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THE BRYOZOAN FAUNA OF THE ROCHESTER SHALE

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THE BRYOZOAN FAUNA OF THE ROCHESTER SHALE.[a]

By RAY S. BASSLER.

INTRODUCTION.

As compared with the other Paleozoic systems affording bryozoa, the Silurian, with the exception of the Helderbergian [b] group, has received least attention. Ulrich has elucidated the bryozoa of the Ordovician and Carboniferous systems particularly in several important monographs, while Hall and Simpson have summed up their papers on this class in Volume VI of the Paleontology of New York, where they have given a comprehensive idea of the many beautiful forms found in the Devonian. However, it can not be said that the bryozoa of any of the Silurian formations have been totally neglected, as a number of publications touch on them. Still, few authors have attempted to work out a fauna in detail. As early as 1852 Professor Hall published fairly complete accounts of the faunas of the Clinton and Niagara of New York, and in 1876 he gave descriptions and figures of the fine assemblage of species found at the noted Niagaran locality, Waldron, Ind. The bryozoa, as well as the other classes, were well represented in these faunas, but, on account of the inadequate methods then used in discriminating specific and generic types, Professor Hall's work needs revision.

Instead of reviewing the Silurian faunas in their geologic order, a study of the species of the Rochester shale has been undertaken first, because the most complete collections that the writer has had the opportunity of studying are from this formation. Since the number of species here is also apparently larger than in any other Silurian horizon, this paper can be used as the basis for comparative remarks in future articles.

Through the kindness of Mr. B. E. Walker, of Toronto, Canada, the writer has been enabled to study the collection made in the vicinity of Grimsby, Ontario, by the late Mr. Pettit. This is a most excellent collection of fossils from the Rochester shale and contains several of the types figured in this paper. A fine collection from Rochester, N. Y., was loaned by Mr. Z. F. Westervelt. Mr. Clifton J. Sarle presented a good series of bryozoa from the same region. Dr. A. W. Grabau loaned all of the material collected by him during his study of the Niagara region. Prof. R. P. Whitfield loaned the Hall types in the American Museum of Natural History. Prof. J. F. Whiteaves sent many Canadian specimens for examination. To all these gentlemen the writer wishes to express his obligations for their generous help. The paleontologic collections of the United States National Museum are rich in Niagara bryozoa and contain, with a few exceptions, all of the material described and figured here. These collections were made at various times by Mr. G. T. McComb, of Lockport, N. Y.; Messrs. E. O. Ulrich, H. E. Dickhaut, and J. M. Nickles, of the United States Geological Survey; Prof. Charles Schuchert, of Yale University; and the writer.

[a] Published by permission of the Assistant Secretary of the Smithsonian Institution.

[b] Throughout this paper the group names used follow the New York classification recently proposed by Messrs. Clarke and Schuchert, although these terms have not been officially adopted by the United States Geological Survey.

Unless otherwise designated, the photographs illustrating this paper were made in the laboratory of the United States National Museum and the drawings are the work of the writer.

From the amount of material studied, the bryozoan fauna of these shales is believed to be represented here with some degree of completeness.

GENERAL DISTRIBUTION OF SILURIAN BRYOZOA.

The Silurian bryozoa as a whole have a facies quite distinct from the preceding and succeeding systems. When they are compared with the Ordovician types, the noticeable features are the predominance of the Cryptostomata and the decline of the Trepostomata. The Cyclostomata continue to hold their own, while the Ctenostomata and Chilostomata, as in all the other Paleozoic systems, have few representatives. In the Devonian the Cryptostomata still predominate, the Cyclostomata have been greatly augmented by species of the Fistuliporidæ, and the Trepostomata, still further reduced in number of species, are represented mainly by genera of the long-enduring Batostomellidæ.

Conditions during Oswegan times were in general so unfavorable for the preservation of fossils that it is not surprising that few bryozoa are known from these rocks. The same conditions, with a slight modification, existed in the Medina, where, however, a small bryozoan fauna is known but is as yet unpublished. This consists of a few species of Trepostomata and Cryptostomata which have been found in the more calcareous strata of the formation.

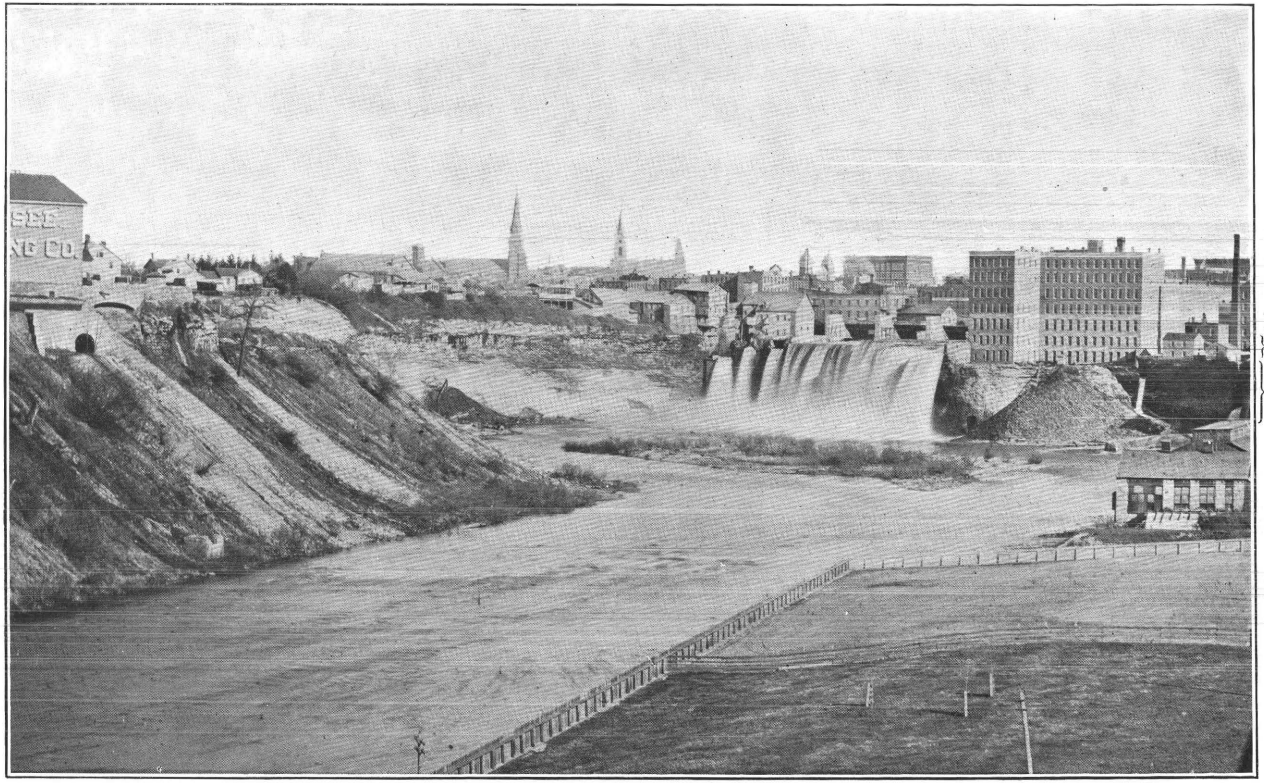
The Clinton and Rochester divisions of the Niagaran group afford species and specimens of this class in great abundance, but in the succeeding Lockport and Guelph divisions the bryozoa are comparatively rare. In New York and Ontario the thin limestone layers of the Clinton are often crowded with *Helopora fragilis* and several species of *Phænopora*, these being the characteristic bryozoa in this region. In Ohio the Clinton beds contain a considerable number of species, but the predominating forms are *Rhinopora verrucosa*, species of *Pachydictya* and *Phænopora*, and a few large ramose Trepostomata, some of which seem to be wanting in the East. The unusual development of the genus *Phænopora* is the striking feature of Clinton time. During the deposition of the Rochester shale, ideal conditions for the development of bryozoa seem to have been reached. Near the middle part of this formation occurs a stratum several feet in thickness that is literally one mass of fragments of these organisms. The correlation of these shales with the Osgood beds in the Indiana Niagaran section and their faunal similarity to the Buildwas beds of the Wenlock of England is discussed later in this paper. As already stated, bryozoa are apparently rarely found in the Lockport and Guelph divisions of the Niagaran.

The Salina and Rondout (Bertie) formations of the Cayugan group were deposited under conditions unsuited to bryozoan life. During the time of the last formation of this group, the Manlius, conditions more favorable to the life of the class returned, a fauna of fifteen or twenty species being known. This will be described by Mr. E. O. Ulrich and the writer in a forthcoming volume of the Maryland Geological Survey.

The various formations of the Helderberg again, especially the New Scotland, are rich in bryozoa. Most of these have been described and illustrated by Hall and Simpson in Volume VI of the Paleontology of New York. Although this series of rocks is referred by some authors to the Devonian, the similarity of its bryozoan fauna to that of the Niagaran is so great that the writer can not see that its position should be other than in the Silurian.

GENERAL DISCUSSION OF THE ROCHESTER SHALE AND ITS BRYOZOAN FAUNA.

Succeeding the Clinton in western New York and Ontario is a shale, which on account of its prominence along Genesee River at Rochester, N. Y., was termed the Rochester shale. In the Niagara region this shale has a thickness of about 70 feet and is divisible into a lower and an upper half. The lower half is generally highly fossiliferous and contains numerous



UPPER FALLS OF GENESEE RIVER, ROCHESTER, N. Y.

Photograph by Webster & Albee.

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limestone bands, especially toward the top, which is formed by a bed about 4 feet thick that is extremely rich in bryozoa. This bed has afforded most of the bryozoa described in this paper. The limestone layers are often composed almost entirely of fragmentary bryozoa cemented together. The upper division of the shales is less calcareous and much less fossiliferous than the lower. It also contains a very different fauna, the prevailing species being pelecypods, ostracods, and trilobites. Toward the top of this division fossils become still rarer and seem to disappear altogether as the basal layers of the overlying Lockport dolomite are reached.

Since the publication in 1852 of Volume II of the Paleontology of New York, the bryozoa of the Rochester shale have received little attention. At that time Professor Hall described a large number of species from the classic locality, Lockport, N. Y. This work was remarkably well done for that date and the methods of study then followed. In the majority of instances the student has little difficulty in identifying the various species. About a third of a century later Mr. E. N. S. Ringueberg added a few new species to the described fauna. These two men are the authors of practically all the forms so far described as originally from this shale. However, neither of them studied the internal characters of their species nor gave definite measurements to any extent, and since the correct generic identification depends on internal rather than external features further work on the fauna is desirable. It is, therefore, the object of this paper to figure and describe the known species, as well as new forms, using modern methods of description.

The Niagara escarpment of western New York and Ontario furnishes numerous localities where natural exposures show the fossiliferous shale. In the vicinity of Lockport, N. Y., the two "gulfs," which indent the escarpment, afford excellent collecting ground, and here, especially in the vicinity of the Erie Canal, much of the material on which this paper is based was procured. Especially fine slabs and washings were obtained in the vicinity of the pulp mills along the Erie Canal. The beautiful preservation and the variety of specimens upon these slabs are brought out in Pls. XXVIII to XXX. At Lockport and localities in western New York in general, the specimens weather out in an excellent state of preservation, so far as external characters are concerned, but on account of the presence of iron pyrites in the shales the internal features are sometimes destroyed.

At Rochester, N. Y., the type locality of the shale, a different style of preservation obtains. In the examples found here the internal features are sometimes obscured by a slight silicification, and caustic potash must be used freely on the specimens to remove the clay, which often obscures the exterior features. Washings containing many or good free specimens are seldom to be found at Rochester, and the thin limestone layers, although containing numerous fossils, are generally so covered with a hard clay that caustic potash is necessary to expose them. At Middleport, N. Y., the limestone layers are sometimes made up almost exclusively of fragmentary bryozoa in an excellent state of preservation, as is shown by the small slab figured in Pl. III.

In the Niagara Gorge[a] the banks and railroad cuts afford a few good exposures, where the bryozoa-bearing shale is well exposed, and as a result a considerable number of species may be found. Here the preservation is essentially the same as at Lockport. The Silurian section is best seen on the American side along the cuts of the New York Central and Hudson River Railroad. The strata dip southward, while the railroad rises in the same direction, with the result that the various formations are crossed in ascending order going toward the Falls. In making the railroad cut, several mounds were left which now form good collecting ground. One of these mounds is on a level with the bryozoan bed, and here numerous specimens may be had. At most places along the gorge, however, the Rochester shale, although well exposed, is inaccessible, as is shown in Pl. II, facing page 4.

In Ontario the principal localities from which bryozoa were obtained for study are Grimsby, Hamilton, and Thorold. Here the Rochester shales become somewhat sandy

[a] The geology of this vicinity has been well described and illustrated by Doctor Grabau in his "Guide to the Geology and Paleontology of Niagara Falls and Vicinity" (Bull. New York State Museum, No. 45, 1901), to which the reader is referred for a more complete discussion.

and the surface characters of the fossils are not so well preserved. However, this is compensated for by the excellent preservation of their internal features. A considerable fauna was determined from the extensive collections made by Mr. Pettit at Grimsby, Ontario.

COLLECTING IN THE ROCHESTER SHALE.

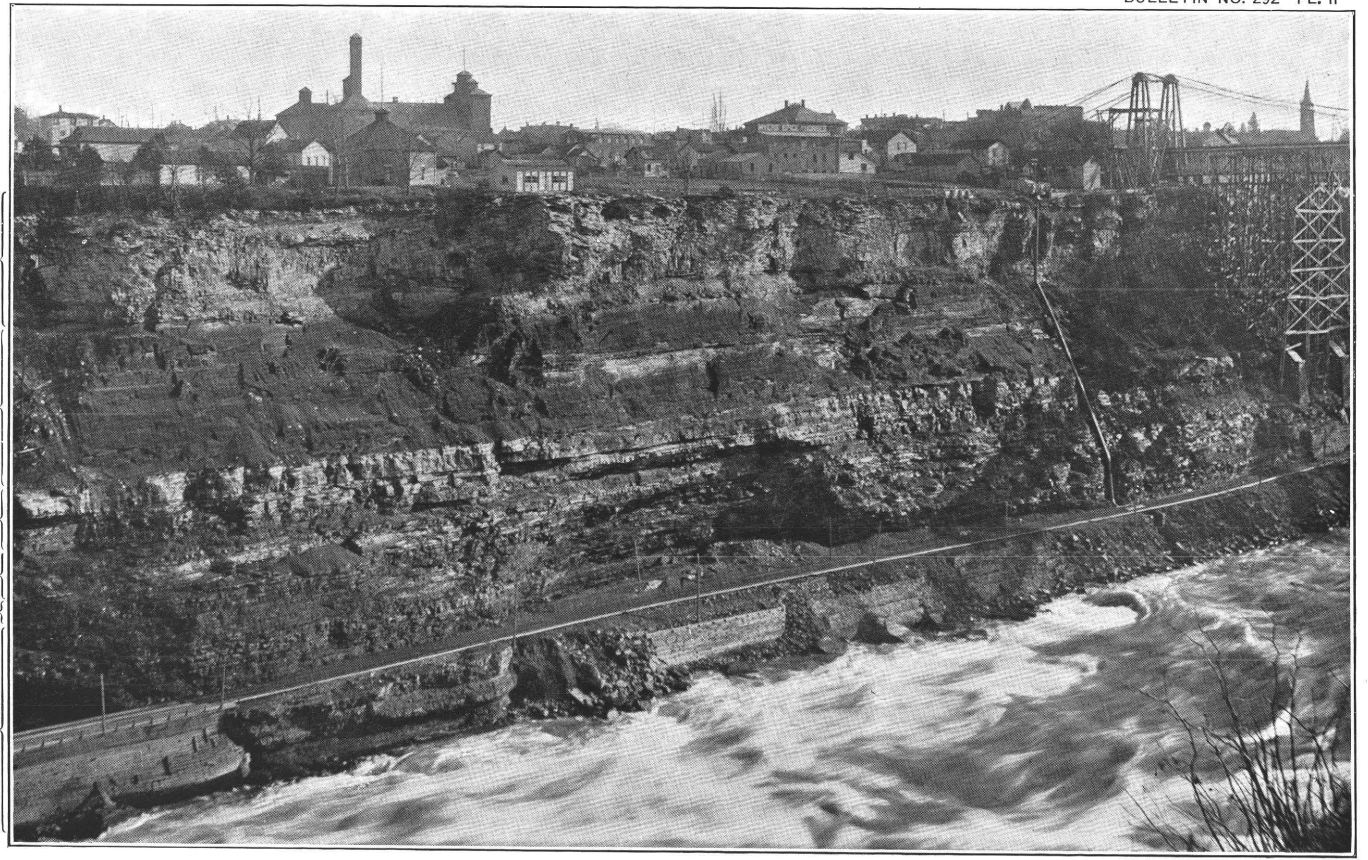
The Rochester shale affords ideal localities for collecting by the process of washing. The shale immediately above or below the fossiliferous limestone bands almost invariably on washing yields free specimens of the species found upon the slabs. Still better results are obtained if the fossiliferous limestone layer be traced until it changes into a marl or clay, as often happens, for here the fossils ordinarily helping to make up the limestone are more complete, and being uncemented can be washed out free. Careful selection of clay from such marly pockets or from above or below unusually rich limestone layers will yield excellent fossils and save time in the picking out of the specimens after the material has been washed.

In washing fossiliferous shale the writer has found that the best method to obtain the specimens in as perfect condition as possible is first to spread out the materia[1] and expose it to the sun for a day or more. When the clays have been weathered in the field, this, of course, is unnecessary. Such an exposure slakes the clay, allows the specimens to dry, and thus become less liable to break, and, moreover, causes the clay to disintegrate more readily. Then if the marl or clay be allowed to soak for a day, the final washing is a short and simple matter, consisting merely in allowing clear water to run over the material until the water passes through without becoming discolored. After the residue has dried, sifting the material into several grades of fineness will aid in assorting the specimens. This method of washing has the advantage of reducing the breaking of the specimens to a minimum, for in the ordinary process the shaking required to hasten the disintegration of the clay breaks or otherwise injures the more delicate fossils.

After washing a sample of fossiliferous Rochester shale it will be found to consist almost entirely of fossil remains. The coarse material is composed largely of fragmentary or entire specimens of brachiopods, crinoidal remains, and ramose or massive bryozoa. In searching for bryozoa, the fragmentary brachiopods and crinoidal remains should be carefully examined, for they are often incrusted by delicate, parasitic species, especially of the Ctenostomata. In washings from certain localities near Lockport, one out of every three or four fragments of *Spirifer niagarensis* was incrusted by the unique bryozoan *Rhopalonaria attenuata*. The finer material usually shows an abundance of the small ramose and fenestrated bryozoa and of young specimens of brachiopods, while the finest siftings afford ostracods and other microscopic organisms.

In England the strata corresponding to the Rochester have been thoroughly searched for fossils by washing, and a large and interesting fauna is the result. Unfortunately little has been published concerning the bryozoa obtained from these washings, but the numerous ostracods described by Jones and Holl and the brachiopods described by Davidson show the value of this method of collecting. Mr. Maw's washings are well known to every student of the Wenlock. Over 20 tons of these shales were washed by him for fossils. The number of specimens picked out ran into the thousands for some of the species. The Rochester shale compares quite as favorably in this respect, since from the residue of 50 pounds of shale so treated the writer picked out over 5,000 specimens of the bryozoan *Chilotrypa ostiolata*, while other small ramose species, such as *Acanthoclema asperum* and *Batostomella granulifera* would be found to occur in the same abundance if one should take the trouble to assort all of the specimens. If 20 tons of this shale were washed, the specimens of at least some of these species would have to be recorded by quantity rather than by number.

Sometimes the fossils of the Rochester are confined entirely to the limy layers. In this case if free specimens are desired many of them may be detached from the slabs without injury by means of caustic potash. Entire zoaria, or even average specimens of such fragile forms as the Phylloporinidæ or Fenestellidæ, can be had only on slabs of limestone or shale. The washings will yield small, clean fragments of these for study, but no large, showy examples for exhibition.



NIAGARA GORGE BELOW THE SUSPENSION BRIDGE, NIAGARA COUNTY, N. Y.

From the Canadian side. Photograph by I. P. Bishop.

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CORRELATION.

For various reasons the exact correlation of the several members of the New York Niagaran with strata of the same age elsewhere has not met with complete satisfaction. The lithologic and faunal differences in beds which should apparently be correlated stratigraphically are so great that it seems evident for these reasons alone that the rocks must have been deposited in separate basins. For lack of sufficient collections the evidence afforded by the bryozoa in the correlation of the various Niagaran deposits is not yet complete, but the present study of the Rochester shale fauna and of collections from the Osgood beds of Indiana indicates the undoubted equivalence of at least these two formations.

The Niagaran strata exposed along the western flank of the Cincinnati anticline in southern Indiana, Kentucky, Tennessee, and northern Alabama have been divided into the following formations:[a]

5. Louisville limestone.
4 Waldron shale.
3. Laurel limestone.
2. Osgood shale and limestone.
1. Clinton limestone.

The distribution and paleontological characteristics of these rocks have been discussed by Foerste in various articles, and the following description of the Osgood formation is based mainly on his work:

Several thin limestone layers having a total thickness of 8 to 15 inches form the base of the Osgood formation. Following these are 11 to 16 feet of clay, which in Kentucky is usually soft, but in Indiana is somewhat indurated. In other sections this lower Osgood clay is overlain by a crinoidal limestone often 5 feet in thickness, and this in turn by the upper Osgood clay variable in thickness but sometimes reaching 5 feet.

According to Foerste, *Pisocrinus*, *Stephanocrinus*, *Holocystites*, *Rhynchotreta*, *Spirifer*, *Cyrtia*, and *Nucleospira* make their first appearance in the Osgood formation. Associated with these, especially in the clayey partings of the limestones, are the bryozoa identified in this paper. Most all of the nonbryozoan genera and in fact identical species even may occur in the Rochester shale. The evidence presented by the bryozoa themselves is shown in the table below.

In regard to the correlation of the Osgood fauna, Foerste[b] remarks as follows: "In many respects the Osgood fauna is a forerunner of that found in the Waldron. It corresponds to the reef fauna at the top of the Clinton of New York, where it occurs in the limestones exposed in the lens-like cross sections just beneath the Rochester shale."

While the writer agrees that the Osgood fauna is a forerunner of the Waldron, and that it also may correspond in part to the reef fauna, comparisons of the bryozoan elements of the faunas seem to show beyond question that the Osgood is chiefly if not exactly comparable with the Rochester shale.

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[a] Foerste, A. F., Twenty-eighth Ann. Rept. Indiana Dept. Geol. Nat. Res., 1904.
[b] Op. cit., p. 30.

The following list of Rochester shale species, showing their distribution, indicates the identity of forms in the two areas:

Alphabetic list of bryozoa in Rochester shale, showing range and comparative abundance.

[r=rare; u=uncommon; c=common.]

	Western New York.	Ontario.	Osgood beds, Indiana.	Waldron beds, Indiana.
Acanthoclema asperum (Hall)	c	c	u	.....
Allonema waldronense Ulrich and Bassler	r	.....	.....	r
Ascodictyon siluriense Vine	r	.....	.....	r
Batostomella granulifera (Hall)	c	c	u	.....
Berenicea consimilis (Lonsdale)	u	r	r	r
Bythopora spinulosa (Hall)	c	c	.....	.....
Callopora clausa n. sp	u	u	c	.....
Callopora elegantula Hall	c	c	c	c
Callopora magnopora Foerste	r	r	.....	.....
Ceramopora imbricata Hall	u	u	c	.....
Ceramopora niagarensis n. sp	u	u	u	.....
Ceramoporella irregularis n. sp	r	.....	.....	.....
Ceramoporella orbiculata (Ringueberg)	u	u	.....	.....
Chilotrypa ostiolata (Hall)	c	c	c	.....
Clathropora alcicornis Hall	r	.....	.....	.....
Clathropora frondosa Hall	u	u	.....	.....
Clathropora frondosa intermedia Nicholson and Hinde	u	u	.....	.....
Cœloclema cavernosa n. sp	r	.....	r	.....
Diamesopora dichotoma Hall	c	c	.....	.....
Diploclema sparsum (Hall)	c	c	.....	.....
Diploclema sparsum argutum n. var	u	.....	.....	.....
Diplotrypa walkeri n. sp	.....	u	.....	.....
Eridotrypa nodulosa n. sp	u	.....	.....	.....
Eridotrypa similis n. sp	u	u	.....	.....
Eridotrypa solida (Hall)	c	c	.....	.....
Eridotrypa spinosa n. sp	u	u	c	.....
Eridotrypa striata (Hall)	c	c	c	.....
Fenestella cribrosa Hall	u	.....	.....	.....
Fenestella elegans Hall	c	c	.....	.....
Fistulipora crustula n. sp. or n. name	c	c	.....	.....
Fistulipora laminata (Hall)	u	u	.....	.....
Fistulipora lockportensis n. sp	u	.....	.....	.....
Fistulipora tuberculosa (Hall)	u	u	.....	.....
Idiotrypa punctata (Hall)	c	c	u	.....
Lichenalia concentrica Hall	u	u	.....	.....
Lioclema asperum (Hall)	c	c	c	.....
Lioclema circinctum n. sp	r	.....	.....	.....
Lioclema explanatum n. sp	c	.....	r	.....
Lioclema globulare n. sp	r	.....	.....	.....
Lioclema multiporum n. sp	c	c	u	.....
Lioclema peculiare n. sp	u	u	r	.....
Lioclema ramulosum n. sp	u	u	u	.....
Lioclemella maccombi n. sp	c	c	r	.....
Loculipora ambigua precursor n. var	r	.....	r	.....
Loculipora ulrichi n. sp	c	c	.....	.....
Meekopora foliacea (Hall)	u	u	.....	.....
Mesotrypa nummiformis (Hall)	u	u	u	.....
Mitoclema sarlei n. sp	c	.....	.....	.....
Monotrypa benjamini n. sp	c	c	c	.....
Monotrypa osgoodensis n. sp	c	c	c	.....

Alphabetic list of bryozoa in Rochester shale, showing range and comparative abundance—Continued.

	Western New York.	Ontario.	Osgood beds, Indiana.	Waldron beds, Indiana.
Monotrypa pediculata n. sp	u	u	u	.....
Nematopora minuta (Hall)	c	c	.....	u
Nicholsonella florida (Hall)	c	c	u	.....
Nicholsonella ringuebergi n. sp	r	.....	.....	.....
Orbignyella expansa (Ringueberg)	u	u	.....	.....
Orbignyella magnopora n. sp	u	u	.....	.....
Pachydictya crassa (Hall)	c	c	c	c
Phænopora ensiformis Hall	u	u	u	.....
Phænopora fimbriata canadensis n. var	r	r	.....	.....
Phylloporina asperato-striata (Hall)	c	c	u	.....
Polypora incepta Hall	c	c	.....	.....
Pseudohornera diffusa (Hall)	r	r	.....	.....
Pseudohornera niagarensis (Hall)	u	u	.....	u
Ptiloporella nervata (Nicholson)	u	u	r	.....
Rhinopora curvata Ringueberg	r	r	.....	.....
Rhombotrypa spinulifera n. sp	u	u	u	.....
Rhopalonaria attenuata Ulrich and Bassler	c	c	.....	u
Semicoscinium tenuiceps (Hall)	c	c	r	.....
Spatiopora maculata (Hall)	u	u	.....	u
Stictotrypa punctipora (Hall)	c	c	.....	.....
Stigmatella globata n. sp	u	.....	.....	.....
Stomatopora dissimilis Vine	u	u	r	r
Stomatopora elongata Vine	r	.....	.....	r
Tæniodictya schucherti n. sp	r	r	.....	.....
Thamniscus dichotomus (Hall)	c	c	.....	.....
Trematopora spiculata Hall	c	c	r	c
Trematopora tuberculosa Hall	c	c	u	.....
Trematopora whitfieldi Ulrich	u	u	.....	c
Vinella ? multiradiata Ulrich and Bassler	r	.....	.....	.....
Vinella radiciformis (Vine)	r	r	.....	r

By comparing the species in this list it will be seen that of the 80 forms recorded in the Rochester shale 33 occur also in the Osgood beds and but 14 in the Waldron beds. Since the Waldron shale has been much more thoroughly searched for bryozoa than the Osgood beds, these figures are significant. It is further to be borne in mind that, since most of the Rochester shale species that are known in Indiana as yet only in the Waldron are almost world-wide in their distribution, more complete collections from the Osgood beds may be confidently expected to materially increase the already large number of species which these beds hold in common with the Rochester shale. For this reason the foregoing tabular comparison is not entirely competent Perhaps the surest way of testing the contemporaneity of the Rochester and Osgood bryozoan faunas is by means of lists from which species known to be of wide range, as well as those common to the Rochester and the Waldron, are excluded. Such lists may fairly be said to comprise, so far as known, only the characteristic species of the Rochester, though not all of them.

