or more may surround large zooecium. Acanthopores at junctions of zooecial walls generally larger than others.

Walls slightly thickened at wide intervals. Diaphragms straight, one-half to two tube diameters apart.

Remarks. — *Chondraulus densus* differs from *C. granosus*, sp. nov., in having a thinner zoarium, larger zooecia, stronger diaphragms, and less conspicuous zones of wall thickening; and from *C. ponderosus* (Rominger) in having a much smaller zoarium, smaller and thicker-walled zooecia, and fewer zones of wall thickening. *C. densus* is compared with *C. petoskeyensis*, sp. nov., on page 239.

Holotype. — No. 19851.

Occurrence. — Potter Farm formation; locality 37.

Chondraulus granosus, sp. nov.

(Pl. XII, Figs. 1–4)

Description. — Zoarium massive; maximum observed thickness 40 mm. Groups of larger zooecia present.

Zooecia polygonal; diameter of average zooecia 0.14 to 0.21 mm.; eight or nine in 2 mm.; diameter of large zooecia 0.28 to 0.3 mm. or a little more; seven in 2 mm., counting from center of group. Small tubes occasionally present. Walls extremely granular, often conspicuously thickened, width equal to diameter of smaller zooecia; in thick-walled zones, composed of wide granular medial band separating laminated deposits lining zooecia; in parts of tangential sections which do not cut thickened zone, granular band constitutes entire wall, laminated deposits being absent. Acanthopores granular, large, those near junctions of zooecial walls of larger size and generally have clear central lumen, average of eighteen to twenty around each zooecium. Wall structure obscured by acanthopores.

Zooecia direct from base to surface of zoarium. Immature zone extremely short or undifferentiated. Walls periodically thickened, usually at regular intervals. Columns of acanthopores produce granular streaks in longitudinal sections through zooecial walls. Diaphragms complete, extremely thin, straight, one to four tube diameters apart.

Remarks. — *Chondraulus granosus* differs from *C. ponderosus* (Rominger) in having smaller, thicker-walled zooecia, a smaller zoarium, and walls thickened at less frequent intervals. *C. granosus* is compared with *C. densus*, sp. nov., and *C. petoskeyensis*, sp. nov., on pages 238 and 239.

Holotype. — No. 19850.

Occurrence. — Bell shale; locality 38.

Chondraulus petoskeyensis, sp. nov.

(Pl. XII, Figs. 11–14)

Description. — Zoarium massive; average maximum thickness observed 20 mm. Groups of larger zooecia approximately 5 mm. apart, measured from center to center, not elevated into monticules and generally inconspicuous.

Zooecia subpolygonal; size variable. In tangential sections smallest tubes appear to be mesopores, but longitudinal sections show them to be young zooecia. Diameter of smallest zooecia usually 0.04 to 0.14 mm.; of average zooecia 0.17 to 0.21 mm.; of large zooecia in clusters 0.25 to 0.28 mm. Seven to ten average zooecia in 2 mm.; six or seven in 2 mm., counting from center of group of larger zooecia. Vague granular acanthopores surround zooecia, those near junctions of zooecial walls larger and more distinctly laminated.

Granular walls slightly thickened at irregular intervals; thickening often sufficiently frequent to produce inconspicuous beading. Diaphragms relatively strong, usually one to two tube diameters apart.

Remarks. — *Chondraulus petoskeyensis* is distinguished by the small average zooecia and the numerous smaller tubes resembling mesopores in tangential sections. It differs from *C. granosus*, sp. nov., and *C. densus*, sp. nov., in having much smaller zooecia, numerous smaller tubes, slightly beaded walls, and smaller and more obscure acanthopores.

Holotype. — No. 19852.

Occurrence. — Collected by Carl Rominger, probably from lower part of the Gravel Point stage; Petoskey, Michigan.

GENUS **DYOIDOPHRAGMA,** gen. nov.

Definition. — Zoarium incrusting, composed of one or more layers. Walls amalgamate, nongranular, generally of uniform thickness. Mature zone long. In addition to thin complete diaphragms, thick and irregular hemiphragms project from proximal side of zooecial walls in mature zone. Mesopores absent, but a few small zooecia present. Acanthopores composed of laminated tissue; large and numerous.

Genotype. — *Dyoidophragma typicale,* sp. nov.

Name. — *δυοειδές,* "of two forms"; *φράγμα,* "partition."

Remarks. — *Dyoidophragma* is defined for stenoporoid bryozoans in which the walls are uniformly thickened and both hemiphragms and complete diaphragms are present. The genus is most closely allied to *Stenophragma* Munro (1912, p. 574), which was defined for stenoporoids having beaded walls and hemiphragms. The structure of the walls, the acanthopores, and the hemiphragms indicate that *Dyoidophragma* may be ancestral to *Stenophragma.*

Dyoidophragma serratum, sp. nov.

(Pl. XIV, Figs. 1–2)

Description. — Zoarium incrusting; maximum thickness observed 1.5 mm. Groups of larger zooecia present but inconspicuous.

Zooecia subpolygonal; average diameter 0.18 mm.; diameter of larger zooecia 0.21 to 0.25 mm.; usually nine in 2 mm. Small tubes occasionally present. Walls moderately thick, amalgamate, clear. Acanthopores of moderate size, well defined, located near junctions of zooecial walls, slightly larger in groups of large zooecia.

Zooecia prone along epizoarium in short immature zone, nearly direct in mature region. Thickness of walls varies in different parts of zoarium, but walls not periodically thickened. Thin diaphragms approximately one tube diameter apart in mature zone, three or four in longer tubes. Thick and irregular hemiphragms project from proximal side of zooecia at intervals throughout mature zone.

Remarks. — *Dyoidophragma serratum* differs from the genotype in having smaller acanthopores, less variation in size of zooecia, greater irregularity in form and distribution of hemiphragms, and greater variation in thickness of zooecial walls.

Holotype. — No. 19853.

Occurrence. — Norway Point formation; locality 47. Doubtfully present in Dock Street clay; locality 53.

Dyoidophragma typicale, sp. nov.

(Pl. XIV, Figs. 13–16)

Description. — Zoarium incrusting, composed of two or three layers, each usually less than 2 mm. in thickness. Strongly elevated monticules composed of larger zooecia 3 to 3.5 mm. apart, measured from center to center.

Zooecia subpolygonal; diameter of intermonticular zooecia 0.14 to 0.19 mm.; nine or ten in 2 mm.; diameter of monticular zooecia 0.21 to 0.28 mm.; eight or nine in 2 mm., counting from center of monticule. Small tubes few. Acanthopores laminated, having large central tubes, numerous, of two sizes, relatively large at junctions of intermonticular zooecial walls, but in monticules size nearly equal to that of intermonticular zooecia.

Zooecia prone along epizoarium in short immature zone, direct throughout long mature zone. Walls conspicuously but uniformly thickened. Thin diaphragms usually one tube diameter apart throughout mature zone. Hemiphragms intermittently developed in mature zone on proximal side of zooecia, usually straight, occasionally curved or irregular, produced by prolongation of wall tissue into tubes and therefore thicker than diaphragms.

Holotype. — No. 19854.

Occurrence. — Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9.

GENUS **EOSTENOPORA**, gen. nov.

Definition. — Zoarium ramose, massive, or laminar. Walls composed of amalgamate laminated tissue, relatively thin, intermittently thickened but not regularly beaded. Diaphragms complete, always present, usually more closely arranged in thick-walled parts of zoarium. Mesopores rare, but a few smaller zooecia generally present. Acanthopores granular, surround zooecia in crowded series, generally larger at junctions of zooecial walls.

Genotype. — *Eostenopora picta*, sp. nov.

Name. — ἠώς, "dawn"; *Stenopora*, a genus.

Remarks. — Lonsdale (1844, p. 161) proposed the genus *Stenopora* and indicated as the genotype the Carboniferous species *S. tasmaniensis*, which he described but did not figure. The following year Lonsdale (1845, p. 262) defined *Stenopora*, described and figured additional species, and gave several illustrations of the genotype. All of Lonsdale's work was based on external characters.

Later workers interpreted the genus in different ways. Ulrich (1890, p. 375), who based his diagnosis of *Stenopora* on the earlier work of Nicholson and Etheridge, restricted the genus to Trepostomata characterized by intermittently thickened walls, relatively numerous acanthopores, few mesopores, and perforated diaphragms. Stenoporoids possessing these characters are now assigned to *Tabulipora* Young, 1883. Lee (1912, pp. 147–149) emended the generic diagnosis of *Stenopora*, basing his revision on Etheridge's monographic study of 1891. He defined the genus as follows: "Zoaria ramose, sublobate, massive, frondescent, laminar or parasitic. Surface even or with maculae and monticules. Zooecia-walls usually periodically thickened in the mature region, but sometimes of uniform thickness. Acanthopores present. Mesopores absent, but a cell smaller than the average is occasionally present at the junction-angles of adjacent zooecia. Tabulae complete, scarce to numerous." Etheridge (1891, p. 49), however, designated *Stenopora crinita* Lonsdale, 1845, as the genotype, ignoring the fact that Lonsdale originally established the genus on *S. tasmaniensis*. Consequently Etheridge's diagnosis of 1891 is misleading.

In the detailed description of *S. tasmaniensis* Lonsdale given by Etheridge (1891, pp. 61–64) the following statement is made: "Tabulae are very sparsely developed, and are often not recognisable at all, but when present are undoubtedly complete." Topotypes of *Stenopora tasmaniensis* in the collections of the United States National Museum illustrate exactly this condition. The fact that the emended diagnoses of *Stenopora* by Etheridge and by Lee were not based on the genotype caused additional confusion in the nomenclature, and led Bassler (1929, p. 55) to propose *Ulrichotrypa* for stenoporoids characterized by beaded walls, numerous acanthopores, and no diaphragms. Because this group actually includes *Stenopora tasmaniensis* Lonsdale, *Ulrichotrypa* becomes a synonym of *Stenopora*, and a new generic name must be proposed and a genotype designated for stenoporoids characterized by beaded walls, numerous acanthopores, and clearly defined complete diaphragms.

The primitive Devonian stenoporoids cannot be assigned to any established Carboniferous genus. The new genus *Eostenopora* is proposed for Batostomellidae having walls of imbricating layers of laminated tissue streaked with granules deposited by the acanthopores, intermittently thickened but not strongly beaded walls, relatively numerous complete diaphragms, numerous acanthopores, and few if any mesopores.

In addition to the new species described here *Eostenopora* includes *Stenopora? incrustans* Ulrich and Bassler, 1913.

Eostenopora compressa, sp. nov.

(Pl. X, Fig. 11; Pl. XI, Fig. 7)

Description. — Zoarium flattened-ramose; average dimensions of branches 5 by 10 mm. Groups of larger zooecia present.

Zooecia polygonal or subpolygonal; diameter of ordinary zooecia 0.21 to 0.28; six or seven in 2 mm.; diameter of larger zooecia 0.3 to 0.4 mm.; five and one half or six and one half in 2 mm., counting from center of group. Walls of ordinary zooecia thin, thicker in groups of larger zooecia. Mesopores few. Acanthopores granular, arranged in crowded series, larger and more distinct at junctions of zooecial walls.

Zooecia curve gently from axial region to periphery, oblique in peripheral region. Walls thin, intermittently thickened at wide intervals in axial region; thickened zones slightly stronger and more frequent as zooecia approach surface. Wall tissue granular. Diaphragms few, usually two or more tube diameters apart in axial zone, and one tube diameter apart in younger parts of zooecia; distribution irregular. Mesopores more closely tabulated than zooecia.

Remarks. — The diagnostic characters of *Eostenopora compressa* are moderately thin walls and widely spaced diaphragms. *E. compressa* resembles the ramose part of *E. tenuimuralis,* sp. nov., more than other species, but differs in having a smaller zoarium, less frequent diaphragms, and larger and more distinct acanthopores at junctions of the zooecial walls. It differs from *E. picta,* sp. nov., in having fewer diaphragms, thinner walls, and less pronounced intermittent thickening; and from *E.? villosa,* sp. nov., in having a much smaller zooecia and more acanthopores and diaphragms.

Holotype. — No. 19855.

Occurrence. — Bell shale; locality 38.

Eostenopora picta, sp. nov.

(Pl. XI, Figs. 3–6)

Description. — Zoarium flattened-ramose; average dimensions of branches 7 by 15 mm. Groups of larger zooecia usually 3 mm. apart, measured from center to center.

Zooecia subpolygonal to round in tangential section, occasionally inflected by acanthopores; diameter of ordinary zooecia 0.21 to 0.28 mm.; usually seven in 2 mm.; diameter of large zooecia approximately 0.35 mm.; six in 2 mm., counting from center of group. Small tubes occasionally present. Walls moderately thick. Crowded series of granular acanthopores surround zooecia; those at junctions of walls of larger size and usually hollow. Acanthopores arranged in single series except in thicker walls of large zooecia; fifteen or more surround each zooecium.

Zooecia slightly oblique in long mature zone. Walls of immature zone thin and slightly granular, of mature region conspicuously thickened and streaked with granules deposited by acanthopores. Intermittent thickening irregularly developed; walls never beaded. Diaphragms thin, one tube diameter or more apart in immature zone, stronger, usually straight but occasionally curved in mature zone, more closely arranged as zooecia approach surface, approximately one-half tube diameter apart in medial and outer mature zones.

Remarks. — The distinguishing characters of *Eostenopora picta* are thick walls, numerous diaphragms, and a well-defined mature zone. *E. picta* differs from the ramose part of the zoarium of *E. tenuimuralis*, sp. nov., in having much thicker walls, more diaphragms, and larger acanthopores; from *E.? villosa*, sp. nov., in having a ramose zoarium, smaller zooecia, much thicker walls, and numerous acanthopores; and is compared with *E. compressa*, sp. nov., on page 244.

Holotype. — No. 19856; paratype No. 19857.

Occurrence. — Alpena limestone; locality 40. Bell shale; locality 38.

Eostenopora primiformis, sp. nov.

(Pl. XII, Figs. 9–10)

Description. — Zoarium incrusting; maximum thickness of laminae 0.63 mm. Groups of larger zooecia usually 3 mm. apart, measured from center to center.

Zooecia polygonal; diameter of average zooecia 0.2 mm.; six in 2 mm., measured diagonally, eight in 2 mm., measured transversely; diameter of large zooecia 0.3 mm. Small tubes few. Walls thin, occupied by vague transverse rows of small granules. Acanthopores small, distinctly nodose on surface, located at or near junctions of zooecial walls.

Zooecia prone along epizoarium for short distance, direct in mature zone. Walls uniformly thickened. Generally one diaphragm in early mature region, absent in shortest zooecia.

Remarks. — *Eostenopora primiformis* closely resembles *E. incrustans* (Ulrich and Bassler) [2] in having an incrusting zoarium, uniformly thickened walls, and few diaphragms, but is distinguished by its thinner walls and the absence of numerous granular acanthopores surrounding the zooecia.

Holotype. — No. 19858.

Occurrence. — Dock Street clay; locality 53.

Eostenopora tenuimuralis, sp. nov.

(Pl. XI, Figs. 8–11)

Description. — Zoarium incrusting and ramose; diameter of branches 15 mm. or more. Groups of large zooecia 3.5 to 4 mm. apart, measured from center to center.

Zooecia polygonal; diameter of average zooecia 0.28 to 0.3 mm.; six to eight in 2 mm.; diameter of large zooecia 0.35 to 0.45 mm., occasionally 0.55 mm.; five to six and one half in 2 mm., counting from center of group. Small tubes few. Walls thin in ramose part of zoarium, nearly twice as thick in incrusting part, occupied by single series of closely arranged granular acanthopores. Acanthopores at junctions of zooecial walls occasionally larger and more clearly defined than granular spots in walls bounding zooecia, on the average twenty acanthopores surround each zooecium.

In ramose part of zoarium zooecia bend gradually outward from axial region, slightly oblique at periphery. Walls thin, granular, slightly thickened near surface; periodic thickening developed at wide intervals, usually inconspicuous. Diaphragms thin, distributed throughout zooecia at distances equal to one tube diameter or a little more; occasionally irregular bands of two or three more closely arranged diaphragms, one-half tube diameter apart, associated with zones of intermittent thickening.

In incrusting part of zoarium zooecia direct; periodic thickening usually absent; diaphragms more closely arranged and walls thicker than in ramose part of zoarium.

Remarks. — The large zoarium, the thin walls, the abundant

[2] Ulrich and Bassler, 1913a, p. 275, Pl. XLII, Figs. 11–16; Pl. XLIV, Fig. 6.

granular acanthopores, and the moderately numerous diaphragms are diagnostic characters of *Eostenopora tenuimuralis.* This species is compared with *E. compressa,* sp. nov., *E. picta,* sp. nov., and *E.? villosa,* sp. nov., on pages 244, 245, and 247.

Holotype. — No. 19859.

Occurrence. — Bell shale; localities 31 and 38.

Eostenopora? villosa, sp. nov.

(Pl. XI, Figs. 1–2; Pl. XII, Fig. 15)

Description. — Zoarium massive and subramose. Conspicuous aggregations of unusually large zooecia usually 5 mm. apart, measured from center to center.

Zooecia polygonal; diameter of average zooecia 0.28 to 0.35 mm.; six in 2 mm.; diameter of large zooecia 0.45 to 0.7 mm.; five in 2 mm., counting from center of group. Small tubes few. Walls usually extremely thin, much thicker in center of groups of large zooecia. Thick walls occupied by closely arranged series of minute granules. Relatively small vague acanthopores at junctions of thicker-walled zooecia, doubtful at junctions of thin-walled zooecia.

Zooecia bend gradually from axial region to surface, direct in outer peripheral region. Walls thin, thickened periodically in both axial and mature zones; thickening usually slight, but intervening walls so thin that beading is often conspicuous. Thickened walls granular and irregular; boundaries generally hazy. In axial region diaphragms developed only in zones of wall thickening, if more than one present, diaphragms separated by space greater than one tube diameter; distribution in peripheral region irregular, always a tube diameter or more apart, often absent for considerable distances.

Remarks. — *Eostenopora? villosa* is characterized by a large massive zoarium, unusually large zooecia, thin walls, vague acanthopores, few diaphragms, and irregular structure in thickened parts of the walls. The structural similarity of the walls in *E.? villosa* and *Trachytoechus,* gen. nov., is discussed on page 262. *E.? villosa* differs from *E. tenuimuralis,* sp. nov., in having larger zooecia, irregular and roughened zones of wall thickening, infrequent diaphragms, and few acanthopores; and is compared with *E. compressa*, sp. nov., and *E. picta*, sp. nov., on pages 244 and 245.

Holotype. — No. 19860.

Occurrence. — Bell shale; locality 38.

Genus LIOCLEMA Ulrich

1882. *Leioclema* Ulrich, Journ. Cincinnati Soc. Nat. Hist., Vol. V, pp. 141, 154.
1900. *Lioclema* Nickles and Bassler, Bull. U. S. Geol. Surv., No. 173, p. 33.
1904. *Lioclema* Ulrich and Bassler, Smithsonian Misc. Coll., Vol. XLVII, p. 38.

Definition from Nickles and Bassler, 1900. — "Zoarium ramose, lamellar, subglobose, or incrusting; surface frequently exhibiting distinct monticules or maculae; zooecia with subcircular or irregularly petaloid apertures, separated by abundant angular mesopores, which in some species are open at the surface, in others closed; diaphragms few in the zooecia, abundant, and sometimes crowded in the mesopores; acanthopores numerous and strong in the typical species, small and inconspicuous in others."

Genotype. — *Callopora punctata* Hall (1858, p. 653).

Remarks. — A number of genera allied to *Lioclema* have been defined by Girty, Lee, and Vinassa de Regny. These genera differ from *Lioclema* in tabulation, type of diaphragms, or wall structure. As restricted by Bassler (1929, p. 54), *Lioclema* now includes species having uniformly thickened walls, complete diaphragms, and tabulated mesopores.

Species of *Lioclema* known from the Traverse rocks of Michigan are characterized by thin laminar zoaria and unusually small zooecia.

Lioclema alpenense, sp. nov.

(Pl. XVI, Figs. 16–18)

Description. — Zoarium incrusting; average thickness 1 mm. Epizoarium thin and irregular. Groups of larger zooecia present.

Zooecia suboval; long diameter usually 0.15 to 0.17 mm.; short diameter 0.11 to 0.14 mm.; length of largest zooecia 0.2 mm.; six or seven in 2 mm. Mesopores variable in shape and size, usually subpolygonal, average diameter less than half that of zooecia. Interspaces equivalent to or more than zooecial diameters. Acanthopores small but well defined, usually two associated with each zooecium, often slightly inflect zooecia.

Zooecia prone along epizoarium for short distance in immature region, direct in mature zone. Walls moderately and uniformly thickened. Occasionally one diaphragm in early mature region of a zooecium; numerous in mesopores, one tube diameter or less apart.

Remarks. — The distinctive characters of *Lioclema alpenense* are numerous mesopores, moderately thick walls, minute acanthopores, and uniformly tabulated mesopores. *L. alpenense* differs from *L. attenuatum*, sp. nov., in having thicker walls, smaller acanthopores, a thicker zoarium, and more regularly tabulated mesopores; from both *L. incompositum*, sp. nov., and *L. passitabulatum*, sp. nov., in having more numerous, usually smaller, and more uniformly tabulated mesopores and a thinner zoarium; from *L. traversense*, sp. nov., in having more mesopores, wider interzooecial spaces, and fewer acanthopores; from *L. explanatum* Bassler (1906, p. 33, Pl. XIII, Figs. 8–10; Pl. XXVI, Fig. 4) in having smaller zooecia, a thinner zoarium, fewer acanthopores, and thicker walls; and from *L. minutissimum* (Nicholson),[3] redescribed by Bassler (1911b, p. 62, Pl. IX, Figs. 3–7), in having a unilaminar zoarium, smaller zooecia, and thicker-walled mesopores.

Holotype. — No. 19861.

Occurrence. — Alpena limestone; locality 40. Doubtfully present in Ferron Point formation; locality 38.

Lioclema attenuatum, sp. nov.

(Pl. XVI, Figs. 13–15)

Description. — Zoarium extremely thin incrustation; thickness 0.25 mm. Groups of slightly larger zooecia present.

Zooecia oval; often inflected; dimensions of average zooecia 0.14 by 0.17 mm.; dimensions of larger zooecia 0.17 by 0.22 mm.; six or seven in 2 mm. Walls of zooecia and mesopores thin.

[3] Nicholson, 1875, p. 77, Fig. 43.

Width of interspaces usually less than zooecial diameters. Mesopores variable in size, longest diameter often more than one half that of zooecia. Acanthopores of moderate size, considering thinness of walls, usually three or four around each zooecium, also developed in walls of mesopores.

Zooecia prone along epizoarium for short distance, direct in mature zone. Walls slightly thickened. Diaphragms not observed in zooecia, few in mesopores, less than one tube diameter apart where tubes are long enough to accommodate more than one.

Remarks. — The diagnostic characters of *Lioclema attenuatum* are an extremely thin zoarium, thin walls, and relatively well developed and numerous acanthopores. *L. attenuatum* differs from *L. traversense*, sp. nov., in having a thinner zoarium, thinner walls, and less variation in size of mesopores; and from *L. minutissimum* (Nicholson) in having a much thinner and unilaminar zoarium, smaller zooecia, and more and larger acanthopores.

Holotype. — No. 19862.

Occurrence. — Potter Farm formation; locality 68.

Lioclema incompositum, sp. nov.

(Pl. XV, Figs. 4–6)

Description. — Zoarium small mass composed of several contorted layers. Groups of larger zooecia present.

Zooecia subcircular; average diameter 0.14 mm.; six to eight in 2 mm.; generally separated by single series of mesopores, but occasionally contiguous. Walls moderately thick. Mesopores variable in size, often large. Acanthopores small, two or three around each zooecium.

Zooecia prone along epizoarium in short immature zone, direct in mature zone. Walls moderately thickened near periphery; long zooecia thin walled in early mature region. Diaphragms few, widely separated in long zooecia, seldom developed in thin parts of zoarium. In mesopores diaphragms irregularly arranged in early mature zone, one-half to one tube diameter apart near periphery. In thin layers change in tabulation of mesopores not observed, tubes so short that only three or four diaphragms are present.

Remarks. — The loose tabulation of the mesopores, which resemble vesicular tissue in the early mature region, is diagnostic of *Lioclema incompositum.* This species differs from *L. passitabulatum,* sp. nov., in having slightly thinner and less granular walls, smaller mesopores and acanthopores, and crowded diaphragms in the peripheral region; from *L. traversense,* sp. nov., in having loosely tabulated mesopores in the early mature region, crowded diaphragms in the outer mature zone, and fewer and smaller acanthopores in the monticules; and from *L. minutissimum* (Nicholson) in having smaller zooecia, more acanthopores, fewer mesopores, and irregular tabulation. *L. incompositum* is compared with *L. alpenense,* sp. nov., on page 249.

Holotype. — No. 19863.

Occurrence. — Partridge Point formation; locality 35.

Lioclema passitabulatum, sp. nov.

(Pl. XVI, Figs. 8–10)

Description. — Zoarium incrusting; usually less than 1 mm. in thickness. Monticules composed of thicker-walled zooecia developed at irregular intervals.

Zooecia subcircular; average diameter 0.14 mm.; diameter of monticular zooecia 0.2 to 0.25 mm.; seven or eight in 2 mm. Walls moderately thick, nearly twice as thick in monticules as in intermonticular areas. Mesopores subangular, of varying sizes, often nearly as large as zooecia, much smaller in monticules, irregularly distributed; zooecia locally in contact, especially in monticules. Acanthopores large and numerous in comparison with those of other species, two or three around a zooecium; larger and more numerous in monticules.

Zooecia prone along epizoarium in short immature zone, direct in mature zone. Walls of mature region minutely granular, strongly thickened in monticulated parts of zoarium. Diaphragms few, widely separated in zooecia. Mesopores uniformly tabulated in intermonticular areas; diaphragms one tube diameter apart; tabulation irregular in monticules.

Remarks. — The relatively large acanthopores and mesopores and the thick-walled zooecia of the monticules are distinguishing characters of *Lioclema passitabulatum.* This species differs from *L. minutissimum* (Nicholson) in having stronger acanthopores, thicker-walled zooecia, particularly in the monticules, and thicker-walled mesopores. *L. passitabulatum* is compared with *L. alpenense,* sp. nov., *L. incompositum,* sp. nov., and *L. traversense,* sp. nov., on pages 249, 251, and 252.

Holotype. — No. 19864.

Occurrence. — Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 17.

Lioclema traversense, sp. nov.

(Pl. XVI, Figs. 11–12)

Description. — Zoarium incrusting; layers 0.5 to nearly 2 mm. in thickness. Monticules composed of larger thicker-walled zooecia irregularly developed.

Zooecia subcircular, slightly inflected by acanthopores in monticules; average diameter 0.14 to 0.17 mm.; diameter of larger zooecia 0.2 mm. or more; seven to nine in 2 mm.; separated by single series of mesopores except in monticules, where zooecia are frequently in contact. Walls moderately thick, usually twice as thick in monticules as in intermonticular areas. Mesopores of variable size; diameter in intermonticular areas usually one half that of zooecia or slightly more, generally smaller in monticules. Acanthopores well defined, of moderate size, larger in monticules, three or four to a zooecium.

Zooecia prone along epizoarium in short immature zone, direct in mature zone. Occasional diaphragm in long zooecia. Diaphragms usually one tube diameter apart in mesopores.

Remarks. — *Lioclema traversense* is characterized by moderately large mesopores in the intermonticular areas, small ones in the monticules, well-defined acanthopores, and regularly tabulated mesopores. This species differs from *L. passitabulatum,* sp. nov., in having more regularly tabulated and generally smaller mesopores and less conspicuous acanthopores; and from *L. minutissimum* (Nicholson) in having smaller zooecia and stronger acanthopores. *L. traversense* is compared with *L. alpenense,* sp. nov., *L. attenuatum*, sp. nov., and *L. incompositum*, sp. nov., on pages 249, 250, and 251.

Holotype. — No. 19865.

Occurrence. — Norway Point formation; locality 47. Ferron Point formation; locality 49. Genshaw formation; locality 14 of A. W. Grabau. Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9 and doubtfully at locality 17. Also doubtfully present in Potter Farm formation; locality 68.

GENUS **MICROCAMPYLUS**, gen. nov.

Definition. — Zoarium usually ramose, occasionally incrusting. Walls amalgamate, granular in mature zone, generally uniformly thickened, but irregularly thickened in some species. Diaphragms present in mature zone. Minute recurved spines similar to those of *Stenoporella* (p. 259) project from walls of zooecia and mesopores in mature zone. Mesopores numerous, sparsely tabulated. Acanthopores laminated, generally large and numerous, developed at random in walls of zooecia and mesopores.

Genotype. — *Microcampylus typicus*, sp. nov.

Name. — μικρός, "small"; καμπύλος, "hooked."

Remarks. — *Microcampylus* differs from *Stenoporella* Bassler in having numerous mesopores and at least a few diaphragms in the zooecia. Numerous granules in addition to acanthopores are present in the walls of zooecia and mesopores in *Microcampylus*, whereas distinct granules are absent in the walls of *Stenoporella* and acanthopores are restricted to the junctions of the zooecial walls.

Microcampylus angularis, sp. nov.

(Pl. XIV, Figs. 11–12)

Description. — Zoarium flattened-ramose; average short diameter 2.5 mm., long diameter 6 mm. Inconspicuous groups of larger zooecia occasionally present, never elevated into monticules.

Zooecia subpolygonal to nearly circular on surface of zoarium; zooecia and mesopores thin-walled and distinctly angular in sections; diameter of average zooecia 0.17 mm.; diameter of large tubes 0.21 mm.; seven and one half or eight and one half in 2 mm. Mesopores variable in size, average diameter approximately one half that of zooecia. Small granules relatively inconspicuous because of thinness of walls. Acanthopores of moderate size, two or three to a zooecium.

Zooecia bend gradually from immature to mature zone, direct near periphery. Walls slightly and uniformly thickened in mature region. One or two diaphragms in oldest part of mature zone, one often present in medial mature region, usually two near periphery.

Axial ratio of short diameter 0.3 : 1.

Remarks. — Thin walls, angular zooecia, and large angular mesopores are diagnostic characters of *Microcampylus angularis.* Diaphragms are more numerous in *M. angularis* than in any other species except *M. multitabulatus,* sp. nov. *M. angularis* differs from *M. typicus,* sp. nov., in having smaller acanthopores, larger mesopores, more diaphragms, and fewer granules.

Holotype. — No. 19866.

Occurrence. — Genshaw formation; locality 14 of A. W. Grabau.

Microcampylus granosus, sp. nov.

(Pl. XV, Figs. 1–3)

Description. — Zoarium ramose; average diameter 3 mm. All zooecia approximately of same size. Acanthopores strongly developed, giving surface hirsute appearance.

Zooecia circular or oval, occasionally inflected; diameter 0.17 to 0.2 mm.; eight or nine in 2 mm. Walls moderately thick; width often equal to one-half zooecial diameter. Minute granules conspicuous in tangential sections. Mesopores of varying sizes, generally small, three to five around a zooecium, approximately twice as numerous as zooecia. Acanthopores large, approximately equal zooecia in number.

Zooecia direct in mature zone. Walls occasionally irregularly thickened, unusually granular. Generally one diaphragm in transition between immature and mature zones and one in medial mature region of each zooecium.

Axial ratio 0.3 : 1 or slightly more.

Remarks. — The distinctive characters of *Microcampylus granosus* are thick walls, conspicuous granules, strong acanthopores, and comparatively few diaphragms. This species differs from *M. traversensis*, sp. nov., another thick-walled species, in having more regularly oval zooecia, fewer but larger acanthopores, more conspicuously granular and thicker walls; from *M. ovatus*, sp. nov., in having larger mesopores and acanthopores and more coarsely granular walls; and from *M. multitabulatus*, sp. nov., in having fewer diaphragms, uniformly thickened walls, and larger acanthopores.

Holotype. — No. 19867.

Occurrence. — Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; localities 9 and 17.

Microcampylus minutus, sp. nov.

(Pl. XIV, Figs. 7–8)

Description. — Zoarium ramose; diameter 1.4 mm. or less.

Zooecia oval; diameter 0.14 to 0.2 mm.; six or seven in 2 mm. Walls moderately thick. Mesopores vary in size, usually small, diameter one fourth to one half that of zooecia, numerous, but not completely isolating zooecia. Acanthopores well defined, equal in size to smallest mesopores, usually associated with mesopores instead of zooecial margins, approximately as numerous as mesopores.

Zooecia curve gently from axial region to periphery, direct in outer mature region. Diaphragms few, one occasionally present in mature region of zooecium and several in mesopores.

Axial ratio 0.3 : 1.

Remarks. — *Microcampylus minutus* differs from other species in having the smallest zoarium, the fewest diaphragms in zooecia, and acanthopores associated with mesopores instead of with both mesopores and zooecia.

Holotype. — No. 19868.

Occurrence. — Alpena limestone; locality 40.

Microcampylus multitabulatus, sp. nov.

(Pl. XIV, Figs. 5–6)

Description. — Zoarium ramose; average diameter 6 mm.

Zooecia oval or round; average diameter 0.13 to 0.15 mm., largest diameter 0.2 mm.; eight or nine in 2 mm. Walls moderately thick, granules well developed. Mesopores of varying sizes, generally small, numerous, usually five or six but occasionally only one or two associated with a zooecium, never entirely isolate zooecia. Acanthopores small, two or three near margins of zooecia or in walls of surrounding mesopores.

Zooecia bend gradually from axial to mature zone. Walls intermittently thickened, conspicuously granular in mature zone. Diaphragms numerous, usually one tube diameter apart in zooecia from late immature region to periphery; distribution occasionally irregular. Few diaphragms in mesopores.

Remarks. — *Microcampylus multitabulatus* differs from other species in having intermittently thickened walls and numerous diaphragms in the mature zone.

Holotype. — No. 19869.

Occurrence. — Genshaw formation; locality 14 of A. W. Grabau.

Microcampylus ovatus, sp. nov.

(Pl. XIV, Figs. 3–4)

Description. — Zoarium flattened-ramose; average dimensions of branches 1.5 by 2 mm.

Zooecia oval; average length 0.17 mm., width 0.13 mm.; eight to ten in 2 mm. Walls thick, equal to or more than one-half zooecial diameter, minutely granular. Mesopores minute, usually four around each zooecium. Acanthopores small, three or four associated with each zooecium and surrounding mesopores.

Zooecia bend gradually from axial to mature zone, direct near periphery. Walls abruptly thickened near surface. One or two diaphragms in transition and mature region of each zooecium.

Remarks. — *Microcampylus ovatus* differs from other species in having uniformly small mesopores and minutely granular walls, the well-defined small granules characteristic of most species being absent. It differs from *M. angularis*, sp. nov., in having smaller, thicker-walled oval zooecia and smaller mesopores; and from *M. multitabulatus*, sp. nov., in having fewer diaphragms and uniformly thickened walls.

Holotype. — No. 19870.

Occurrence. — Ferron Point formation; locality 49. Doubtfully present in Genshaw formation; locality 14 of A. W. Grabau.

Microcampylus tenuis, sp. nov.

(Pl. XV, Figs. 7–8)

Description. — Zoarium incrusting; maximum thickness of laminae 1.2 mm.