Partial list of characteristic Rochester and Osgood bryozoa.

Acanthoclema asperum.
Batostomella granulifera.
* Bythopora spinulosa.
Callopora clausa.
Ceramopora imbricata.
Ceramopora niagarensis.
Chilotrypa ostiolata.
* Diamesopora dichotoma.
* Diploclema sparsum.
Eridotrypa spinosa.
* Eridotrypa solida.
Eridotrypa striata.
* Fenestella elegans.
* Fistulipora crustula.
Idiotrypa punctata.
* Lichenalia concentrica.
Lioclema asperum.
Lioclema explanatum.
Lioclema multiporum.
Lioclema peculiare.
Lioclema ramulosum.
Lioclemella maccombi.
Loculipora ambigua var. precursor.
* Loculipora ulrichi.
* Meekopora foliacea.
Mesotrypa nummiformis.
* Mitoclema sarlei.
Monotrypa benjamini.
Monotrypa osgoodensis.
Monotrypa pediculata.
Nicholsonella florida.
Phylloporina asperato-striata.
* Polypora incepta.
Rhombotrypa spinulifera.
* Stictotrypa punctipora.
* Thamniscus dichotomus.
Trematopora tuberculosa.

Of the above list of 37 species, those marked with an asterisk appear to be limited to the Rochester shale. The remaining 24 species, or about 65 per cent, are common to the Rochester shale and the Osgood beds. After weeding out the wide-ranged (European and American) species from those shown in the main list to be common to the Rochester and the Waldron shales, only 7 species remain to be set against the 24 in the Osgood beds, and of this residue 3 species, viz, *Callopora elegantula*, *Pachydictya crassa*, and *Trematopora spiculata*, occur in all three beds. The evidence in favor of the equivalence of the Osgood and Rochester is further strengthened by the fact that while practically all of the known Osgood bryozoa occur also in the Rochester, the Waldron, on the contrary, contains many that are unknown in that formation.

The Wenlock shales of England contain a comparatively large bryozoan fauna which has received but little study. Of this series the Buildwas beds seem to hold a fauna most similar to that of the Rochester shale, and a careful comparison of the two will probably bring out the fact that they are closely related.

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The following review contains references to the literature bearing on the bryozoa found in these shales and a brief outline of the work done in each case:

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GRABAU, A. W. Bull. Buffalo Soc. Nat. Sci., VII, No. 1, 1901. Reprint of the above paper.

HALL, JAMES. Natural History of New York, Geology, IV, 1843, p. 116, figs. 2, 3. A good figure of the reverse of *Pseudohornera diffusa* is given as a "coral resembling Isis."

HALL, JAMES. Natural History of New York, Paleontology, II, 1852. Describes as corals the following new genera and species of bryozoa, all from Lockport, N. Y., a few species, however, being also recorded from Rochester and other localities in western New York: *Callopora* n. gen., *C. elegantula* n. sp., *C. florida* n. sp., *C. laminata* n. sp , *C. aspera* n. sp., *C. nummiformis* n. sp., *Trematopora* n. gen., *T. tuberculosa* n. sp., *T. coalescens* n. sp. *T. punctata* n. sp., *T. ostiolata* n. sp., *T. solida* n. sp., *T. striata* n. sp., *T. granulifera* n. sp.. *T. aspera* n. sp., *T. spinulosa* n. sp., *T. sparsa* n. sp , *Stictopora punctipora* n. sp., *Diamesopora dichotoma* n. gen. et sp. (genus not characterized), *Clathropora* n. gen., *C. alcicornis* n. sp., *C. frondosa* n. sp., *Retepora diffusa* n. sp., *R. asperato-striata* n. sp., *Hornera* (?) *dichotoma* n. sp., *Fenestella elegans* n. sp., *F. tenuiceps* n. sp., *F. cribrosa* n. sp. (from lower part of Niagara limestone), *Polypora incepta* n. sp., *Ceramopora* n. gen., *C. imbricata* n. sp., *C. incrustans* n. sp., *C. foliacea* n. sp., *Rhinopora tuberculosa* n. sp *Lichenalia* n. gen., *L. concentrica* n. sp., *Sagenella* n. gen., *S. membranacea* n. sp.

HALL, JAMES. Natural History of New York, Paleontology, VI, 1887, pl. 61. Figures by mistake a species from the Rochester shale and names it *Stictopora scitula*.

NICHOLSON, H. A., and HINDE, G. J. Canadian Journal, new ser., XIV, 1874. They record the occurrence of *Clathropora frondosa, C. intermedia,* and *Retepora asperato-striata* in the Niagara limestone (Rochester shale) at Thorold Ontario, and of *Trematopora ostiolata* and *Fenestella tenuiceps* at Niagara River. They also give descriptions and comparisons of *Clathropora frondosa* and *C. intermedia,* the latter being a new species. Figures of *Clathropora intermedia* and *Trematopora ostiolata* are given.

NICHOLSON, H. A. Paleontology of the Province of Ontario, 1875, pp. 59, 60. So far as the bryozoa of the Rochester shale are concerned, this is a reproduction of the preceding work.

NICHOLSON, H. A. Geological Survey of Ohio, Paleontology, II, 1875, p. 264, pl. 25, figs. 11, 11a. Describes and figures *Fenestella nervata* n. sp. from the Niagara at Cedarville, Ohio. This species has since been recognized in the Rochester shale in New York and Ontario.

NICKLES, JOHN M., and BASSLER, R. S. Synopsis of American fossil bryozoa. Bull. U. S. Geol. Survey No. 173, 1900. They record the literature and synonomy of Rochester shale as well as other American fossil bryozoa.

RINGUEBERG, E. N. S. New genera and species of fossils from the Niagara shales. Bull. Buffalo Soc. Nat. Sci., V. 1886. Describes as new species from Lockport, N. Y., *Ceramopora orbiculata, Rhinopora curvata, Stomatopora recta, S. parva,* and *Chætetes expansus.*

ROEMER, FERD. Lethæa Geognostica, I, Lethæa Palæozoica, Atlas, 1876, pl. 12, figs. 2a, 2b, 4a–4c. Reproduces some of Hall's figures of *Retepora diffusa* Hall, and in the explanation of the plate applies the new name *Pseudohornera diffusa.* Figures, as a new species from the island of Gotland, *Ptilodictya fenestrata,* a form very much like *Clathropora frondosa* Hall.

ULRICH, E. O. American Paleozoic bryozoa. Jour. Cincinnati Soc. Nat. Hist, V–VII, 1882–1884. In discussing *Homotrypa* some of the characters of *Trematopora tuberculosa* Hall are stated in Vol. V, p. 241. A full description of *Callopora elegantula* Hall, is given on page 250. In Vol. VI, p. 257, he discusses Hall's genus *Trematopora* and gives an amended definition. Hall's species are distributed as follows: *Trematopora coalescens=Trematopora,T. solida=Trematopora?,* and *T. ostiolata=Chilotrypa.* On page 259 he describes *Trematopora tuberculosa* Hall. In Vol. VII, p. 39, in discussing *Coscinium* Keyserling, he remarks on Hall's genus *Clathropora* and the type species *C. frondosa.* Pages 43–44 give some of the characters of *Lichenalia* and the type species *L. concentrica,* of which he figures a tangential section in Pl. III, fig. 5. On page 49 he refers to his new genus *Chilotrypa* Hall's *Trematopora ostiolata.*

ULRICH, E. O. Paleozoic bryozoa. Geol. Survey Illinois, VIII, 1890. On page 368 the genus *Diploclema* is established and *Trematopora sparsa* Hall is made one of the types. The new genus *Stictotrypa* is founded (p. 393), with *Stictopora similis* Hall as the genotype, and on page 394, fig. 13, a vertical section of *S. similis* Hall and tangential and vertical sections of *S. punctipora* Hall are given. On page 399 *Drymotrypa* n. gen. is described, *Retopora diffusa* Hall being made the type. Hall's *Thamniscus niagarensis* is referred here. On page 425, in discussing the genus *Lioclema,* the following of Hall's species are referred here: *Callopora aspera, C. florida,* and *C. laminata.* On page 463 a full description of *Ceramopora imbricata,* accompanied by figures of the internal structure, is given. The genus *Diamesopora* is discussed on page 467. On page 607, when discussing *Thamniscus, Hornera dichotoma* Hall is referred here, while *Thamniscus niagarensis* Hall belongs to *Drymotrypa.*

ULRICH, E. O., and BASSLER, R. S. A revision of the Paleozoic bryozoa. Smithsonian Miscell. Coll. (Quart. issue), XLV, 1904. They describe and figure *Rhopalonaria attenuata* n. sp., *Vinella radiciformis* (Vine), *V.* (?) *multiradiata* n. sp., and *Ascodictyon siluriense* Vine, from the Rochester shale.

VINE, G. R. Silurian uniserial Stomatoporæ and Ascodictyon. Quart. Geol. Jour. Soc. London, XXXVII, 1881. Figures and describes on page 615, *Stomatopora dissimilis* n. sp. from the Buildwas beds, Wenlock shales, Shropshire, England.

VINE, G. R. Notes on the polyzoa of the Wenlock shales, Wenlock limestone and shales over Wenlock limestone. Quart. Jour. Geol. Soc. London, XXXVIII, 1882. Describes among other Silurian species the following, which have been recognized in the Rochester shale: *Stomatopora dissimilis*, *S. dissimilis* var. *elongata*, *Ascodictyon stellatum* var. *siluriense*, *Ascodictyon radiciforme*, and *Diastopora consimilis*.

DESCRIPTIONS OF GENERA AND SPECIES.

Class BRYOZOA Ehrenberg.

Order CTENOSTOMATA Busk.

The zoarium in this relatively small order is horny or membranaceous, and consists of tubular stolons, from the internodes of which the zoœcia are developed. The zoœcia are usually isolated and have a terminal orifice which in the living state is closed by an operculum composed of setæ.

When compared with the other orders of bryozoa, species of Ctenostomata are not common in the Rochester shale, five representing four genera having thus far been found This, however, is not unusual, as the order is poorly represented in all the geologic formations. The infrequency of fossil Ctenostomata may be accounted for by the prevailing character of their zoaria, the zoarium in the majority of the living types of this order being membranaceous, and hence incapable of preservation in the fossil state.

One of the Rochester shale species, *Rhopalonaria attenuata*, is represented by numerous specimens; another, *Vinella radiciformis*, is uncommon; while the remaining three, *Vinella multiradiata*, *Ascodictyon siluriense*, and *Allonema waldronense* are comparatively rare. Continued searching will probably reveal the presence of species belonging to another ctenostomatous genus, namely *Heteronema*, since representatives of this genus are known in other Silurian strata.

Mr. Ulrich and the writer have recently made the fossil Ctenostomata the subject of a small monograph [a], and the following descriptions are based mainly on this work. Since this publication, no new species have been found in the Rochester shale, although several new forms have come to light in other horizons.

Family RHOPALONARIIDÆ Nickles and Bassler.

Genus RHOPALONARIA Ulrich.

All the species of this genus closely resemble each other, since, as a rule, nothing remains but the impressions of the stolons—clay-filled or empty excavations in the body incrusted. However, experience has shown that the variation in the dimensions of these more or less accurate impressions serves as well in discriminating the species as the zoaria themselves.

Rhopalonaria is distinguished from all other genera of the Ctenostomata by the fusiform internodes or cells, by their pinnate arrangement, and by the fact that they excavate their host.

RHOPALONARIA ATTENUATA Ulrich and Bassler.

Pl. IV, figs. 4, 5.

Rhopalonaria attenuata Ulrich and Bassler, Smithsonian Miscell. Coll. (Quart. issue), XLV, 1904, p. 268, pl. 66, figs. 4, 5.

In all the specimens at hand this species is represented by a series of excavations upon the surface of the object it incrusted, crinoid columns, cystid plates, brachiopods, and bryozoans being used indiscriminately. These impressions show that the zoarium consisted either of slender stolons constricted at rather regular intervals or of segments slightly fusiform in

[a] Smithsonian Miscell. Coll. (Quart. issue), XLV, 1904, pp. 256–294.

outline. From a central stolon or series of segments, lateral branches are given off at approximately right angles, and in the same manner these divide again until the result is a network of anastomosing branches arranged pinnately. Length of segments somewhat variable, 3 to 3.5 in 2 mm. Orifice not observed because of the preservation, but probably situated in the swollen end of the segments.

The differences between this species and *R. venosa* Ulrich [a] from the Richmond group are slight, the length and arrangement of the internodes and stolons being practically the same in each. *R. attenuata*, however, may be distinguished by the extreme tenuity of the internodes and stolons, and by the comparative rigidity of their arrangement. The zoœcial and zoarial features of the two, if preserved, would probably show more differences, but as the excavations alone have been found, slight variations must serve in discriminating species.

Occurrence.—The figured types were found in the Rochester shale at Lockport, N. Y., where specimens are not uncommon. Examples have also been found in the same formation at Rochester and Lewiston, N. Y., in the Niagara Gorge, and at Grimsby and Thorold, Ontario. The Clinton limestone at Mifflintown, Juniata County, Pa., and the Waldron shale at Waldron, Ind., and at Newsom, Tenn., furnish specimens which can not be separated from the typical form.

Catalogue numbers, 43116, 43117, 35733, 35477, U. S. National Museum.

Family VINELLIDÆ Ulrich and Bassler.

Genus VINELLA Ulrich.

Zoarium parasitic, consisting of very slender, tubular threads or stolons, arranged more or less distinctly in a radial manner. Surface of threads with a single row of small pores, which may be wanting locally and may vary considerably in the degree of their separation. Zoœcia unknown, probably deciduous.

VINELLA RADICIFORMIS (Vine).

Pl. IV, figs. 2, 3.

Ascodictyon radians Vine (part), Quart. Jour. Geol. Soc. London (provisional placement), XXXVII, 1881, p. 619.
Ascodictyon radiciforme Vine, ibid., XXXVIII, 1822, p. 53, figs. 1, 3.
Ascodictyon radiciforme Vine, Ann. and Mag. Nat. Hist. (5), XIV, 1884, p. 83, figs. 1–5.
Ascodictyon radiciforme Vine, Proc. Yorkshire Geol. and Polytech. Soc., IX, 1887, pp. 183–4, pl. 12, fig. 5.
Ascodictyon radiciforme Vine, ibid., XII, 1892, p. 87.
Vinella radiciformis Ulrich, Geol. and Nat. Hist. Survey Minnesota, Final Rept., III, pt. 1, 1893, p. 113.
Vinella radiciformis Ulrich and Bassler, Smithsonian Miscell. Coll. (Quart. issue), XLV, 1904, p. 275. pl. 68, fig. 7.

This species, originally described from the Wenlock shales, has been noted at a number of American localities. Its delicate zoaria are generally found incrusting smooth-shelled brachiopods, crinoid columns, or the epithecated side of bryozoa, such as explanate species of *Fistulipora* or *Lioclema*. The rather widely separated nuclei and the extreme tenuity of the radiating threads are especially characteristic. Near the centers themselves the radii are slightly swollen, but their average thickness elsewhere lies between 0.03 and 0.04 mm. Sometimes the threads seem to bifurcate or to wander about without much order, and often the nuclei are difficult to distinguish from the points where the threads merely cross.

Occurrence.—Buildwas beds of the Wenlock shales, Shropshire, England; Rochester shales, Rochester and Lockport, N. Y.; Grimsby, Ontario; Waldron shale, Waldron, Ind; Clinton formation, Sevenmile Creek, near Eaton, Ohio.

Catalogue numbers, 35476, 43145, 43146, U. S. National Museum.

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[a] Ulrich, Jour. Cincinnati Soc. Nat. Hist., II, 1879, p. 26, pl. 7, figs. 24, 24a.

VINELLA? MULTIRADIATA Ulrich and Bassler.

Pl. IV, fig. 1.

Vinella? multiradiata Ulrich and Bassler, Smithsonian Miscell. Coll. (Quart. issue), XLV, 1904, p. 276, pl. 68, fig. 8.

But two specimens of this interesting and peculiar organism have been found, and, as no additional facts have been observed, the remarks by Ulrich and the writer in describing the species are quoted below.

Original description.—The specimen on which this peculiar species is founded incrusts a crinoid column about three-fourths of an inch in length, about two-thirds covered with the supposed *Vinella*. At intervals varying from little more than 0.5 mm. to about 2 mm. the surface of the incrusting sheet presents subcircular, cup-shaped depressions, 0.12 mm. to 0.2 mm. in diameter, inclosed by a low rim from which 14 to 20 closely arranged threads proceed in all directions. The radii are commonly disposed in sets of three to five, those emanating from neighboring centers overlapping and interweaving in the interspaces. The sheet seems to consist in most parts of at least two superposed layers. Minute details of structure not preserved.

At first sight, under a low power of magnification, the specimen recalled the attached basal disks of articulating bryozoa, like *Arthropora* and *Escharopora*, but it soon became evident that the resemblance was deceptive and extended only to the common possession of cup-shaped depressions and lines radiating from them. Under a higher power the radii proved to be simple threads and not radially arranged walls separating rows of elongated zoœcial apertures, which is the structure of the attached disks of the articulating bryozoa referred to. Of course the much smaller size of the *Vinella* was apparent from the beginning of our investigations. Though now thoroughly satisfied that we are not dealing with bases of zoaria, we think it quite possible that they may prove to be the bases of isolated zoœcia. Whatever the future may prove it to be, it impresses us as a very interesting organism, and it is the hope that other collectors may succeed in finding more and better specimens that has induced us to describe it.

Occurrence.—Rochester shale, Lockport, N. Y.

Catalogue number, 43144, U. S. National Museum.

Genus ALLONEMA Ulrich and Bassler.

Original description.—Fossil zoaria of which only the creeping base is known. This attaches itself to foreign bodies and consists of strings of sausage-like, bulbous, fusiform or pear-shaped internodes or vesicles varying greatly in size in different species. Surface of internodes minutely punctate, while a number in each colony exhibit a larger pore-like depression, usually near one end of the vesicle or internode that is regarded as marking the point where erect zoœcia were attached.[a]

ALLONEMA WALDRONENSE Ulrich and Bassler.

Pl. IV, fig. 9.

Allonema waldronense Ulrich and Bassler, Smithsonian Miscell. Coll. (Quart. issue), XLV, 1904, p. 283, pl. 67, fig. 5.

A single small example of this rather uncommon species was found incrusting the epitheca of a fistuliporoid in the Rochester shale at Middleport, N. Y. This specimen agrees so closely with the type that for purposes of identification the original description is repeated below.

Original description.—Colonies small, consisting of an irregular, winding series of comparatively few and rather large, inflated internodes. The series branches occasionally, and a few of the internodes appear to be quite isolated. The internodes vary greatly in form, some being globular or elliptical, others pyriform, and a few of the largest bilobate. The last probably consist of two partially confluent vesicles. With all this variation, the internodes still remain within reasonable distance of the average size that we consider characteristic of the species. The average length may be placed at about 0.5 mm., the width at 0.3 mm.

Occurrence.—Waldron shales of the Niagaran group, Waldron, Ind.; Rochester shale, Middleport, N. Y.

Catalogue number, 43128, U. S. National Museum.

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[a] Ulrich and Bassler, Smithsonian Miscell. Coll. (Quart. issue), XLV, 1904, p. 279.

Family ASCODICTYONIDÆ Ulrich.

Genus ASCODICTYON Nicholson and Etheridge, jr.

Zoarium parasitic, consisting of ovate or pyriform vesicles, arranged in radial clusters or isolated, and connected with each other by very delicate, hollow threads. Walls of vesicles perforated by closely arranged, minute pores. Zoœcia unknown.

ASCODICTYON SILURIENSE Vine.

Pl. IV, figs. 6-8.

Ascodictyon stellatum Vine, Quart. Jour. Geol. Soc. London, XXXVII, 1881, p. 618.
Ascodictyon stellatum var. *siluriense* Vine, ibid., XXXVIII, 1882, p. 52, figs. 1, 2.
Ascodictyon stellatum var. *siluriense* Vine, Ann. and Mag. Nat. Hist. (5), XIV, 1884, p. 81, fig. 7.
Ascodictyon stellatum var. *siluriense* Vine, Proc. Yorkshire Geol. and Polytech. Soc., IX, 1887, p. 184, pl. 12, fig. 6.
Ascodictyon siluriense Vine, ibid., XII, 1892, p. 88, pl. 2, fig. 1.
Ascodictyon siluriense Ulrich and Bassler, Smithsonian Miscell. Coll. (Quart. issue), XLV, 1904, p. 286, pl. 68, figs. 11, 12.

Description (Ulrich and Bassler).—Vesicles pyriform, the small end more or less drawn out, 0.1 mm to 0.2 mm. in diameter, and 0.3 mm. to 0.5 mm. in length, arranged in clusters of four to eight, with clusters of four or five occurring oftener than six to eight. Connecting threads about 0.03 mm. in thickness, comparatively straight, with clusters of vesicles occurring at intervals of 2.5 mm. or more.

Compared with *A. stellatum*, this species is distinguished by its usually fewer and less closely arranged vesicles in each cluster, by the greater average length and more pyriform shape of the vesicles, and by the comparative rigidity of the connecting threads.

Several well-preserved examples of this cosmopolitan Silurian species have been found in the Rochester shale at Lockport. The pyriform radially arranged vesicles and the delicate connecting threads form a zoarium so different from all associated bryozoa that comparison is unnecessary.

Occurrence.—Vine's types were found in the Wenlock shale, Buildwas beds, Shropshire, England. In America the species occurs in the Rochester shale at Lockport, N. Y., and in the Waldron shale at Waldron, Ind., and Newsom, Tenn.

Catalogue numbers, 43135, 43138, U. S. National Museum.

Order CYCLOSTOMATA Busk.

The simple tubular zoœcia with thin, minutely porous walls, the absence of marsupia and appendicular organs and the presence of oœcia characterize this order. The Cyclostomata are fairly well represented in this formation, the majority of the species belonging to the *Ceramoporidæ* and *Fistuliporidæ*, two families which have only recently been referred to the order with certainty.

Family DIASTOPORIDÆ Busk (emend. Ulrich).

Genus STOMATOPORA Bronn.

Zoarium adnate, branching dichotomously; zoœcia subtubular or subpyriform, arranged in a single linear series; aperture subterminal.

STOMATOPORA ELONGATA (Vine).

Pl. IV, figs. 10-14.

Stomatopora dissimilis var. *elongata* Vine, Quart. Jour. Geol. Soc. London, XXXVIII, 1882, p. 50.
Stomatopora elongata Vine, Ann. and Mag. Nat. Hist. (5), XIV, 1884, p. 85, fig. IV, 2.
Stomatopora parva Ringueberg, Bull. Buffalo Soc. Nat. Hist., V, 1886, p. 20, pl. 2, fig. 16.

Original description (Vine).—*Stomatopora dissimilis* Vine var. a. *elongata.* Zoarium very irregular, clustering. Zoœcia elongated, with, at times, long stoloniferous processes which intermingle with the cells. When colonial growth is distinct, arrangement of cells is linear and uniserial. Measured under favorable circumstances, about three cells occupy the space of one line.

Locality.—Buildwas beds (Wenlock shales), England.

The collection of Mr. John M. Nickles contains an example of this species from the original Wenlock shales material studied by Mr. Vine. Fig. 10, Pl. IV, represents several of the zoœcia of this specimen enlarged, and a comparison of this figure with those of the American form shows that there can be little doubt of the specific identity of the two. This English specimen is labeled *Stomatopora elongata* in Mr. Vine's handwriting, so that there is no question of its authenticity. The long stoloniferous processes which Mr. Vine mentions as intermingling with the cells are the stolons of ctenostomatous bryozoa such as *Vinella* or *Ascodictyon* and have no connection at all with the *Stomatopora*. Such widely diverse incrusting species are often found with their zoaria intermingled and but little care is usually required to determine that one is merely growing over the other. The following description brings out the characters as observed by the writer:

Zoarium incrusting foreign objects, the smooth epitheca of corals or bryozoa being most favored in the American examples. Zoœcia uniserial, branching at irregular intervals, slender, fusiform, increasing slowly in size from a diameter of 0.03 to 0.04 mm. at the proximal end to one of 0.15 to 0.18 mm. at the distal or anterior end, which, although normally rounded, is sometimes slightly drawn out. An average zoœcium is 0.60 mm. in length; when arranged in a straight line, seven zoœcia may be counted in the space of 4 mm. Aperture small, rounded, subterminal, with a slightly elevated border and less than half the greatest width of the zoœcium in diameter. Surface of the zoœcia smooth, probably finely porous.

Compared with other uniserial forms of *Stomatopora*, *S. elongata* resembles *S. delicatula* James, which ranges through the Mohawkian and Cincinnatian groups, but the latter species has slightly longer and more slender zoœcia. In all probability *S. elongata* is the Silurian representative of the Ordovician *S. delicatula*. The very much larger and relatively shorter, transversely wrinkled zoœcia of the associated *Stomatopora dissimilis* are so different that comparisons are scarcely necessary.

The American form here identified as *Stomatopora dissimilis* is probably the same as *Stomatopora parva* Ringueberg, but the description and figures of the latter are so poor that without an examination of the type specimen the synonymy can not be determined with absolute certainty. In spite of this uncertainty, the writer has ventured to place Ringueberg's species as a synonym on the strength of his original description, which, for the sake of comparison, is quoted below:

> Adnate, minute, irregularly branching. Cells uniserial subcylindrical, not inflated, somewhat variable in length, some being a third shorter than the average. Calice slightly elevated. This species is about one-third as large as *S. recta* and is readily recognized by its minute size and straight cells. (From the Niagara shales at Lockport, N. Y.)

Occurrence.—Buildwas beds, Wenlock shales, Shropshire, England; Clinton formation, Sevenmile Creek, near Eaton, Ohio; Rochester shale, Rochester and Lockport, N. Y., Waldron shale, Newsom, Tenn.

Catalogue number, 35475, U. S. National Museum.

Stomatopora dissimilis Vine.

Pl. IV, figs. 15-19.

Stomatopora dissimilis Vine, Quart. Jour. Geol. Soc. London XXXVII, 1881, pp. 615, 616, figs. 1-8; XXXVIII, 1882, p. 50.

Stomatopora recta Ringueberg, Bull. Buffalo Soc. Nat. Hist., V, 1886, p. 20, pl. 2, figs. 15, 15a.

Aulopora sp. Hall Nat. Hist. New York, Pal. II, 1852, pl. 50, figs. 27, 29.

Original description.—Zoarium adnate, branching generally attached to stems of Crinoidea, very rarely to broken shells; branches linear, sometimes wavy and anastomosing. Zoœcia invariably uniserial, and, in the best preserved, very finely ribbed transversely; the oral extremity slightly raised; orifice circular or subcircular. Oœcial cells rather ventricose and strongly ribbed (?). Each normal zoœcium about half a line; average about 6 to 3½ lines.

A series of specimens from the Silurian rocks of various localities in Europe and America shows that the Wenlock shales species described by Vine as *Stomatopora dissimilis* has as

wide a distribution as the accompanying Cyclostomata, *Stomatopora elongata* Vine, and *Berenicea consimilis* (Lonsdale). As indicated in the above synonymy, the American form was figured by Hall in 1852 without a specific designation, and later was figured and described by Ringueberg as *Stomatopora recta*.

The zoarium of *S. dissimilis* is parasitic, other bryozoa, brachiopods, and crinoid columns or plates being usually selected; uniserial, with lateral series branching usually irregularly but sometimes very regularly and at right angles to the main series. Zoœcia subcylindrical or club shaped, about 0.10 mm. in diameter at the proximal end and increasing to 0.35 mm. at the rounded distal portion; an average zoœcium is 1.15 mm. in length with 5 to 6 in 5 mm. Apertures large, subterminal, bounded by a raised rim-like border. Zoœcia marked transversely by fine wrinkles or striations.

The large zoœcia with their transverse striations or wrinkles particularly characterize *S. dissimilis* and serve to distinguish it from all other Paleozoic species of the genus.

Occurrence.—Vine's types are from the Buildwas beds of the Wenlock shales, Shropshire, England. The species occurs also in the Silurian beds on the island of Gotland; in the Rochester shale at Rochester, Lockport, Middleport, Niagara Falls, and other localities in western New York; in the same shale at Grimsby, Ontario; and in the Osgood beds at Osgood, Ind.

Catalogue numbers, 35472, 35473, 44112, 44113, U. S. National Museum.

Genus BERENICEA Lamouroux.

The adnate zoarium of thin, discoid, flabellate or irregular crusts with tubular zoœcia arranged in irregularly alternating lines distinguishes this genus from other members of the *Diastoporidæ*.

BERENICEA CONSIMILIS (Lonsdale).

Pl. V, figs. 1–5.

Aulopora consimilis Lonsdale, in Murchison's Sil. System, pt. 2, 1839, p. 675, pl. 15.
Diastopora (Aulopora) consimilis Vine, British Assoc. Rept., 1881.
Diastopora consimilis Vine, Quart. Jour. Geol. Soc. London, XXXVIII, 1882, p. 58.
Diastoporella consimilis Vine, British Assoc. Rept., Foss. Polyzoa, IV, 1883.
Diastoporella consimilis Vine, Proc. Yorkshire Geol. and Polytech. Soc., IX, 1887, p. 190, pl. 12, figs. 18–20.
——— ——— Hall, Nat. Hist. New York, Pal. II, 1852, p. 173, pl. 40E, figs. 8a, b.
Sagenella elegans Hall, Twenty-eighth Ann. Rept. New York State Mus. (doc. ed.), 1876, pl. 7, figs. 12, 13; ibid. (Mus. ed.), 1879, p. 118 pl. 7, figs. 12, 13.
Sagenella elegans Hall, Eleventh Ann. Rept. Indiana Geol. Nat. Hist., 1882, p. 242, pl. 6, figs. 12, 13.
Sagenella elegans Simpson, Fourteenth Ann. Rept. State Geol. New York for the year 1894, 1897, pl. 20, fig. 4.
Berenicea elegans Nickles and Bassler, Bull. U. S. Geol. Survey No. 173, 1900, p. 181.
Sagenella membranacea Hall, Nat. Hist. New York, Pal. II, 1852, p. 172, pl. 40E, fig. 6a, b.
Berenicea membranacea Nickles and Bassler, Bull. U. S. Geol. Survey No. 173. 1900, p. 181.

A study of many specimens from various Silurian localities in Europe and America has shown that the species first described by Lonsdale as *Aulopora consimilis* is a cosmopolitan form ranging throughout several formations but eminently characteristic of the Silurian rocks as a whole. Lonsdale's description and figures are complete enough for the determination of the form, but the species is more accurately defined in the later work of Vine. A comparison of the types of *Sagenella elegans* and *S. membranacea* with specimens from England and Gotland indicates that all represent the same species. *Sagenella membranacea* is founded upon a worn example from the Rochester shale, while the type of *S. elegans* from the Waldron beds is a normal specimen growing upon a pelecypod.

Lonsdale's original description is as follows:

Aulopora consimilis sp. n., Lons. pl. 15, f. 7, magnified twice. A. incrusting, tubes round, close together, radiated, bifurcated; openings circular, raised; margin thick. This fossil is singularly like *Aulopora compressa* of Goldfuss (Petref., p. 84, Taf. XXXVIII, f. 17), found in the Oolitic series of Germany.

The essential characters, as viewed by the writer, are given in the following description:

Zoarium incrusting foreign bodies, the smooth shells of brachiopods or crinoid plates being usually favored. Growth commencing at a point from which the zoœcia radiate. Zoœcia contiguous, cylindrical, about 1 mm. in length and 0.22 mm. wide. Aperture circular, slightly raised, about 0.20 mm. in diameter. Zoœcia marked by delicate transverse annular striations.

The elongate, sharply defined, transversely lined zoœcia form the important specific character and distinguish this beautiful species from other Paleozoic forms of the genus.

Occurrence.—Wenlock limestone, Dudley, England (Lonsdale); Buildwas beds, Wenlock shales, Shropshire, England; Silurian, island of Gotland; Rochester shale, Rochester, Lockport, and other localities in western New York, and Grimsby, Ontario; Osgood beds, Osgood, Ind.; Waldron beds, Waldron, Ind., and Newsom, Tenn.

Catalogue numbers, 35565, 35474, 44114, 44115, U. S. National Museum.

Family ENTALOPHORIDÆ Reuss.

Genus DIPLOCLEMA Ulrich.

Zoarium ramose, with tubular zoœcia diverging on all sides from a wavy mesial lamina; apertures circular, prominent.

DIPLOCLEMA SPARSUM (Hall).

Pl. V, figs. 6, 7; Pl. XXIII, figs. 4-6.

Trematopora sparsa Hall, Nat. Hist. New York, Pal. II, 1852, p. 155, pl. 40A, figs. 12 a-d.
Diploclema sparsa Ulrich, Geol. Survey Illinois, VIII, 1890, p. 368, pl. 53, fig. 10.
Diploclema sparsa Grabau, Bull. New York State Mus. Nat. Hist., No. 45, 1901, p. 162, fig. 57.

The zoarium of this species is composed of small, subcylindrical ramulets, ovate in cross sections, about 0.5 mm. in width, 0.3 to 0.4 mm. in thickness, and dividing dichotomously at intervals of 10 mm. or more. The zoœcia are thin walled, long, tubular, opening upon the surface with slightly protruding circular apertures, which, when well preserved, are surrounded by a peristome, 0.15 to 0.18 mm. in diameter; four zoœcia in 2 mm. measuring longitudinally; a branch is formed of five or six linear series, adjacent series alternating. Interapertural space smooth or very faintly granulose.

The widely separated rounded apertures and the small branches celluliferous on all sides readily distinguish this neat little species. Small fragments of *Thamniscus dichotomus* Hall might be confused, but the more closely distributed apertures and branches, celluliferous on one side only, distinguish that form superficially, the internal structure of the two being quite different.

Diploclema sparsum has been considered by both Vine and Ulrich to be closely related to *Spiropora regularis* Vine from the Wenlock of England, but a critical comparison of the American species with specimens of the latter received from Mr. Vine shows the two forms to be specifically quite distinct. *Diploclema* (*Spiropora*) *regularis* forms more robust zoaria, the branches averaging almost 1 mm. in diameter, while measuring longitudinally two zoœcia are found in 2 mm. The branches of *Diploclema sparsum*, as mentioned above, are 0.5 mm. in diameter and have four zoœcia in 2 mm.

Occurrence.—Rochester shale, Lockport, Rochester, Niagara Falls, and other localities in New York; Grimsby and Hamilton, Ontario.

Catalogue numbers, 35734, 44071, U. S. National Museum.

DIPLOCLEMA SPARSUM var. ARGUTUM n. var.

Pl. V, figs. 8, 9.

This subordinate name is proposed for the reception of a number of specimens which differ from *Diploclema sparsum* in the following respects: First, the zoarium is more robust, cylindrical, and bears four or five ranges of zoœcia upon each side, while the typical form

of the species is of slender ramulets, showing only two or three rows of zoœcia. Second, specimens of the variety very commonly exhibit a distinct pore in front of each zoœcial aperture, while in the species itself this pore is rarely seen.

Vine probably had this variety in mind when he identified his *Spiropora regularis* [a] as occurring at Lockport, N. Y. However, *D. sparsum* and variety *argutum* differ decidedly from *Spiropora regularis* in that the latter has considerably larger zoœcia.

Occurrence.—Not uncommon at Lockport, N. Y.

Catalogue number, 35557, U. S. National Museum.

Genus MITOCLEMA Ulrich.

Mitoclema Ulrich, Jour. Cincinnati Soc. Nat. Hist., V, 1882, p. 150.
Compare *Clonopora* Hall, Nat. Hist. New York, Pal. VI, 1886, p. 25, and *Entalophora* Lamouroux Exp. meth. des genres de pol., 1821, p. 81.

Ramose Cyclostomata composed of long tubular zoœcia diverging from an imaginary axis in all directions to the surface, where they bend outward, and often become free and much produced. Apertures circular, usually arranged in regular transverse or subspiral series.

As to the advisability of referring the following new species to the Ordovician genus *Mitoclema* or to the very similar *Clonopora*, founded upon Devonian forms, the writer is still in doubt. Both of these genera may eventually prove to be synonyms of the recent genus *Entalophora*. Undoubted species of *Stomatopora* and *Berenicea* are found in most of the formations from Ordovician to recent times, and it is not at all unlikely that *Entalophora* will also prove to be one of these long-enduring simple cyclostomatous generic types.

MITOCLEMA SARLEI n. sp.

Pl. V, figs. 10–12.

Zoarium of very small, slender, ramose, cylindrical branches 0.35 to 0.45 mm. in diameter. Zoœcia long, tubular, with circular apertures about 0.1 mm. in diameter projecting upward and outward from the body of the stem. Measuring longitudinally, there are about three zoœcia in 2 mm. The space between the zoœcial apertures is generally smooth, but sometimes exhibits faint transverse wrinkles.

All of the specimens of this species so far observed are attached to slabs, but these indicate that each branchlet bears four longitudinal rows of zoœcia whose apertures are so placed that a somewhat regular ascending spiral series is the result. In the number of zoœcia, *M. sarlei* is different from all of the described species of the genus, no other form having so few rows of apertures.

This neat species is named in honor of Mr. Clifton J. Sarle, of Rochester, N. Y., who kindly collected a considerable number of bryozoa at that place for the writer.

Occurrence.—Common on the thin slabs of limestone in the Rochester shale at Rochester, N. Y.

Catalogue number, 35460, U. S. National Museum.

Family CERAMOPORIDÆ Ulrich.

Genus CERAMOPORA Hall.

In 1890 Ulrich [b] restricted the genus *Ceramopora* to the type species, *C. imbricata*, making the peculiar, spongy, basal tissue in connection with the indefinite wall structure, large openings in the walls, and absence of diaphragms, the characteristic features. Since that time other undoubted species of *Ceramopora* have been discovered which show that the more important characters of the genus are the indefinite wall structure of both zoœcia and mesopores and the large openings in the walls allowing neighboring tubes to communicate

[a] Quart. Jour. Geol. Soc. London, XXVIII, 1882, p. 56, figs. 4–6.
[b] Geol. Survey Illinois, VIII, 1890, p. 493.

with each other. The growth may be free, discoid, lamellate, massive, or incrusting, the spongy basal layer may be absent, and the diaphragm may or may not occur.

The various species of *Ceramopora* may be distinguished by external features that are more readily perceived by a study of actual examples than by description. This peculiar aspect of the surface seems to be the result of the open mesopores, together with the irregularity of both zoœcia and mesopores, and the prominent lunaria.

CERAMOPORA IMBRICATA Hall.

Pl. VI, figs. 1-10.

Ceramopora imbricata Hall, Nat. Hist. New York, Pal. II, 1852, p. 169, pl. 40E, figs. 1a-i.
Ceramopora imbricata Ulrich, Geol. Survey Illinois, VIII, 1890, p. 463, pl. 39, figs. 1-1b.
Ceramopora imbricata Grabau, Bull. New York State Mus., No. 45, 1901, p. 163, fig. 58.

Ulrich (op. cit.), has brought out the salient features of this species in the following description:

Zoarium free, discoidal, plano-convex, under side sometimes slightly concave, from 5 to 15 mm. in diameter; thickness at center seldom exceeding 4 mm., usually only about 2 or 3 mm. No epitheca on the lower side. Lower or basal portion of zoarium composed of a cellular or spongy tissue, from which the zoœcia grow out more or less obliquely. At the depressed center of the zoarium the zoœcia are nearly direct, but toward the margin they gradually become more and more oblique. Zoœcia compressed tubular, being long oval in transverse section. Apertures imbricating, arranged in multiplying radial series, all facing away from the center, triangular or oval in outline, 0.5 to 0.7 mm. in their long diameter. Intercellular space occupied by irregularly flexuous rows of mesopores, variously shaped, short. Zoœcial tubes and mesopores communicate rather freely by means of perforations in the walls. Besides, the walls have that granular structure which is supposed to indicate originally minutely porous condition. Lunarium small, yet well marked. No diaphragms developed.

To the above may be added that growth in this species commences parasitically on small foreign objects, crinoid stems being usually selected. As new tubes are added, the free disk-shaped zoarium results by growth beyond the object originally incrusted. The latter in some specimens is still preserved but more frequently is represented only by the cicatrix of attachment. Measuring along one of the rows radiating from a macula, three zoœcia are usually found in a distance of 2 mm. A young or even average specimen is made up of a central macula from which the zoœcia radiate toward the growing edge, but larger examples exhibit several maculæ.

The discoid growth, spongy basal layer, and the conspicuous maculæ with the radiating, oblique, imbricated zoœcia are characters by which this species can readily be distinguished not only from all associated bryozoa but also from other species of *Ceramopora*. *Mesotrypa nummiformis* has a similar discoid method of growth but the much smaller zoœcia, absence of a lunarium and the epithecated under surface are external characters which will distinguish it at once.

Occurrence.—Not uncommon in the Rochester shale at Rochester, Lewiston, and Lockport, N. Y., and in the same formation at Thorold and Grimsby, Ontario. Rather abundant in the Osgood beds at Osgood, Ind.

Catalogue numbers, 35464, 35465, 35466, 43280, U. S. National Museum.

CERAMOPORA NIAGARENSIS n. sp.

Pl. VI. figs. 11-13.

Zoarium explanate, at first attached to foreign bodies, then becoming free and provided with an epitheca; by the superposition of several layers, rounded or irregular lumps 2 to 4 cm. in diameter may result. Thickness of the individual layers of a zoarium varying from 1 to 2 mm. Celluliferous surface rough on account of the prominent lunaria and exhibiting well-marked maculæ composed of open mesopores. Zoœcial apertures nearly direct, ovate, three in 2 mm., rather regularly arranged about the maculæ. Lunarium strongly elevated and well developed, occupying the posterior half of the zoœcial aperture. Mesopores, as usual in the genus, open at the surface and variable in size, shape, and number, but commonly about two to a zoœcium.

Vertical sections show that the walls of the tubes are at first thin but thicken in the mature region where the characteristic indefinite structure and the pore-like openings are well exhibited. Diaphragms wanting. In tangential sections the large, well-defined lunarium projecting in the zoœcial cavity is the special feature, while the ovate zoœcia, irregular mesopores, and indefinite wall structure are also well brought out.

With the exception of *Ceramopora imbricata* and *C. labecula*, all of the Niagaran species described by Hall under *Ceramopora* appear to be fistuliporoids. The free zoarium of *C. imbricata* and the small attached disks of *C. labecula* are differences in growth that will readily distinguish them from the species here described. The open mesopores, strongly arched, prominent lunaria, and radiating zoœcia present an appearance so different from associated bryozoa that this is not likely to be confused with any other species.

Occurrence.—Not uncommon in the Rochester shale at Rochester and Lockport, N. Y., and at Grimsby, Ontario. Rare in the Osgood beds at Osgood, Ind.

Catalogue numbers, 35735, 35736, U. S. National Museum.

Genus CERAMOPORELLA Ulrich.

Zoarium of incrusting layers, which by superposition may form masses; zoœcia short, tubular, with thin walls; apertures oval, oblique, the lunarium forming a hood; mesopores abundant, often completely encircling the zoœcia.

Hitherto this generic type has been supposed to have been restricted to the Ordovician, but the following species possess all of the features of the genus.

CERAMOPORELLA ORBICULATA (Ringueberg).

Pl. IX, figs. 12–15.

Ceramopora orbiculata Ringueberg, Bull. Buffalo Soc. Nat. Hist., V. 1886, p. 19, pl. 2, figs. 13, 13a.

Original description.—Habit parasitic, small, flat, discoid, central portion slightly elevated, from which point the lip of a lamination extends outward and curving backward to the outer border of the disk, showing that it increased by growing upon itself in spiral laminæ, and gives no evidence of any further lateral extension. Cells closely arranged, directed outward from the center at an oblique angle tending in the direction of the spiral growth, and have a prominent nariform calice over the upper side. Outer border of disk striate.

From the upper part of the shale.

The specimen described and figured by Ringueberg proved upon examination to be the young of a *Ceramoporella*, at first supposed by the writer to be a new species. These small incrusting disks are not uncommon in the shales, and a careful study of their zoœcial characters will usually determine their relations to older specimens. Most of the various ceramoporoids and fistuliporoids commence their growth as small incrusting disks which appear quite distinct and often seem to bear no relation to the mature form. The following are the characters of Ringueberg's species as observed in mature specimens.

Zoarium of thin parasitic incrustations seldom exceeding 0.40 mm. in thickness. Surface smooth, exhibiting at intervals of 2 to 2.5 mm. small, solid maculæ from which the zoœcia radiate. Zoœcial apertures round to oval, placed at the bottom of vestibular areas formed by thin coalescing ridges occupying the interspaces. About 10 zoœcia in 2 mm. Lunaria crescentic, small but prominent, occupying about one-sixth of the vestibular perimeter, and with the ends projecting slightly into the zoœcial cavity. The vestibular areas are polygonal in outline, usually quadrangular when the radiate arrangement is pronounced, and bear the lunaria on the angle nearest a macula.

A perfect specimen of this neat little species with its radiating zoœcia and prominent lunaria forms one of the prettiest bryozoans of this formation. The extremely small zoœcia, polygonal outline of the vestibules, small crescentic lunarium, and the radiate, almost diagrammatic arrangement of the zoœcia about the maculæ are characters which will cause this form to be easily identified.

Occurrence.—Not uncommon in the Rochester shale at Lockport, Rochester, Lewiston, and Niagara Falls, N. Y., and at Grimsby, Ontario.

Catalogue numbers, 35478, 35479, 35737, U. S. National Museum.

CERAMOPORELLA IRREGULARIS, n. sp.

Pl. IX, figs. 7–9.

Zoarium incrusting, the type specimen growing around a crinoid column and consisting of two superposed layers of zoœcia varying from one-third to 1 mm. in thickness. Zoœcial apertures direct, arranged radially about the maculæ, which are small and inconspicuous and consist mainly of mesopores. Zoœcia usually angular, 4 to 5 in 2 mm., with thin walls, the posterior one-fourth exhibiting the sharply elevated lunarium which is less overarching and more erect than usual. Mesopores rather numerous, angular, thin-walled, irregular in size and shape.

Vertical sections show that the zoœcia have a small axial region and a large peripheral zone. The walls exhibit the indefinite hazy structure transversely marked that is characteristic of the family as a whole and is known as ceramoporoid structure. A single diaphragm is inserted in some of the zoœcial tubes. Tangential sections bring out the lunarium and the irregular zoœcia and mesopores particularly.

This interesting species is closely related to the Cincinnatian form, *Ceramoporella distincta* Ulrich, but differs in having a larger and more prominent lunarium, and more irregular zoœcia and mesopores. Care must be taken to separate it from the associated *Ceramopora niagarensis*, which it resembles externally in some respects. However, upon examination with the lens, the angular, thin-walled, direct zoœcia and mesopores of the *Ceramoporella* contrast strongly with the thick-walled, oblique zoœcia and long-drawn-out lunarium of the *Ceramopora*.

Occurrence.—Rather rare in the Rochester shale at Lockport, N. Y.

Catalogue number, 35480, U. S. National Museum.

Genus CŒLOCLEMA Ulrich.

The Niagaran rocks of New York and Indiana contain several new species of ceramoporoids which in the present state of knowledge can only be referred to the Ordovician genus *Cœloclema*. These Silurian forms have several features in common which, with a careful study of this group, will probably cause them to be assigned elsewhere. *Cœloclema* was established for ceramoporoids having zoœcia as in *Ceramoporella*, but differing in that the zoarium formed hollow branches lined internally with a striated epitheca.

CŒLOCLEMA CAVERNOSA n. sp.

Pl. XXIII, figs. 10–13.

Zoarium of hollow branches varying in diameter from 2 to 5 mm., lined internally with a striated epitheca; thickness of zoarium 0.5 mm. or less. Surface without monticules but rough on account of the projecting lunaria. Maculæ small, solid, not a prominent feature. Zoœcia arranged in regularly ascending diagonally intersecting rows, measuring along one of the rows, 5 zoœcia in 2 mm. Posterior wall of zoœcia raised, long drawn out, and overarching the aperture, forming the prominent lunarium. Internal structure as in *Ceramoporella* and related genera of the Ceramoporidæ.

The only associated hollow-branched species, *Fistulipora tuberculosa* (Hall), may readily be separated from the form just described by its very small, strongly bilobed zoœcia and different internal structure.

Occurrence.—Half a dozen specimens were found in the Rochester shale at Lockport, N. Y.; rare in the Osgood beds at Osgood, Ind.

Catalogue number, 35471, U. S. National Museum.

Genus SPATIOPORA Ulrich.

Zoarium forming thin crusts, usually on *Orthoceras;* zoœcia very short, nearly direct; apertures irregular, with blunt spines at the angles, no lunarium developed; elevated, elongated maculæ usually a conspicuous feature.

The following species agrees in all respects generically and is otherwise closely related to typical Cincinnatian forms, such as *S. lineata* Ulrich.

SPATIOPORA MACULATA (Hall).

Pl. VIII, figs. 1–4; Pl. IX, figs. 10, 11.

——— ——— Hall, Nat. Hist. New York, Pal. II, 1852, pl. 40E, figs. 7a, b.
Paleschara maculata Hall, Twenty-eighth Ann. Rept. New York State Mus. (doc. ed.), 1876, pl. 8, figs. 9, 10; ibid. (Mus. ed.), 1879, p. 121, pl. 8, figs. 9–13.
Paleschara maculata Hall, Eleventh Ann. Rept. Indiana Geol. Nat. Hist., 1882, p. 246, pl. 7, figs. 9–13.
Leptotrypa maculata Ulrich, Jour. Cincinnati Soc. Nat. Hist., VI, 1883, p. 158.
Paleschara? aspera Hall, Twenty-eighth Ann. Rept. New York State Mus. (doc. ed.), 1876, pl. 8, figs. 11–13.

Several specimens were found in the Rochester shale agreeing in all respects with typical examples of the species from the Waldron shale described by Hall as *Paleschara maculata*. A study of the internal and external features of these in connection with the Waldron specimens shows that Hall's species is a *Spatiopora* with close relation to the Lorraine forms *S. maculosa* and *S. lineata* Ulrich.[a] The Niagaran form differs from both, however, in having considerably larger zoœcia. Hall has given good figures of the species and these, with a drawing of the surface and internal structure, are reproduced on Pls. VIII and IX. Old examples show the well-marked maculæ which suggested the specific name, but in young specimens the maculæ are much less conspicuous, the principal feature being the well-marked lineate arrangement of the zoœcia.

The zoarium of *S. maculata* consists of exceedingly thin expansions, generally incrusting the shells of *Platystoma*, although smooth brachiopods are sometimes selected. Zoœcia elongate, polygonal, and arranged lineately in young examples, measuring longitudinally 4 to 5 in 2 mm. and 7 in the same space transversely; hexagonal, and the lineate arrangement less pronounced in older specimens where 6 zoœcia may be counted in 2 mm. With age small spines develop until in the most mature specimens the walls inclosing a zoœcium bear from 12 to 15 of these blunt acanthopore-like structures generally found in *Spatiopora*.

Occurrence.—Waldron shale, Waldron, Ind., and Newsom, Tenn.; Rochester shale, Lockport, N. Y., and Grimsby, Ontario.

Catalogue numbers, 35461, 35462, 35463, U. S. National Museum.

Family FISTULIPORIDÆ Ulrich.

Genus FISTULIPORA McCoy.

Zoarium massive, lamellate, ramose, parasitic or free; under surface with a wrinkled epitheca; zoœcia cylindrical or somewhat compressed, direct or almost so, thin walled until near the surface, and provided usually with a few diaphragms, and encircled by one or more series of vesicles; apertures subradially arranged about the maculæ, ovoid, subtriangular or pyriform, the lunarium more or less strongly developed; surface between apertures smooth or granular.

FISTULIPORA LAMINATA (Hall).

Pl. VII, figs. 4–6; Pl. VIII, figs. 9, 10.

Callopora laminata Hall, Nat. Hist. New York, Pal. II, 1852, p. 146, pl. 40, figs. 3a–e.
Leioclema? laminatum Ulrich, Geol. Survey Illinois, VIII, 1890, pp. 416, 425.
Lioclema (*?Nicholsonella*) *laminatum* Nickles and Bassler, Bull. U. S. Geol. Survey No. 173, 1900, p. 304.

Professor Hall distinguished this species from the associated *Callopora* (now *Nicholsonella*) *florida* by the much smaller cell apertures, but an examination of his figured type shows that it is a specimen of a well-marked species of *Fistulipora* differing from associated forms of this genus in its laminar growth, small zoœcia, and well-developed lunarium. The zoœcia are usually trilobate in outline because of the well-developed lunarium occupying about one-third of the circumference and indenting the cavity. Five to six zoœcia may be counted in 2 mm., while the diameter of an individual zoœcium is usually 0.20 mm. In width the interzoœcial spaces average the diameter of the zoœcia and are occupied by vesicles, which

[a] Jour. Cincinnati Soc. Nat. Hist., VI, 1883, p. 167, pl. 7.

become closely arranged as the surface is approached. At the surface the vesicles are replaced by a dense calcareous deposit, which gives the solid aspect to the maculæ and interzoœcial spaces.

Compared with *Fistulipora lockportensis*, which also has a laminate growth, *F. laminata* may be readily distinguished by its much smaller zoœcia and strong lunaria. The other associated species of the genus differ so much in growth and other characters that they should not be confused.

Occurrence.—Rather uncommon in the Rochester shale at Lockport and Rochester, N. Y., and at Grimsby, Ontario.

Catalogue numbers, 35467, 35468, 35738, U. S. National Museum.

FISTULIPORA TUBERCULOSA (Hall).

Pl. VII, figs. 11-15; Pl. VIII, figs. 7, 8; Pl. XXIII, fig. 14.

Rhinopora tuberculosa Hall, Nat. Hist. New York, Pal. II, 1852, p. 170, pl. 40E, figs. 4a-c.
Rhinopora tuberculosa Grabau, Bull. New York State Mus., No. 45, 1901, p. 175, fig. 77.

The type specimen of *Rhinopora tuberculosa* was found by the writer to be a somewhat crushed example of a *Fistulipora* having a utricular method of growth and occurring in comparative abundance in the shales. Other more perfect specimens show the following diagnostic characters:

Zoarium consisting of irregular hollow branches, with a wrinkled epitheca on the inside, averaging 5 mm. in diameter when not crushed; thickness of zoarium ranging from 0.5 to 1.0 mm. Surface exhibiting at intervals averaging 3 mm. subsolid, slightly elevated monticules from which the zoœcia radiate in distinct lines. Apertures small, elongate oval, 0.20 mm. in their longer diameter and 0.10 mm. in the shorter, 7 to 8 in 2 mm. Lunarium very prominent and overarching more than one-half the aperture. Maculæ and zoœcial interspaces occupied by angular vesicles.

The utricular form of growth, small zoœcia, and prominent lunaria are characteristic of this species and cause it to be easily distinguished from associated forms of *Fistulipora*.

Although the individual branches of this species are small, an entire zoarium is often of considerable size, one specimen in the collection of the United States National Museum being 13 cm. high and 15 cm. in breadth.

Occurrence.—Not uncommon at Lockport and other localities in western New York; Grimsby, Ontario.

Catalogue numbers, 35486, 35487, U S. National Museum.

FISTULIPORA LOCKPORTENSIS n. sp.

Pl. VII, figs. 1-3.

Zoarium forming irregular lumps made up of superposed layers 10 cm. in diameter, but more often consisting of epithecated laminar expansions 5 cm. wide and composed of layers each 1½ to 3 cm. thick. Surface rough on account of the large zoœcial apertures and exhibiting rather irregular and inconspicuous rounded monticules. The latter may be distinguished most easily by the presence of maculæ, from which the zoœcia radiate. Zoœcia in the immediate vicinity of the maculæ slightly larger and with more prominent lunaria; 4 zoœcia in 2 mm. Apertures rounded and with a distinctly elevated peristome; the posterior half more elevated and forming the lunaria, which is usually inconspicuous and seldom indents the zoœcial cavity. Maculæ and interzoœcial spaces occupied as usual in the genus by vesicles. Diaphragms usually wanting in the zoœcial tubes, although occasionally a few thin delicate ones may be developed.

The laminar or irregular growth, large zoœcia, and inconspicuous lunaria are particularly characteristic of this species. The associated *F. laminata* also has an explanate method of growth, but its much smaller zoœcia and well-developed lunaria will serve as a ready means of distinction.

Occurrence.—Not uncommon at Lockport and Rochester, N. Y.

Catalogue numbers, 35488, 35489, U. S. National Museum.

FISTULIPORA CRUSTULA n. sp. or new name.

Pl. VII, figs. 7–10; Pl. VIII, figs. 16, 17; Pl. XXIII, fig. 15.

Compare *Ceramopora incrustans* Hall, Nat. Hist. New York, Pal. II, 1852, p. 169, pl. 40E, figs. 2a–d; Grabau, Bull. New York State Mus., No. 45, 1901, p. 163, fig. 59.

Zoarium incrusting, usually consisting of a single layer and this seldom more than 1 mm. in thickness. Surface marked with conspicuous maculæ, which are sometimes elevated, but more often depressed below the plane of the zoœcial aperture. Measured from center to center the maculæ are on an average 3.5 mm. apart. Zoœcial apertures 6 to 7 in 2 mm., arranged in more or less regular series radiating from the maculæ. When the zoarium is in the youthful condition or the surface is worn, the zoœcial apertures are somewhat rounded or trilobate and are separated by mesopores; but in the perfect mature stage the zoœcial interspaces are occupied by walls or ridges, which, coalescing, form a polygonal area inclosing the aperture. Lunaria small, but well developed, appearing as a crescentic elevation at one of the angles and projecting slightly into the zoœcial cavity.