Zooecia round; diameter 0.14 to 0.17 mm., occasionally 0.25 mm.; eight or nine in 2 mm. Walls thin, granules conspicuous in tangential sections. Mesopores small, subcircular, numerous, usually seven or eight around each zooecium, often completely isolate zooecia, arranged in single series. Acanthopores large, diameter equivalent to or greater than that of mesopores, usually one or two, occasionally three or four, associated with each zooecium and surrounding mesopores.

Immature zone relatively long; zooecia generally direct through most of length. One diaphragm in each zooecium just before walls thicken to form mature zone.

Remarks. — *Microcampylus tenuis* is the only known species having an incrusting zoarium. The mesopores are more numerous and uniform in size, shape, and distribution than in other species. It differs from *M. typicus*, sp. nov., in having an incrusting zoarium, fewer diaphragms, and greater uniformity in size, shape, and distribution of acanthopores and mesopores.

Holotype. — No. 19871.

Occurrence. — Potter Farm formation; locality 68. Doubtfully present in Genshaw formation at locality 14 of A. W. Grabau and in Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl, at locality 9.

Microcampylus traversensis, sp. nov.

(Pl. XV, Figs. 9–11)

Description. — Zoarium ramose; average diameter 3 mm.

Zooecia oval to round, often irregular; long diameter 0.14 to 0.17 mm., short diameter 0.11 to 0.15 mm.; eight or nine in 2 mm., measured longitudinally. Walls moderately thick; granules fairly well defined but less conspicuous than in some other species. Mesopores small, irregular in shape, usually three or four around each zooecium, never isolate zooecia. Acanthopores moderately large, usually three or four associated with zooecium and surrounding mesopores.

Zooecia bend abruptly between axial and mature zones, direct through most of mature zone. Walls uniformly thickened, granular. One diaphragm generally present in late immature zone or transition, one in early mature region, and occasionally one near periphery of each zooecium.

Axial ratio ranges from 0.2 : 1 to 0.3 : 1.

Remarks. — The diagnostic characters of *Microcampylus traversensis* are the irregular shape of zooecia and mesopores, the fewness of the diaphragms, and the moderate number of well-defined acanthopores. *M. traversensis* differs from *M. typicus*, sp. nov., in having smaller zooecia, smaller and fewer mesopores, and less prominent granules. It is compared with *M. granosus*, sp. nov., on page 255.

Holotype. — No. 19872; paratype No. 19883.

Occurrence. — Ferron Point formation; locality 49. Genshaw formation; locality 14 of A. W. Grabau. Doubtfully present in Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9.

Microcampylus typicus, sp. nov.

(Pl. XV, Figs. 12–15)

Description. — Zoarium ramose; average diameter 4 mm. No groups of larger zooecia.

Zooecia irregularly round or oval; average diameter 0.17 mm., occasionally 0.21 mm.; seven to nine in 2 mm. Walls moderately thick. Granules conspicuous in tangential sections. Mesopores variable in shape and size, diameter ordinarily less than half that of zooecia, usually six to eight around each zooecium, never completely isolate zooecia. Acanthopores large, solid at surface, occasionally inflect zooecia, two or three associated with a zooecium and surrounding mesopores, irregularly arranged, not restricted to junctions of zooecial walls.

Zooecia bend through arc of nearly 90 degrees from central axial region into mature zone, perpendicular to surface through most of mature zone. Thin walls of immature zone thicken gradually in transition zone, mature walls minutely granular and slightly irregular in thickness. One or two diaphragms in transition, usually two diaphragms three or more tube diameters apart in later mature zone, absent in peripheral region. Few widely spaced diaphragms in mesopores. Small recurved spines project from walls of zooecia and mesopores in mature zone.

Axial ratio 0.25 : 1.

Holotype. — No. 19873.

Occurrence. — Ferron Point formation; locality 49. Doubtfully present in Genshaw formation; locality 14 of A. W. Grabau.

Genus STENOPORELLA Bassler

1936. *Stenoporella* Bassler, Journ. Washington Acad. Sci., Vol. 26, p. 157.

Original definition. — "Like *Stenopora* Lonsdale, 1844, save that instead of diaphragms, numerous spines project from the walls into the zooecial cavity, and the beaded structure of the walls is nearly obsolete. *Stenophragma* Munro, 1912, has semi-diaphragms projecting from one side of the walls only and has regularly beaded wall structure."

Genotype. — *Stenoporella romingeri* Bassler (1936, p. 157, Figs. 1–3).

Stenoporella? devonica, sp. nov.

(Pl. XIV, Figs. 9–10)

Description. — Zoarium irregularly ramose; average diameter 15 mm. No conspicuous groups of large zooecia.

Zooecia polygonal, subpolygonal in tangential sections; diameter 0.25 to 0.28 mm.; eight or nine in 2 mm. Small tubes occasionally present. Walls moderately thick, amalgamate, medial part granular. Acanthopores of moderate size, solid at surface, usually three or four at junctions of walls of each zooecium.

Zooecia bend gradually from axial to mature region, direct in long mature zone. Walls heavily laminated, often irregularly thickened. Diaphragms well defined, moderately thick, numerous, generally four in early mature region and two or more in younger part of each zooecium; distribution more or less irregular, approximately one tube diameter apart. Minute spines project from zooecial walls in mature zone.

Remarks. — *Stenoporella? devonica* has similar zooecia and acanthopores and few if any mesopores, as in *S. romingeri* Bassler, but differs in having diaphragms and heavily laminated wall tissue.

Holotype. — No. 19874.

Occurrence. — Bell shale; locality 38.

Genus **STEREOTOECHUS,** gen. nov.

Definition. — Zoarium laminar, superimposed layers may form small masses. Groups of larger zooecia present. Walls thick, completely amalgamate, laminated, irregularly thickened at frequent intervals, occasionally slightly beaded. Diaphragms complete and numerous. Mesopores absent. Acanthopores well defined, laminated, located at or near junctions of zooecial walls.

Genotype. — *Stereotoechus typicus,* sp. nov.

Name. — **στερεός,** "solid"; **τοῖχος,** "wall."

Remarks. — *Stereotoechus* is established for primitive stenoporoids having nongranular walls, numerous diaphragms, and acanthopores restricted to the junctions of the zooecial walls. *Eostenopora,* gen. nov., in which the laminated walls are streaked with granules deposited by the acanthopores, seems to be intermediate between *Stereotoechus* and *Chondraulus,* gen. nov., which is defined for those stenoporoids having walls composed of extremely granular tissue. *Stereotoechus* has characters which suggest that it may be ancestral to *Stenopora* Lonsdale. For example, the wall structure of *Stereotoechus* is similar to that of *Stenopora,* and by very little modification the thinner and slightly beaded walls could have given rise to the pronounced beading in the mature zone of *Stenopora.* The structure of the acanthopores is the same in both genera. If the diaphragms in *Stereotoechus* had atrophied, a form similar to *Stenopora* would have resulted.

Stereotoechus typicus, sp. nov.

(Pl. XIII, Figs. 10–13)

Description. — Zoarium small mass composed of two or more layers. Groups of larger zooecia approximately 4 mm. apart, measured from center to center.

Zooecia subpolygonal to subcircular; diameter of average zooecia 0.14 to 0.17 mm.; eight to ten in 2 mm.; diameter of larger zooecia 0.21 to 0.3 mm.; seven in 2 mm., counting from center of group. Walls moderately thick, amalgamate, nongranular. Small tubes few. Acanthopores well defined, of moderate size, project strongly on surface in groups of large zooecia, four or five around each zooecium at junctions of walls.

Zooecia direct. Immature zone poorly differentiated; walls strongly thickened near base of layer; periodic constrictions usually not pronounced, but occasionally strong enough to produce beading. Diaphragms numerous, one-half to one tube diameter apart throughout length of zooecia.

Remarks. — *Stereotoechus typicus* is easily distinguished from associated species by its clear, laminated, and slightly beaded walls, laminated acanthopores, and abundant diaphragms.

Holotype. — No. 19881; figured specimen No. 19882.

Occurrence. — Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9. Norway Point formation; localities 46 and 47.

Genus TRACHYTOECHUS, gen. nov.

Definition. — Zoarium massive. Walls amalgamate, laminated, relatively thin, extremely granular. In longitudinal sections walls irregularly thickened, flexuous; boundaries frequently vague; laminated tissue projected into zooecia as heterophragms. Diaphragms complete, straight or slightly curved. Heterophragms corrugated on upper surface, appear fimbriate in sections. Mesopores absent, but small zooecia present. Small granules arranged in single or double series in zooecial walls. Laminated acanthopores at junctions of walls, particularly in groups of larger zooecia.

Genotype. — *Trachytoechus typicus*, sp. nov.

Name. — τραχύς, "rough"; τοῖχος, "wall."

Remarks. — *Trachytoechus* is characterized by irregular hazy walls, small granules, and corrugated heterophragms, and is tentatively assigned to the Batostomellidae because the walls are amalgamate, irregularly thickened, and occupied by small granules. The hazy irregularity of wall structure suggests relationship with the Trematoporidae.

Although *Eostenopora? villosa*, sp. nov. (p. 247), has walls similar in structure to those of *Trachytoechus*, it has no heterophragms and cannot be assigned to this genus.

Some of the specimens figured by Hall (1876, Pl. XXXVII, Figs. 6–8 only) as *Chaetetus tenuis* belong to *Trachytoechus*. Likewise, the specimens described and figured by Rominger (1892, p. 60, Pl. III, Figs. 1–3) as *Monotrypa tennis* (*sic*) (Hall) are a species of *Trachytoechus*, but may not be *T. tenuis* (Hall).

In addition to *Trachytoechus romingeri*, sp. nov., and *T. typicus*, sp. nov., which are found in the Traverse of Michigan, *T. tenuis* (Hall) occurs in the Upper Helderberg of New York, and is reported by Rominger from Sandusky, Ohio. Undescribed species of *Trachytoechus* from the Onondaga limestone at the Falls of the Ohio are in the collections of the United States National Museum.

Trachytoechus romingeri, sp. nov.

(Pl. XIII, Figs. 7–9)

Description. — Zoarium massive, composed of superimposed laminae; thickness of laminae ranges from 1 to 6 mm. Groups of larger zooecia approximately 4 mm. apart, measured from center to center.

Zooecia polygonal; diameter of average zooecia 0.25 to 0.31 mm.; seven or eight in 2 mm.; diameter of large zooecia 0.42 to 0.49 mm.; five and one half or six in 2 mm., counting from center of group. Single or double series of small granules in zooecial walls. Larger granular spots at junctions of zooecia and a few large laminated acanthopores associated with groups of larger zooecia.

Zooecia direct. Walls moderately thick and granular, irregularly thickened. Diaphragms straight or slightly curved, generally two to four tube diameters apart, absent through longer spaces in some zooecia. Heterophragms fimbriate in tangential section, moderately numerous, occasionally united with straight diaphragms.

Remarks. — *Trachytoechus romingeri* differs from *T. typicus*, sp. nov., in having a laminar zoarium, thicker walls, stronger and more uniformly distributed granules, and smaller zooecia; and from the species figured by Rominger (1892, Pl. III, Figs. 1–3) as *Monotrypa tennis* (*sic*) (Hall) in having slightly thinner walls, smaller ordinary zooecia, and no monticules.

Holotype. — No. 19875.

Occurrence. — Collected by Carl Rominger probably from Genshaw formation; Long Lake, near Alpena, Michigan.

Trachytoechus typicus, sp. nov.

(Pl. XIII, Figs. 1–6)

Description. — Zoarium massive. Groups of larger, thicker-walled zooecia 5 to 6 mm. apart, measured from center to center.

Zooecia polygonal; diameter of average zooecia 0.28 to 0.35 mm.; six in 2 mm.; diameter of large zooecia 0.42 to 0.56 mm.; five in 2 mm., counting from center of group. Walls of average zooecia extremely thin. Thicker walls of large zooecia occupied by single or double series of small granules. Large laminated acanthopores at junctions of walls of some large zooecia.

Zooecia direct. Walls flexuous, irregularly thickened, granular; boundaries hazy. Diaphragms generally straight, one to four tube diameters apart, occasionally absent through longer space. Corrugated heterophragms project from walls, appear fimbriate in tangential section; moderately numerous.

Holotype. — No. 19876.

Occurrence. — Bell shale; locality 38.

FAMILY AMPLEXOPORIDAE ULRICH

1890. *Amplexoporidae* Ulrich, Geol. Surv. Ill., Vol. VIII, p. 376.
1900. *Amplexoporidae* Nickles and Bassler, Bull. U. S. Geol. Surv., No. 173, p. 30.
1904. *Amplexoporidae* Ulrich and Bassler, Smithsonian Misc. Coll., Vol. XLVII, p. 40.

Definition from Nickles and Bassler, 1900. — "Zoarium usually ramose or discoidal, rarely bifoliate; zoöecia simple, prismatic tubes, with a well-marked divisional line (seen in tangential sections as a fine black line) between adjoining tubes; diaphragms present; mesopores practically absent, but small abortive cells sometimes occur among the larger ones in the monticules; acanthopores generally abundant, but may be wanting."

Genus DISCOTRYPA Ulrich

1882. *Discotrypa* Ulrich, Journ. Cincinnati Soc. Nat. Hist., Vol. V, p. 155.
1900. *Discotrypa* Nickles and Bassler, Bull. U. S. Geol. Surv., No. 173, p. 30.

Definition from Nickles and Bassler, 1900. — "Zoarium a thin, free, or parasitic circular expansion; surface smooth, or with low, broad monticules; zooecia thin-walled, direct; apertures hexagonal or rhomboidal, very regular in their arrangement, decreasing in size from the centers of the monticules outward; neither mesopores nor acanthopores present."

Genotype. — *Chaetetes elegans* Ulrich (1879, p. 130, Pl. XII, Figs. 12–12a).

Discotrypa vera, sp. nov.

(Pl. IV, Figs. 1–3)

Description. — Zoarium incrusting; usually less than 1 mm. in thickness. Prominent monticules approximately 3.5 mm. apart, measured from center to center.

Zooecia polygonal or rhomboidal; average diameter of intermonticular zooecia 0.2 mm.; six or seven in 2 mm.; diameter of monticular zooecia 0.35 to 0.45 mm. or more; five and one half in 2 mm., counting from center of monticule. Walls thick, conspicuously integrate, usually thicker in monticules than in intermonticular areas. Few small tubes in monticules. Acanthopores absent.

Immature zone poorly differentiated. Zooecia direct. Walls uniformly thickened. Diaphragms often curved, resembling cystiphragms, thick, numerous, usually two or three in space equal to one tube diameter.

Remarks. — *Discotrypa? devonica* Ulrich (1886, p. 25, Pl. II, Figs. 8–8a) is the only other described species from the Devonian. The monticular zooecia are 0.55 mm. or more in diameter and are considerably larger than those of *D. vera*. *D.?* *devonica* Ulrich is inadequately figured, but it has thinner walls and fewer diaphragms than *D. vera*.

Holotype. — No. 19877.

Occurrence. — Bell shale; locality 31.

Family CYCLOPORIDAE Nickles and Bassler
(*incertae sedis*)

1900. *Cycloporidae* Nickles and Bassler, Bull. U. S. Geol. Surv., No. 173, p. 53.

The family has never been defined.

Genus CYCLOPORA Prout

1860. *Cyclopora* Prout, Trans. St. Louis Acad. Sci., Vol. I, p. 574.
1890. *Cyclopora* Ulrich, Geol. Surv. Ill., Vol. VIII, pp. 403, 671.
1900. *Cyclopora* Nickles and Bassler, Bull. U. S. Geol. Surv., No. 173, p. 53.

Definition from Nickles and Bassler, 1900. — "Zoarium unilaminar, parasitic or free; zooecia subtubular, hemisepta wanting or but little developed; vestibules with rather thick walls; between the vestibules are mesopores crossed by thick diaphragms, which usually have a central perforation and are open at the surface; apertures subcircular, with a smooth or granulose peristome; acanthopores sometimes present."

Genotype. — *Cyclopora fungia* Prout (1860, p. 577).

Cyclopora? lunata, sp. nov.
(Pl. XVI, Figs. 1–3)

Description. — Zoarium incrusting; average thickness 0.3 mm. Zooecia crescent-shaped. Intervestibular pores nearly circular or irregularly elongate. Diameter of combined zooecial aperture and intervestibular pore 0.21 to 0.28 mm.; diameter of zooecial apertures 0.07 to 0.1 mm.; eight in 2 mm., measured with long diameter, ten in 2 mm., diagonally. Thick walls crossed by closely arranged transverse rows of granules. Mesopores and vague acanthopores occasionally present at junctions of zooecia.

Zooecia prone along epizoarium in immature zone. Vestibules have moderately thick walls. Intervestibular pores conspicuously expanded at surface of zoarium. Diaphragms and hemiphragms absent.

Remarks. — The systematic position of *Cyclopora* is not conclusively established. Mississippian species have some characters diagnostic of the Cryptostomata. *Cyclopora? lunata* may be a primitive representative of the genus, even though diagnostic cryptostomatous characters are not developed.

C.? lunata has a zoarium similar to that of the genotype, but differs in having crescentic zooecial apertures and in lacking diaphragms in the "mesopores." In addition to the large intervestibular pores it has small and inconspicuous mesopores at the junctions of zooecial walls.

Holotype. — No. 19878.

Occurrence. — Ferron Point formation; locality 38.