In thin sections the zoœcia are seen to be at first prostrate and then to bend almost at right angles direct to the surface. Interzoœcial spaces occupied by a considerable number of large angular vesicles, the maculæ also being simply clusters of vesicles.

The incrusting growth, well-marked maculæ, size of zoœcia, small sharply defined crescentic lunaria, and the inclusion of the apertures in polygonal areas are particularly characteristic of this species. In all probability the latter feature would cause this form to be regarded as a species of *Selenopora* Hall,[a] the distinguishing feature of this genus being the situation of the apertures in a polygonal area formed by coalescing ridges. Inasmuch as this peculiarity has been observed in other genera, notably *Ceramoporella*, the writer has deferred the reference of this and similar forms to *Selenopora* until a thorough study of the entire group can be undertaken.

The types of *Ceramopora incrustans* could not be found, but, judging from Hall's figures, that species and the one here described are apparently the same. The new name *Fistulipora crustula* is here proposed in the event of the two proving to be the same, the specific name *incrustans* having been applied to a European Carboniferous *Fistulipora*, first described by Phillips as *Calamopora incrustans*. Should Hall's types be found and differ from the specimens of *F. crustula* here described, both names will stand, unless of course *Ceramopora incrustans* proves to be a true *Fistulipora*, when another new name will become necessary.

Occurrence.—Abundant in the Rochester shale at Lockport, Niagara Gorge, and Rochester, N. Y., and at Grimsby, Ontario.

Catalogue numbers, 35481, 35482, 35483, 35556, U. S. National Museum.

Genus CHILOTRYPA Ulrich.

Small ramose *Fistuliporidæ* with a narrow irregularly contracting and expanding axial tube.

CHILOTRYPA OSTIOLATA (Hall).

Pl. VIII, figs. 11–15; Pl. IX, figs. 1–4.

Trematopora ostiolata Hall, Nat. Hist. New York, Pal. II, 1852, p. 152, pl. 40A, figs. 5a–m.
Chilotrypa ostiolata Ulrich, Jour. Cincinnati Soc. Nat. Hist., VII, 1884, pl. 3, figs. 7, 7a.
Chilotrypa ostiolata Grabau, Bull. New York State Mus., No. 45, 1901, p. 164, fig 60.
Trematopora coalescens Hall, Nat. Hist. New York, Pal. II, 1852, p. 150, pl. 40A, figs. 2a, b.
Chilotrypa? coalescens Nickles and Bassler, Bull. U. S. Geol. Survey No. 173, p. 207.

This is probably the most abundant bryozoan of the Rochester shale, fragments being found in great numbers wherever the bryozoan beds are exposed. Often several inches or more of strata are composed almost entirely of fragments of this species. Hall and Ulrich have amply illustrated and described the species, but for the sake of completeness, and in order to give measurements, the following description is offered:

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[a] Nat. Hist. New York, Pal. VI, 1889, p. xvii.

Zoarium of small ramose cylindrical stems dividing irregularly at somewhat variable distances and averaging 2 or 3 mm. in diameter. Surface smooth but exhibiting at regular intervals small, solid, slightly depressed maculæ, around which the zoœcia are somewhat larger than usual and radially arranged. Zoœcia rounded to oval, 6 in 2 mm. measuring in the direction of their greater length, 0.20 to 0.25 mm. in diameter. Zoœcial margin elevated highest posteriorly, where it forms the lunarium, but gradually diminishing toward the anterior end. Interzoœcial spaces occupied by vesicles which become filled by a dense deposit of tissue at the surface. Axial tube narrow, about 0.60 mm. wide at the most expanded portion and becoming reduced to 0.10 mm. where least expanded.

Through the kindness of Professor Whitfield the writer was enabled to examine the types of both *Trematopora ostiolata* and *T. coalescens*, with the result as indicated in the above synonymy. The type of the latter is a broad, frequently dividing branch differing otherwise in no respect from typical specimens of the former. In the writer's opinion, this species is merely the basal portion of *Chilotrypa ostiolata*. In this event the specific name *coalescens* should have precedence as its description precedes that of *Trematopora ostiolata*. However, the latter name has become so grafted into the literature that it seems unwise to change it for the hitherto practically unknown form, *T. coalescens*.

Occurrence.—Very abundant at Lockport and at all the other Rochester shale localities in New York and Canada. Also common in the Osgood beds at Osgood, Ind.

Catalogue numbers, 35492, 44117, 35490, 35491, U. S. National Museum.

Genus MEEKOPORA Ulrich.

Zoarium of broad, bifoliate fronds, celluliferous on both faces; zoœcia with numerous diaphragms, oblique apertures, and not very prominent lunaria. The following species is the earliest known of the genus:

MEEKOPORA FOLIACEA (Hall).

Pl. VIII, figs. 5, 6; Pl. IX, figs. 5, 6.

Ceramopora foliacea Hall, Nat. Hist. New York, Pal. II, 1852, p. 170, pl. 40E, figs. 3a–c.
Meekopora foliacea Nickles and Bassler, Bull. U. S. Geol. Survey No. 173, 1900, p. 312.

Zoarium bifoliate, growing into thin, flat expansions sometimes as much as 40 mm. in length and breadth; thickness usually 1 mm. Surface smooth but showing conspicuous narrow, solid, elongate maculæ pointed distally and dividing, each of the divisions pointing and narrowing in the direction of growth. Apertures oblique, subcircular, 0.20 to 0.25 mm. in longer diameter and 0.15 to 0.20 mm. in shorter, directed toward the growing edge of the zoarium and arranged in rather regular, diagonally intersecting rows. Proximal part of the zoœcium slightly raised, forming the lunarium; interzoœcial spaces solid.

In vertical sections the zoœcia are seen to be at first prostrate along the axis separating the two layers and then to bend abruptly toward the surface. The interzoœcial space is here seen to be filled with vesicles which decrease in size and increase in number as the surface is approached. At and just below the surface the vesicles are obscured or replaced by a dense calcareous tissue which gives the solid aspect of the interzoœcial spaces externally.

The bifoliate growth of this form distinguishes it from all associated fistuliporoids, while the other bifoliate bryozoa are so different otherwise that specific mention of them is not necessary. Other easily recognized characters are the elongate, branched maculæ, the zoœcia with lunaria pointed distally, and the solid interzoœcial spaces. *Meekopora foliacea* is the earliest known species of the genus, and, as would be expected, has not yet developed the typical generic characters.

Whitfield and Hovey [a] in their catalogue of types and figured specimens in the American Museum of Natural History have regarded Hall's type of *Ceramopora foliacea* as identical with *Lichenalia concentrica*. From a personal examination of the types of the two

[a] Bull. Am. Mus. Nat. Hist., vol. 11, pt. 2, 1899, pp. 104, 105.

species in question, the writer is certain that this is an error. The type of the former species is bifoliate and exhibits all the characters of the specimens here described and figured as *Meekopora foliacea*, while the types of *Lichenalia concentrica* are circular, unilaminate expansions with totally different external and internal features. Comparison of the figures of the two species given on the plates of the present work will show how little allied these two forms really are.

Occurrence.—A rather abundant fossil in the Rochester shale at Lockport, Rochester, and other localities in New York, and at Grimsby, Ontario.

Catalogue numbers, 35484, 44116, U. S. National Museum.

Order TREPOSTOMATA Ulrich.

This order, which comprises the "monticuliporoids," is fairly well represented specifically in the Rochester shale. Species forming large zoaria, such as are abundant in the Mohawkian and Cincinnatian groups, seldom occur, the majority of the forms appearing dwarfed or of the small ramose type. Of the number of species so far found, Hall has described twelve, and Ulrich, Ringueberg, and Foerste one each. The remaining are here regarded as new.

Family MONTICULIPORIDÆ Nicholson (emend. Ulrich).

Genus ORBIGNYELLA Ulrich and Bassler.

Orbignyella Ulrich and Bassler, Smithsonian Miscell. Coll. (Quart. issue), XLVII, 1904, p. 18.

This genus was recently proposed by Mr. Ulrich and the writer for the reception of those species which differed from true *Monticulipora* in having curved diaphragms instead of cystiphragms, in wanting the peculiar irregularly granulose wall structure of that genus and in possessing true acanthopores.

ORBIGNYELLA EXPANSA (Ringueberg).

Pl. X, figs. 5–8.

Chætetes expansus Ringueberg, Bull. Buffalo Soc. Nat. Hist., V. 1886, p. 20, pl. 2, fig. 17.

Original description.—Corallum spreading in an irregular lamina. Cells sharply angulate, of various shapes from quadrangular to hexagonal; partitions thin; margins of partitions smooth or slightly crenate; dentate at their juncture. The oblique rhomboid cell is seen wherever a regular growth took place. Length of cells, from one-sixteenth to three-sixteenths of an inch; about ten cells to one-eighth of an inch.

Through the kindness of Doctor Ringueberg the writer was enabled to compare specimens with the type of the species. The following description is based upon the type and other well-preserved specimens and thin sections:

Zoarium of lamellate, epithecated expansions composed of one or more layers, each of which is usually several millimeters in thickness. Surface smooth, but exhibiting conspicuous clusters composed of zoœcia attaining a diameter one and one-half times as great as that of the intermacular zoœcia. Zoœcia polygonal, thin walled, 4 in 2 mm., counting from the center of a macula, or 6 of the ordinary ones in the same space; when well preserved, showing minute granulations along the walls and small acanthopores usually at the angles. Mesopores wanting. Zoœcial tubes thin walled in the short axial region, slightly thickened in the peripheral, where they contain a rather crowded series of curved diaphragms, three usually occurring in the distance of a tube diameter.

This species resembles *O. lamellosa* (Ulrich) of the Richmond of Illinois in several respects, but the smaller zoœcia of the latter (8 in 2 mm.) distinguish it at once. All of the associated lamellate forms are so different that comparison is not necessary.

Occurrence.—Uncommon at Lockport, Niagara Gorge, and Rochester, N. Y., and at Grimsby, Ontario.

Catalogue numbers, 35540, 35541, U. S. National Museum.

ORBIGNYELLA MAGNOPORA n. sp.

Pl. X, figs. 9–12.

This species resembles *O. expansa* in mode of growth, consisting of an explanate expansion composed of one or more layers of zoœcia. It is distinguished even with the naked eye by the unusually large, thin-walled zoœcia, of which there are 3 to 4 of the intermacular zoœcia in 2 mm., while *O. expansa*, although a large-celled species, has thicker walls and 6 zoœcia in the same space. The surface is smooth and the maculæ are sometimes detected with difficulty, the zoœcia being usually quite uniform in size. Walls thin; acanthopores and mesopores wanting. Diaphragms curved and developed at intervals averaging their own diameter apart.

The large zoœcia will distinguish this from all other species of the genus, as well as from associated bryozoa.

Occurrence.—The types are from Grimsby, Ontario, but the species has also been found at Lockport and Rochester, N. Y.

Catalogue numbers, 35537, 35538, 35539, U. S. National Museum.

Genus MESOTRYPA Ulrich.

Species of this genus are readily recognized by the discoid, generally free zoarium, with the zoœcial tubes crossed by curved diaphragms, and mesopores abundantly developed and closely tabulated. The following is the only species known from strata younger than the Ordovician:

MESOTRYPA NUMMIFORMIS (Hall).

Pl. X, figs. 1–4.

Callopora nummiformis Hall, Nat. Hist. New York, Pal. II, 1852 p. 148, pl. 40, figs. 5, a, b.
Calloporella? nummiformis Ulrich, Geol. Survey Illinois, VIII, 1890, p. 416.
Diplotrypa milleri Ulrich, Jour. Cincinnati Soc. Nat. Hist., V, 1882, p. 245, pl. 11, figs. 2–2c.
Mesotrypa milleri Nickles and Bassler, Bull. U. S. Geol. Survey No. 173, 1900, p. 312.

Zoarium discoid, about 10 mm. in diameter and 3 mm. thick; base slightly concave, covered with a concentrically wrinkled epitheca; celluliferous side convex, smooth, with maculæ composed of larger zoœcia and more numerous mesopores distributed at intervals of usually 3 mm., but not conspicuous. Zoœcial apertures, according to the number of mesopores, polygonal or subcircular in outline; 6 to 7 in 2 mm. Zoœcial tubes crossed by curved diaphragms, irregular in distribution, varying from one to four in a tube diameter. Mesopores closely tabulated, numerous in the younger part of the zoarium, and often closing up as the surface is approached. Acanthopores apparently not present.

A comparison of the type specimens of the Rochester shale form, *Callopora nummiformis* Hall, with those of *Mesotrypa milleri* (Ulrich) from the corresponding horizon at Osgood, Ind., shows that both are founded upon the same species. Among the associated forms, *Orbignyella expansa* (Ringueberg) has curved diaphragms, but the explanate growth, absence of mesopores, and larger zoœcia readily distinguish it. The only associated discoid species, *Ceramopora imbricata* Hall, is otherwise so distinct that there is little danger of confusing the two.

Occurrence.—Rather uncommon in the Rochester shale at Lockport, Rochester, and other localities in New York, and at Grimsby and Thorold, Ontario. More abundant in the Osgood beds at Osgood, Ind., where Ulrich's types were obtained.

Catalogue numbers, 35542, 35543, 35544, U. S. National Museum.

Family HETEROTRYPIDÆ Ulrich.

Genus STIGMATELLA Ulrich and Bassler.

Hitherto this genus has been supposed to be represented only in the Ordovician, and therefore the discovery of a Silurian species is not without interest. The zoarium is extremely variable, ranging from incrusting to massive and ramose, although each particular method of growth is constant for a species. The particular generic character, however,

other than the heterotrypoid wall structure, is the development of the acanthopores in narrow zones, which occur intermittently in the zoarium. The following species exhibits this character fairly well, although not so markedly as in some of the Ordovician forms.

STIGMATELLA GLOBATA n. sp.

Pl. XIV, figs. 6–9.

Zoarium of rounded masses, globular where growth occurred about a small, short object, and elongate when the zoœcia covered a ramose bryozoan or a similar long, narrow body; the variation in length of the longer diameter in the specimens studied ranging from 10 mm. to 20 mm. Zoœcia polygonal, 7 in 2 mm., thin walled, generally in contact. Mesopores few, averaging one to a zoœcium. Acanthopores small and moderately numerous when one of the zones is cut by thin sections, but otherwise practically wanting. Diaphragms few in both zoœcia and mesopores.

The most noticeable feature in vertical sections is the development of acanthopores in zones averaging 0.35 mm. in length and occurring at intervals of 1 mm. A zoarium of some size is therefore made up of a number of such intermittent zones.

The massive zoarium, thin-walled polygonal zoœcia, and the occurrence of the acanthopores in zones will serve to distinguish this species, although care must be taken not to confound it with the similar zoaria of *Diplotrypa walkeri* and *Lioclema globulare*.

Occurrence.—Not uncommon in the Rochester shale at Lockport and Rochester, N. Y.

Catalogue number, 35769, U. S. National Museum.

Family BATOSTOMELLIDÆ Ulrich.

In point of species this is the most prolific family represented in these shales, no less than fifteen forms, referred to five genera, being found. Most of the species afford excellent thin sections, in which the chief character of the family, the fused walls of the zoœcia and mesopores, is well shown.

Genus BATOSTOMELLA Ulrich.

A zoarium of slender, smooth, ramose branches with small, rounded or oval zoœcia, separated by more or less numerous mesopores and having usually very numerous acanthopores, characterizes this genus. The mesopores, however, seldom show at the surface, since with age they become filled with a calcareous tissue and the surface usually shows only solid zoœcial interspaces bearing the numerous acanthopores.

The following species, although the first of the genus in matter of time, is very similar to the Mississippian types:

BATOSTOMELLA GRANULIFERA (Hall).

Pl. XIII, figs. 1–5; Pl. XXIV, figs. 10, 11; Pl. XXV, figs. 11, 12.

Trematopora granulifera Hall, Nat. Hist. New York, Pal. II, 1852, p. 154, pl. 40A, figs. 9a–e.
Batostomella granulifera Nickles and Bassler, Bull. U. S. Geol. Survey No. 173, 1900, p. 180.
Batostomella granulifera Grabau, Bull. New York State Mus., No. 45, 1901, p. 164, fig. 61.

Zoarium of slender, ramose branches, usually about 2 mm. in diameter. Surface smooth, hirsute because of the numerous acanthopores. Zoœcia rounded, elongate, 8 in 2 mm. longitudinally and 10 to 11 transversely. Mesopores moderately abundant, usually closed at the surface. Acanthopores numerous, seven on an average surrounding a zoarium. Zoœcial tubes thin walled in the axial region and thickened in the peripheral, where the acanthopores and mesopores are developed, the latter closed, as the surface is approached, by a deposit of tissue. Diaphragms absent in both zoœcia and mesopores.

Several associated bryozoa, notably *Acanthoclema asperum* (Hall) and *Lioclema ramulosum* n. sp., resemble this form superficially. Under the definition of the latter their differences are indicated, while *A. asperum* may be separated externally by its smaller branches and different arrangement of the zoœcia, these in young specimens being arranged in quincunx lines and elongate-striate in old examples. Internally the two are of course quite different.

Occurrence.—Very abundant at Lockport, Rochester, Middleport, and other New York localities; Grimsby, Hamilton, and Thorold, Ontario. Rare in the Osgood beds at Osgood, Ind.

Catalogue number, 35517, U. S. National Museum.

Genus BYTHOPORA Miller and Dyer.

The oblique apertures drawn out anteriorly, canaliculate interspaces, and few mesopores and acanthopores characterize this genus.

Bythopora spinulosa (Hall).

Pl. XIII, figs. 6, 7; Pl. XXIV, figs. 12 13.

Trematopora spinulosa Hall, Nat. Hist. New York, Pal. II, 1852, p. 155, pl. 40A, figs. 11a-c.
Bythopora spinulosa Nickles and Bassler, Bull. U. S. Geol. Survey No. 173, 1900, p. 180.
Bythopora spinulosa Grabau, Bull. New York State Mus., No 45, 1901, p. 166, fig. 64.

This little form is easily recognized by its narrow cylindrical branches 1 to 2 mm. in diameter, with surface smooth except that, at intervals of about 0.5 mm., sharp, conical projections 0.1 to 0.2 mm. in height are developed.

Zoœcia thin walled in the axial region, proceeding in a gradual curve to the surface, where they open obliquely; walls in the peripheral region considerably thickened. Apertures long, oval, the posterior end somewhat elevated, 7 or 8 in 2 mm. measuring lengthwise. Diaphragms and mesopores not developed. Acanthopores wanting unless the sharp projections of the surface are of the nature of these structures.

Occurrence.—Common at Lockport, Rochester, Lewiston, and Niagara Falls, N. Y.; Thorold, Hamilton, and Grimsby, Ontario.

Catalogue number, 35516, U. S. National Museum.

Genus ERIDOTRYPA Ulrich.

This long-lived generic type is well represented in the Rochester shale both in the way of species and in the comparative abundance of specimens. The characters of *Eridotrypa*, as based on the genotype *E. mutabilis* Ulrich, a Middle Ordovician species, are ramose zoaria having more or less oblique, thick-walled zoœcia with diaphragms most closely set in the earlier part of the short mature region, a variable number of mesopores with numerous diaphragms, and few small acanthopores. The Ordovician species usually possess all of the generic characters as given above, but those from later formations sometimes diverge widely from the generic definitions. *E. striata* (Hall) possesses the typical generic characters and evidently is a survivor of the *E. mutabilis* group of species. *E spinosa*, however, differs by developing a large number of well-marked acanthopores, while *E. nodulosa* and *E. solida* vary in another direction by having diaphragms in neither the zoœcia nor mesopores, these three species in all other respects, however, being true members of the genus. This same variation is exhibited in other Silurian and Devonian species of the genus, of which six or seven have been described, and several new forms have been found. When the knowledge of the genus is more complete, it will probably be found that, although essentially the same general type of structure pertains to all, now and then species are developed with characters indicating relations to other genera. The vertical sections of *E. nodulosa* and *Bythopora spinulosa* (Hall), as figured on Pls. XI and XIII, are certainly very similar.

Eridotrypa spinosa n. sp.

Pl. XII, figs. 1-3; Pl. XXV, fig. 15.

This fine species is readily distinguished from the described species of *Eridotrypa* and from the associated solid ramose bryozoa by its large, thick-walled zoœcia and very numerous acanthopores. The zoarium is of ramose, frequently dividing cylindrical branches about 3 mm. in thickness. The surface of the branches is smooth, the maculæ being so inconspicuous as to be detected with difficulty.

As is usual with species of this genus, the zoœcial apertures vary considerably in appearance at the surface. In young stages the apertures are elongate, the walls slightly raised posteriorly and often confluent with those of the next zoœcium, thereby giving a striate appearance to the branch. With age the apertures become more direct and polygonal, the walls ridge-shaped and thickened, and numerous blunt acanthopores appear. In the latter condition a few mesopores are observed, these usually appearing as shallow depressions between the zoœcia. Measuring longitudinally, 4 zoœcia may be counted in 2 mm.

Thin sections bring out especially the large number of acanthopores and the thick zoœcial walls characteristic of the species. They also show that the tabulation is very much like that prevailing in the typical Ordovician species of the genus, namely, that diaphragms are most abundant near the turn from the axial to the peripheral region, that they are present but less numerous in the axial region, and that they are often wanting in the outer part of the peripheral zone. The acanthopores are very large for the genus and are most frequently arranged in rows paralleling the length of the branch. Sometimes as many as fourteen are seen surrounding a zoœcium, although eight is the usual number. The mesopores are irregularly developed and are of various sizes and shapes. When seen in vertical sections they show the usual development of diaphragms. Comparisons with the associated and somewhat similar species *E. striata* (Hall) are given under the description of that form.

Occurrence.—Not uncommon in the Rochester shale at Grimsby, Ontario, rare at Lockport and Lewiston, but more abundant at Rochester, N. Y. Common in the Osgood beds at Osgood, Ind.

Catalogue numbers, 35521, 35522, 35739, 44128, U. S. National Museum.

ERIDOTRYPA NODULOSA n. sp.

Pl. XI, figs 14, 15; Pl. XXV, figs. 1-3.

Zoarium of small, slender, cylindrical, monticulated branches about 2 mm. in diameter, dividing at intervals of 10 mm. or more. The maculæ are developed sometimes as sharp tubercules, but usually as strongly elevated elongate monticules which by their confluence assume an annular or spiral arrangement. Zoœcia varying, according to the maturity of the specimen, from oval oblique in young examples to polygonal in older specimens. A few small acanthopores are sometimes observed at the surface and mature examples show mesopores to be present.

Internal characters.—Because of the very short peripheral region, tangential sections are difficult to prepare, but sections of a very old example show polygonal zoœcia, large and irregular mesopores and small acanthopores. Diaphragms wanting in both zoœcia and mesopores.

The strongly monticulated zoarium distinguishes this from small ramose forms associated with it. *Trematopora tuberculosa* has a similar monticulated zoarium, but its branches are considerably larger and the external and internal features are totally different, as a glance at the figures will show.

Occurrence.—Not uncommon at Lockport and Rochester, N. Y.

Catalogue number, 35524, U. S. National Museum.

ERIDOTRYPA SOLIDA (Hall).

Pl. XII, figs. 7-9; Pl. XXIV, figs. 20-23; Pl. XXV, fig. 16.

Trematopora solida Hall, Nat. Hist. New York, Pal. II, 1852, p. 153, pl. 40A, figs. 6a-e.
Homotrypa ? solida Nickles and Bassler, Bull. U. S. Geol. Survey No. 173, 1900, p. 293.

This is one of the largest solid, ramose bryozoa occurring in the Rochester, and the thick cylindrical branches varying from 5 to 10 mm. in diameter, together with the smooth surface, thin-walled angular zoœcia, and few mesopores, distinguish it from the associated forms.

The specimens usually found have elongate polygonal zoœcia opening at the surface somewhat obliquely. The oldest specimen seen shows the following external and internal characters. At the surface the zoœcia are direct, thin walled, polygonal, in contact laterally, but with the angles occupied by shallow mesopores. Sections show that the zoœcial tubes are thin walled and flexuous in the axial region and but slightly thickened in the very short peripheral zone, where a few mesopores and still fewer acanthopores are developed. Not a trace of a diaphragm has been observed in either zoœcia or mesopores. Measuring lengthwise, 6 to 7 zoœcia in 2 mm.

The resemblance of this species in several respects to *Homotrypa confluens* Foerste[a] and *Homotrypa similis* Foord[b] caused Nickles and the writer to refer it as above. The two species mentioned have thin flexuous walls in the axial region and a short peripheral zone, both of which are characters of *E. solida*, but they differ in developing a short series of cystiphragms and diaphragms. In spite of this difference in tabulation, these three species have much in common and future investigations may show that *Eridotrypa* and this section of *Homotrypa* are more closely related than the classification now shows. *E. solida* is far from being a typical *Eridotrypa*, but its combination of characters seems to indicate that genus more than any other. A similar species is *Eridotrypa appressa* Ulrich from the Hamilton formation of Illinois and Iowa.

This species is so different from the associated members of the genus that comparison is not necessary. The external characters have already been pointed out and vertical fractures show the short peripheral region and absence of diaphragms very well with a hand lens. Specimens are often found crushed, the thin-walled axial region apparently not being able to stand much pressure.

Professor Hall mentions this as a rare form, but it seems to be quite abundant in the collections.

Occurrence.—Common at Lockport, Rochester, and other localities in New York; Grimsby and Thorold, Ontario.

Catalogue numbers, 35525, 35526, U. S. National Museum.

ERIDOTRYPA SIMILIS n. sp.

Pl. XII, figs. 10–14; Pl. XXVI, figs. 1, 2.

Zoarium apparently free, consisting of a short, stout basal portion obtusely pointed at the lower end and growing upward by dichotomous branching into six or more cylindrical stems, usually about 5 mm. in diameter. Surface smooth, the maculæ being inconspicuous and distinguished by having slightly larger zoœcia and more numerous mesopores than usual. Zoœcial apertures direct, varying from angular to rounded, the shape depending upon the number of mesopores present. Walls ridge-shaped at the surface and hence appearing thin, but in thin sections they are seen to be considerably thickened. Well-preserved specimens show small acanthopores at the junction angles of the walls. Mesopores numerous in the maculæ, where they isolate the zoœcia, elsewhere usually few and placed in the angles between the zoœcia. Five to 6 zoœcia in 2 mm.

The external as well as internal characters of this form are such that the species should be recognized with little difficulty. In the immature region the zoœcia are thin walled and have diaphragms distributed at intervals of about five times their own diameter. In the late immature and early part of the mature region one or more diaphragms are inserted and are placed about their own diameter apart when more than one are present. The late part of the mature region shows no diaphragms. Compared with the zoœcia, the mesopores are closely tabulated, for here the diaphragms are arranged about their own diameter apart throughout the tube length. Tangential sections show that the zoœcia are rounded polygonal in outline and that each is surrounded by a thick ring-like wall composed of fine-grained sclerenchymatous tissue. The mesopores usually have no distinct investing wall

[a] Geol. Survey Ohio, VII, 1895, p. 600.
[b] Contrib. Micro-Pal. Cambro-Sil., Canada, 1883, p. 10, pl. 2, figs. 2–2d.

like that of the zoœcia, and appear as mere openings between the zoœcia. However, sections through the mature region of aged specimens (see Pl. XII, fig. 13), in addition to rather numerous small, granular, knotty acanthopores, show thick walls encircling both zoœcia and mesopores.

The zoarial growth of this interesting species is precisely the same as that pertaining to the highly characteristic Trenton bryozoan *Eridotrypa briareus* (Nicholson).[a] Internally the two species are also similar, but the slightly larger zoœcia and larger and more numerous acanthopores of the Niagaran species will serve to distinguish them.

Occurence.—A dozen or more specimens were found at Lockport, Niagara Falls, and Lewiston, N. Y., Grimsby and Thorold, Ontario.

Catalogue numbers, 35518, 35519, 35520, U. S. National Museum.

Eridotrypa striata (Hall).

Pl. XII, figs. 4–6; Pl. XXIV, figs. 3–6; Pl. XXV, fig. 14.

Trematopora striata Hall, Nat. Hist. New York, Pal. II, 1852, p. 153, pl. 40, fig. 7a–d.
Trematopora ? striata Grabau, Bull. New York State Mus., No. 45, 1901, p. 167, fig. 66.

The specimens described and figured by Hall as *Trematopora striata* prove upon examination to be the basal portions of a species of *Eridotrypa* found rather frequently in the Rochester shale.

As usual in basal expansions or on old examples overgrown by a layer of young zoœcial tubes, the zoœcia of this as well as other species of *Eridotrypa* are oblique and drawn out anteriorly. This seems to be a more permanent character in *E. striata* than in other species, and suggested the specific name.

The base of *E. striata* is seldom found, the more abundant specimens being fragments of the slender branching zoarium. The specimen figured on Pl. XXV is typical and shows the character of the species.

Internally *E. striata* differs little from the typical species of the genus. Indeed, in all features this Niagaran form is very close to the Ordovician species *E. mutabilis*. Compared with associated bryozoa, *E. striata* resembles *E. spinosa*, but the smaller zoarium, smaller zoœcia (6 in 2 mm.), and the few small acanthopores of the former will serve to distinguish the two forms.

Occurrence.—Common in the Rochester shale at Lockport, Niagara Falls, and Rochester, N. Y., and at Grimsby, Ontario. Also rather abundant in the Osgood beds at Osgood, Ind.

Catalogue numbers, 35545, 44132, U. S. National Museum.

Genus LIOCLEMA Ulrich.

Although this genus reached its highest development specifically in later rocks, the Rochester shale affords a good representation. Individuals of the various species found here occur usually quite frequently, *L. asperum* and *L. multiporum* being particularly abundant, *L. ramulosum* being not uncommon among the small ramose forms, and *L. explanatum* and *L. circinctum* occurring least often. Some of these have a wide geographical distribution, the three first mentioned occurring also in Indiana.

Lioclema asperum (Hall).

Pl. XI, figs. 1–3; Pl. XXIV, figs. 14–16.

Callopora aspera Hall, Nat. Hist. New York, Pal. II, 1852, p. 147, pl. 40, figs. 4 a–i.
Lioclema asperum Ulrich, Geol. Survey Illinois, VIII, 1890, pp. 416, 425.
Lioclema aspera Grabau, Bull. New York State Mus., No. 45, 1901, p. 165, fig. 63.

Zoarium incrusting foreign bodies, forming, by the superposition of several layers, round or irregular masses, or, by growth upon ramose bryozoa or other cylindrical objects, rounded branches. Layers varying from 0.5 to 1.5 mm. in thickness; surface smooth, but, when well preserved, hirsute from the abundance of acanthopores. Maculæ of slightly larger zoœcia and more abundant mesopores but not a conspicuous feature.

[a] *Chætetes briareus* Nicholson, Geol. Survey Ohio, Pal., II, 1875, p. 202, Pl. XXI, figs. 13–13b.

Zoœcia thin walled, 6 in 2 mm., polygonal to rounded, the outline depending upon the number of mesopores intervening. Mesopores open at the surface, numerous, and because of their frequency the zoœcia are seldom in contact. In the maculæ often three rows of mesopores separate adjoining zoœcia. Acanthopores large and numerous, 3 to 5 usually encircling a zoœcium and often indenting the zoœcial cavity, thus giving a petaloid appearance seen at the surface and in sections.

Internal characters.—This species affords very pretty thin sections, the tangential especially so when showing the full development of acanthopores and mesopores. In such a section the acanthopores are seen to be large, sometimes as much as 0.1 mm. in diameter, and to show the central canal distinctly. Zoœcia as a rule 0.20 mm. in diameter and with walls slightly thicker than those of the mesopores. Vertical sections indicate that the axial region is short and the bend to the peripheral often quite abrupt. With the inception of the latter region mesopores are developed. Diaphragms are practically wanting in the zoœcial tubes, but are quite abundant in the mesopores, being placed at intervals varying from one-half to a whole tube diameter. Some of the numerous acanthopores are cut by vertical sections which show clearly the internal features of these structures.

The incrusting habit of growth, smooth surface, size of zoœcia, abundant and unusually large, conspicuous acanthopores and numerous mesopores cause this species to be easily identified. The only form with which it might be confused is the associated and very abundant *L. multiporum*, but the latter has much smaller zoœcia and unusually numerous, small mesopores and acanthopores to distinguish it, irrespective of the different internal structure. Certain forms of *L. asperum* resemble the two lamellate species *L. circinctum* and *L. explanatum*. The similarity, however, is only in method of growth, the other specific characters being quite different.

Occurrence.—Abundant in the Rochester shale at Lockport, Rochester, Niagara Gorge, and near Lewiston, N. Y., and at Grimsby, Ontario. Not uncommon in the Osgood beds at Osgood, Ind.

Catalogue numbers, 35504, 35505, 44124, U. S. National Museum.

Lioclema explanatum n. sp.

Pl. XIII, figs. 8–10; Pl. XXVI, fig. 4.

Zoarium, a laminar expansion composed of a single layer varying from several millimeters to a centimeter or more in thickness, or a more or less rounded mass formed of several superposed layers; under surface concentrically wrinkled; upper surface celluliferous, smooth, with maculæ inconspicuous. Zoœcia subcircular, those in the intermacular spaces averaging 0.25 mm. in diameter and about five occurring in 2 mm. Mesopores large, rather numerous, and usually isolating the zoœcia. Acanthopores small, inconspicuous, and generally seen only in thin sections; few in number, an average of two to a zoarium, although sometimes as many as four may be present.

The principal internal characteristic of this species is the loose tabulation of both the zoœcial tubes and the mesopores and in this respect *L. explanatum* differs from all the associated forms of *Lioclema*. In the zoœcia the diaphragms vary in distance from each other from a tube diameter to three or more times that dimension. The same variation is exhibited in the mesopores, but because of their narrower diameter these appear more closely tabulated.

The laminar growth, large zoœcia, and comparatively few and small acanthopores, distinguish this species externally from the associated forms of the genus, while the internal characters, as mentioned above, are quite different from any of the other species. Associated laminar species, such as *Nicholsonella florida* (Hall), will not be confused because of their floriform apertures and solid interzoœcial spaces. Probably the closest ally is *L. asperum*, but the different tabulation, larger zoœcia, explanate growth, and especially the much less numerous and smaller acanthopores, are points of difference.

Occurrence.—Rochester shale, not uncommon at Rochester, N. Y. Osgood beds, rare at Osgood, Ind.

Catalogue number, 35503, U. S. National Museum.

LIOCLEMA CIRCINCTUM n. sp.

Pl. XIII, figs. 11-14.

The growth of this beautiful species is the same as that of *L. explanatum*, consisting of several laminæ growing upon each other and producing an expansion several centimeters in diameter and three or four millimeters in thickness. Celluliferous surface smooth, under surface covered with a wrinkled epitheca. Zoœcia isolated from each other by at least one row of numerous small mesopores, sometimes by two or three rows, while in the maculæ four or five rows may be found separating the zoœcia, which here are a trifle larger than usual. Because of the number and small size of the mesopores the outline of the zoœcia varies from many sided to approximately circular, the latter shape occurring more frequently. An average zoœcium is 0.18 mm. in diameter; 6 in 2 mm. Mesopores small, polygonal, as many as fourteen sometimes observed bordering a zoœcium. Acanthopores apparently wanting. Diaphragms developed at intervals of a tube diameter or less in the mesopores but wanting in the zoœcia. Tangential sections when viewed under a high power show the finely granulose wall structure figured on Pl. XIII.

The small numerous mesopores isolating the zoœcia, absence of acanthopores, and explanate zoarium will distinguish this fine species. *L. explanatum*, although similar in growth, is readily distinguished by its acanthopores, larger zoœcia, larger and fewer mesopores, and different tabulation of both zoœcia and mesopores. The other species of the genus are so different that comparisons are hardly necessary.

Occurrence.—Rochester shale, rare at Lockport, N. Y.

Catalogue number, 35509, U. S. National Museum.

LIOCLEMA MULTIPORUM n. sp.

Pl. XI, figs. 4-6; Pl. XXIII, fig. 18; Pl. XXVII, fig. 20.

This species resembles *L. asperum* in habit of growth, but under a hand lens is easily distinguished by having much smaller zoœcia and an unusually large number of small acanthopores and mesopores. The surface is smooth and the maculæ are composed chiefly of mesopores. The zoœcia are irregularly rounded or floriform in outline because of the numerous acanthopores indenting their walls. An average zoœcium is 0.17 mm. in diameter and seven zoœcia may be counted in 2 mm. Mesopores small, two or three rows usually isolating the zoœcia, although in the maculæ seven or eight rows may be counted. Acanthopores small, very numerous, seven or eight often encircling a zoœcium, and many developed among the mesopores.

Internally *L. multiporum* exhibits a marked difference from *L. asperum*, in that diaphragms are almost entirely wanting in both zoœcia and mesopores, and in that the walls of the peripheral region are considerably thickened. Fossils incrusted by this species often also bear expansions of *L. asperum*, and such specimens exhibiting the two forms side by side show the specific differences very clearly.

All of a small lot of specimens collected at the same locality at Rochester, N. Y., showed a departure from the usual method of growth in that their zoaria rose into dwarfed branches. Here apparently the conditions were such as to allow an erect zoarium to develop.

Occurrence.—An abundant species in the Rochester shale, the types being from Lockport, but Rochester, Niagara Gorge, and near Lewiston, N. Y., and Hamilton and Grimsby, Ontario, furnish many specimens. Specimens are also found, although more rarely, in the Osgood beds outcropping near Waldron, Ind.

Catalogue numbers, 35501, 35502, 44122, U. S. National Museum.

LIOCLEMA RAMULOSUM n. sp.

Pl. XI, figs. 11–13; Pl. XXV, figs, 9, 10.

Probably *Callopora* n. s. Hall, Nat. Hist. New York, Pal. II, 1852, pl. 40, figs. 6 a, b.

This neat form is easily distinguished from the associated species of *Lioclema* by its ramose habit of growth and few but large acanthopores. The branches are cylindrical, 2 to 3 mm. in diameter, and divide at intervals of about 10 mm. Surface smooth. Zoœcia thin-walled, elongate polygonal or rounded, averaging 0.20 mm. in length, 0. 12 mm. in width, and measuring lengthwise 7 in 2 mm.; isolated from each other by one or two rows of open, angular mesopores. Acanthopores few, but quite conspicuous, about 1 to each zoœcium and arranged with a certain amount of regularity among the mesopores. Zoœcial tubes thin walled and somewhat flexuous in the axial region, but becoming thickened in the peripheral region. Diaphragms wanting in both regions of the zoœcia and seldom if ever developed in the mesopores.

To the unaided eye this species is identical with the associated *Batostomella granulifera* (Hall), but with a hand lens the two are easily separated; *L. ramulosum* by the open mesopores and few large acanthopores, and *B. granulifera* by its very numerous acanthopores and closed mesopores. Internally the two are also quite different.

Occurrence.—Not uncommon in the Rochester shale at Lockport, N. Y., and Grimsby, Ontario. Rare in the Osgood beds near Waldron, Ind.

Catalogue numbers, 35508, 44125, U. S. National Museum.

LIOCLEMA GLOBULARE n. sp.

Pl. XXVII, figs. 18, 19.

Zoarium a rounded mass about 10 mm. in diameter. Zoœcia polygonal, almost circular when the mesopores are more numerous than usual, larger than associated species of *Lioclema*, 5 occurring in 2 mm., and the average diameter being 0.30 mm. Mesopores small but sometimes numerous enough to isolate the zoœcia. Acanthopores few and inconspicuous, rarely seen at the surface, and determined with certainty only in thin sections. Diaphragms wanting in the zoœcial tubes and developed at irregular intervals in the mesopores.

Although the large zoœcia, few acanthopores, and globular method of growth will serve to distinguish this from the associated species of *Lioclema*, still care must be exercised to separate it from *Diplotrypa walkeri*. In growth, size of zoœcia, and number of mesopores, as well as other external features, the latter species is precisely the same, but thin sections show the different generic relations. In *D. walkeri*, however, the mesopores have straight walls and are crossed by closely set, regularly arranged diaphragms, while the walls of *L. globulare* are indented wherever diaphragms are inserted, thus giving a beaded appearance to the mesopore. In addition, the diaphragms of *L. globulare* are irregular in shape, number, and placement. A vertical fracture therefore will serve to distinguish the zoaria of the two species, *L. globulare* showing no diaphragms in the zoœcia and irregularly spaced diaphragms in the beaded mesopores, and *D. walkeri* exhibiting diaphragms in both zoœcia and mesopores, closely placed in the latter.

Occurrence.—Rare in the Rochester shale at Lockport, N. Y.

Catalogue number, 35771, U. S. National Museum.

LIOCLEMA PECULIARE n. sp.

Pl. XXIII, figs. 19–22; Pl. XXV, fig. 13.

A number of specimens of *Lioclema* have been found in the collections from Lockport and other Rochester shale localities that differ from the associated species of the genus particularly in that the walls of the zoœcia show at the surface a row of small crowded granular-like acanthopores. An examination with a hand lens will thus readily determine this form, but other points of difference are the thin-walled zoœcia and unusually few mesopores. The following description is believed to contain the more important characters.

Zoarium incrusting, species of *Atrypa* being selected most often, but other brachiopods, bryozoa, or trilobite tests also observed to have been grown upon by this species. These incrustations are generally thin and seldom consist of more than two superposed layers, each averaging 0.6 mm. in thickness. Surface smooth, maculæ inconspicuous. Zoœcia polygonal, 7 in 2 mm., with thin walls. Mesopores usually few, seldom numerous enough to isolate the zoœcia. Internally as well as externally the most striking feature is the crowded row of small granules or acanthopores which occupy the zoœcial wall. These are particularly well shown in tangential section but are also generally to be seen at the surface. Acanthopores of the size and shape usually seen in species of *Lioclema* seem to be entirely absent.

Occurrence.—Rochester shale, Lockport and other localities in New York. Rare in the Osgood beds at Osgood, Ind.

Catalogue number, 35770, U. S. National Museum.

Genus LIOCLEMELLA Foerste.

Zoœcial structure much as in *Lioclema* but the zoarium consists of cylindrical, fusiform or branched stems pointed at the base for articulation.

Lioclemella maccombi n. sp.

Pl. XI, figs. 7–10; Pl. XXV, figs. 5–7.

Zoarium of slender, smooth, unbranched, cylindrical stems, 1.5 to 2 mm. in diameter and reaching a length of 30 mm., pointed at the proximal end for articulation with a base attached to foreign objects. Short examples are thickest and rounded at the distal extremity while long specimens have their greatest diameter about the middle and taper gradually toward each end. Zoœcia thin walled, angular, 6 in 2 mm. Mesopores variable in number, generally small and few, but sometimes so numerous as to isolate the zoœcia. Well-preserved mature specimens exhibit small, but well-marked acanthopores occupying the junction angles of the zoœcia. Vertical sections show that the zoœcial tubes proceed to the surface in a gentle curve and that the diaphragms seem to be restricted to the axial region, where they vary from one-half to two tube diameters in distance from each other. In the mesopores the diaphragms are about their own diameter apart. Tangential sections exhibit the small acanthopores occupying the junction angles.

Compared with described species of *Lioclemella*, *L. maccombi* resembles, especially in mode of growth, *L. fusiformis* (Whitfield) and *L. subfusiformis* (James) from the Richmond formation, and *L. ohioensis* (Foerste), a Clinton species, but differs from each in having decidedly larger zoœcia and few mesopores. When complete, the shape of the zoarium distinguishes this species from associated forms, but small fragments sometimes bear a great resemblance to similar specimens of *Eridotrypa striata* (Hall). The latter species, however, branches frequently and fragments usually show a bifurcation, while the zoœcia also are usually quite elongate. Fragments of *L. maccombi* do not branch, usually taper slightly, and have thin-walled polygonal zoœcia.

This fine species is named in honor of Mr. George T. McComb, of Lockport, N. Y., who by collections has generously aided the writer in making this paper as complete as possible.

Occurrence.—Not uncommon in the washings and on slabs from the Rochester shale at Lockport, Lewiston, and Niagara Falls, N. Y., and Grimsby and Hamilton, Ontario. Rare in the Osgood beds at Osgood, Ind.

Catalogue numbers, 35535, 35536, U. S. National Museum.

Family AMPLEXOPORIDÆ Ulrich.

Genus RHOMBOTRYPA Ulrich and Bassler.

The quadrate shape of the zoœcia in the axial region is especially characteristic of this genus. This feature is best observed at the ends of the branches.

RHOMBOTRYPA SPINULIFERA n. sp.

Pl. X, figs. 13-16; Pl. XXV, fig. 21.

Zoarium small, ramose; branches slender, cylindrical, about 3 mm. in diameter, dividing at intervals of 10 mm. or more; surface smooth, maculæ not a conspicuous feature, and composed of mesopores and of zoœcia slightly larger than usual. In mature specimens the zoœcia at the surface are thin walled, rounded to elongate polygonal in outline and separated from each other, sometimes entirely but usually only laterally, by mesopores. Mature specimens also show small acanthopores rather regularly distributed and about one to each zoœcium. In young specimens the zoœcia are rhomboidal in shape and arranged regularly in quincunx lines.

Tangential sections show that the mesopores are quite variable in number and shape and that the spines of the surface are of the nature of true acanthopores; 6 to 7 zoœcia in 2 mm., measuring longitudinally, and transversely 10 to 11 rows in the same space. Transverse sections show the zoœcia to be quadrate in outline in the axial region, 11 to 12 in 2 mm. In the axial region of vertical sections the zoœcial walls are thin and become but slightly thickened in the peripheral; diaphragms wanting entirely in the zoœcia and very few in the mesopores. Vertical sections also indicate that new tubes are interpolated at approximately the same level. Vertical fractures also bring out this fact by showing alternate zones of smooth sides and of rough edges, the zoœcial tubes exhibiting in the first instance the flat sides of their walls, and in the latter case exposing their angles. In order to accommodate new zoœcia this turning about of the tubes in the axial region becomes necessary because of their quadrate shape. These zones of turnings are concentric and occur at intervals of about 0.7 mm.

By a glance at the quadrate zoœcia exposed at the end of a branch one distinguishes this neat species from associated small ramose forms. The presence of acanthopores separates it from other species of the genus.

Hitherto this type of monticuliporoids has been supposed to have been confined to the Richmond formation, the type of the genus, *R. quadrata* (Rominger) being a very characteristic fossil of these rocks. The discovery of the species just described in younger rocks is therefore of considerable interest.

Occurrence.—Rather rare in the Rochester shale at Lockport, where the type specimen was found, and at Thorold, Ontario, but not uncommon at Rochester, N. Y. The species has also been noted in comparative abundance in the Osgood beds at Osgood, Ind.

Catalogue numbers, 35594, 35595, U. S. National Museum.

Family CONSTELLARIIDÆ Ulrich.

Genus NICHOLSONELLA Ulrich.

The following two species are apparently the last representatives of this genus, which is identified for the first time in the Silurian system. As might be expected, both differ in some respects from the typical Ordovician species, but the general aspect of each is such that *Nicholsonella* seems the only genus to which they can be referred with some certainty. Both develop the peculiar character of *Nicholsonella*, namely, that with age the walls of the mesopores become obscured by a calcareous deposit filling the interzoœcial spaces. Indeed, the walls of the zoœcia and mesopores have an indefinite structure throughout the mature region that is in marked contrast with the clear-cut walls of *Lioclema*, to which genus both species had formerly been referred.

NICHOLSONELLA FLORIDA (Hall).

Pl. XIV, figs. 10, 11; Pl. XXIV, figs. 1, 2.

Callopora florida Hall, Nat. Hist. New York, Pal. II, 1852, p. 146, pl. 40, figs. 2a–f.
Leioclema floridum Ulrich, Geol. Survey Illinois, VIII, 1890, pp. 416, 425.
Lioclema florida Grabau, Bull. New York State Mus., No. 45, 1901, p. 165, fig. 62.
Lioclema (? *Nicholsonella*) *floridum* Nickles and Bassler, Bull. U. S. Geol. Survey No. 173, 1900, p. 304.

Zoarium an explanate expansion varying from 3 to 10 mm. in thickness and sometimes attaining a width of 50 mm., although the specimens are usually seldom over 25 mm. wide. Base marked with a wrinkled epitheca. Celluliferous surfaces without monticules, even, the maculæ being inconspicuous and composed of groups of zoœcia of the normal size but separated by interspaces slightly wider than usual. Zoœcia large, rounded, two to three in 2 mm., and on an average slightly less than 0.5 mm. in diameter. Apertures floriform, the acanthopores inflecting the zoœcial walls which encroach upon the zoœcial cavity. Interzoœcial spaces open in young specimens and showing one or two rows of mesopores separating adjoining zoœcia, but in old specimens closed with a solid, granulose deposit. Acanthopores large, numerous, averaging four or five to each zoœcium, and inflecting the walls so as to give the floriform or petaloid appearance to the zoœcial aperture.

Internal characters.—Carefully prepared vertical sections show a very short, immature region in which the zoœcia are prostrate, and although their walls are of a clearer structure than that obtaining in the mature zone, even here their indistinct nature is clearly shown. With the inception of the mature region, the bend to which is quite abrupt, mesopores and acanthopores are developed. Here the wall structure already noted becomes still less distinct, and, finally, in the older parts of the zoarium, the walls of the zoœcia, and especially of the mesopores, become obliterated by a deposit of granular tissue. Diaphragms are inserted in the zoœcial tubes at an average distance apart of a trifle less than their own diameter. The diaphragms of the mesopores are at a like distance from each other, but because of their narrower diameter appear more crowded.

As is usual in most Trepostomata, the diaphragms are more abundant in the later than in the earlier parts of the mature region. The acanthopores of this and of the following species are quite different from the normal form of this structure, as they are seen in vertical sections to be simply tubes with a more or less definite wall inclosing a central clear space. No trace of the usual laminated tissue arranged in cone-like layers and pierced vertically by a central canal can be observed.

Tangential sections present various appearances, according to the portion of the zoarium cut by them. At the beginning of the peripheral regions the walls of the zoœcia and mesopores are thin and although hazy in structure are still fairly clear. Here the acanthopores are small and inconspicuous. Higher up in the mature region the walls are considerably thickened and the acanthopores have increased in size and number. Finally, in the most mature or aged condition, the interzoœcial space is occupied by a granular tissue obscuring the mesopores and through which the acanthopores pierce.

The large, rounded, isolated zoœcia, floriform apertures, closed interspaces, numerous acanthopores, and explanate growth, are characters which make the identification of this species quite easy. The closely related form *N. ringuebergi* n. sp. is distinguished by the presence of much smaller zoœcia. *Lioclema explanatum* has a similar method of growth but the smaller zoœcia and open mesopores are points of difference distinguished by the unaided eye. Internally the two are also quite different as their respective generic references indicate.

Occurrence.—Not uncommon in the Rochester shale at Lockport, Rochester, Niagara Falls, and Lewiston, N. Y.; Grimsby and Thorold, Ontario; Osgood beds, Osgood, Ind. Specimens that can not be distinguished from the typical New York form occur in the Silurian strata of the island of Gotland.

Catalogue numbers, 35510, 35511, U. S. National Museum.

NICHOLSONELLA RINGUEBERGI n. sp.

Pl. XIV, figs. 12, 13.

The various collections from the Rochester shale have shown half a dozen specimens of a species of *Nicholsonella* agreeing with the associated *N. florida* in method of growth but differing decidedly in the size of the zoœcia and in several internal characters. This form, for which the name *Nicholsonella ringuebergi* is proposed, has seven zoœcia in 2 mm., a feature in marked contrast with *N. florida*, which has two to three in the same space. The average zoœcium of *N. florida* is 0.50 mm. in diameter, while that of *N. ringuebergi* is only 0.23 mm. Internally the absence of diaphragms in the zoœcial tubes will further distinguish the present species from the associated form.

This neat species is named in honor of Dr. E. N. S. Ringueberg, of Lockport, N. Y., in appreciation of his work on the paleontology of the Rochester shale. The small, floriform apertures, many acanthopores, and the explanate growth will readily distinguish this from other bryozoa of this region.

Occurrence.—Rather uncommon at Lockport, N. Y.

Catalogue number, 35493, U. S. National Museum.

Genus IDIOTRYPA Ulrich.

Idiotrypa Ulrich, Jour. Cincinnati Soc. Nat. Hist., VI, 1883, p. 272.
Idiotrypa Miller, North American Geol. and Pal., 1889, p. 310.
Idiotrypa Ulrich, Geol. Survey Illinois, VIII, 1890, p. 375.
Idiotrypa Simpson, Fourteenth Ann. Rept. State Geol. New York for 1894, 1897, p. 591.

This genus was established by Ulrich for the reception of a single species, *I. parasitica*, from the Osgood beds of the Niagaran of Indiana. The genus was supposed to differ fundamentally from all trepostomatous genera in that the zoarium was not clearly differentiated into mature and immature regions. Further, the development of the tabulæ at equal distances from each other in both zoœcia and mesopores seemed so much at variance with that obtaining in the monticuliporoids as then known that the systematic position of the genus appeared more doubtful. The peculiar tabulation Ulrich held to be essentially comparable with that characterizing *Cumulipora*, a Cretaceous genus of the Chilostomata, which agrees further with *Idiotrypa* in having similarly perforated diaphragms. Subsequently this author recognized the true affinities of the genus by allying it with *Constellaria* and *Nicholsonella*.[a]

Idiotrypa parasitica occurs rarely at the Indiana locality, but a number of specimens identical with Ulrich's species have been found at Lockport and other New York localities. The sections figured by Ulrich were prepared from a mature example in which the peculiar tabulation and pores are developed to the utmost. These sections also happened not to show an immature region. On Pls. XVII and XXIV Ulrich's figures and also other views of the internal characters of the species are reproduced, and the latter especially show that the genus is a true member of the Trepostomata, differing decidedly from other genera of this suborder only in development of diaphragm in both zoœcia and mesopores at frequent and equal distances. The structure of the zoœcia and mesopores otherwise is precisely like that characterizing the Constellariidæ several species of *Nicholsonella* especially showing very similar pores or foramina penetrating the walls and mesopores. Indeed, the genus is so near *Nicholsonella* that the only important difference seems to be the equal development of diaphragms in both zoœcia and mesopores.

[a] Geol. Survey Illinois, VIII, 1890, p. 375.

IDIOTRYPA PUNCTATA (Hall).

Pl. XVII, figs. 4–10; Pl. XXIV, figs. 17–19.

Trematopora ?? punctata Hall, Nat. Hist. New York, Pal. II, 1852, p. 151, pl. 40A, figs. 4a–c.
Idiotrypa parasitica Ulrich, Jour. Cincinnati Soc. Nat Hist., VI, 1883, p. 273, pl. 13, figs. 1–1c.
Idiotrypa parasitica Simpson, Fourteenth Ann. Rept. State Geol. New York for the year 1894, 1897, p. 591, figs. 187–189

As indicated by the above synonymy, Ulrich's *Idiotrypa parasitica* is identical with Hall's *Trematopora ?? punctata*. This fact could not be established with certainty by comparison with the published descriptions and figures of Hall's species, but a study of thin sections prepared from the original type of *T. punctata*, left no doubt in the writer's mind as to their identity.

Mr. Ulrich has given a careful description of his species and the portion agreeing with the present view is reproduced below:

> Zoarium consisting of parasitic expansions, of variable thicknesses, usually attached to ramose bryozoa, but sometimes growing upon other foreign bodies. The true zoœcia have circular apertures, often closed by centrally perforated opercula, of an average diameter of one one hundred and twentieth of an inch, surrounded by a slightly elevated, thin, granulose, peristome. They are arranged with considerable regularity in series, in which from eight to ten may be counted in the space of 0.1 of an inch. The intertubular spaces are of somewhat variable thickness, and usually appear to be solid; occasionally, however, the mouths of shallow interstitial depressions may be observed. The spiniform tubuli usually do not constitute a conspicuous external feature.
>
> Tangential sections show that the walls of the true cells are marked by a dark circular band, equivalent to the peristome surrounding the apertures. Within this band may be noticed, besides a limited number of rather thin-walled spiniform tubuli, a large number of smaller circular structures, usually provided like the spiniform tubuli, with a very minute lucid central spot. These doubtless represent the granules above stated to occur on the peristome in well-preserved examples. The visceral cavities of all the cells appear to be more or less filled by sclerenchyma. This is due to the fact (shown in vertical sections) that the horizontal partitions are thicker at their junction with the walls of the tubes than they are more centrally, the cavities left between them being, therefore, of lenticular form. Some of the true zoœcia show a central, obscurely circumscribed area that may represent the openings of opercula of previous layers. These sections show further that whenever the horizontal partitions are brought to light a large number of concentrically arranged dark or lucid spots may be detected, which in the true cells gradually increase in size toward the circumference.

Vertical sections show that a very short immature zone is present in which the zoœcial walls are thin and diaphragms practically wanting. With the inception of the mature zone the mesopores develop, the wall of both zoœcia and mesopores become greatly thickened, and diaphragms are inserted at frequent and equal intervals in each.

Idiotrypa punctata is so different from all associated bryozoa that confusion with other species will hardly occur.

Occurrence.—Not uncommon in the Rochester shale at Lockport, Rochester, and other New York localities. Less abundant in the Osgood beds at Osgood, Ind.

Catalogue numbers, 35496, 35497, 43674, U. S. National Museum.

Family CALLOPORIDÆ Ulrich.

Genus CALLOPORA Hall.