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EXPLANATION OF PLATE I

PAGE

Anomalotoechus tuberatus, sp. nov. 188

1. Surface of incrusting zoarium, showing prominent conical monticules composed of larger thick-walled zooecia. Holotype (No. 19802). × 5
2. Tangential section of holotype, showing distribution of acanthopores and relative size of thin-walled intermonticular and thick-walled monticular zooecia. × 20
3. Longitudinal section of holotype, showing slight irregularities in thickness of walls and the distribution of diaphragms and cystiphragms. × 20

   Bell shale; locality 38

Anomalotoechus typicus, sp. nov. 189

4. Tangential section of holotype, showing thin walls, larger acanthopores associated with large zooecia, and relative size of large and small zooecia (No. 19801). × 20
5. A few zooecia, showing clear amalgamate walls and solid acanthopores. × 50
6. Longitudinal section of holotype, showing irregular thickening of zooecial walls and distribution of diaphragms and cystiphragms in hollow part of zoarium. × 20
7. A few zooecia, showing detailed structure. × 50

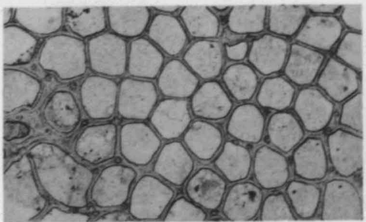
   Ferron Point formation; locality 29

Atactotoechus bifoliatus, sp. nov. 191

8. Longitudinal section of holotype, showing distribution of diaphragms and cystiphragms. Section broken along median lamina of bifoliate zoarium (No. 19803). × 8
9. Part of the longitudinal section, showing poorly defined immature zone, thin granular irregularly thickened walls, and more closely arranged diaphragms and cystiphragms opposite thickened parts of zooecial walls. × 20
10. Tangential section of holotype, showing thin walls, absence of acanthopores, and relative size of zooecia in monticular and intermonticular areas. × 20
11. A zooecium, showing clear amalgamate walls. × 50

    Dock Street clay; locality 53

PLATE I



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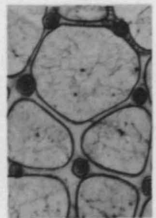

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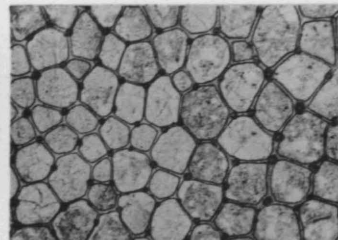

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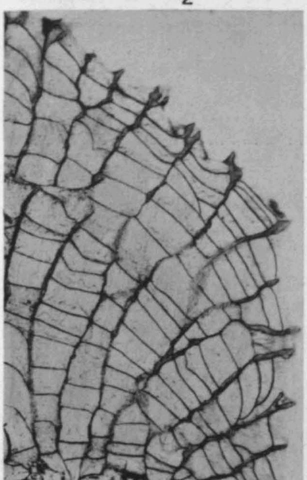

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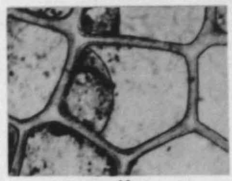

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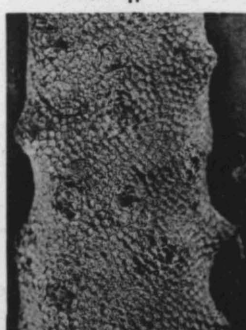

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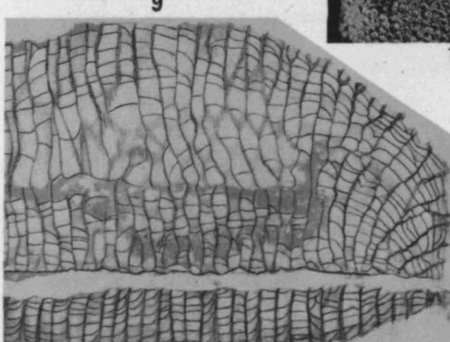

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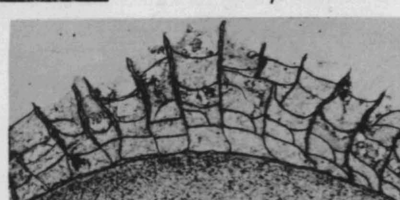

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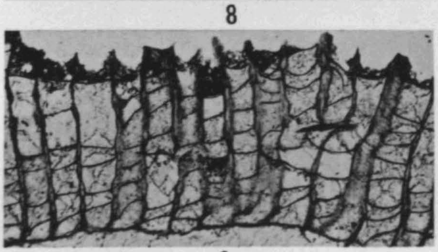

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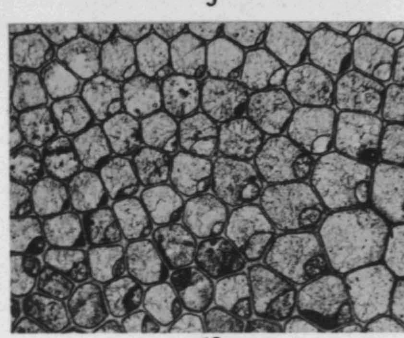

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EXPLANATION OF PLATE II

PAGE

Atactotoechus casei, sp. nov. 192

1. Longitudinal section, showing two zones of wall thickening and distribution of diaphragms and cystiphragms. Holotype (No. 19804). × 10
2. Longitudinal section of holotype, showing structure of walls and closely arranged diaphragms and cystiphragms in outer mature region. × 20
3. Tangential section of holotype, showing amalgamate walls, large thick-walled monticular and small thinner-walled intermonticular zooecia, and absence of acanthopores. × 20

Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 17

Atactotoechus limbatus, sp. nov. 193

4. Longitudinal section through almost half of zoarium, showing extremely short mature zone, and wide immature region in which diaphragms and cystiphragms predominate in zones of wall thickening. Holotype (No. 19806). × 10
5. Longitudinal section of holotype, showing structure of walls in youngest part of zoarium and crowded band of diaphragms and cystiphragms near periphery. × 20
6. Tangential section of holotype, showing large monticular zooecia in center and smaller thin-walled zooecia at right. Walls of zooecia in center of monticule appear thin because section is cut below short mature zone. Thick walls shown in lower part of figure are typical of monticules. × 20
7. A zooecium, showing amalgamate-heterotrypid wall structure and large vague acanthopores usually associated with large zooecia. × 50

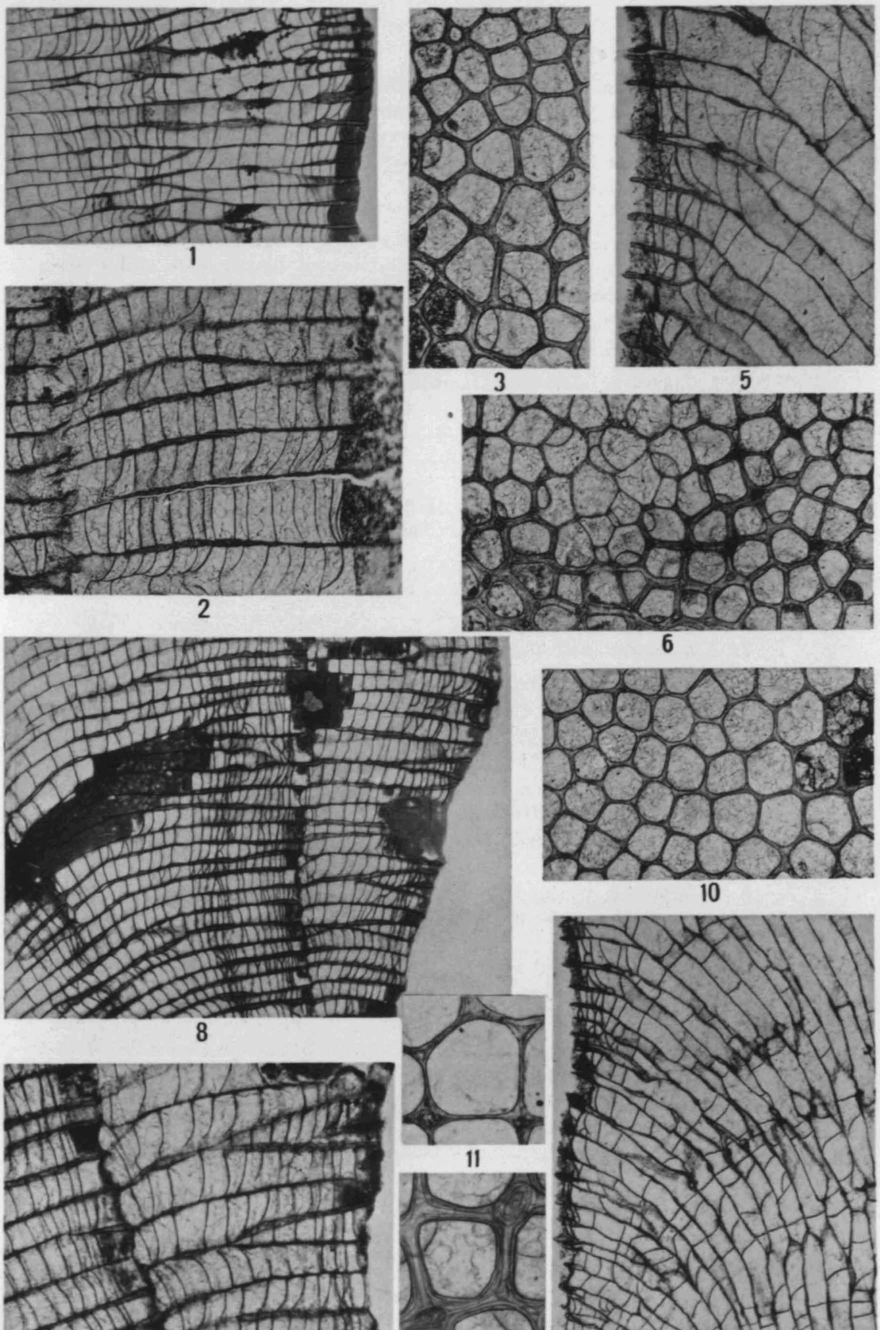
Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9

Atactotoechus creber, sp. nov. 192

8. Longitudinal section, showing distribution of diaphragms and cystiphragms in mature and immature regions and conspicuous bands of crowded diaphragms and cystiphragms in zones of wall thickening. Holotype (No. 19805). × 10
9. Longitudinal section of holotype, showing thin granular walls between thick-walled zones in outer mature region. × 20
10. Tangential section of holotype, showing amalgamate structure and large slightly thicker-walled monticular and small thin-walled intermonticular zooecia. × 20
11. A zooecium, showing poorly defined acanthopores at junctions of thin zooecial walls. × 50

Norway Point formation; locality 47

Plate II



EXPLANATION OF PLATE III

PAGE

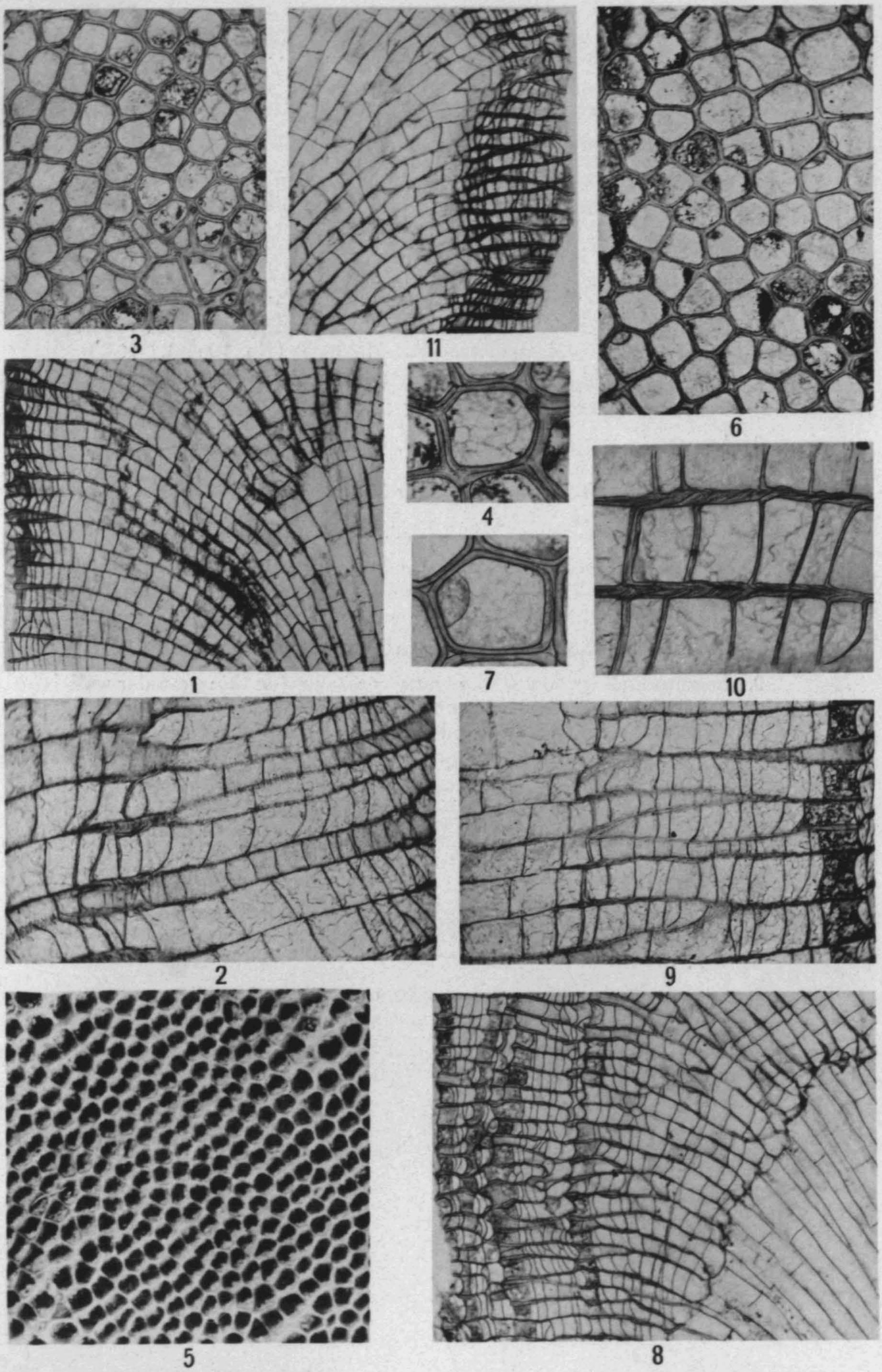
Atactotoechus spissus, sp. nov. 195

1. Longitudinal section through half of zoarium, showing widely separated diaphragms in thin-walled zones of axial region and crowded bands of diaphragms and cystiphragms in thick-walled zones. Specimen (No. 19808) introduced here for comparison with holotype. × 10
   Norway Point formation; locality 47
2. Longitudinal section, showing two zones of wall thickening in outer mature region and strongly laminated diaphragms and cystiphragms opposite thickened walls. Holotype (No. 19807). × 20
3. Tangential section of holotype, showing a few small acanthopores and relative size of large and small zooecia. × 20
4. A zooecium, showing integrate structure of walls in outer mature zone. × 50
   Norway Point formation; locality 46

Atactotoechus typicus, sp. nov. 196

5. Surface of zoarium, showing prominent monticules composed of large zooecia. Holotype (No. 19809). × 10
6. Tangential section of holotype, showing integrate walls, few acanthopores in monticules, and relative size of monticular and intermonticular zooecia. × 20
7. A zooecium, showing integrate structure. × 50
8. Longitudinal section of holotype, showing few widely separated diaphragms in immature region, increasing frequency of diaphragms and cystiphragms in early mature zone, and close tabulation of thick-walled zooecia near periphery. × 10
9. Longitudinal section through outer mature region of holotype, showing laminated structure of wall thickenings, granularity of thin walls, and strongly laminated diaphragms in thick-walled zones. × 20
10. Part of longitudinal section, showing detailed structure of walls, diaphragms, and cystiphragms in zone of intermittent thickening. × 50
    Norway Point formation; locality 46
11. Longitudinal section, showing longer mature zone developed beneath monticules and conspicuously crowded diaphragms and cystiphragms in thick-walled zone. Specimen (No. 19810) introduced here for comparison with holotype. × 10
    Norway Point formation; locality 47

PLATE III



EXPLANATION OF PLATE IV

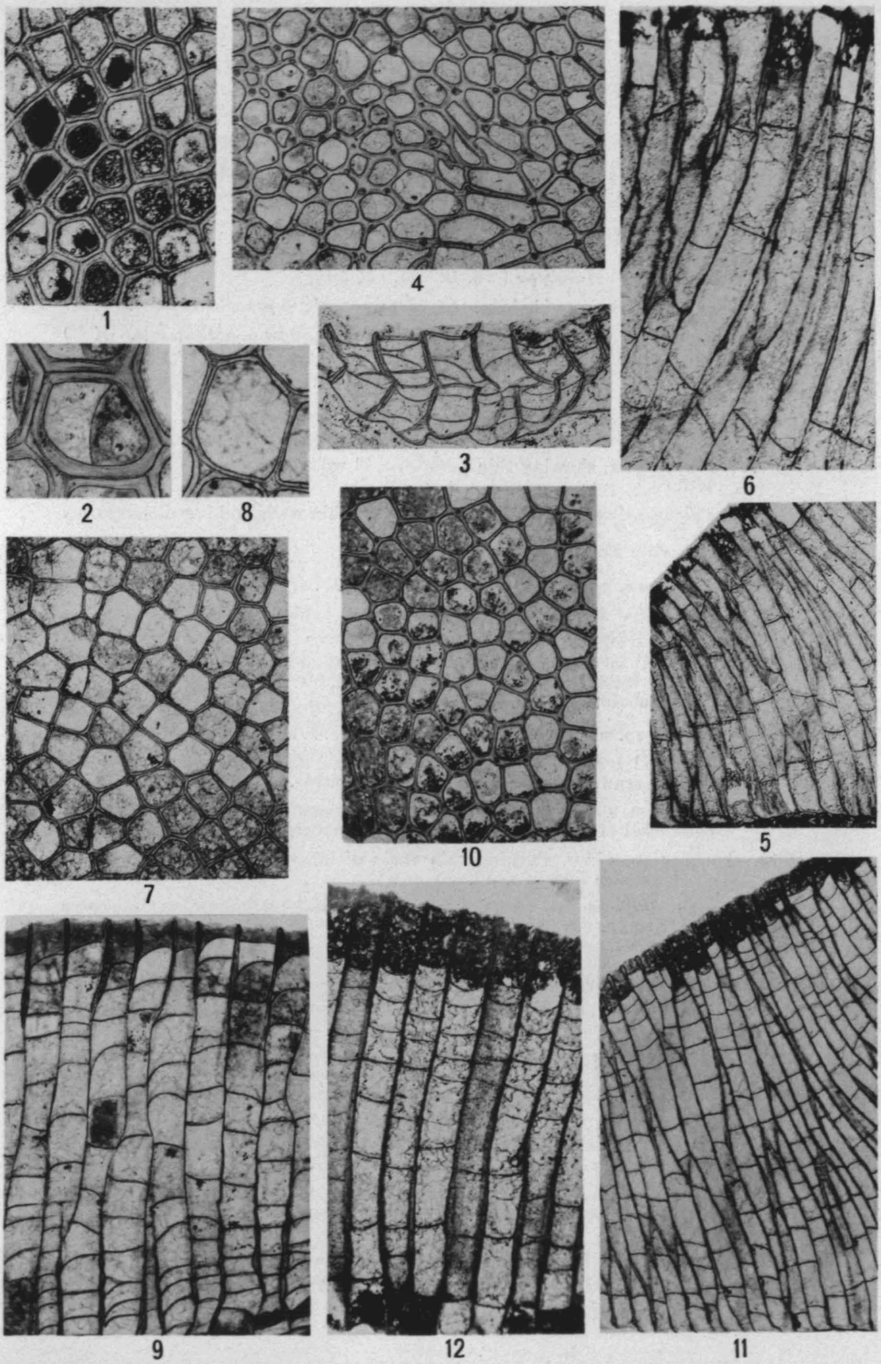
1. Tangential section, showing thick integrate walls and absence of acanthopores. Holotype (No. 19877). × 20
2. A zooecium, showing detailed structure. × 50
3. Longitudinal section of holotype, showing uniformly thickened integrate walls of incrusting zoarium and distribution of straight and curved diaphragms. × 20
   Bell shale; locality 31