This is one of the best-characterized genera of trepostomatous bryozoa. Its species are usually represented by an abundance of specimens, and, having a wide distribution geographically and a limited range geologically, are good horizon markers. The diagnostic characters of the genus are the ramose habit of growth, the rounded or angular zoœcia and more or less numerous mesopores, the absence of acanthopores, and especially the method of tabulation. The mesopores are always closely tabulated, the zoœcia less so, but have the diaphragms inserted in the following order: With the inception of a zoœcium numerous diaphragms are developed and continue in the same abundance until the tube has reached the normal size; then in the rest of the axial region diaphragms are less common, indeed sometimes almost wanting entirely, but when the peripheral zone is reached their number increases again. Compared with other genera the zoœcia attain their normal

size slowly, and this causes a transverse section to show two well-defined sets of tubes, the large set circular, representing the zoœcia of normal size, and the small of angular, variously shaped cells indicating zoœcia in different stages of development. This latter character enables one to distinguish a Callopora by merely examining the end of a branch with a lens. The size of the matured zoœcia and the shape and number of those still developing are often good specific characters.

The Silurian species of *Callopora* differ from the numerous Ordovician forms in having unusually large, conspicuous zoœcia. This characteristic pertains to all of the Calloporas known in these strata with the exception of a new species found in the Clinton at Hamilton, Ontario, which is of the Ordovician *C. ramosa* type. For the purpose of comparison these large-celled forms may be divided into two groups, the first typified by the genotype *C. elegantula* Hall and the second with *C. magnopora* Foerste as the representative form. The first group is characterized by large rounded zoœcia with numerous mesopores, and includes, besides *C. elegantula*, *C. perelegans* Hall from the New Scotland beds of New York, *C. nana* Nicholson from the Wenlock of England, and a few undescribed species or varieties closely related to the genotype. Of the second group, only *C. magnopora* has been described. *C. clausa*, a new species described in this paper, belongs to this section, while at least one undescribed form is known. The peculiarity of the group is that at the surface the mesopores are reduced almost to a minimum, the zoœcia as a result being angular and contiguous.

CALLOPORA ELEGANTULA Hall.

Pl. XVII, figs. 11–15; Pl. XXVI, fig. 12.

Callopora elegantula Hall, Nat. Hist. New York, Pal. II, 1852, p. 144, pl. 40, figs. 1a–m.
Callopora elegantula Ulrich, Jour. Cincinnati Soc. Nat. Hist., V, 1882, p. 250, pl. 11, figs. 6–6b.
Callopora elegantula Grabau, Bull. New York State Mus., No. 45, 1901, p. 167, fig. 67.

This beautiful species well deserves to be the type of the fine genus *Callopora*. The species is widely distributed geographically and is easily recognized. Professor Hall figured the macroscopic characters quite fully and later Mr. Ulrich gave views of the internal structure. The following description sums up the specific characters:

Zoarium ramose, of frequently branching stems 3 to 5 mm. in diameter; surface smooth, the maculæ distinguished by the presence of zoœcia slightly larger than the average and of mesopores more abundant than usual. Zoœcia thin walled, rounded, 4 to 5 in 2 mm., separated by a variable number of angular, thin-walled mesopores, which are often numerous enough to isolate the zoœcial tubes. Zoœcial apertures closed in the perfect state by ornamented covers or opercula having a central circular perforation with a diameter about two-fifths that of the zoœcia. Six to eight well-marked ridges distributed at equal distances from each other radiate from the central opening to the margin.

Tangential sections bring out the circular thin-walled zoœcia separated by the numerous angular mesopores of variable size and shape. Because of the numerous mesopores the dark divisional line between adjoining zoœcia is seldom observed. The striking feature of vertical sections is the difference in tabulation between the zoœcial tubes and the mesopores. In the early stages of the zoœcia the diaphragms are closely set and continue so until the tube has reached the normal diameter. Then diaphragms are inserted at intervals of about a tube diameter until the peripheral region is reached, when they become more abundant again. The mesopores, which are developed only in the peripheral region, are closely tabulated, two diaphragms usually occurring in a space equaling the mesopore's diameter. The tabulation of the mesopores and of the early part of the zoœcia is identical and it is probable that these two regions were occupied by similar zooids. Transverse sections show the usual two sets of zoœcia, the one, large and rounded, representing the zoœcia that have reached the normal size, and the other, small, unequal, and angular, representing the younger zoœcia in various stages of development.

No difficulty will be experienced in separating *Callopora elegantula* from all associated bryozoa, the small, rounded stems with large, circular zoœcia and numerous mesopores making the species easy of recognition. The new species next described as *C. clausa* has

a similar method of growth, but the few mesopores and polygonal zoœcia distinguish it without considering the different internal characters. The representative of *C. elegantula* in Europe seems to be the form described by Nicholson in 1884 from the Buildwas beds of the Wenlock as *Callopora nana*.[a] Indeed, the two species are so closely related that the writer can not point out any satisfactory means of distinguishing them. Internally the two are alike and externally the only difference noted is that the average diameter of the zoarial branches of *C. elegantula* is about twice that of the European species. This, however, is a minor character and further investigation will probably show that *C. nana* can scarcely be regarded as more than a variety of *C. elegantula*.

Occurrence.—Very abundant in the Rochester shale at Rochester, Lockport, Niagara Falls, and other localities in New York, and at Grimsby, Hamilton, and Thorold, Ontario. Also abundant in the Osgood beds of the Niagaran at Osgood and Waldron, Ind. The species is also found in Niagaran strata at numerous points in the Mississippi Valley.

Catalogue numbers, 35534, 35533, 44129, 35528, U. S. National Museum.

CALLOPORA CLAUSA n. sp.

Pl. XV, figs. 9–12.

This neat little species agrees with *C. elegantula* in growth and general characteristics, but differs in the following respects: Mesopores are almost entirely wanting at the surface, the few that are present being usually restricted to the maculæ. As a result, the zoœcia are polygonal in outline and contiguous. Internally *C. clausa* may be distinguished from *C. elegantula* by the more abundant diaphragms in the zoœcial tubes, these being about twice as numerous in both the axial and peripheral regions. Vertical sections show that mesopores develop, as usual, with the inception of the peripheral region, but close before the surface is reached. The zoœcial walls are greatly thickened in the peripheral region by a dense deposit of tissue and in tangential sections the walls are seen to vary in thickness from one-half to two-thirds the diameter of the zoœcial tubes, although at the surface the walls appear quite thin, because here only their crest or summit is seen.

C. clausa is probably more closely related to *C. magnopora* than to the genotype, but the size of the zoarium and the tabulation of the zoœcia are so different that the two will hardly be confused. The zoarium of small, cylindrical, smooth branches, 3 to 4 mm. in diameter, the large, angular zoœcia, 4 to 5 in 2 mm., few mesopores, and internally the numerous diaphragms in both zoœcia and mesopores are the specific characters of this interesting form.

Occurrence.—Rather uncommon in the Rochester shale at Lockport and Rochester, N. Y., and Grimsby, Ontario. Several specimens were also obtained in the Osgood beds at Osgood, Ind.

Catalogue numbers, 44130, 35531, 35530, U. S. National Museum.

CALLOPORA MAGNOPORA Foerste.

Pl. XV, figs. 1–8; Pl. XXVI, fig. 3.

Callopora magnopora Foerste, Bull. Sci. Lab. Denison Univ., 11, 1887, p. 173; III, pl. 16, fig. 5.
Callopora magnopora Foerste, Geol. Survey Ohio, VII, 1895, p. 600, pl. 29, fig. 5.

This species, which is not uncommon in the Clinton of Ohio, seems to be absent in the corresponding strata of New York, where, however, it reappears in the succeeding Rochester shale. Foerste's figures and description are inadequate, and the following description is based upon specimens received from that author.

Zoarium more or less irregularly ramose, the branches sometimes being subcylindrical and regularly dividing but often consisting of gnarled stems irregular in shape; diameter of branches varying from 5 to 12 mm. or more, but averaging 7 or 8 mm. Surface smooth, maculæ of larger zoœcia than those of the intermacular spaces, but not conspicuous.

[a] Ann. and Mag. Nat. Hist. (5), XIII, 1884, p. 120, pl. 7, figs. 4–4b.

Zoœcia larger than is usual in species of this genus, with subangular apertures and moderately thin walls, an average of 4 in 2 mm. Mesopores usually small and comparatively few at the surface, larger and more abundant at deeper zones in the zoarium. Opercula closing the zoœcia not observed at the surface, but detected in tangential sections.

Internal characters.—Tangential sections exhibit considerable variation in the size and shape of the zoœcia and the size and number of the mesopores. The reason for this is seen in vertical sections. Commencing with the mature region, more or less numerous mesopores are developed and these, as the surface of the zoarium is approached, are seen to become gradually smaller and less numerous and often pinched out altogether at the surface, the zoœcial diameter consequently becoming greater. A tangential section therefore passing through the early part of the peripheral region will show numerous mesopores and rounded zoœcia, while one taken just below the surface of the zoarium exhibits few and small mesopores and larger, angular zoœcia. In each case, however, because of this relation between the zoœcia and mesopores, the number of zoœcia in a given space is the same, even though they vary in diameter.

The surest guide for the identification of *C. magnopora* is the vertical section where the tabulation of the tubes is exhibited. All of the many specimens and sections examined indicate that the tabulation is the most constant feature of this as well as all the other species of the genus. The zoœcial tubes are closely tabulated at their inception, this tabulation continuing until the normal diameter of the zoœcia has been reached. Then diaphragms are absent altogether until the peripheral region is reached, and here they are uncommon, only one or rarely two being inserted in each tube.

The large zoarium and the peculiar tabulation of *C. magnopora* is so different from other species of the genus that comparisons are scarcely necessary. Vertical fractures when moistened and examined under a lens show the characteristic tabulation so well that sections are not a necessary adjunct for the identification of the species. The identification of the species in the Rochester shale is based upon a single example from Grimsby, Ontario. This specimen is a well-preserved subcylindrical branch 35 mm. in length and 10 mm. in diameter. The external characters are the same as in the typical Clinton specimens and, as our figures here given will show, the internal features of the two are identical.

Occurrence.—Abundant in the Clinton formation at Dayton, Centerville, and other localities in Ohio. Rare in the Rochester shale at Grimsby, Ontario.

Catalogue numbers, 35532, 44131, U. S. National Museum.

Family TREMATOPORIDÆ Ulrich.

Genus TREMATOPORA Hall.

Ulrich has shown in his "American Paleozoic Bryozoa" that of the numerous species referred to this genus by Hall only a few are congeneric with the common Rochester shale form, *T. tuberculosa*, the first species following the generic definition. The genus and species have been well defined by Ulrich in the work cited above, and the following description is but an adaptation from this author, the numerous specimens and thin sections showing no additional features.

Trematopora has many characters in common with the prolific Ordovician genus *Batostoma* and is probably the Silurian representative of the latter. The general internal structure of the two genera is similar, but the few diaphragms in the zoœcia, beaded mesopores, rounded zoœcia with more or less well-developed peristomes and comparatively small acanthopores, and the solid interspaces are characteristic of *Trematopora*.

TREMATOPORA TUBERCULOSA Hall.

Pl. XIII, figs. 15, 16; Pl. XVII, fig. 1-3; Pl. XXV, fig. 8.

Trematopora tuberculosa Hall, Nat. Hist. New York, Pal. II, 1852, p. 149, pl. 40A, figs. 1a-g.
Trematopora tuberculosa Ulrich, Jour. Cincinnati Soc. Nat. Hist., VI, 1883, p. 259, pl. 13, figs. 2-2b.
Trematopora tuberculosa Grabau, Bull. New York State Mus., No. 45, 1901, p. 166, fig. 65.

Zoarium of irregularly ramose, solid, often flattened branches, an average specimen being 5 or 6 mm. wide and 3 or 4 mm. in thickness. Surface studded usually with low

rounded monticules, 3 to 3.5 mm. apart, measuring from center to center; sometimes, however, the maculæ are developed as sharp or elongate tubercules. Zoœcial apertures oval, 6 to 7 in 2 mm. measuring lengthwise, with more or less elevated peristomes, each bearing two or three rather large and conspicuous acanthopores. Interzoœcial spaces solid and somewhat depressed, the mesopores being closed at the surface by a pellicle-like covering. Mesopores few to numerous, the zoœcia sometimes being in contact but more often separated from each other by a distance varying from one-half to their entire diameter apart.

The fully matured region of most specimens is so short that good tangential sections are difficult to prepare. A section passing through the zoœcia just below the surface shows that they are oval and marked by rather thick ring-like walls within which acanthopores are developed. The mesopores are angular and thin walled, but often the section passes through the covering of the mesopores, in which case the walls are not visible, but the interzoœcial spaces are occupied by a fine tissue perforated by more or less numerous granular-like structures. In deep tangential sections the difference between zoœcia and mesopores is so small that they are distinguished with difficulty, each having thin walls and being about equal in size.

Vertical sections present the following characters: In the axial region the zoœcia are large with very thin walls and no diaphragms. With the inception of the peripheral region the walls are slightly thickened, and mesopores and acanthopores are developed, the diameter of the zoœcia being lessened by the introduction of the mesopores. The zoœcia in this region usually show no diaphragms, one or two rarely being developed in each tube, but the mesopores exhibit them in comparative abundance. The mesopores also give a beaded appearance, being constricted at intervals, diminishing from the interior toward the surface and each constriction being marked by a diaphragm. The last diaphragm has the minutely perforated laminated tissue developed upon it which closes the mesopores at the surface, but other diaphragms in the same tube are often thickened with the same tissue, although usually not to the extent obtaining at the surface.

The solid tuberculated branches with small zoœcia surrounded by peristomes bearing rather conspicuous acanthopores and with closed interspaces, make *Trematopora tuberculosa* an easily recognized species. The other species of the genus are so different that comparison is unnecessary. There is no associated bryozoan with which this species might be confused, save possibly *Eridotrypa nodulosa*, which has a similar growth and strongly tuberculated surface. The zoarium of the latter species, however, is smaller, the zoœcia have neither peristomes bearing acanthopores surrounding them nor solid interspaces, while internally the structure of the two is quite different.

Occurrence.—Very abundant in the Rochester shale at Lockport, Lewiston, Niagara Gorge, and elsewhere in New York and at Grimsby and Thorold, Ontario. Rare in the Osgood beds at Osgood, Ind.

Catalogue numbers, 43618, 35573, 35515, 44427, U. S. National Museum.

TREMATOPORA WHITFIELDI Ulrich.

Pl. XXIII, figs. 16, 17; Pl. XXVII, figs. 16, 17.

Trematopora whitfieldi Ulrich, Jour. Cincinnati Soc. Nat. Hist., VI, 1883, p. 262, pl. 13, figs. 4, 4a.

In the Waldron shales of Indiana may be found numerous specimens of a small ramose bryozoan, which has been described by Ulrich under the above name. A few examples identical in all respects with the western form occurred in the collections from the Rochester shale. Ulrich's original description covers the specific characters fully, and, with slight changes, is given below.

Zoarium slender, ramose, branches smooth, with an average diameter of 2.5 mm., and dividing dichotomously at intervals of 10 mm. more or less. True zoœcia subequal with elliptical apertures, surrounded by thin, more or less distinct peristomes, and uniformly arranged in diagonally intersecting series over the entire surface. In these 7 to 8 zoœcia

occupy the space of 2 mm. The longer diameter of their aperture is about 0.20 mm., while the shorter or transverse diameter averages about 0.15 mm. The interstitial cells are numerous, usually completely isolating the true zoœcia. Their apertures vary in depth in different specimens, being in some not readily distinguishable from the true zoœcial orifices and in others, on account of the interstitial membrane, scarcely detectable, being indicated only by shallow depressions between the peristomes of the true cells, which might be overlooked by a careless observer. Well-preserved examples show a number of small spiniform tubuli, whose position is usually on the peristomes.

Tangential sections show that the true zoœcia are elliptical in cross section, that their walls are slightly thickened by a secondary deposit on the inside, and that they are almost invariably completely isolated by a series of interstitial cells. These are angular, thin walled, and often larger than the true cells. A few spiniform tubuli may be detected, but not readily, on account of the many particles of pyrites of iron, which always obscure to a greater or less extent the minute internal characters of the bryozoa from the Waldron locality.

Longitudinal sections show that the true zoœcia are entirely without diaphragms. The peripheral region is very narrow, and, near the surface, always one and often two interstitial tubes separate the true zoœcia. The interstitial tubes are usually crossed by but a single diaphragm, which is placed about midway between their point of origin and the apertural covering. The tube is generally a little restricted where the diaphragm occurs.

This species differs from *T. tuberculosa* Hall in its much smaller, smooth, and cylindrical branches, which have altogether a more delicate appearance. Compared with *T. spiculata* Miller, it differs in its more elliptical and somewhat larger cell apertures and more distinct peristome.

Occurrence.—Quite abundant in the Waldron shales at Waldron and elsewhere in Indiana; less common in the Rochester shale at Lockport, N. Y., and Grimsby, Ontario.

Catalogue numbers, 44108, 35763, U. S. National Museum.

Trematopora spiculata Miller.

Pl. XXVII, figs. 14, 15.

Trematopora spinulosa Hall, Twenty-eighth Ann. Rept. New York State Mus. (doc. ed.), 1876, pl. 11, figs. 11, 12. (Not *T. spinulosa* Hall, 1852.)

Trematopora spiculata Miller, American Pal. Foss., 2d ed., 1877, p. 245. (Proposed for *T. spinulosa*, preoccupied by Hall in 1852.)

Trematopora spiculata Hall, Twenty-eighth Ann. Rept. New York State Mus. (Museum ed.), 1879, p. 114, pl. 11, figs. 11, 12.

Trematopora spiculata Hall, Eleventh Ann. Rept. Indiana Geol. Nat. Hist., 1882, p. 235, pl. 10, figs. 11, 12.

The study of the type specimen of this species now preserved in the collections of the American Museum of Natural History showed that it is an example of a form occurring rather abundantly in the Waldron shale of Indiana and less commonly in the Rochester shale of New York and Canada. The identity of this species was not suspected hitherto, because, as the type specimen shows, the enlarged view of the surface figured by Hall incorrectly represents this feature. The zoœcia, instead of being angular and contiguous, as represented in this figure, are in reality subovate and separated by a row of angular mesopores, which often attain a size equaling or exceeding the zoœcia themselves. The following description is believed to set forth the salient features of the species.

Zoarium of solid, ramose, frequently branching stems averaging 2 mm. in diameter. Zoœcia oval to circular, with a more or less well-developed peristome, thin walled, 0.17 mm. and 0.14 mm. in their longer and shorter diameters, respectively, 7 in 2 mm., measuring lengthwise. Interzoœcial spaces often as wide as the zoœcia and occupied by large, angular mesopores. Acanthopores small, but often so numerously developed as to occupy every angle, thus giving the spiculated surface.

Compared with *Trematopora whitfieldi* Ulrich, the only closely related associated species, the present form may be distinguished by its more circular and smaller zoœcia and relatively wider interapertural spaces. The acanthopores are also a more prominent surface feature and serve as an additional means of separating the two forms.

Occurrence.—Rather uncommon both in the Waldron shale at Waldron, Ind., and in the Rochester shale at Lockport, N. Y., and Grimsby, Ontario. Rare in the Osgood beds at Osgood, Ind.

Catalogue numbers, 35760, 35762, U. S. National Museum.

Genus MONOTRYPA Nicholson.

The massive zoarium consisting of simple, large, prismatic zoœcia, with thin, straight, or crinkled walls, usually few diaphragms, and no acanthopores or mesopores, is characteristic of this genus. The species described below represent two sections of the genus, one in which the zoœcia have crinkled walls and no diaphragms and the other with straight walls and diaphragms. However, as various species are intermediate in their characters between these extremes, this division of the genus is probably more an artificial than a natural one.

MONOTRYPA OSGOODENSIS n. sp.

Pl. XVI, figs. 1–5.

Compare *Astrocerium constrictum* Hall, Nat. Hist. New York, Pal. II, 1852, p. 123, pl. 34A, figs. 2a–c, 3a–e.

Zoarium massive, generally consisting of flat or hemispherical disks 10 to 20 mm. in diameter and 4 to 10 mm. high, but sometimes of larger rounded masses 20 to 30 mm. in thickness. Growth commences upon other organisms, but as it continues the zoarium becomes free and the base lined with a concentrically wrinkled epitheca. Celluliferous surface smooth, the zoœcia composing the maculæ being a trifle larger than the ordinary ones and on a plane with them. Zoœcial apertures thin walled, polygonal in outline, usually hexagonal, 4 to 5 in 2 mm. Acanthopores and mesopores wanting, the structures simulating the latter probably being young zoœcia.

Sections show that the walls are thin and straight, that the diaphragms are developed at intervals of from a tube diameter or more apart in the immature region to three in the same space in the mature zone. The immature and mature regions are very similar, but may be distinguished by the more numerous diaphragms and slight thickening of the walls in the latter region. Large zoaria often show successive immature and mature regions.

Specimens of this species are very similar externally to the associated *M. benjamini*, but a vertical fracture will show the differences, *M. osgoodensis* having straight walls and diaphragms and *M. benjamini* showing crinkled walls, no diaphragms, and slightly larger zoœcia. The zoœcia of *Orbignyella expansa* are also quite similar in size and shape, but the explanate growth and different internal structure will distinguish it. Hall has probably included this species with his *Astrocerium constrictum*, as some of his figures of the coral appear to represent this bryozoan. There should be no difficulty in separating the two, because of the thick walls and projecting septa of the coral.

Occurrence.—Abundant in the Osgood beds at Osgood, Ind., not uncommon in the Rochester shale at Lockport and Rochester, N. Y.

Catalogue numbers, 35498, 35499, 44118, U. S. National Museum.

MONOTRYPA BENJAMINI n. sp.

Pl. XVI, figs. 6–9; Pl. XXVI, fig. 11.

Zoarium of globular or subglobular masses a centimeter or more in diameter. Surface smooth, maculæ not conspicuous. Zoœcia angular, thin walled, usually 4 in 2 mm.; diaphragms wanting. Zoœcial walls finely crenulated, 15 or more wrinkles in 2 mm.

This species is congeneric and, indeed, very closely related to the genotype of Hall's genus *Ptychonema*, *P. tabulatus* from the Lower Devonian of New York. Judging from the description and figures, Hall's species forms larger zoaria, has slightly larger zoœcia, and more widely separated corrugations than the form here described. The genus *Ptychonema* was established for species having slightly corrugated walls and no diaphragms. As the genotype of *Monotrypa* has crinkled walls and few diaphragms and other species of the

genus exhibit no diaphragms at all and straight walls, the combination of crinkled walls and absence of diaphragms seems a poor generic character. *Ptychonema* is therefore considered a synonym.

The only associated globular species with which *M. benjamini* might be confused is *Stigmatella globata*, but the much smaller zoœcia of the latter are noticeable with the unaided eye. Some specimens of *Orbignyella expansa* might be confused with this form, but the presence of curved diaphragms in the former is a distinguishing feature without considering the different growth and wall structure. *M. benjamini* is easily and certainly identified by observing the crenulated walls as seen in vertical fractures. Weller [a] has recently described a closely related species, *M. corrugata*, from the Decker Ferry formation of New Jersey. This species, however, has smaller zoœcia (10 in 3.5 mm.), a few diaphragms in the mature region, and the crenulation of the walls are fewer and much less pronounced.

The specific name is in honor of Dr. Marcus Benjamin, editor of the United States National Museum, to whom the writer is indebted for many courtesies.

Occurrence.—Not uncommon at Lockport, N. Y. One example of the same form was found at Osgood, Ind.

Catalogue numbers, 35500, 44129, U. S. National Museum.

MONOTRYPA PEDICULATA n. sp.

Pl. XVI, figs. 10-13.

Zoarium of small subglobular or pear-shaped pedunculate masses averaging 10 mm. in height and half that amount in width; base often slightly expanded. Surface smooth, maculæ inconspicuous. Zoœcia angular, thin walled, 6 to 7 in 2 mm. Acanthopores and mesopores wanting. Vertical sections show that the zoœcial tubes have somewhat flexuous walls and that diaphragms are absent. The walls, however, do not exhibit the crinkling usually observed in species without diaphragms.

The unusual growth obtaining in this species is a character making identification comparatively easy. The initial zoœcia are parasitic upon foreign objects and continue to grow upward, opening only at the top. In this way the pedunculate form of the zoarium is produced, the lower portion of the colony being without apertures and covered with an epitheca or pellicular membrane. When new zoœcia are interpolated the zoarium assumes the normal globular form with the zoœcia opening laterally as well as distally. Compared further with the associated species of the genus, *M. pediculata* differs from both in having smaller zoœcia. Other distinguishing characters are the absence of diaphragms and the flexuous walls.

Occurrence.—Rochester shale, Rochester, N. Y. Osgood beds, Osgood, and near Waldron, Ind.

Catalogue numbers, 44119, 44120, U. S. National Museum.

Genus DIPLOTRYPA Nicholson.

Distinguished from *Monotrypa* by the presence of mesopores.

DIPLOTRYPA WALKERI n. sp.

Pl. XIV, figs. 1-5; Pl. XXV, fig. 4.

Zoarium of small masses, irregular, rounded, or pyriform in shape and varying from 10 to 20 mm. in their diameter. Maculæ of larger zoœcia and more numerous mesopores are present, but are not a conspicuous feature of the smooth surface. Zoœcia, 6 in 2 mm., sometimes angular but more often somewhat rounded and separated, at least partially, by mesopores. Acanthopores wanting. Mesopores numerous, usually small but sometimes half as large as the zoœcia proper.

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[a] Geol. Survey New Jersey, Pal. III, 1903, p. 223, pl. 18, figs. 1-5.

Vertical sections are particularly instructive and bring out the generic characters. Diaphragms are wanting in the immature region of the zoœcial tubes and few are found in the mature zone. Indeed, in a zoarium built up of several successive immature and mature regions the latter region is recognized chiefly by the presence of diaphragms. In the mesopores the diaphragms are at intervals varying from one-half to an entire diameter apart. The mesopores also exhibit a feature that has been noticed in other species of the genus, namely that at about the same height in the zoarium a number of mesopores with their close tabulation will cease as such and their places be taken by the untabulated zoœcial tubes. The tabulation and size of the zoœcia in this species are so different from those of other species of the genus that comparison is not necessary. Associated species with a similar zoarium are the various species of *Monotrypa*, but the absence of mesopores in these forms will easily distinguish them under a lens.

This species is named in honor of Mr. B. E. Walker, of Toronto, Canada, in appreciation of his keen interest in paleontology and his generous help in loaning many fine specimens.

Occurrence.—Not uncommon at Grimsby, Ontario, and at Lockport and Rochester, N. Y.

Catalogue number, 35527, U. S. National Museum.

Order CRYPTOSTOMATA Vine.

Representatives of eighteen genera distributed among eight families of this order are found in the Rochester shale, making the Cryptostomata the best represented group, generically at least. Cryptostomatous bryozoa are characterized by the primary zoœcial orifice being produced into a tubular shaft—the vestibule.

Family PHYLLOPORINIDÆ Ulrich.

Genus PHYLLOPORINA Ulrich.

This genus comprises characters pertaining to several orders, and is one of the "comprehensive" types that occur occasionally in Paleozoic strata. The zoarium is of irregularly anastomosing branches, with two to eight rows of apertures on the obverse side, the reverse longitudinally striated; tabulated interstitial spaces closed at the surface; acanthopores generally present.

PHYLLOPORINA ASPERATO-STRIATA (Hall).

Pl. XVIII, figs. 1–5.

Retepora asperato-striata Hall, Nat. Hist. New York, Pal. II, 1852, p. 161, pl. 40C, figs. 2a–h.
Subretepora asperato-striata Miller, North American Geol. and Pal., 1889, p. 326.
Phylloporina asperato-striata Ulrich, Geol. Survey Illinois, VIII, 1890, p. 332, pl. 53, figs. 5–5b
Phylloporina asperato-striata Grabau, Bull. New York State Mus., No. 45, 1901, p. 168, fig. 68.

Zoarium of rather regularly inosculating branches arising from a slightly expanded base and forming a reticulate, flat, undulating or broadly funnel-shaped expansion, sometimes reaching a diameter of 70 or 80 mm. Branches varying from 0.8 to 1 mm. in width, but usually the different parts of the same specimen are uniform in this respect. Fenestrules rather regular in shape, oval to subelliptical, but somewhat variable in size, the average being about 1.10 mm. in length and 0.45 mm. in width. Measuring longitudinally 9 to 10 fenestrules may be counted in 20 mm., while transversely 15 occupy the same space. The celluliferous side exhibits 4 to 6 ranges of zoœcia. Apertures circular or subpolygonal, closely crowded together, 6 to 7 in 2 mm. In well-preserved examples the longitudinal striæ of the reverse side are seen under a magnifier to be minutely denticulate, thus suggesting the specific name.