4. Tangential section, showing well-defined acanthopores and relative size of large and small zooecia. Holotype (No. 19846). × 20
5. Longitudinal section of holotype near center of zoarium, showing widely spaced diaphragms. × 10
6. Longitudinal section of holotype, showing only slight intermittent wall thickening. × 20
   Genshaw formation; locality 50

7. Tangential section, showing thin integrate walls, few vague acanthopores, and relative size of large and small zooecia. Hypotype (No. 19811). × 20
8. A zooecium, showing integrate structure of walls. × 50
9. Longitudinal section of same hypotype, showing thin granular walls between thickened zones and distribution of diaphragms and cystiphragms in thick- and thin-walled parts of zooecia. × 20
   Norway Point formation; locality 47

10. Tangential section, showing relative size of large and small zooecia, uniformly thin walls, and well-defined acanthopores. Holotype (No. 19813). × 20
11. Longitudinal section of holotype near center of zoarium, showing zone of abnormal thickening in walls of early mature region. × 10
12. Longitudinal section of holotype near edge of zoarium, showing distribution of diaphragms and slight irregularities in otherwise uniformly thickened walls. × 20
    Genshaw formation; locality 14 of A. W. Grabau

Plate IV



EXPLANATION OF PLATE V

PAGE

Eridotrypella hybrida, sp. nov. 214

1. Tangential section, showing elongate zooecia, heterotrypid walls, and granular acanthopores. Holotype (No. 19826). × 20

2. Longitudinal section of holotype, showing moderately thick-walled oblique zooecia of mature zone, diaphragms in transition and early mature regions, and few heterophragms. × 20
   Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9

Leptotrypa? spinifera, sp. nov. 222

3. Longitudinal section, showing short zooecia, and diaphragms in mature zone only. Holotype (No. 19836). × 20

4. Tangential section of holotype, showing conspicuous acanthopores. × 20

5. A zooecium, showing laminated structure of hollow acanthopores. × 50
   Ferron Point formation; locality 49

Leptotrypa? nicholsoni, sp. nov. 221

6. Tangential section, showing polygonal thin-walled zooecia and moderately numerous small acanthopores. Holotype (No. 19835). × 20

7. A few zooecia, showing thin heterotrypid walls and vague acanthopores. × 50

8. Longitudinal section of holotype, showing thin walls and few diaphragms. × 20
   Ferron Point formation; locality 38

Stigmatella hybrida, sp. nov. 234

9. Longitudinal section, showing periodic thickening of walls and distribution of diaphragms. Paratype (No. 19848). × 20

10. Tangential section, showing heterotrypid walls and few minute acanthopores. Holotype (No. 19847). × 20
    Bell shale; locality 38

Cyphotrypa? unica, sp. nov. 201

11. Tangential section, showing thin-walled angular zooecia and distribution of acanthopores. Holotype (No. 19814). × 20

12. A zooecium, showing heterotrypid wall structure and solid acanthopores composed of laminated tissue in outer mature zone. × 50

13. Another zooecium, showing thin walls of large hollow acanthopores in early mature zone. × 50

14. Longitudinal section of holotype, showing several hollow acanthopores and distribution of diaphragms. × 20
    Ferron Point formation; locality 49

Eridotrypella brevis, sp. nov. 211

15. Tangential section, showing thin-walled elongate zooecia and few small but well-defined acanthopores. Holotype (No. 19822). × 20

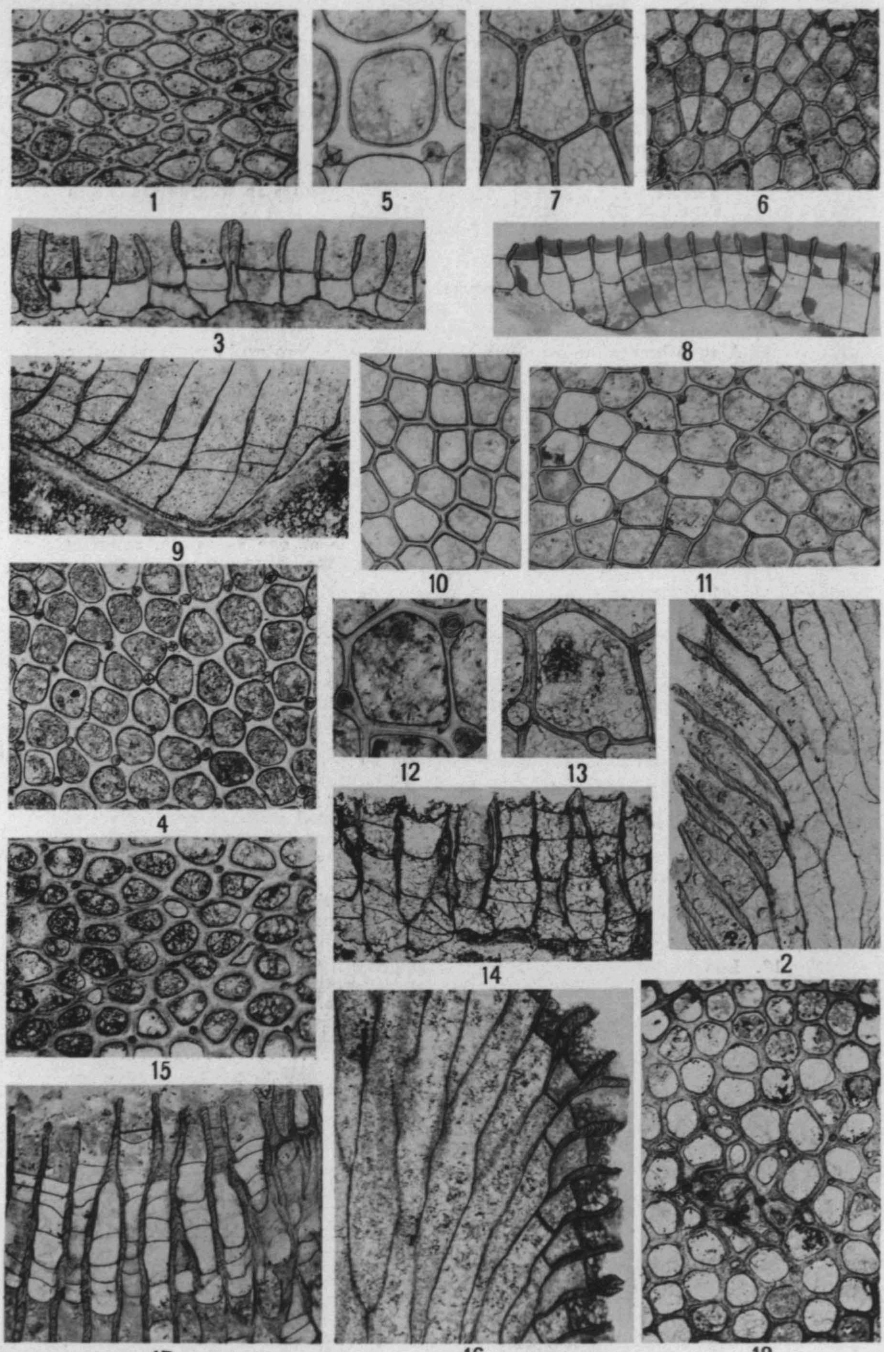
16. Longitudinal section of holotype through half of zoarium, showing thin uncrenulated walls of immature region, nearly direct zooecia of short mature zone, and few diaphragms in transition and early mature zones. × 20
    Bell shale; locality 31

Cyphotrypa? maculosa, sp. nov. 199

17. Longitudinal section, showing thick walls, distribution of diaphragms, and nearly solid laminated tissue composing monticule. Holotype (No. 19812). × 20

18. Tangential section of holotype, showing acanthopores in subsolid monticule near center of figure, and larger zooecia surrounding monticule. × 20
    Genshaw formation; locality 14 of A. W. Grabau

PLATE V



EXPLANATION OF PLATE VI

PAGE

Eridotrypella granosa, sp. nov. 213

1. Tangential section, showing vague granular acanthopores, granules, and relative size of large and small zooecia. Holotype (No. 19825). × 20
2. A zooecium, showing well-defined heterotrypid wall structure, transverse rows of granules in wide medial band, and thick laminated deposits lining zooecia. × 50
3. Longitudinal section of holotype, showing strongly thickened walls of mature zone and diaphragms in outer mature as well as transition zone. × 20

   Ferron Point formation; locality 49

Eridotrypella obliqua (Ulrich) 215

4. Tangential section of outermost mature zone, showing typical development of transverse rows of granules in medial band of heterotrypid walls. Hypotype (No. 19829). × 20
5. A zooecium, showing detailed structure of heterotrypid walls, granular acanthopores, and thin laminated deposits lining zooecia. × 50
6. Tangential section, cut slightly deeper in mature zone than section shown in Figure 4, showing almost complete absence of granules and extremely vague granular spots at junctions of zooecia. Hypotype (No. 19828). × 20
7. Longitudinal section, showing oblique walls of mature zone, thin crenulated walls of immature zone, and few diaphragms in transition zone. Hypotype (No. 19828). × 20
8. Longitudinal section through mature zone of one zooecium, showing laminated structure of walls and diaphragms. Hypotype (No. 19829). × 50

   Ferron Point formation; locality 49

Eridotrypella minuta, sp. nov. 215

9. Surface of zoarium, showing elongate-polygonal zooecia and absence of acanthopores. Holotype (No. 19827). × 20
10. Longitudinal section of holotype, showing oblique zooecia and thickened walls of mature zone and position of diaphragms in early mature region. × 20

    Ferron Point formation; locality 29

Eridotrypella devonica, sp. nov. 212

11. Longitudinal section, showing thin crenulated walls of immature and strongly thickened walls of mature zones and regularly arranged diaphragms in transition and early mature regions. Holotype (No. 19823). × 20
12. Tangential section of holotype, showing thick-walled oval zooecia, large granular acanthopores, and numerous small granules in walls. × 20

    Potter Farm formation; locality 42

13. Longitudinal section, showing same structure of walls, length of mature zone, and number of diaphragms as holotype (Fig. 11), but showing also a few heterophragms. Specimen (No. 19824). × 20

    Potter Farm formation; locality 37

Eridotrypella simplex, sp. nov. 216

14. Tangential section, showing elongate zooecia, thin heterotrypid walls, and granular acanthopores. Holotype (No. 19830). × 20
15. Longitudinal section of holotype, showing thin crenulated walls of immature and slightly thickened walls of short mature zones, extremely oblique zooecia, and diaphragms in transition region. × 20

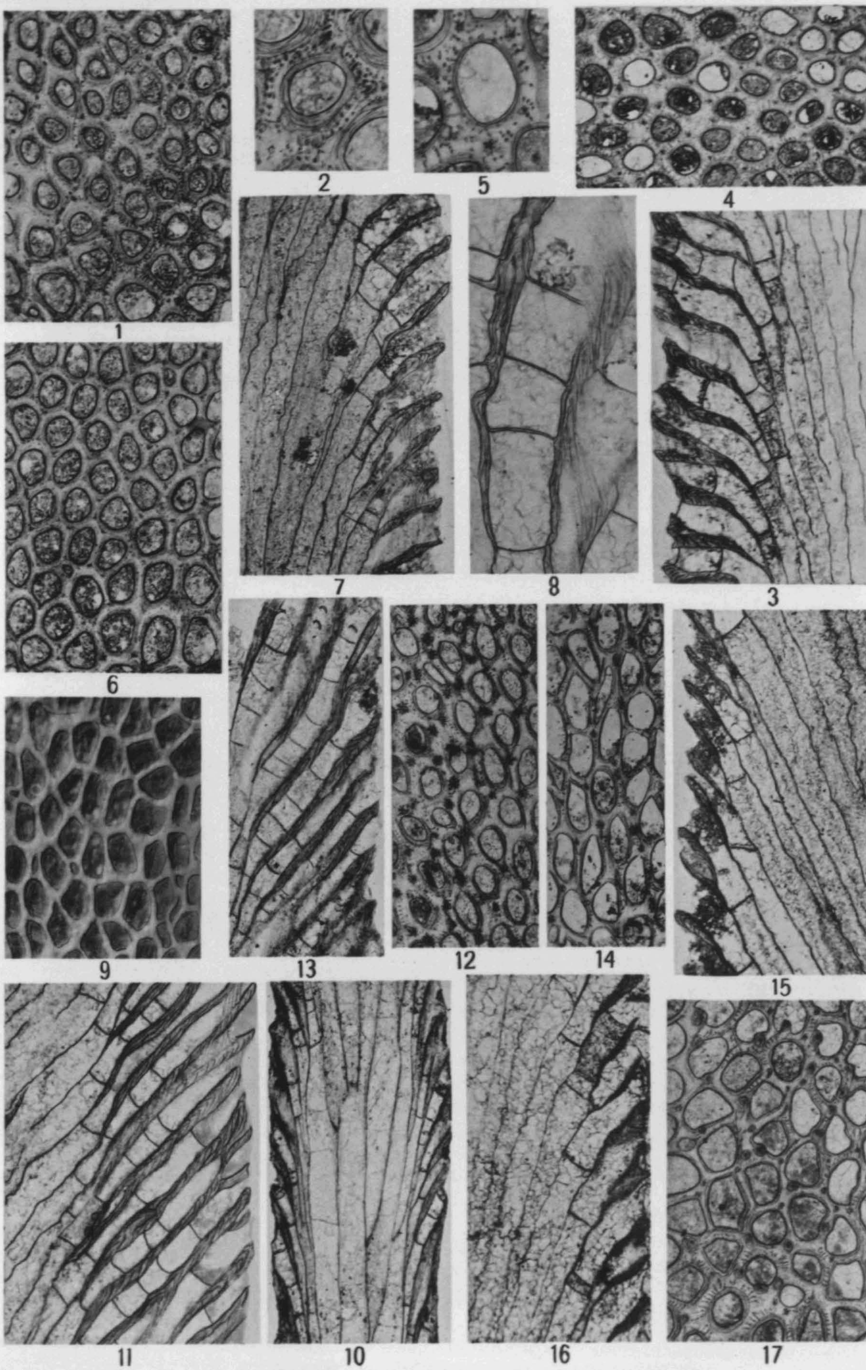
    Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9

Eridotrypella sinuosa, sp. nov. 217

16. Longitudinal section, showing obliquity of zooecia, crenulated walls in immature zone and strongly flexuous thick granular walls in mature zone, and few diaphragms in transition zone. Holotype (No. 19831). × 20
17. Tangential section of holotype, showing acanthopores inflecting zooecia, numerous small granules, and strongly thickened walls in monticule. × 20