Both the external and internal characters of this well-marked species have been figured, the former by Hall and the latter by Ulrich. The large anastomosing branches with four to six rows of polygonal zoœcia are readily recognized.

Occurrence.—Abundant at Lockport, Rochester, Niagara Falls, and other localities where the Rochester shale outcrops in western New York, and at Grimsby, Thorold, and Hamilton, Ontario. Rare in the Osgood beds at Osgood, Ind.

Catalogue number, 35740, 35741, 43441, U. S. National Museum.

Genus PSEUDOHORNERA Roemer.

Pseudohornera Roemer, Leth. geog., Leth. Pal., I, Atlas, 1876, expl. pl. 12.
Drymotrypa Ulrich, Geol. Survey Illinois, VIII, 1890, p. 399.
Drymotrypa Miller, North American Geol. and Pal., First App., 1892, p. 684.
Thamnocella Simpson, Fourteenth Ann. Rept. State Geol. New York for 1895, 1897, p. 525.
Drymotrypa Nickles and Bassler, Bull. U. S. Geol. Survey No. 173, 1900, p. 235.

It is unfortunate that the well-defined genus *Drymotrypa* must be abandoned in favor of the name *Pseudohornera*, which not only lacks description but also expresses a false relationship; but as both genera were founded upon the same species, Hall's *Retepora diffusa*, there is no doubt of their identity. In the explanation of Pl. 12, figs. 2a, 2b, of the work cited, Roemer gives the new name *Pseudohornera diffusa* to Hall's species and illustrates the genus by copies of Hall's figures, intending, no doubt, to define the genus in the text, which, however, never appeared. The rules of nomenclature require recognition of generic names founded upon well-illustrated species, and, as *Pseudohornera* meets with this requirement, the name is here used in place of *Drymotrypa*. The writer may be accused of inconsistency in recognizing *Pseudohornera* in place of *Drymotrypa* and then accepting *Phylloporina* instead of the much earlier name *Subretepora*, both of which were founded upon the same type of structure, but the two are not parallel cases. *Pseudohornera* is founded upon good figures correctly illustrating the type species while D'Orbigny's *Subretepora* was proposed for *Intricaria clathrata* Hall, which was both figured and described incorrectly.

The writer is indebted to Miss Margaret W. Moodey, of the United States National Museum, for calling attention to *Pseudohornera*, as well as for many other valuable bibliographic references which she has discovered during the preparation of a catalogue of North American invertebrate fossils.

The zoarium in *Pseudohornera* is of dichotomously dividing branches, celluliferous on one side and longitudinally striated on the reverse. The zoœcia are in several ranges and spring from a thin double plate, beneath which is a number of vesicles; the vestibules expand from the orifice to the angular apertures.

PSEUDOHORNERA NIAGARENSIS (Hall).

Pl. XVIII, fig. 20; Pl. XIX, figs. 14–16.

Fenestella n. sp. Hall, Nat. Hist. New York, Pal. II, 1852, pl. 40D, fig. 4.
Thamniscus ? Niagarensis Hall, Twenty-eighth Ann. Rept. New York State Mus. (doc. ed.), 1876, pl. 11, figs. 22–25; ibid. (Mus. ed.), 1879, p. 126, pl. 11, figs. 22–25.
Thamniscus niagarensis Hall, Eleventh Ann. Rept. Indiana Geol. Nat. Hist., 1882, p. 254, pl. 10, figs. 22–25.
Drymotrypa niagarensis Ulrich, Geol. Survey Illinois, VIII, 1890, p. 299.
Thamniscus Niagarensis Simpson, Fourteenth Ann. Rept. State Geol. New York, for the year 1894, 1897, pl. 9, figs. 15–17.

The collections from the Rochester shale contain several well-preserved specimens of this species, which was described from the Waldron beds at Waldron, Ind., and hitherto has not been recorded from any other horizon or locality. The Waldron specimens show a slight variation in the shape of the celluliferous side, this being either angular along a central line, or rounded. The specimens from New York exhibit only an angulated obverse. This angulation is a good specific character, the rounded obverse being only a feature of the aged condition. Compared with *P. diffusa*, this species, in addition to having the character just mentioned, is distinguished by having the reverse marked with 3 to 5 granulose striæ, instead of 6 to 8, in the width of a branch, and by an obverse side with 3 to 4 ranges of more rounded zoœcia. *P. niagarensis* has not the graceful method of growth pertaining to *D. diffusa* and is a less handsome species in every respect.

The specimen figured by Hall as *Fenestella* (n. sp.) on Pl. 40D, fig. 4, of Nat. Hist. New York, Pal. II, proves to belong to this species.

Occurrence.—Not uncommon in the Rochester shale at Lockport and Niagara Falls, N. Y., and in the Waldron shale at Waldron, Ind.

Catalogue number, 35742, U. S. National Museum.

PSEUDOHORNERA DIFFUSA (Hall).

Pl. XVIII, figs. 6-9; Pl. XXIII, figs. 1-3.

Retepora diffusa Hall, Nat. Hist. New York, Pal. II, 1852, p. 160, pl. 40C.
Pseudohornera diffusa Roemer, Leth. geog., Leth. Pal., I, Atlas, 1876, pl. 12, fig. 2.
Drymotrypa diffusa Ulrich, Geol. Survey Illinois, VIII, 1890, p. 399, pl. 53, fig. 7, 7b.
Drymotrypa diffusa Grabau, Bull. New York State Mus., No. 45, 1901, p. 169, fig. 69.
Compare *Polypora ? problematica* Vine, Quart. Jour. Geol. Soc. London, XXXVIII, 1882, p. 62.

This, the genotype, has been fully figured and described by Hall and Ulrich, and the following description is inserted mainly for the sake of completeness.

Zoarium, a loosely spreading frond growing in a plane and consisting of branches about 1.5 mm. in diameter, dividing dichotomously at short intervals; an entire zoarium about 50 mm. in both height and width. Celluliferous side bearing from 4 to 6 rows of zoœcia, springing from a thin double lamina, 5 zoœcia in 2 mm. measuring lengthwise. Noncelluliferous side marked by 6 to 8 longitudinal striæ.

This beautiful form is readily recognized by its dichotomously dividing, nonanastomosing branches, the longitudinally striated reverse and the smooth, slightly rounded obverse bearing 4 to 6 ranges of zoœcia. The associated species, *P. niagarensis*, has a similar method of growth, but may easily be distinguished by its usually angular obverse, bearing circular apertures, and fewer ranges of zoœcia.

The collections of the U. S. National Museum contain specimens of *Polypora? problematica* Vine, identified by the author of that species, which are closely related if not identical with Hall's species. At any rate, *Polypora ? problematica* is the European representative of *Pseudohornera diffusa*.

Occurrence.—Rather uncommon in the Rochester shale at Lockport and Rochester, N. Y., and at Grimsby, Ontario.

Catalogue number, 43389, U. S. National Museum.

Family FENESTELLIDÆ King.

Genus FENESTELLA Lonsdale.

Zoarium flabellate or funnel shaped, celluliferous on the inner side; branches generally straight, sometimes flexuous, connected at regular intervals by dissepiments; apertures in two rows, separated by a plain or tuberculated keel.

FENESTELLA CRIBROSA Hall.

Pl. XIX, figs. 3-5.

Fenestella cribrosa Hall, Nat. Hist. New York, Pal. II, 1852, p. 166, pl. 40D, figs. 3a, b.

Original description.—Frond expanded or cyathiform; branches strong, irregularly bifurcating; surface striated; transverse bars or dissepiments thin, scarcely enlarging at their junction with the branches; fenestrules small, quadrangular, sometimes oval; poriferous side unknown.

Fenestrules eleven in the space of three lines longitudinally, and eighteen in the same space transversely.

This species is readily distinguished by the small angular fenestrules, which are much more numerous than in the same space in any other species in this group; the branches are quite as strong, or even stronger than in *F. elegans*. It is easily distinguished, therefore, by the noncelluliferous side alone.

The specimen in the collections of the American Museum of Natural History, marked as the type of this species, does not agree with either Hall's description or figures, but appears to be an example of *Polypora incepta*. In the Rochester shale at the localities mentioned below, several examples of a neat little *Fenestella* have been found which agree in all essential respects with Hall's description and figures. Under these circumstances the writer believes that the specimen now designated as the type of the species has been inadvertently marked as such, and that the original type, which possibly has been lost, was an example of the form figured on Pl. XIX as *F. cribrosa*.

F. cribrosa may readily be distinguished from associated fenestellids by the small size and quadrangular shape of the fenestrules, the wide branches, and striated noncelluliferous side. On the celluliferous face the characters to be noted are the occurrence of protruding zoœcial apertures generally two but sometimes three to a fenestrule. The carina is moderately elevated but conspicuous spines are developed, averaging two to a fenestrule.

Occurrence.—Rather rare at Lockport; not uncommon at Middleport, N. Y.

Catalogue number, 35553, U. S. National Museum.

Fenestella elegans Hall.

Pl. XIX, figs. 1, 2.

Fenestella elegans Hall, Nat. Hist. New York, Pal. II, 1852, p. 164, pl. 40D, figs. 1a-g.
Fenestella elegans Grabau, Bull. New York State Mus., No. 45, 1901, p. 170, fig. 70.

The characters of this as well as most of the other Rochester shale fenestellids have been well illustrated by Hall, and the following brief description and measurements are given for completeness:

Fenestrules quadrangular, 3 to 4 in 3 mm., measuring longitudinally, and 6 in 3 mm. transversely. Zoœcia in two ranges separated by a sharp, moderately elevated carina, which in perfect specimens bears small spines at intervals of about 0.4 mm.; 4 zoœcia to a fenestrule. On the reverse side the fenestrules are quadrangular and two or three fine striations mark the branches.

Occurrence.—Fragments are common at Lockport, the type locality, and at all the other localities in western New York; good specimens occur also at Thorold, Hamilton, and Grimsby, Ontario.

Catalogue number, 44143, U. S. National Museum.

Genus PTILOPORELLA Hall.

Like *Fenestella*, except that at regular intervals the branches are considerably thickened and form rib-like supports.

Ptiloporella nervata (Nicholson).

Pl. XXIV, figs. 24, 25; Pl. XXVI, figs. 5, 6.

Fenestella nervata Nicholson, Pal. Ohio, II, 1875, p. 264, pl. 25, figs. 11, 11a.
Ptiloporella nervata Miller, North American Geol. and Pal., 1889, p. 319.

Several large examples and numerous fragments of this species were found at Grimsby, Ontario, and at Lockport, N. Y., one of them collected by Mr. Ulrich showing a spread of 160 mm. The rib-like development of the branches at regular intervals will cause the recognition of the form to be easy. The measurements of the Rochester shale specimens agree in all essential respects with the Ohio types as figured by Nicholson, so that there seems to be no question of their specific identity. For convenience of reference, Nicholson's figures are reproduced on Pl. XXIV.

Occurrence.—Rochester shale, Lockport, N. Y., and Grimsby, Thorold, and Hamilton, Ontario; Osgood beds, Osgood, Ind. Nicholson's types were found in the Niagara limestone at Cedarville, Ohio.

Catalogue numbers, 35743, 44144, U. S. National Museum.

Genus SEMICOSCINIUM Prout.

Zoarium as in *Fenestella* save that the zoœcia are developed on the outer side of the branches and that the keel has a much expanded summit.

Semicoscinium tenuiceps (Hall).

Pl. XIX, figs. 6, 7.

Fenestella tenuiceps Hall, Nat. Hist. New York, Pal. II, 1852, p. 165, pl. 40D, figs. 2a–b.
Semicoscinium tenuiceps Ulrich, Geol. Survey Illinois, VIII, 1890, p. 355.
Semicoscinium tenuiceps Grabau, Bull. New York State Mus., No. 45, 1901, p. 171, fig. 72.

Hall's figures bring out the characters of this species so well that there is no difficulty in distinguishing it from the associated fenestellids. The sharp, prominent carina, the essential feature of the genus, is somewhat flexuous or undulating toward the base of the zoarium but straighter in the upper portions. Three to 4 fenestrules may be measured in 3 mm. longitudinally, and 4 to 6 in the same space transversely; 4 to 5 zoœcia to a fenestrule. In the typical forms of *Semicoscinium*, the fenestrules on the inner or reverse side are subrhomboidal or rounded, but in this and other early species the fenestrules are much as in *Fenestella*, thus showing the origin of the genus.

Occurrence.—Abundant at Lockport, Rochester, Lewiston, and Niagara Falls, N. Y.; Grimsby, Ontario. Rare in the Osgood beds at Osgood, Ind.

Catalogue numbers, 35744, 35745, 35746, U. S. National Museum.

Genus POLYPORA McCoy.

Zoarium as in *Fenestella*, but the median keel is absent and two to eight rows of zoœcia are present on a branch.

Polypora incepta Hall.

Pl. XIX, figs. 8–13.

Polypora incepta Hall, Nat. Hist. New York, Pal. II, 1852, p. 167, pl. 40D, figs. 5a–f.
Polypora incepta Ulrich, Geol. Survey Illinois, VIII, 1890, p. 358, pl. 55, fig. 1.
Polypora incepta Grabau, Bull. New York State Mus., No. 45, 1901, p. 172, fig. 73.

This pretty form was adequately figured by Hall and is easily distinguished from associated fenestellids by its more robust habit of growth and the additional ranges of zoœcia. The specific characters are as follows: Zoœcia in three or four ranges; apertures oval, alternating, branches dividing regularly; dissepiments slender, little enlarged at their junction with the branches. Fenestrules oblong, quadrangular, 4 to 4.5 in 6 mm., measuring longitudinally, and 7 to 10 in the same space transversely. Reverse side of branches longitudinally striated.

Occurrence.—Not uncommon at Rochester and Lockport N. Y., and Grimsby, Ontario.

Catalogue numbers, 35747, 35748, 44145, U. S. National Museum.

Genus LOCULIPORA Hall.

The zoarium in this genus resembles *Fenestella* except that the dissepiments are short, typically reduced to a minimum, and that the branches and dissepiments are carinated, the carinæ coalescing and their summits much expanded, causing the obverse and reverse sides to have much the same appearance.

Loculipora was founded upon a Hamilton species, *Fenestella perforata* Hall, in which the branches approach so closely together that the zoœcial apertures appear to occupy the dissepiments as well as the branches. Thin sections, however, show that the dissepiments are, as usual, nonporiferous, but are reduced in length to such an extent that the branches are brought almost into contact. In the species discussed below, for which type of structure the generic term *Tectulipora* was proposed by Hall, the dissepiments, although more pronounced, still exhibit considerable variation in this respect and show their relation to the more typical forms of *Loculipora*. *Tectulipora*, therefore, could be distinguished from *Loculipora* only by the better development of the solid portions of the dissepiments, but at present this feature can not be considered as a good generic character.

LOCULIPORA ULRICHI n. sp.

Pl. XXI, fig. 2; Pl. XXV, figs. 22–24.

Compared with the Waldron species, *L. ambigua* Hall, this new form presents the following differences. First, the form of the zoarium, especially the basal portion, differs in that it is much narrower, is stalk-like, and expands much more slowly; second, the reverse side of the zoarium is less distinctly papillated; third, the obverse side is more regularly and constantly striated; fourth, the fenestrules on the obverse (outer) side are more regular and quadrate in form; fifth, the apertural rim of the zoœcia is less developed; and sixth, the zoarium as a whole is a trifle less robust. The stalk-like form of the zoarium, the regularly striated obverse side, and the quadrate form of the fenestrules are the most obvious features and will readily prevent confusion with related species.

Tangential sections of *L. ulrichi* show that the apertural rim is so little developed that it is scarcely distinguishable, but in similar sections of *L. ambigua* the rim is a very conspicuous feature. Compared further *L. ulrichi* has smaller fenestrules, 8 occurring in 5 mm., measuring lengthwise, and 10 in the same space transversely, while in *L. ambigua* 6 and 9 occur respectively in the same spaces.

The other Silurian species, *L. gothlandica* Ulrich, from the island of Gotland, is also related, but differs in that its fenestrules are smaller and less quadrate and the zoarium expands more rapidly.

This fine species is named in honor of Dr. E. O. Ulrich of the U. S. Geological Survey, to whom the writer is indebted for valued suggestions and help in the preparation of this paper.

Occurrence.—Lockport, Lewiston, Niagara Gorge, and Rochester, N. Y.; Grimsby and Thorold, Ontario.

Catalogue numbers, 35548, 35765, 35766, U. S. National Museum.

LOCULIPORA AMBIGUA var. PRECURSOR n. var.

Compare *Loculipora ambigua* (Hall), Twenty-eighth Ann. Rept. New York State Mus. (doc. ed.), 1876, pl. 11, figs. 17–21; (Mus. ed.) 1879, p. 123, pl. 11, figs. 17–21; Eleventh Ann. Rept. Indiana Geol. Nat. Hist., 1882, p. 248, pl. 11, figs. 17–21.

This subordinate name is proposed to distinguish a form of *Loculipora* found rather rarely in the Rochester shale at Lockport, and in the corresponding Osgood beds at Osgood, Ind. All of the specimens so far seen agree with *L. ambigua* in size and in having an obtusely conical zoarium with comparatively irregular branches and fenestrules. The reverse side of the branches is granulo-striate, agreeing in this respect with young specimens of *L. ambigua*, but the zoœcial apertures of the proposed variety are scarcely so much elevated as in the typical form of the species. Better material perhaps might show reasons for considering this a distinct species, but at present it seems best to consider it only an early variety of the Waldron form.

Occurrence.—Apparently rare in the Rochester shale at Lockport, N. Y., and in the Osgood beds at Osgood, Ind.

Catalogue numbers, 35554, 35555, U. S. National Museum.

Genus THAMNISCUS King.

Zoarium as in *Polypora*, but branches bifurcate more frequently and are rarely or not at all connected by dissepiments.

THAMNISCUS DICHOTOMUS (Hall).

Pl. XVIII, figs. 17–19; pl. XXVII, figs. 1–7.

Hornera ? dichotoma Hall, Nat. Hist. New York, Pal. II, 1852, p. 163, pl. 40 C, fig. 3d (not figs. 3a, b).
Subretepora dichotoma Miller, North American Geol. and Pal., 1889, p. 326.
Thamniscus dichotomus Ulrich, Geol. Survey Illinois, VIII, 1890, p. 607.
Stictopora dichotoma Whitfield and Hovey, Bull. Am. Mus. Nat. Hist., XI, pt. 2, 1899, p. 108.

At most localities showing the Rochester shale, abundant specimens of an undoubted and well-marked species of *Thamniscus* may be found which has been regarded as identical with *Hornera ? dichotoma* Hall. In their catalogue of type specimens in the American Museum of Natural History[a], Whitfield and Hovey referred this species to *Stictopora* with the remark that the specimen of *Hornera ? dichotoma* which bears Professor Hall's original ticket and references to the figures (Nat. Hist. New York, Pal. II, 1852, pl. 40C, figs. 3a, 3b) is not like either description or figures, but is elliptical in section and poriferous on both sides. Through the courtesy of Professor Whitfield the writer has been able to examine the type specimen referred to and finds it to be a narrow but otherwise normal example of the common *Pachydictya crassa* (Hall). Hall's figures, 3a and 3b, are poor and differ in several respects from the type specimen, so that it is a question whether this example is really the original. They might equally well represent a branch of the abundant *Thamniscus*. Under these circumstances it seems best to disregard these two figures and base the species upon the third figure, 3d, and Hall's description, instead of considering *Hornera ? dichotoma* as synonymous with *Pachydictya crassa*. As the original description quoted below and the figure on Pl. XXVII show, *Hornera ? dichotoma* is an easily distinguished form of *Thamniscus*, differing from other American forms by its extremely regular, dichotomously branching method of growth.

Original description.—Stems minute, semicylindrical, rigidly branching or bifurcating; one surface striated longitudinally, the other celluliferous; cells with round or oval apertures, which open from the summit of a pustuliform elevation.

This species is extremely minute, its characters being scarcely distinguishable with the naked eye. In its striated and poriferous surface it resembles in general characters *Retepora;* but the mode of branching is different, and the cells are round or oval, with the openings elevated above the surface of the branch, which does not occur in *Retepora.*

The following description is believed to contain the essential characters of the species:

Zoarium of small, slender, dichotomously dividing branches generally 0.4 or 0.5 mm. in breadth but increasing to 0.6 or 0.7 mm. before a bifurcation. Branching regular, occurring at intervals of 5 to 7 mm.; angle of bifurcation small, generally less than 30°. Branches flat on the reverse, slightly convex on the obverse or celluliferous side. Zoœcia usually arranged in three or four ranges, but just before a bifurcation the number may be increased to five or six. Zoœcial apertures circular or oval, 0.10 to 0.12 mm. in diameter opening from the summits of small pustuliform elevations, 8 in 2 mm. measured longitudinally. In young specimens the zoœcia are arranged in well-marked longitudinal series separated by a low ridge, the zoœcial spaces are faintly marked with small nodes, and the elevations from which the apertures open are pronounced. In old examples the separating ridges and zoœcial elevations are less pronounced while the apertural walls bear numerous nodes which often indent the zoœcial cavity. The noncelluliferous side is longitudinally striated, the lines as shown on well-preserved specimens being composed of small nodes or granules.

The regular, dichotomously branching method of growth, the flat, striated, noncelluliferous face, and the slightly convex obverse side with small rounded zoœcia are characters which readily distinguish *Thamniscus dichotomus* from all associated bryozoa.

Occurrence.—Lockport, Rochester, and other localities in western New York; Grimsby and Hamilton, Ontario.

Catalogue numbers, 35558, 35751, 44147, U. S. National Museum.

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[a] Bull. Am. Mus. Nat. Hist., XI, pt. 2, 1899, p. 108.

Family PTILODICTYONIDÆ Ulrich.

Genus PHÆNOPORA Hall.

Distinguished from *Ptilodictya* by the presence of two or more mesopores in each interspace between the ends of the apertures.

PHÆNOPORA ENSIFORMIS Hall.

Pl. XXVII, figs. 8, 9.

Phænopora ensiformis Hall, Nat. Hist. New York, Pal. II, 1852, p. 48, pl. 18, figs. 8a–c.
Phænopora ensiformis Nicholson and Hinde, Canadian Journal, new ser., XIV, 1874, p. 142.
Phænopora ensiformis Nicholson, Pal. Province Ontario, 1875, p. 45, figs. 19, 2, 2a.
Ptilodictya ensiformis Ulrich, Jour. Cincinnati Soc. Nat. Hist., V, 1882, p. 172.
Phænopora ensiformis Foerste, Geol. Survey, Ohio, VII, 1895, p. 598.

A narrow, unbranched species of *Phænopora* occurs not uncommonly at most of the Rochester shale localities and agrees in all respects with the Clinton form described by Hall as *Phænopora ensiformis*. In this form the characteristic mesopores occupying the interspaces between the ends of the aperture are often made out with difficulty and this fact causes the zoarium to resemble *Ptilodictya* very closely. Upon close examination, however, or by means of thin sections, two small mesopores may be found occupying the position normal for *Phænopora*.

The zoarium, which is bifoliate and pointed at the base for articulation, averages 25 mm. in length and 2 mm. in width; each face bears from 7 to 11 parallel rows of zoœcia; 6 zoœcia in 2 mm. measured longitudinally; apertures in linear series between slightly raised longitudinal lines, quadrangular, measuring about 0.18 mm. by 0.30 mm., but in marginal series, oval slightly oblique and larger than in the middle ranges.

Occurrence.—Abundant in the Clinton rocks of western New York and Ontario, and not uncommon in the Rochester shale of the same region. Rare in the Clinton rocks of Ohio and also in the Osgood beds at Osgood, Ind.

Catalogue number, 35752, U. S. National Museum.

PHÆNOPORA FIMBRIATA var. CANADENSIS n. var.

Pl. XXI, figs. 17–19.

Compare *Phænopora fimbriata* (James) Foerste, Bull. Sci. Lab. Denison Univ., II, 1887, p. 161; ibid., III, 1888, pl. 15, fig. 7.

The form for which the above varietal name is proposed agrees in method of growth with the characteristic Ohio Clinton species *Phænopora fimbriata*, but differs in the following respects. First the zoœcia of the variety are smaller, 8 occurring in 2 mm., measuring lengthwise, while only 6 are found in the same space in the Clinton form. Second, the walls of the variety are considerably thinner while the mesopores are small and inconspicuous. While the thin walls and small, inconspicuous mesopores of the variety may be due to a youthful stage of growth in the specimens studied, yet the smaller zoœcia seem to be of sufficient importance to designate the Rochester shale form as a good variety if not a species.

Occurrence.—Rochester shale, Lockport, N. Y., and Grimsby, Ontario.

Catalogue numbers, 35753, 44148, U. S. National Museum.

Genus CLATHROPORA Hall.

Like *Ptilodictya* save that the zoarium consists of branches anastomosing so as to form a regular network with round or oval fenestrules.

CLATHROPORA FRONDOSA Hall.

Pl. XX, figs. 5–11; Pl. XXI, figs. 6, 7.

Clathropora frondosa Hall, Nat. Hist. New York, Pal. II, 1852, p. 160, pl. 40B, figs. 5 a-c.
Clathropora frondosa Grabau, Bull. New York State Mus. No. 45, 1901, p. 174, fig. 75.

Zoarium large, frondescent, consisting of anastomosing branches forming a network which in old examples is often 10 cm. or more in length and width. Proximal portion marked with finer longitudinal striæ, long and pointed in young examples, but with age becoming so thickened as to be wedge shaped. This part of the zoarium articulates into a cup-shaped depression of a spreading base attached to foreign objects. The older the zoarium the more thickened is the proximal portion, and here the branches sometimes become so broad that the fenestrules are obliterated. Branches elliptical in cross section 1.5 to 3 mm. in breadth and carrying on each side from 8 to 15 or even more ranges of zoœcia arranged in linear series. Fenestrules oval, 1.2 by 2 mm. being an average dimension although, because of age and position, considerable variation is found; about 2.5 or 3 in 10 mm., measuring longitudinally, and the same number in 8 or 9 mm. diagonally. Zoœcial apertures rhomboidal, oblong-quadrangular, or elongate-hexagonal, the shape varying in different portions of the zoarium, 8 to 9 in 2 mm. longitudinally and 11 in the same space measured transversely.

There is no associated species save the variety mentioned below with which this might be confounded. A large complete example with its network of branches, oval fenestrules and pointed base forms an exceedingly handsome cabinet specimen.

Occurrence.—Fragments are common, but complete specimens are more rarely found. Lockport, N. Y., Thorold, Hamilton, and Grimsby, Ontario.

Catalogue numbers, 44146, 44147, U. S. National Museum.

CLATHROPORA FRONDOSA INTERMEDIA Nicholson and Hinde.

Clathropora intermedia Nicholson and Hinde, Canadian Journal, new ser., XIV, 1874, p. 140, fig. 5.
Clathropora intermedia Nicholson, Pal. Province Ontario, 1875, p. 59, fig. 29 a, b.

Original description.—*Clathropora intermedia* Nich. and Hinde. Perforations moderately large, from two-thirds to one line in diameter, placed at intervals of rather more than half a line, six or seven rows of cells in half line, and seven or eight rows between any two perforations.

Niagara limestone, Thorold, Ontario.

The authors of this form distinguished it from *Clathropora frondosa* mainly on account of the possession of larger fenestrules. As shown under the above description, the size of the fenestrules is a variable character. The only additional character found by the writer to distinguish the two forms is that the zoœcia of *C. intermedia* are slightly larger than those of Hall's species; the former having 7 in 2 mm. longitudinally, and 9 to 10 in the same space transversely, while the latter, as stated above, has 8 and 11 in the corresponding measurements. The two distinctive characters mentioned are so slight that *C. intermedia* can hardly be regarded as more than a variety of *C. frondosa*.

Occurrence.—Rochester shale, Thorold and Hamilton, Ontario.

Catalogue numbers, 35749, 35750, U. S. National Museum.

CLATHROPORA ALCICORNIS Hall.

Pl. XX, figs. 1-4.

Clathropora alcicornis Hall, Nat. Hist. New York, Pal. II, 1852, p. 159, pl. 40B, figs. 4 a-c.
Clathropora alcicornis Grabau, Bull. New York State Mus., No. 45, 1901, p. 174, fig. 76.

This form is easily recognized from the figures given by Hall and is distinguished from all other species of the genus by the failure of the branches to form a network with oval fenestrules as in the typical species. Otherwise the structure is as required for the genus, as the

thin section prepared from the type specimen, figured on Pl. XX, indicates. The zoœcia are large, 5 to 6 in 2 mm., measuring longitudinally and about 10 in the same space transversely.

Occurrence.—Rare in the shales at Lockport, N. Y.

Family STICTOPORELLIDÆ Nickles and Bassler.

Genus TÆNIODICTYA Ulrich.

Zoarium growing from a basal expansion into narrow, dichotomously divided branches or broad fronds; zoœcial structure much as in *Ptilodictya*. The species described below, although the earliest known, appears to possess all the essential generic characters.