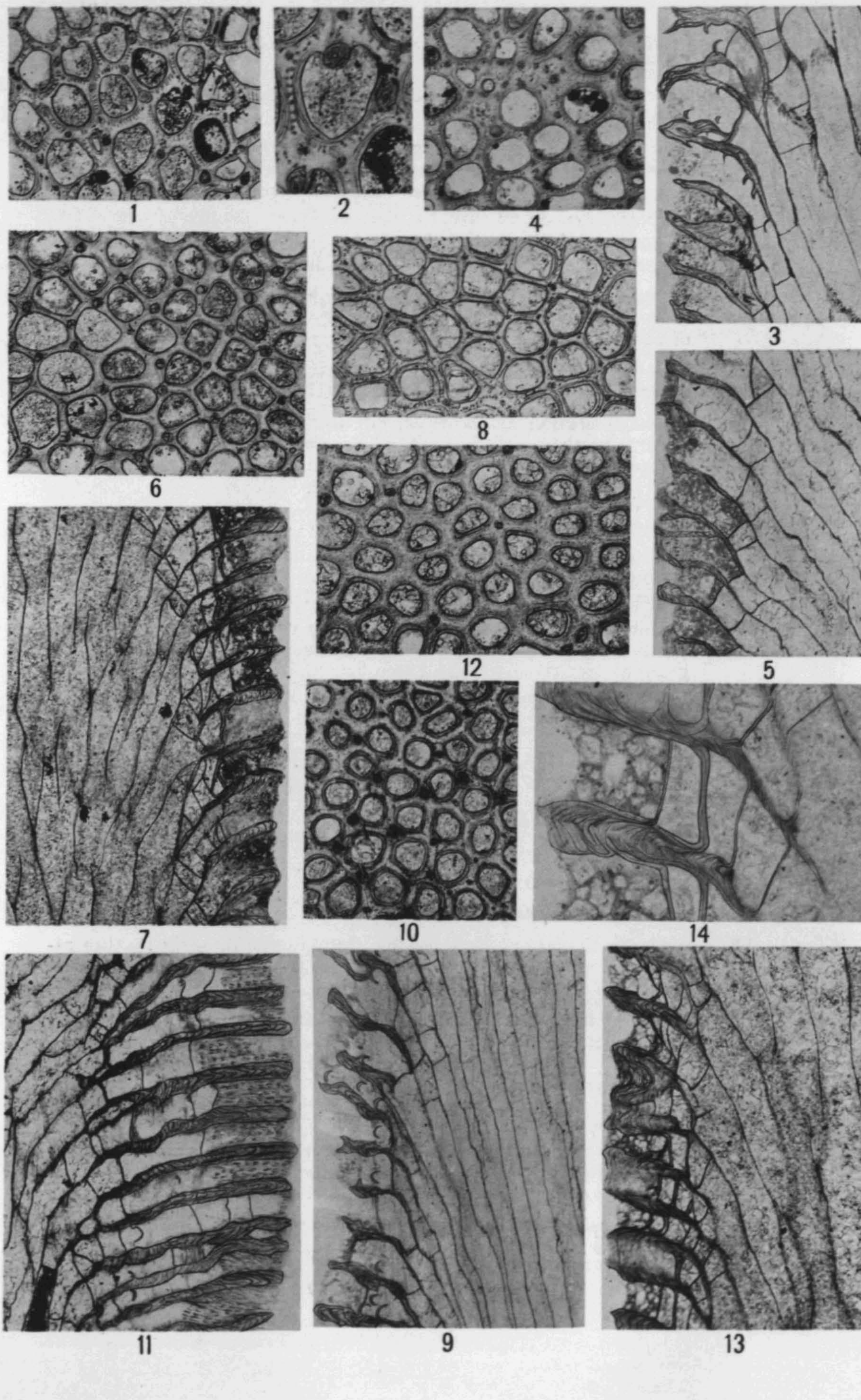
    Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 17

PLATE VI



EXPLANATION OF PLATE VII

Plate VII



EXPLANATION OF PLATE VIII

PAGE

Eridocampylus ulrichi, sp. nov. 209

1. Longitudinal section through half of zoarium, showing wide axial region and nearly direct zooecia in narrow mature zone. Paratype (No. 19880). × 10
2. Longitudinal section, showing thin crenulated walls of immature zone, laminated walls of nearly direct zooecia in mature zone, few diaphragms, and small thick heterophragms. Holotype (No. 19879). × 20
3. Mature zone of a zooecium, showing structure of walls and heterophragms formed by projection of laminated tissue. × 50
4. Tangential section of holotype, showing heterotrypid wall structure, numerous small granules, and granular acanthopores at junctions of zooecial walls in outermost peripheral region. × 20
5. A zooecium, showing detailed structure of walls and a laminated heterophragm projecting into zooecial cavity. × 50
6. Tangential section of holotype, cut below outer peripheral region (Fig. 4), showing relative size of large and small zooecia and almost complete absence of granules and acanthopores. × 20
   Ferron Point formation; locality 49.

Eridocampylus mollis, sp. nov. 206

7. Longitudinal section, showing abrupt bend of zooecia in early mature region, thick granular walls of mature zone, and small heterophragms. Holotype (No. 19819). × 20
8. Tangential section of holotype, showing relative size of large and small zooecia, thick walls crossed by transverse rows of granules, granular acanthopores, and two heterophragms. × 20
   Potter Farm formation; locality 68

Eridocampylus obliquus, sp. nov. 208

9. Tangential section, showing elongate zooecia, moderately thick walls, and vague acanthopores. Holotype (No. 19818). × 20
10. Longitudinal section of holotype, showing oblique zooecia of mature zone, distribution of diaphragms, and moderately numerous heterophragms. × 20
    Norway Point formation; locality 47

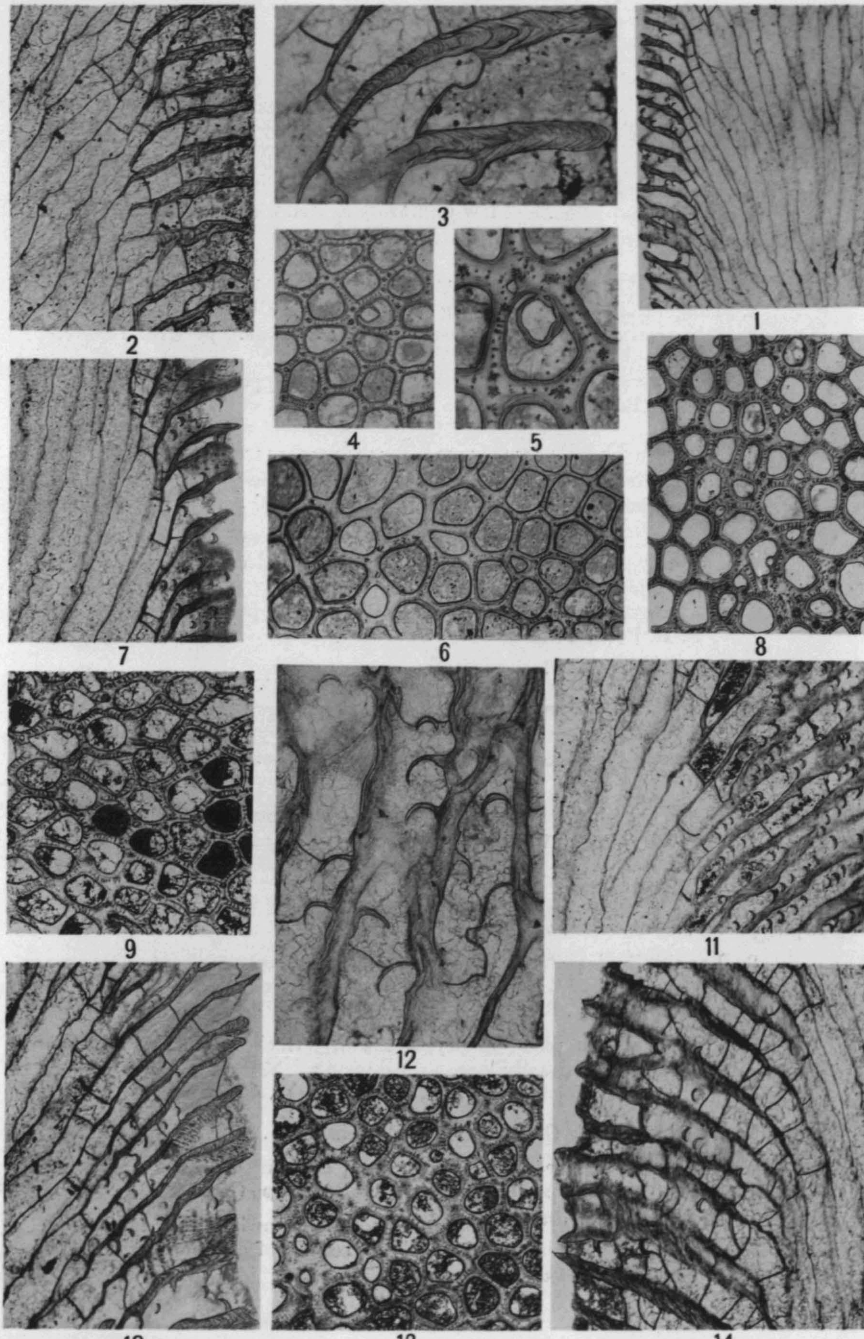
Eridocampylus summus, sp. nov. 209

11. Longitudinal section, showing few diaphragms in early mature region and numerous heterophragms in thick-walled mature zone. Holotype (No. 19821). × 20
12. A few zooecia in mature zone, showing laminated structure of walls and projecting heterophragms. × 50
    Gravel Point stage; bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 17

Eridocampylus multitabulatus, sp. nov. 207

13. Tangential section, showing transverse rows of granules in medial band of heterotrypid walls and small granular acanthopores near junctions of zooecia. Holotype (No. 19820). × 20
14. Longitudinal section of holotype, showing laminated wall structure, slightly oblique zooecia in mature zone, numerous diaphragms, and few large heterophragms. × 20
    Ferron Point formation; locality 49

Plate VIII



EXPLANATION OF PLATE IX

PAGE

Leptotrypella ohioensis (Stewart) 228

1. Tangential section, showing relative size of large and small zooecia and well-defined moderately numerous acanthopores. Hypotype (No. 19840). × 20
2. Longitudinal section of same hypotype, showing thin uncrenulated walls in immature zone and occasional irregularly thickened walls in mature zone, and few uniformly spaced diaphragms. × 20
   Bell shale; locality 38

Eridocampylus summus, sp. nov. 209

3. Tangential section, showing heterotrypid wall structure and numerous acanthopores inflecting zooecia. Holotype (No. 19821). × 20
   Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 17

Leptotrypella parva, sp. nov. 229

4. Tangential section, showing small zooecia and small well-defined acanthopores. Holotype (No. 19841). × 20
5. Longitudinal section of holotype, showing narrow axial region, uniformly thickened walls of mature zone, and distribution of diaphragms. × 20
   Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9

Leptotrypella aequabilis, sp. nov. 224

6. Tangential section, showing relative size of large and small zooecia, nongranular medial band in thick heterotrypid walls, and large acanthopores occasionally inflecting zooecia. Holotype (No. 19837). × 20
7. Longitudinal section of holotype, showing numerous diaphragms and uniformly thickened walls of direct zooecia in mature zone. × 20
   Ferron Point formation; locality 38

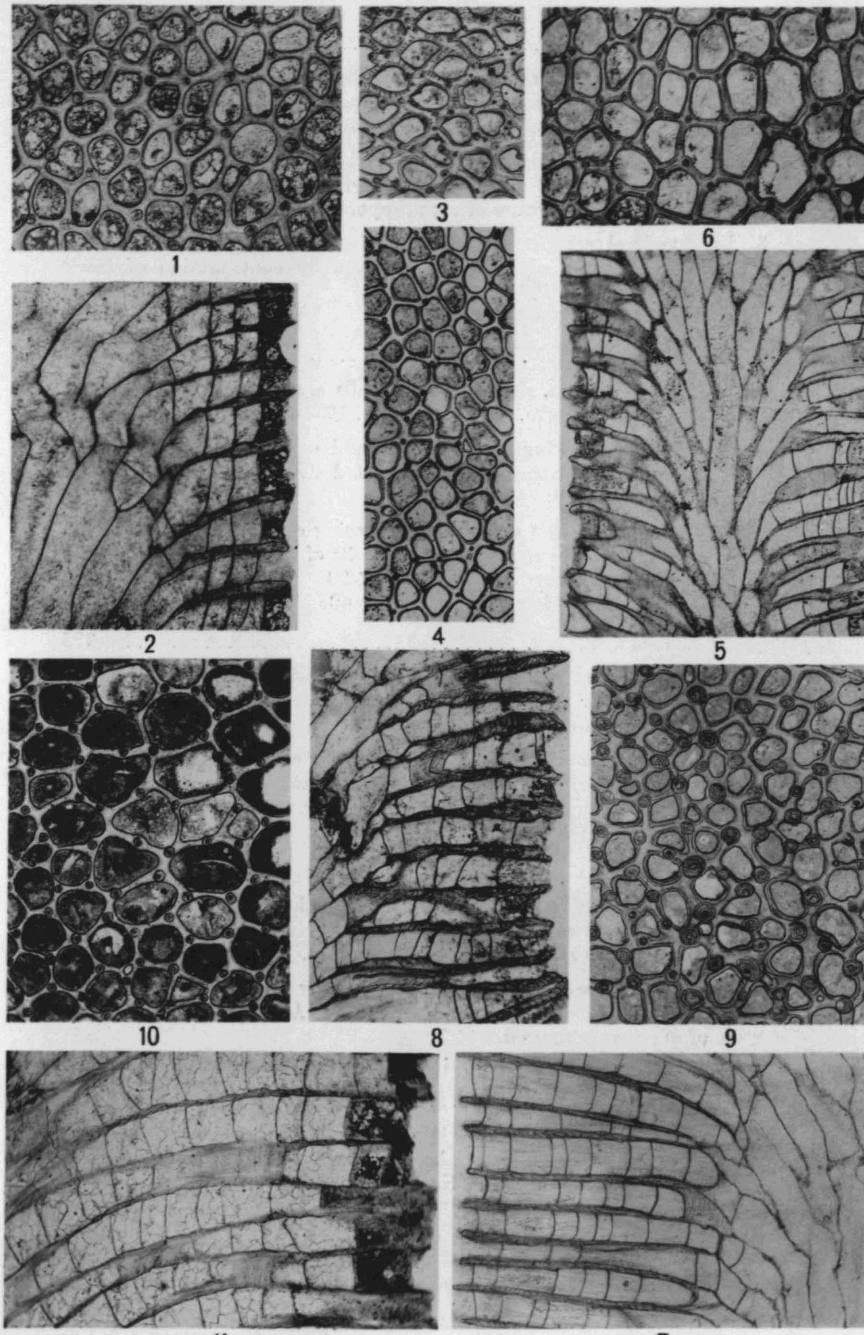
Leptotrypella magninodosa, sp. nov. 226

8. Longitudinal section, showing numerous diaphragms and irregularly thickened walls of mature zone. Holotype (No. 19838). × 20
9. Tangential section of holotype, showing thick zooecial walls and numerous unusually large acanthopores. × 20
   Genshaw formation; locality 14 of A. W. Grabau

Leptotrypella moniliformis (Nicholson) 226

10. Tangential section, showing large zooecia in clusters and moderately large and numerous acanthopores. Hypotype (No. 19839). × 20
11. Longitudinal section of same hypotype, showing numerous uniformly spaced diaphragms in direct zooecia of mature zone. × 20
    Dock Street clay; locality 53.

Plate IX



EXPLANATION OF PLATE X

PAGE

Leptotrypella varia, sp. nov. 232

1. Tangential section, showing thick laminated deposits lining zooecia, moderately numerous acanthopores, and relative size of large and small zooecia. Holotype (No. 19845). × 20
2. A zooecium, showing laminae of darker tissue separating narrow light-colored medial band from wide laminated deposits lining zooecia, and structure of acanthopores. × 50
3. Longitudinal section of holotype, showing conspicuous irregular thickening of mature walls produced by continuation of thick diaphragms. × 20

   Bell shale; locality 38

Leptotrypella undans, sp. nov. 231

4. Tangential section, showing thick walls and numerous moderately large acanthopores. Holotype (No. 19844). × 20
5. A zooecium, showing thick medial band separating thin laminated deposits lining zooecia, and laminated structure of acanthopores. × 50
6. Longitudinal section of holotype, showing crenulated walls of wide axial region, abruptly thickened walls of short mature zone, and distribution of few diaphragms. × 20

   Ferron Point formation; locality 49

Leptotrypella gemmata, sp. nov. 225

7. Tangential section, showing thicker-walled zooecia in monticule and large solid acanthopores where section is closer to surface. Holotype (No. 19843). × 20
8. Longitudinal section of holotype, showing conspicuously thickened walls of mature zone, several hollow acanthopores closed at surface, and thick diaphragms in early mature zone. × 20

   Bell shale; locality 38

Leptotrypella pellucida, sp. nov. 230

9. Tangential section, showing wide light-colored minutely granular medial band separating laminated zooecial deposits and absence of acanthopores. Holotype (No. 19842). × 20
10. Longitudinal section of holotype, showing long mature zone and arrangement of numerous diaphragms. Approximately one third of zoarium is figured. × 20

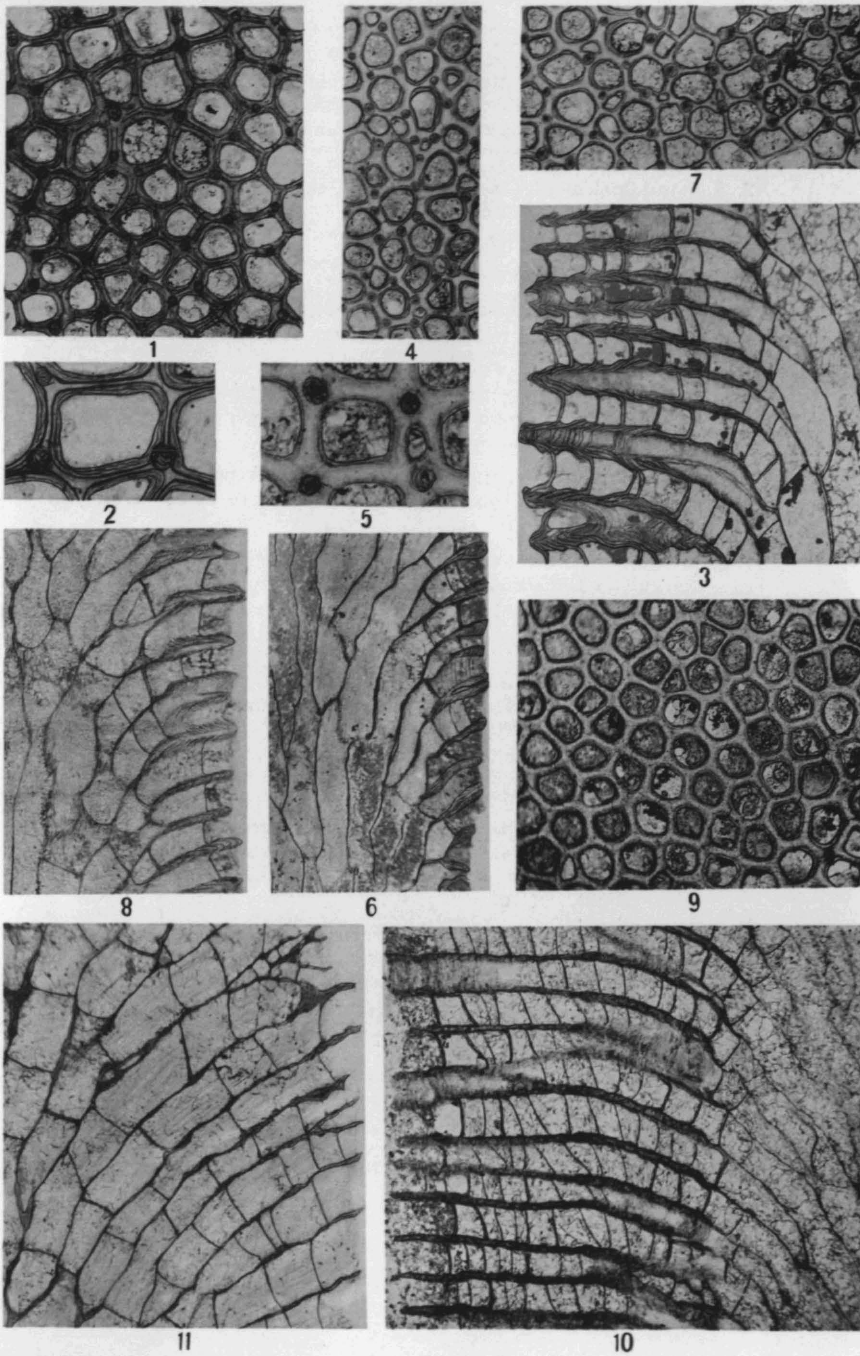
    Ferron Point formation; locality 49

Eostenopora compressa, sp. nov. 243

11. Longitudinal section, showing thin-walled zooecia, intermittent thickening of walls in axial and mature zones, and widely spaced diaphragms. Holotype (No. 19855). × 20

    Bell shale; locality 38

Plate X



EXPLANATION OF PLATE XI

PAGE

Eostenopora? villosa, sp. nov. 247

1. Longitudinal section through approximately one third of zoarium, showing periodic thickening and occasional beading of thin walls and few widely spaced diaphragms in zones of wall thickening. Holotype (No. 19860). × 10
2. Longitudinal section in mature region, showing granular walls and irregularity of structure. × 20
   Bell shale; locality 38

Eostenopora picta, sp. nov. 244

3. Tangential section, showing moderately thick walls, numerous small acanthopores, and relative size of large and small zooecia. Paratype (No. 19857). × 20
4. A zooecium, showing amalgamate wall structure, small granular acanthopores surrounding zooecia, and larger acanthopores at junctions of zooecial walls. × 50
5. Longitudinal section, showing irregularly thickened walls and distribution of numerous diaphragms in mature zone. Holotype (No. 19856). × 20
6. A zooecium in the mature zone, showing laminated structure of irregularly thickened walls. × 50
   Alpena limestone; locality 40

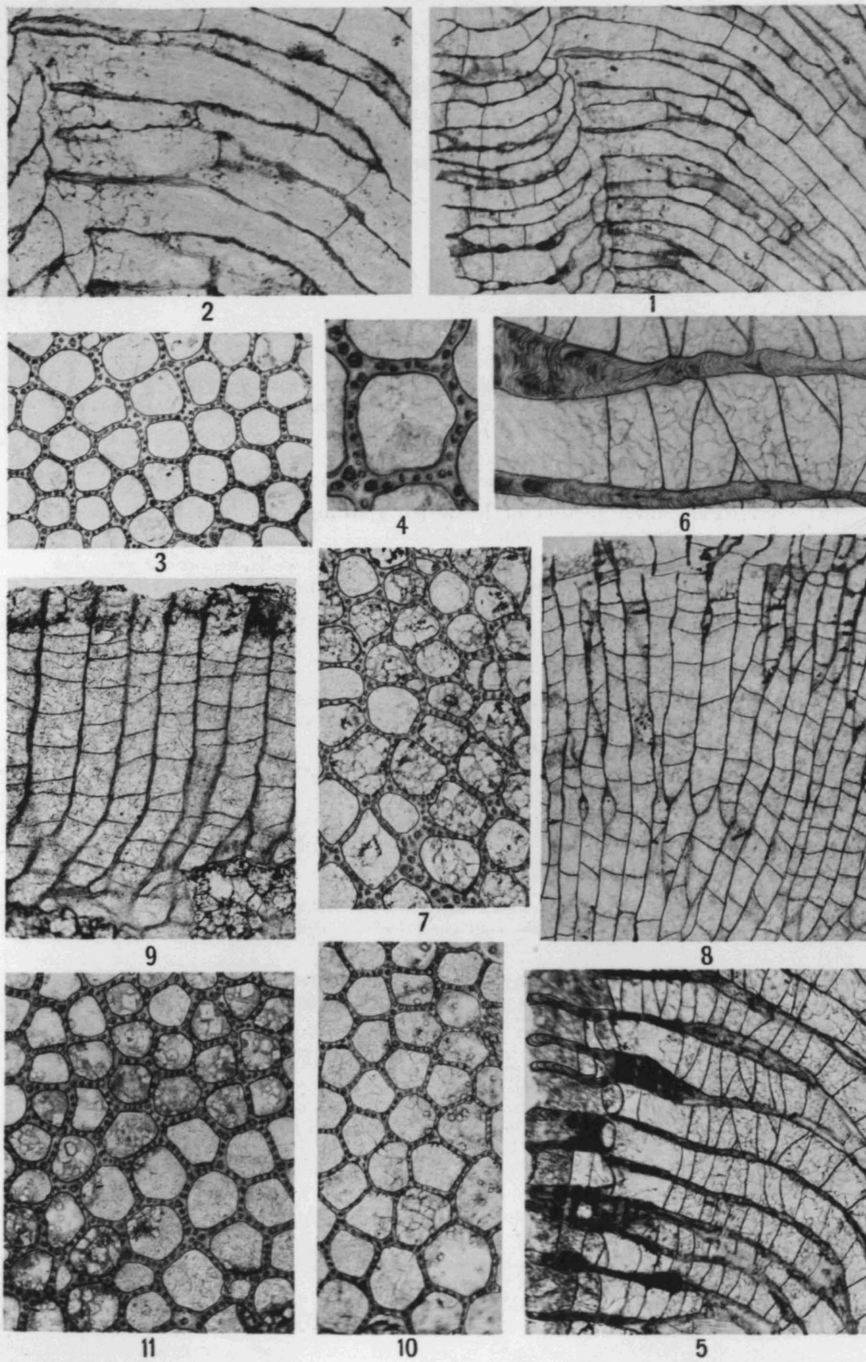
Eostenopora compressa, sp. nov. 243

7. Tangential section, showing numerous acanthopores, relative size of large and small zooecia, and thicker walls of large zooecia. Holotype (No. 19855). × 20
   Bell shale; locality 38

Eostenopora tenuimuralis, sp. nov. 246

8. Longitudinal section through ramose part of zoarium, showing thin walls periodically thickened at wide intervals and more closely arranged diaphragms in zones of wall thickening. Holotype (No. 19859). × 10
9. Longitudinal section of holotype through incrusting part of zoarium, showing absence of immature zone, moderately thick walls, slight intermittent thickening, and closely arranged diaphragms. × 20
10. Tangential section of holotype, showing thin walls characteristic of ramose part of zoarium. × 20
11. Tangential section of holotype, showing thicker walls in incrusting part of zoarium, relative size of large and small zooecia, and numerous acanthopores. × 20
    Bell shale; locality 38

PLATE XI



EXPLANATION OF PLATE XII

PAGE

Chondraulus granosus, sp. nov. 238

1. Longitudinal section near surface of zoarium, showing granular columns of acanthopores, thin diaphragms, and widely spaced zones of periodic wall thickening. Holotype (No. 19850). × 10
2. Part of a zooecium, showing laminated structure of granular walls and acanthopores in zone of periodic thickening. × 50
3. Tangential section of holotype, showing extremely granular walls, laminated linings of thick-walled zooecia, and large central tubes of acanthopores at junctions of zooecial walls. × 20
4. A zooecium, showing detailed structure of walls and acanthopores. × 50
   Bell shale; locality 38

Chrondraulus densus, sp. nov. 237

5. Longitudinal section, showing small extent of immature zone, periodic thickening of walls, and distribution of diaphragms. Holotype (No. 19851). × 10
6. Several zooecia, showing periodic thickening of walls, granular columns of acanthopores, and arrangement of diaphragms. × 20
7. Tangential section of holotype, showing numerous acanthopores surrounding zooecia. × 20
8. A zooecium, showing amalgamate granular walls, numerous granular acanthopores surrounding zooecia, and larger hollow acanthopores at junctions of zooecial walls. × 50
   Potter Farm formation; locality 37

Eostenopora primiformis, sp. nov. 245

9. Tangential section, showing polygonal zooecia, thin walls crossed by transverse rows of granules, and small acanthopores. Holotype (No. 19858). × 20
10. Longitudinal section of holotype, showing thin incrusting zoarium, uniformly thickened walls of mature zone, and few diaphragms. × 20
   Dock Street clay; locality 53

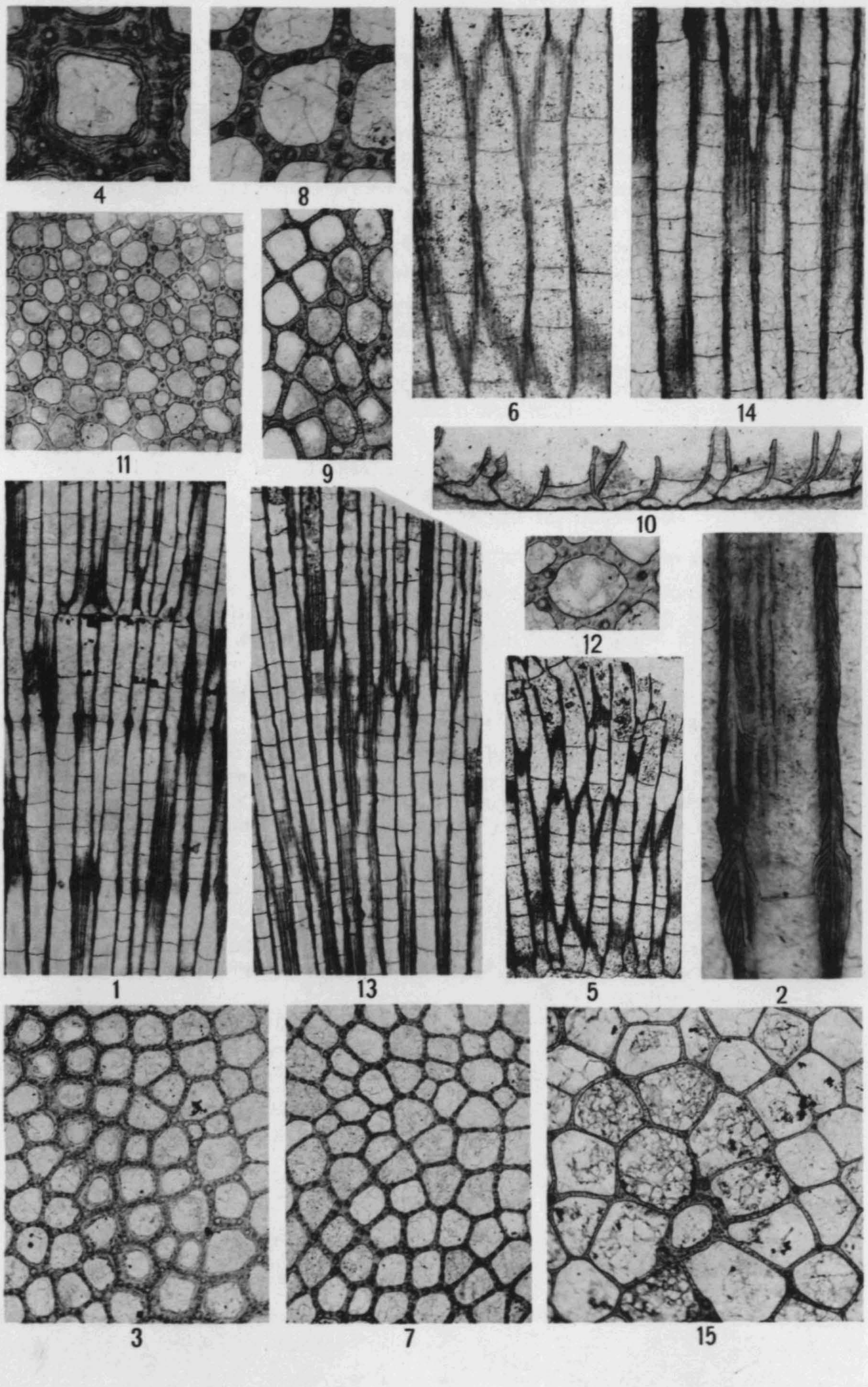
Chondraulus petoskeyensis, sp. nov. 239

11. Tangential section, showing heterogeneous arrangement of large and small zooecia, and distribution of acanthopores. Holotype (No. 19852). × 20
12. A zooecium, showing vague granular acanthopores surrounding zooecia, and a few stronger hollow acanthopores. × 50
13. Longitudinal section of holotype, showing inconspicuous beading of walls, granular columns of acanthopores, and distribution of diaphragms. × 10
14. Several zooecia, showing granular wall structure, slight periodic thickening, and comparatively numerous diaphragms. × 20
   Probably lower Gravel Point stage; Petoskey, Michigan

Eostenopora ? villosa, sp. nov. 247

15. Tangential section, showing large and slightly thicker-walled zooecia of cluster, smaller extremely thin-walled normal zooecia, small granules, and vague acanthopores at junctions of some zooecial walls. Holotype (No. 19860). × 20
   Bell shale; locality 38

PLATE XII



EXPLANATION OF PLATE XIII

PAGE

Trachytoechus typicus, sp. nov. 263

1. Tangential section, showing relative size of large and small zooecia, thicker walls occupied by granules, few vague acanthopores at junctions of zooecial walls, and fimbriate heterophragms. Holotype (No. 19876). × 20
2. A zooecium, showing amalgamate wall structure, numerous granules, and one acanthopore. × 50
3. Another zooecium, showing hollow central cavity and fimbriate outer margin of projecting heterophragm. × 50
4. Longitudinal section of holotype, showing distribution of diaphragms and heterophragms in upper part of zoarium. × 10
5. Longitudinal section of holotype, showing irregularly thickened hazy granular walls, few diaphragms, and heterophragms in several zooecia in medial part of zoarium. × 20
6. A zooecium, showing detailed structure of walls and projecting heterophragms. Heterophragm near top of figure at left sectioned through corrugated margin. × 50

   Bell shale; locality 38

Trachytoechus romingeri, sp. nov. 262

7. Tangential section, showing moderate size of zooecia, single or double series of granules in walls, and relatively well defined acanthopores at junctions of zooecial walls. Holotype (No. 19875). × 20
8. A zooecium, showing detailed structure of amalgamate walls, granules, and acanthopores. × 50
9. Longitudinal section of holotype, showing heterophragms, irregularity and intermittent thickening of walls, and distribution of diaphragms in zooecia near top of zoarium. × 20

   Probably Genshaw formation; Long Lake, near Alpena, Michigan

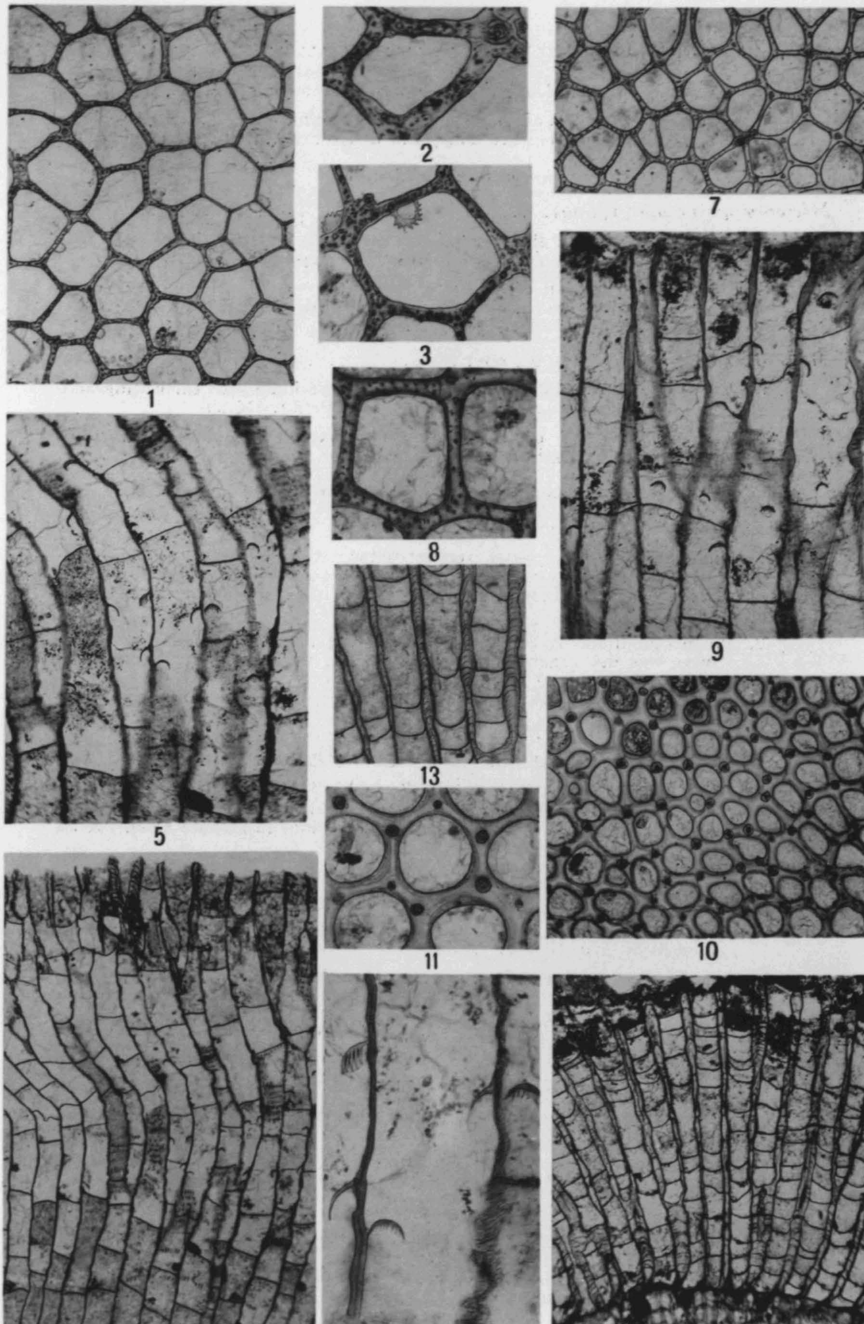
Stereotoechus typicus, sp. nov. 261

10. Tangential section, showing thick nongranular amalgamate walls, subcircular zooecia, and numerous well-defined acanthopores. Specimen (No. 19882) introduced here for comparison with holotype. × 20

    Norway Point formation; locality 47
11. Several zooecia, showing detailed structure of walls and acanthopores. Holotype (No. 19881). × 50
12. Longitudinal section of holotype, showing periodic thickening and occasional beading of walls, and distribution of diaphragms in one layer of massive zoarium. × 20
13. Parts of several zooecia, showing laminated wall structure and slight beading. × 30

    Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9

PLATE XIII



EXPLANATION OF PLATE XIV

PAGE

Dyoidophragma serratum, sp. nov. 240

1. Tangential section, showing thick amalgamate walls of subpolygonal zooecia and well-defined acanthopores. Holotype (No. 19853). × 20
2. Longitudinal section of holotype, showing laminated walls, thick irregular hemiphragms in mature zone, and distribution of thin complete diaphragms. × 20
   Norway Point formation; locality 47

Microcampylus ovatus, sp. nov. 256

3. Tangential section, showing thick-walled oval zooecia, tiny mesopores, and numerous small acanthopores. Holotype (No. 19870). × 20
4. Longitudinal section of holotype, showing small size of zoarium, thick walls of mature zone, and arrangement of diaphragms. × 20
   Ferron Point formation; locality 49

Microcampylus multitabulatus, sp. nov. 255

5. Longitudinal section, showing pronounced periodic wall thickening and numerous diaphragms. Holotype (No. 19869). × 20
6. Tangential section of holotype, showing thick granular walls, small mesopores and acanthopores, and spines projecting into cavities of zooecia. × 20
   Genshaw formation; locality 14 of A. W. Grabau

Microcampylus minutus, sp. nov. 255

7. Tangential section partly reconstructed, showing oval zooecia, well-defined acanthopores associated with mesopores of various sizes, and minute spines extending into zooecial cavities. Holotype (No. 19868). × 20
8. Longitudinal section of holotype, showing large tabulated mesopores, very few diaphragms in zooecia, and, in upper half of figure, small spine bases. × 20
   Alpena limestone; locality 40

Stenoporella ? devonica, sp. nov. 259

9. Tangential section, showing moderately thick walls of polygonal zooecia and distribution of acanthopores. Holotype (No. 19874). × 20
10. Longitudinal section of holotype, showing thick laminated walls, moderately numerous diaphragms, and small spines in mature zone. × 20
    Bell shale; locality 38

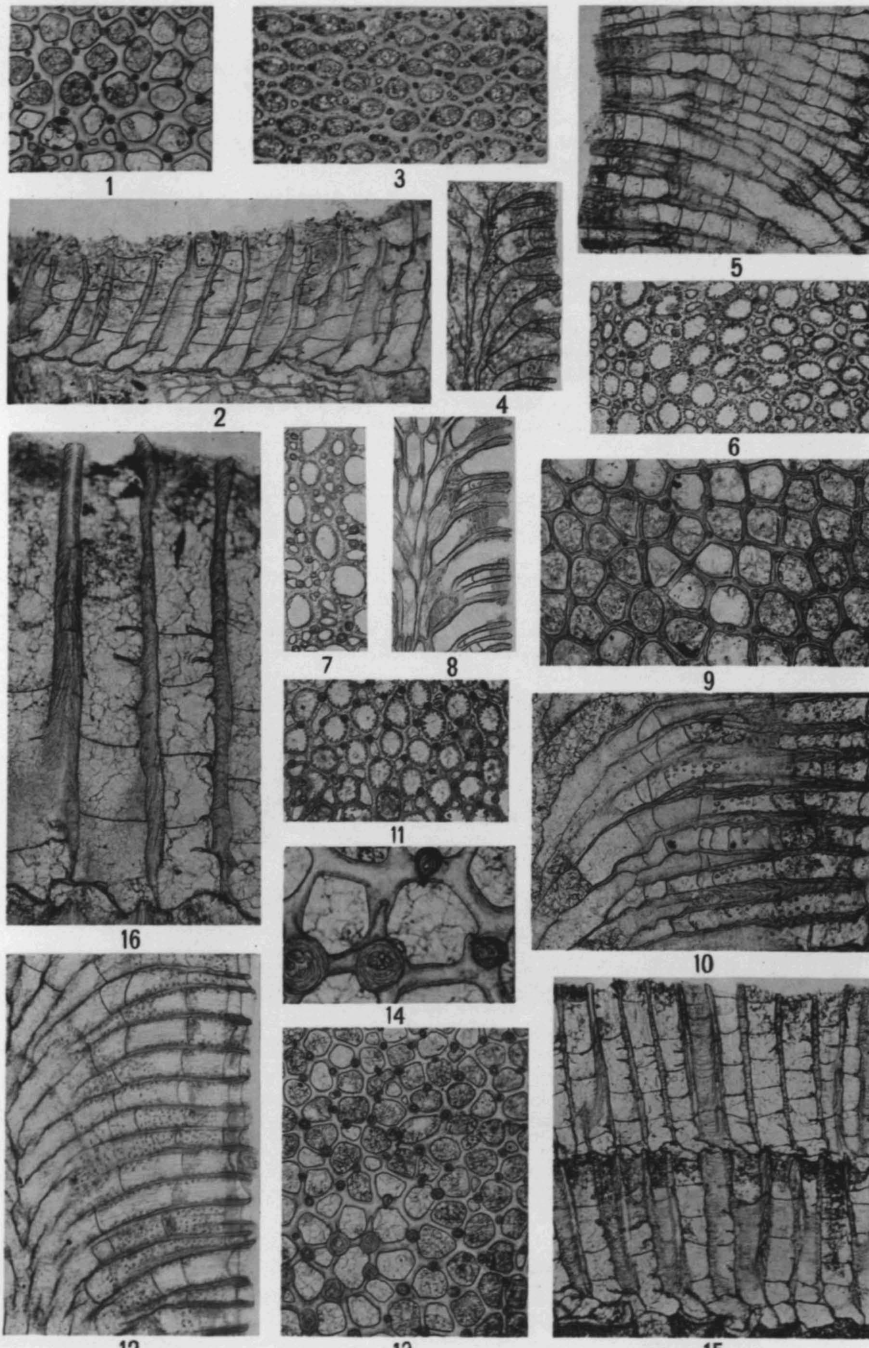
Microcampylus angularis, sp. nov. 253

11. Tangential section, showing angular thin-walled zooecia and mesopores, spines projecting into zooecia, and moderately large acanthopores. Holotype (No. 19866). × 20
12. Longitudinal section of holotype, showing thinness of walls and distribution of diaphragms. × 20. Numerous minute spine bases cause mature walls to appear granular
    Genshaw formation; locality 14 of A. W. Grabau

Dyoidophragma typicale, sp. nov. 241

13. Tangential section, showing relative size of large and small zooecia and extremely large acanthopores in monticule. Holotype (No. 19854). × 20
14. Two monticular zooecia, showing amalgamate walls and laminated structure of acanthopores. × 50
15. Longitudinal section of holotype, showing uniform thickness of walls, distribution of thin diaphragms, and thick irregular hemiphragms on proximal sides of zooecia. × 20
16. A few zooecia, showing structure of thin diaphragms, laminated walls, and irregular hemiphragms. × 50
    Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9

PLATE XIV



EXPLANATION OF PLATE XV

PAGE

Microcampylus granosus, sp. nov. 254

1. Tangential section, showing oval zooecia, small mesopores, thick granular walls, and large acanthopores. Holotype (No. 19867). × 20

2. A few zooecia, showing numerous minute granules in walls, laminated structure of acanthopores, and spines projecting into cavities of zooecia and mesopores. × 50

3. Longitudinal section of holotype, showing irregularly thickened granular walls. × 20
   Gravel Point stage: bed 3, zone 6 ("upper blue shale"), of E. R. Pohl; locality 9

Lioclema incompositum, sp. nov. 250

4. Longitudinal section through thin incrusting layer, showing regular tabulation of mesopores and absence of diaphragms in zooecia. Holotype (No. 19863). × 20

5. Longitudinal section of holotype, showing irregularly distributed diaphragms in older parts of mesopores, and few widely separated diaphragms in zooecia in thicker part of zoarium than that shown in Figure 4. × 20

6. Tangential section of holotype, showing irregular shape of zooecia, large polygonal mesopores, moderately thick walls, and small acanthopores. × 20
   Partridge Point formation; locality 35

Microcampylus tenuis, sp. nov. 257

7. Tangential section, showing variable size of thin-walled zooecia, tiny granules, numerous small mesopores, and large acanthopores. Holotype (No. 19871). × 20

8. Longitudinal section of holotype, showing few diaphragms in zooecia and none in mesopores. × 20
   Potter Farm formation; locality 68

Microcampylus traversensis, sp. nov. 257

9. Tangential section, showing small irregular mesopores, moderately thick walls, and numerous strong acanthopores. Paratype (No. 19883). × 20

10. A few zooecia, showing granular walls, laminated acanthopores, and spines projecting into zooecia and mesopores. Holotype (No. 19872). × 50

11. Longitudinal section of holotype, showing uniformly thickened mature walls, few diaphragms, and relative width of axial and mature zones. × 20
    Ferron Point formation; locality 49

Microcampylus typicus, sp. nov. 258

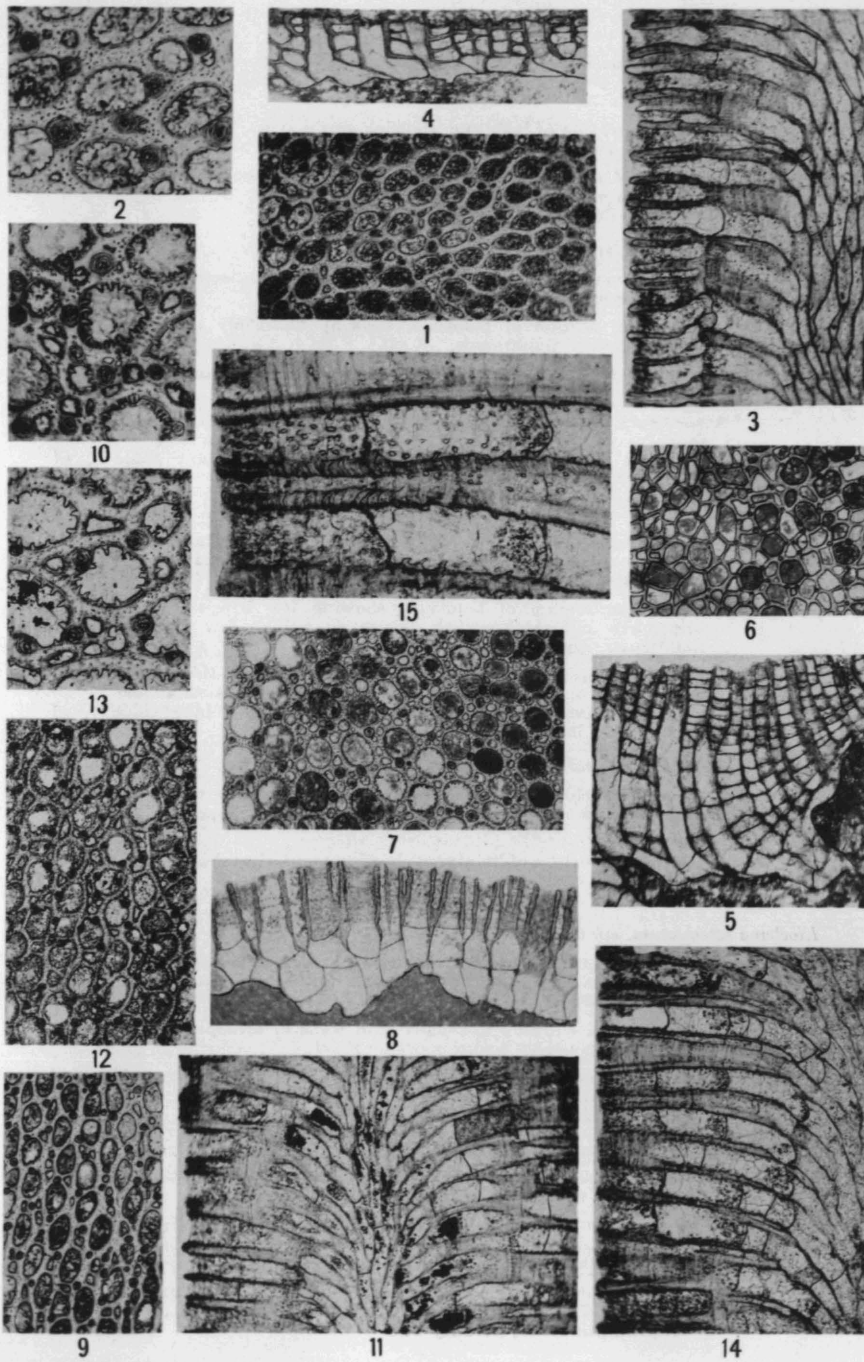
12. Tangential section, showing moderately thick granular walls of zooecia and mesopores and distribution of numerous acanthopores. Holotype (No. 19873). × 20

13. A few zooecia, showing small granules in amalgamate walls, large laminated acanthopores, and short strong spines projecting into zooecia and mesopores. × 50

14. Longitudinal section of holotype, showing uniformly thickened walls of mature zone and distribution of diaphragms. × 20

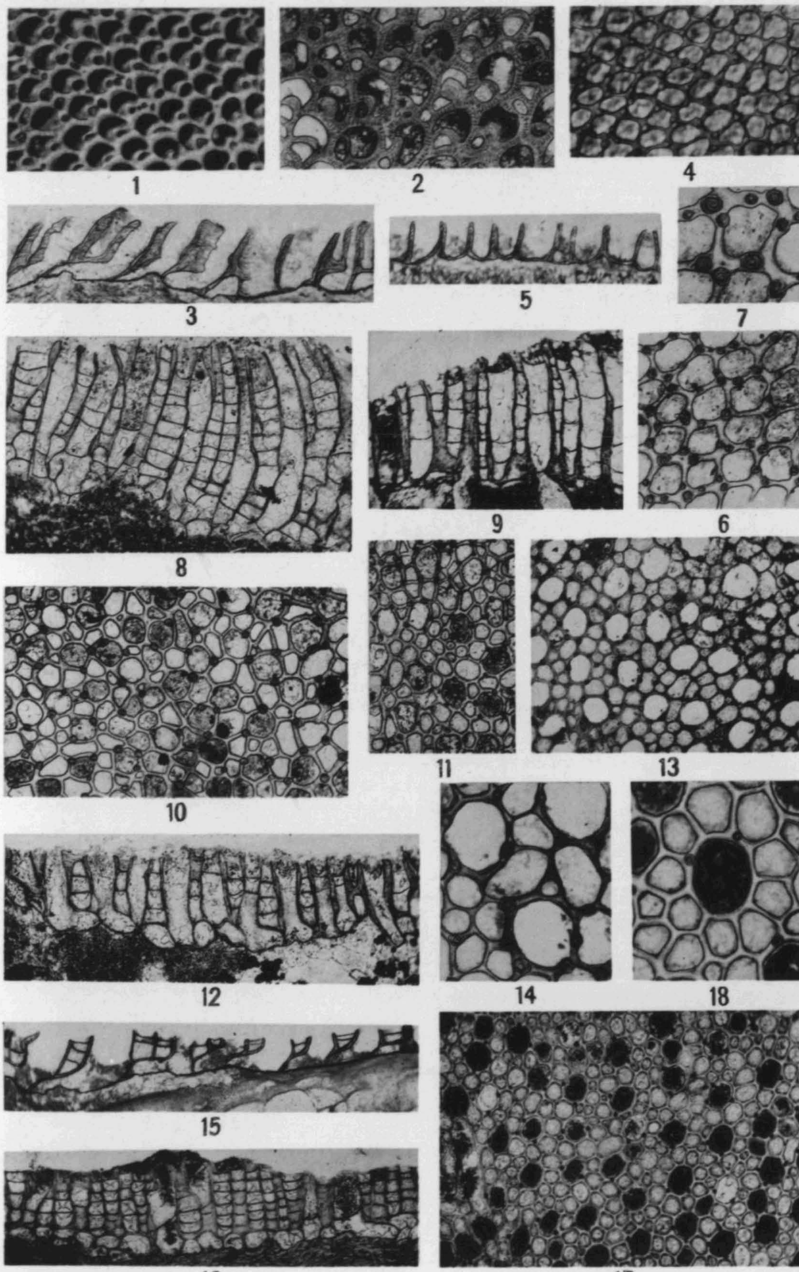
15. A few zooecia in mature zone, showing laminated wall structure, small curved spines projecting from walls, and spine bases. × 50
    Ferron Point formation; locality 49

PLATE XV



EXPLANATION OF PLATE XVI

PLATE XVI



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