TÆNIODICTYA SCHUCHERTI n. sp.

Pl. XXVII, figs. 10–13.

Zoarium, as observed from the only specimen found, of flexuous, parallel-edged branches, 3 mm. in width, dividing dichotomously at intervals of from 6 to 9 mm. Zoœcial apertures rather large for the genus, 4 in 2 mm., measuring longitudinally, and 7 in the same space transversely, arranged in longitudinal series.

The figures of the internal structure show that this form has all the characters of *Tæniodictya* with the exception that the interspaces are not transversely lined as in other species of the genus. This feature is one of age and its absence in the specimen studied may be due to its youthful condition.

The large zoœcia will distinguish this from other species of the genus. The only associated species with which it might be confused is *Pachydictya crassa*, but the oval aperture with thick ringlike walls and different internal structure of the latter are points of difference.

The specific name is in honor of Prof. Charles Schuchert, who collected the type specimen and to whom the writer is indebted for many favors.

Occurrence.—Rochester shale, Grimsby, Ontario.

Catalogue number, 35772, U. S. National Museum.

Family RHINIDICTYONIDÆ Ulrich.

Genus PACHYDICTYA Ulrich.

The species of this genus found in the Rochester shale is a cosmopolitan form which has been noted in most of the divisions of the Niagara. It is, therefore, of little value for purposes of exact correlation and marks the rocks of this group in general only.

PACHYDICTYA CRASSA (Hall).

Pl. XVIII, figs. 11, 12; Pl. XXI, figs. 14–16.

Stictopora crassa Hall, Nat. Hist. New York, Pal. II, 1852, p. 45, pl. 18, figs. 4 a–c.
Ptilodictya crassa Nicholson and Hinde, Canadian Journal, new ser., XIV, 1874.
Stictopora scitula Hall and Simpson, Nat. Hist. New York, Pal. VI, 1887, pl. 61, figs. 24, 25.
Pachydictya scitula Ulrich, Geol. and Nat. Hist. Survey Minnesota, Final Rept., III, pt. 1, 1893, p. 147.

The external features of this species have been well figured by Hall and Simpson and there is no difficulty in the identification of the form.

The zoarium consists of a narrow, dichotomously branching frond with sharp, parallel edges; branches elliptical in cross section with narrow noncelluliferous margins marked by faint striæ; zoœcial apertures oval, arranged in parallel longitudinal rows separated by linear ridges, 4 in 2 mm. measuring lengthwise.

The narrow bifoliate branches with large, rounded zoœcia distinguish the species from all associated forms.

Occurrence.—Common at all the Rochester shale localities in New York and Ontario; also very abundant in the Osgood beds at Osgood, Ind., as well as in the Niagaran rocks in general.

Catalogue numbers, 35754, 35755, U. S. National Museum.

Family RHABDOMESONTIDÆ Vine.

Genus ACANTHOCLEMA Hall.

Zoœcial tubes arising from a filiform axis in the center of the slender, ramose branches; apertures oval, in diagonally intersecting or linear series; acanthopores generally numerous.

ACANTHOCLEMA ASPERUM (Hall).

Pl. XXI, figs. 3–5; Pl. XXIV, figs. 7–9; Pl. XXV, figs. 17–20.

Trematopora aspera Hall, Nat. Hist. New York, Pal. II, 1852, p. 154, pl. 40A, figs. 10 a–c.
Batostomella? aspera Nickles and Bassler, Bull. U. S. Geol. Survey No. 173, p. 189.

Zoarium of small cylindrical ramulets about 1 mm. in diameter. Surface smooth but, under a lens, hirsute because of the numerous acanthopores. Zoœcial apertures oval or elongate elliptical, usually 0.25 mm. in their longer diameter and 0.10 in the shorter, 4 in 2 mm. measuring lengthwise, arranged in rather regular longitudinal rows, of which there are 7 in 2 mm. Acanthopores numerous, as many as 8 or 10 surrounding an aperture and often inflecting it.

The main features brought out in vertical sections are the growth of the zoœcial tubes from a filiform axis, the small inferior hemiseptum, and the thick, laminated deposit of the interzoœcial spaces traversed by the acanthopores. Tangential sections through the mature region show the numerous acanthopores and thick interzoœcial tissue, while deeper sections reveal the rhomboidal shape of the primitive zoœcia.

This very abundant species might be confused with the equally abundant *Batostomella granulifera*, but the larger zoaria, smaller and more numerous acanthopores, less regularly arranged zoœcia, and interzoœcial spaces occupied by mesopores are points of difference. Internally the two are widely different.

Occurrence.—Rochester shale at Lockport, Rochester, and Niagara Falls, N. Y.; Grimsby, Hamilton, and Thorold, Ontario; Osgood beds at Osgood, Ind.

Catalogue numbers, 35756, 44149, U. S. National Museum.

Family ARTHROSTYLIDÆ Ulrich.

Genus NEMATOPORA Ulrich.

The following is a well-developed species of this genus, differing but little from some of the Ordovician forms. *Nematopora* is distinguished from other members of the Arthrostylidæ in that the zoarium is continuous instead of jointed above the pointed basal extremity.

NEMATOPORA MINUTA (Hall).

Pl. XVIII, fig. 10. Pl. XXI, figs. 8–11.

Trematopora ? (*Trachypora*) *minuta* Hall, Twenty-eighth Ann. Rept. New York State Mus. (doc. ed.), pl. 11, fig. 8.
Trematopora minuta Hall, Twenty-eighth Ann. Rept. New York State Mus. (Mus. ed.), p. 113, pl. 11, fig. 8.
Trematopora minuta Hall, Eleventh Ann. Rept. Indiana Geol. Nat. Hist., p. 234, pl. 10, fig. 8.
Nematopora minuta Ulrich, Geol. Survey Illinois, VIII, p. 645.

In the Rochester shale collections numerous examples of a single species of *Nematopora* have been observed, which, upon comparison with the type of Hall's *Trematopora minuta*, from the Niagaran at Waldron, Ind., have proved to belong to the same species.

Original description.—Bryozoum ramose, very slender; branches frequent, widely diverging; diameter, 0.5 millimeter. Cell apertures elongate-oval, length about 0.4 mm., and width 0.2 mm.; distance from each other longitudinally about equal to the length of an aperture, arranged in spiral rows along the branch. Margins distinctly elevated and granulose, and separated from each other by tortuous lines of nodes.

To the above description may be added the following: The zoarium is ramose, but the lower end is pointed for attachment in a base spread over other objects. Measuring longi-

tudinally 5 to 6 zoœcia may be counted in 2 mm. Thin sections (see Pl. XXI, figs. 8–11) show that the species has all the internal characters of *Nematopora*.

In the small size of the zoarium and in the arrangement of the zoœcia they are quite different from associated bryozoa with the exception of *Acanthoclema asperum* (Hall). The latter, however, may readily be distinguished by its more robust growth, stronger granules or acanthopores, and less regularly arranged zoœcia. Internally the two are quite different.

Occurrence.—Rather uncommon in the Waldron shale at Waldron, Ind. More abundant in the Rochester shale at all of the localities in western New York and Ontario.

Catalogue numbers, 35773, 35774, U. S. National Museum.

Family RHINOPORIDÆ Ulrich.

This family was established provisionally by Ulrich [a] for the reception of the unique Silurian generic type *Rhinopora* Hall, the bifurcating structures traversing the surface of the type species, *R. verrucosa*, being so different from any known bryozoan that the genus could not be classified otherwise. Since that time Mr. Ulrich and the writer, while investigating the subject of Paleozoic bryozoa in general, discovered that the family could with slight emendation include three other genera, namely, *Stictotrypa* Ulrich, *Diamesopora* Hall, and *Lichenalia* Hall. It was also at this time that the relations and structure of the last two genera mentioned were ascertained. Up to this time *Diamesopora* was supposed to be congeneric with *Coeloclema* Ulrich, an Ordovician genus belonging to the Ceramoporidæ, while *Lichenalia* was regarded as a synonym of *Fistulipora* McCoy. *Stictotrypa*, although placed under the Ptilodictyonidæ, had always proved a troublesome genus to locate naturally. The four genera now constituting the Rhinoporidæ have a few characters somewhat at variance, but when reduced to their simplest terms, all agree in possessing the following cryptostomatous characters: Oblong or rhomboidal zoœcia, direct vestibules, and hemisepta, the latter, however, being but little developed. *Rhinopora* is a broad bifoliate type, *Diamesopora* forms hollow ramose branches, *Stictotrypa* has narrow bifoliate branches, and the growth of *Lichenalia* is in semicircular, unilaminate expansions.

The first opportunity to publish the new information concerning the Rhinoporidæ occurred in United States Geological Survey Bulletin No. 173, where, with the kind permission of Mr. Ulrich, Nickles and the writer gave short emended descriptions of the family and the genera constituting it. For convenience of reference, these descriptions are repeated below in their respective places.

With the emendations pointed out above, the family Rhinoporidæ may now be defined as follows:

Zoarium variable in form; zoœcia prone along the basal membrane, simple, oblong, or rhomboidal; vestibules direct, hemisepta wanting or almost so; front of zoœcia below vestibule commonly strengthened with solid or vesicular tissue.

Genus RHINOPORA Hall.

Two species considered by their authors as members of this genus have been described from the Rochester shale. The first, *Rhinopora tuberculosa* Hall, is now known, from an examination of the type specimen by the writer, to belong to *Fistulipora*, while the second, *Rhinopora curvata* Ringueberg, seems to be a true member of the genus.

The generic characters of *Rhinopora* are as follows. Zoarium forming large, undulating bifoliate expansions, celluliferous on both sides; surface usually smooth, rarely with solid monticules, and traversed by slender, rounding, bifurcating ridges, which appear as shallow grooves when the surface is worn; apertures nearly circular, occupying the summits of prominent papillæ; mesopores present, but closed at the surface; large median tubuli in the mesotheca.

[a] Geol. Survey Illinois, VIII, 1890, p. 388.

Rhinopora curvata Ringueberg.

Pl. XXII, figs. 12, 13.

Rhinopora curvata Ringueberg, Bull. Buffalo Soc. Nat. Hist., V, 1886, p. 19, pl. 2, fig. 14.

Original description.—Corallum very thin; foliate. Cells round or roundish oval, placed near the upper side of the thin pustulate calices that rise gradually from the surface at their lower side, thereby giving an upward direction to the cells. The cells are arranged closely in regular rows that cross each other diagonally; thus making a quincunx disposition of them; the regularity of the rows is sometimes disturbed by the bifurcation of a row as the frond increased in size.

Curve amounting to the width of three rows in one-half inch. Cells seven to one-eighth of an inch in the rows.

This coral bears some resemblance to *R. verrucosa* of the Clinton group; which differs, however, in the cells being much more prominent, the pustulose character being more defined, rising abruptly from the surface, in having the cell opening centrally located, and by its small cells.

Rhinopora curvata may be readily distinguished from all associated Rochester shales species by its broad, bifoliate growth, large zoœcia (4 in 2 mm., measuring along the diagonal rows), with the posterior portion of the peristome considerably elevated, and the arrangement of the apertures in well-defined diagonal lines.

Only a few specimens of this species have been studied, and none of these exhibits the characteristic covered canals of typical *Rhinopora*. Otherwise, however, the internal structure is essentially the same, and also differs in no way but method of growth from that of *Lichenalia*.

Occurrence.—Rochester shale, Lockport, N. Y., and Grimsby, Ontario.

Catalogue number, 35767, U. S. National Museum.

Genus LICHENALIA Hall.

Lichenalia Hall, Nat. Hist. New York, Pal. II, 1852, p. 171.

Lichenalia Nickles and Bassler, Bull. U. S. Geol. Survey No. 173, p. 54. (Not *Lichenalia* of other authors.)

This genus was founded by Hall upon thin, epithecated, subcircular expansions occurring in the Rochester shale at Lockport, designated by him as *Lichenalia concentrica*. In parting the shale, the rough celluliferous sides of these expansions naturally adhere more closely to the matrix, and as a result the noncelluliferous, epithecated side is usually observed. Associated epithecated bryozoa from Lockport and elsewhere have been referred to the species irrespective of any other character, and *Lichenalia concentrica* is usually quoted as a characteristic Niagaran fossil wherever the rocks of that formation are studied. Here the value of thin sections is demonstrated, as it is only by their aid that the true relations of *Lichenalia* could be definitely ascertained. Hall's original definitions of the genus and species are of value only in that the genotype is restricted to the thin, epithecated expansions occurring at Lockport and elsewhere in western New York. All his later definitions of the genus are based on species of *Fistulipora*, which are in no manner related to the original types of *Lichenalia*. A study of Hall's type of *L. concentrica* and of other examples from New York shows that the generic characters are as follows: "Zoarium a subcircular unilaminar expansion; zoœcia prostrate; elongate-subrhomboidal, with direct subtubular vestibules; apertures rounded, with peristome much elevated on the posterior side; interspaces depressed, (?) cellulose."

To this definition of Nickles and the writer may be added the following remarks. Thin sections show that, as in *Rhinopora*, the surface of *Lichenalia concentrica* is traversed by slender, bifurcating ridges which in reality are closed canals. These probably represent the maculæ of other bryozoa, and are more often seen in thin sections because, as mentioned above, the surface is seldom observed. The occurrence of these canals in both *Rhinopora* and *Lichenalia* and the other points of agreement of the two genera leave their different methods of growth as the only distinguishing character. The cellulose (?) interspaces mentioned in the above definition of the genus have been determined only by the study of thin sections. The few specimens showing the celluliferous face have been in

such a state of preservation or condition of growth that the interspaces have always appeared depressed and solid. From the manner in which the walls of the mesopores occupying the zoœcial interspaces have been inserted, as shown on Pl. XXII, their purpose seems to have been mainly that of a strengthening tissue.

Altogether, both *Lichenalia* and *Rhinopora* are unique types of bryozoa and, so far as known, are restricted to Niagaran strata. Species described under these generic names from other horizons seem in all instances to belong elsewhere.

Lichenalia concentrica Hall.

Pl. XXII, figs. 1-6; Pl. XXVI, figs. 7-10.

Lichenalia concentrica Hall, Nat. Hist. New York, Pal. II, 1852, p. 171, pl. 40E, figs. 5a-g.

As this is the genotype and apparently the only valid species of the genus, the specific characters are as given in the generic diagnosis. The thin, unilaminate zoarium, large zoœcia (averaging 0.5 mm. in their longer diameter), and the meandering surface canals, are characters making the species easily recognized. Good specimens can be found only in the unweathered shales, and, in parting the shales, usually the epithecated side alone is shown. The disintegrated shales yield small fragments, but these, especially when still partly covered with clay, bring out the fact that the posterior portion of the zoœcial wall is unusually high. On account of the unusual structure shown in this type, the species is figured in detail.

Occurrence.—A characteristic fossil of the Rochester shale at Lockport, Rochester, and other localities in western New York. Good specimens may also be had at Grimsby, Ontario.

Catalogue number, 35775, U. S. National Museum.

Genus STICTOTRYPA Ulrich.

Zoarium ramose, not pointed at the base; branches dichotomously dividing, narrow, compressed; apertures circular or elliptical, with distinct, usually evenly elevated peristomes; interspaces flat or concave, composed of horizontally laminated solid tissue.

Stictotrypa punctipora (Hall).

Pl. XXII, figs. 7-11; Pl. XXIV, figs. 26, 27.

Stictopora punctipora Hall, Nat. Hist. New York, Pal. II, 1852, p. 157, pl. 40B, figs. 2a-c.
Stictotrypa punctipora Ulrich, Geol. Survey Illinois, VIII, 1890, p. 394, fig. 13a.

Hall and Ulrich (op cit.) have figured this species so well that its recognition is a matter of no difficulty. The more important of their figures, together with views of the internal structure, are given on the plates mentioned above.

The narrow, bifoliate zoarium, with branches averaging 3 mm. in width, and the elliptical zoœcial apertures with a well-marked peristome are so different from other bryozoa of this formation that comparison is not necessary. Measuring along one of the rows, 6 to 7 zoœcia may be counted in a space of 2 mm.

In thin sections the rhomboid or square shape of the primitive zoœcium, the blunt inferior hemiseptum, and the short cryptostomatous cell are well shown. With respect to these characters, thin sections of this species and *Diamesopora dichotoma* are strikingly similar, as a reference to the figures of the internal structure will show.

The various species of *Stictotrypa* resemble each other closely, but *S. punctipora* may readily be separated by the fact that the peristome is highest anteriorly, thus giving a notched appearance to the aperture.

Occurrence.—Rather abundant at Lockport, Rochester, and Niagara Falls, N. Y., Grimsby, Hamilton, and Thorold, Ontario.

Catalogue number, 35776, U. S. National Museum.

Genus DIAMESOPORA Hall.

Diamesopora Hall, Nat. Hist. New York, Pal. II, 1852, p. 158 (not defined).
Diamesopora Nickles and Bassler, Bull. U. S. Geol. Survey No. 173, 1900, p. 54.
Diamesopora Grabau, Bull. New York State Mus., IX, No. 45, 1901, p. 175.

Diamesopora Hall and Simpson, Nat. Hist. New York, Pal. VI, 1887, pp. xv, 19 (definition based on species of *Chilotrypa*).
Diamesopora Miller, North American Geol. and Pal., 1889, p. 30. (Includes, besides the genotype, species of *Cœloclema* and *Chilotrypa*.)
Diamesopora Simpson, Fourteenth Ann. Rept. State Geol. New York for the year 1894, 1897, p. 566. (Definition contains in part characters of both *Diamesopora* and *Chilotrypa*.)
Diamesopora Ulrich, Geol. Survey Illinois, VIII, 1890, pp. 380, 467; Geol. and Nat. Hist. Survey Minnesota, Final Rept. III, pt. 1, 1893, p. 330; Zittel's Textbook Pal. (Eng. ed.), 1896, p. 268 (= *Coeloclema*).

A study of thin sections of the genotype of Hall's *Diamesopora*, *D. dichotoma*, and of his *Trematopora osculum*, a related species found very abundantly in the Waldron shales in Indiana, showed, as indicated before, that the genus has until recently been misunderstood and incorrectly defined and classified. Ulrich proposed the name *Cœloclema* for similar, hollow-stemmed Ordovician species, but before defining the genus, abandoned it under the impression that his forms were congeneric with *D. dichotoma*. As the above synonymy shows, this author based his definition of *Diamesopora* more upon species of *Cœloclema* than upon the genotype. The two genera are now known to be so far removed from each other as to be classified under different orders, *Coeloclema* being a member of the Ceramoporidæ, a family of Cyclostomata, and *Diamesopora* having the rhomboidal primary zoœcia and tubular vestibule characteristic of the Cryptostomata.

Nickles and the writer (op. cit.) defined the genus as follows: "Zoarium ramose, of hollow stems lined internally by an epitheca; zoœcia simple, hexagonal, or rhomboidal, with an oval orifice in the anterior half, which, with growth, forms a tubular vestibule; apertures with peristomes equally elevated or highest posteriorly; intervestibular spaces compact or horizontally laminated."

The diagnostic characters are the mode of growth, the cryptostomatous zoœcia, tubular vestibule, and compact intervestibular space. Lunaria are absent, but their structures are simulated when the peristomes are highest posteriorly. A blunt superior hemiseptum is often found projecting from the zoœcial wall, but is seldom a conspicuous feature.

DIAMESOPORA DICHOTOMA Hall.

Pl. XXI, figs. 12, 13; Pl. XXIV, figs. 28–30.

Diamesopora dichotoma Hall, Nat. Hist. New York, Pal. II, 1852, p. 158, pl. 40B, figs. 3a–d.
Diamesopora dichotoma Grabau, Bull. New York State Mus., No 45, 1901, p. 175, fig. 78.

Fragments of this species are usually found as flattened branches crushed by pressure, but the normal zoarium is of smooth, hollow, ramose, cylindrical stems, 2 to 4 mm. in diameter, with the internal cavity now occupied by clayey matter.

The largest specimen seen shows that, as a rule, the zoaria seldom branches, a long straight stem of 4 or 5 cm. in length usually occurring. The crust forming the hollow zoarium is about 0.60 mm. in diameter, the interior or basal portion lined with a transversely striated basal membrane—the epitheca. Maculæ inconspicuous and only distinguished by the absence of zoœcial apertures. In young specimens the zoœcia are seen to be arranged in regularly ascending spiral lines, but the older the zoarium the more obscured becomes this arrangement. The zoœcia in young examples have well-marked peristomes generally elevated highest anteriorly, but these also become less conspicuous with age, and in many specimens the peristomes are not visible at all.

Internal characters.—Thin sections of this species are particularly instructive, since without them the cryptostomatous character of the genus would not be suspected. They show (1) that the primitive zoœcium is rhomboidal in outline, (2) that a tubular vestibule is developed in the anterior portion, (3) that at the junction of the posterior wall of the primi-

tive zoœcium and the vestibule, a blunt superior hemiseptum is sometimes developed, and (4) the investibular spaces are filled by a dense, horizontal, laminated tissue. The orifice is about 0.2 mm. in diameter, and counting along one of the spiral rows, 6 are found in 2 mm.

Occurrence.—Abundant at Lockport, Rochester, Lewiston, Niagara Falls, and other New York localities; also at Hamilton and Grimsby, Ontario.

Catalogue number, 35759, U. S. National Museum.

SYNONYMIC LIST OF SPECIES.

Acanthoclema asperum (Hall).
Allonema waldronense Ulrich and Bassler.
Ascodictyon radiciforme Vine. See Vinella radiciformis.
Ascodictyon siluriense (Vine).
Ascodictyon stellatum var. siluriense Vine. See Ascodictyon siluriense.
Aulopora consimilis Lonsdale. See Berenicea consimilis.
Batostomella? aspera Nickles and Bassler. See Acanthoclema asperum.
Batostomella granulifera (Hall).
Berenicea consimilis (Lonsdale).
Berenicea elegans Nickles and Bassler. See Berenicea consimilis.
Berenicea membranacea Nickles and Bassler. See Berenicea consimilis.
Bythopora spinulosa (Hall).
Callopora aspera Hall. See Lioclema asperum.
Callopora clausa n. sp.
Callopora elegantula Hall.
Callopora florida Hall. See Nicholsonella florida.
Callopora laminata Hall. See Fistulipora laminata.
Callopora magnopora Foerste.
Callopora nummiformis Hall. See Mesotrypa nummiformis.
Calloporella? nummiformis Ulrich. See Mesotrypa nummiformis.
Ceramopora foliacea Hall. See Meekopora foliacea.
Ceramopora imbricata Hall.
Ceramopora incrustans Hall. See Fistulipora crustula.
Ceramopora niagarensis n. sp.
Ceramopora orbiculata Ringueberg. See Ceramoporella orbiculata.
Ceramoporella irregularis n. sp.
Ceramoporella orbiculata (Ringueberg).
Chætetes expansus Ringueberg. See Orbignyella expansa.
Chilotrypa? coalescens Nickles and Bassler. See Chilotrypa ostiolata.
Chilotrypa ostiolata (Hall).
Clathropora alcicornis Hall.
Clathropora frondosa Hall.
Clathropora frondosa intermedia Nicholson and Hinde.
Clathropora intermedia Nicholson and Hinde. See Clathropora frondosa intermedia.
Cœloclema cavernosa n. sp.
Diamesopora dichotoma Hall.
Diastopora consimilis Vine. See Berenicea consimilis.
Diastoporella consimilis Vine. See Berenicea consimilis.
Diploclema sparsum (Hall).
Diploclema sparsum argutum n. var.
Diplotrypa milleri Ulrich. See Mesotrypa nummiformis.
Diplotrypa walkeri n. sp.
Drymotrypa diffusa Ulrich. See Pseudohornera diffusa.
Drymotrypa niagarensis Ulrich. See Pseudohornera niagarensis.
Eridotrypa nodulosa n. sp.

Eridotrypa similis n. sp.
Eridotrypa solida (Hall).
Eridotrypa spinosa n. sp.
Eridotrypa striata (Hall).
Fenestella cribrosa Hall.
Fenestella elegans Hall.
Fenestella nervata Nicholson. See Ptiloporella nervata.
Fenestella tenuiceps Hall. See Semicoscinium tenuiceps.
Fistulipora crustula n. sp. or n. name.
Fistulipora laminata (Hall).
Fistulipora lockportensis n. sp.
Fistulipora tuberculosa (Hall).
Homotrypa? solida Nickles and Bassler. See Eridotrypa solida.
Hornera? dichotoma Hall. See Thamniscus dichotomus.
Idiotrypa parasitica Ulrich. See Idiotrypa punctata.
Idiotrypa punctata (Hall).
Leioclema florida Ulrich. See Nicholsonella florida.
Leioclema? laminatum Ulrich. See Fistulipora laminata.
Leptotrypa maculata Ulrich. See Spatiopora maculata.
Lichenalia concentrica Hall.
Lioclema asperum (Hall).
Lioclema circinctum n. sp.
Lioclema explanatum n. sp.
Lioclema florida Grabau. See Nicholsonella florida.
Lioclema globulare n. sp.
Lioclema (?Nicholsonella) laminatum Nickles and Bassler. See Fistulipora laminata.
Lioclema multiporum n. sp.
Lioclema peculiare n. sp.
Lioclema ramulosum n. sp.
Lioclemella maccombi n. sp.
Loculipora ambigua precursor n. var.
Loculipora ulrichi n. sp.
Meekopora foliacea (Hall).
Mesotrypa milleri Nickles and Bassler. See Mesotrypa nummiformis.
Mesotrypa nummiformis (Hall).
Mitoclema sarlei n. sp.
Monotrypa benjamini n. sp.
Monotrypa osgoodensis n. sp.
Monotrypa pediculata n. sp.
Nematopora minuta (Hall).
Nicholsonella florida (Hall).
Nicholsonella ringuebergi n. sp.
Orbignyella expansa (Ringueberg).
Orbignyella magnopora n. sp.
Pachydictya crassa (Hall).
Pachydictya scitula Ulrich. See Pachydictya crassa.
Paleschara? aspera Hall. See Spatiopora maculata.
Paleschara maculata Hall. See Spatiopora maculata.
Phænopora ensiformis Hall.
Phænopora fimbrata canadensis n. var.
Phylloporina asperato-striata (Hall).
Polypora incepta Hall.
Pseudohornera diffusa (Hall).
Pseudohornera niagarensis (Hall).

Ptilodictya crassa Nicholson and Hinde. See Pachydictya crassa.
Ptilodictya ensiformis Ulrich. See Phænopora ensiformis.
Ptiloporella nervata (Nicholson).
Retepora asperato-striata Hall. See Phylloporina asperato-striata.
Retepora diffusa Hall. See Pseudohornera diffusa.
Rhinopora curvata Ringueberg.
Rhinopora tuberculosa Hall. See Fistulipora tuberculosa.
Rhombotrypa spinulifera n. sp.
Rhopalonaria attenuata Ulrich and Bassler.
Sagenella elegans Hall. See Berenicea consimilis.
Sagenella membranacea Hall. See Berenicea consimilis.
Semicoscinium tenuiceps (Hall).
Spatiopora maculata (Hall).
Stictopora crassa Hall. See Pachydictya crassa.
Stictopora dichotoma Whitfield and Hovey. See Thamniscus dichotomus.
Stictopora punctipora Hall. See Stictotrypa punctipora.
Stictopora scitula Hall and Simpson. See Pachydictya crassa.
Stictotrypa punctipora (Hall).
Stigmatella globata n. sp.
Stomatopora dissimilis Vine.
Stomatopora dissimilis elongata Vine. See Stomatopora elongata.
Stomatopora elongata (Vine).
Stomatopora parva Ringueberg. See Stomatopora elongata.
Stomatopora recta Ringueberg. See Stomatopora dissimilis.
Subretepora asperato-striata Miller. See Phylloporina asperato-striata.
Subretepora dichotoma Miller. See Thamniscus dichotomus.
Tæniodictya schucherti n. sp.
Thamniscus dichotomus (Hall).
Thamniscus? niagarensis Hall. See Pseudohornera niagarensis.
Trematopora aspera Hall. See Acanthoclema asperum.
Trematopora coalescens Hall. See Chilotrypa ostiolata.
Trematopora granulifera Hall. See Batostomella granulifera.
Trematopora ostiolata Hall. See Chilotrypa ostiolata.
Trematopora minuta (Hall). See Nematopora minuta.
Trematopora?? punctata Hall. See Idiotrypa punctata.
Trematopora solida Hall. See Eridotrypa solida.
Trematopora sparsa Hall. See Diploclema sparsum.
Trematopora spiculata Miller.
Trematopora spinulosa Hall (1852). See Bythopora spinulosa.
Trematopora spinulosa Hall (1876). See Trematopora spiculata.
Trematopora striata Hall. See Eridotrypa striata.
Trematopora tuberculosa Hall.
Trematopora whitfieldi Hall.
Vinella? multiradiata Ulrich and Bassler.
Vinella radiciformis (Vine).

PLATES III TO XXXI.

PLATE III.

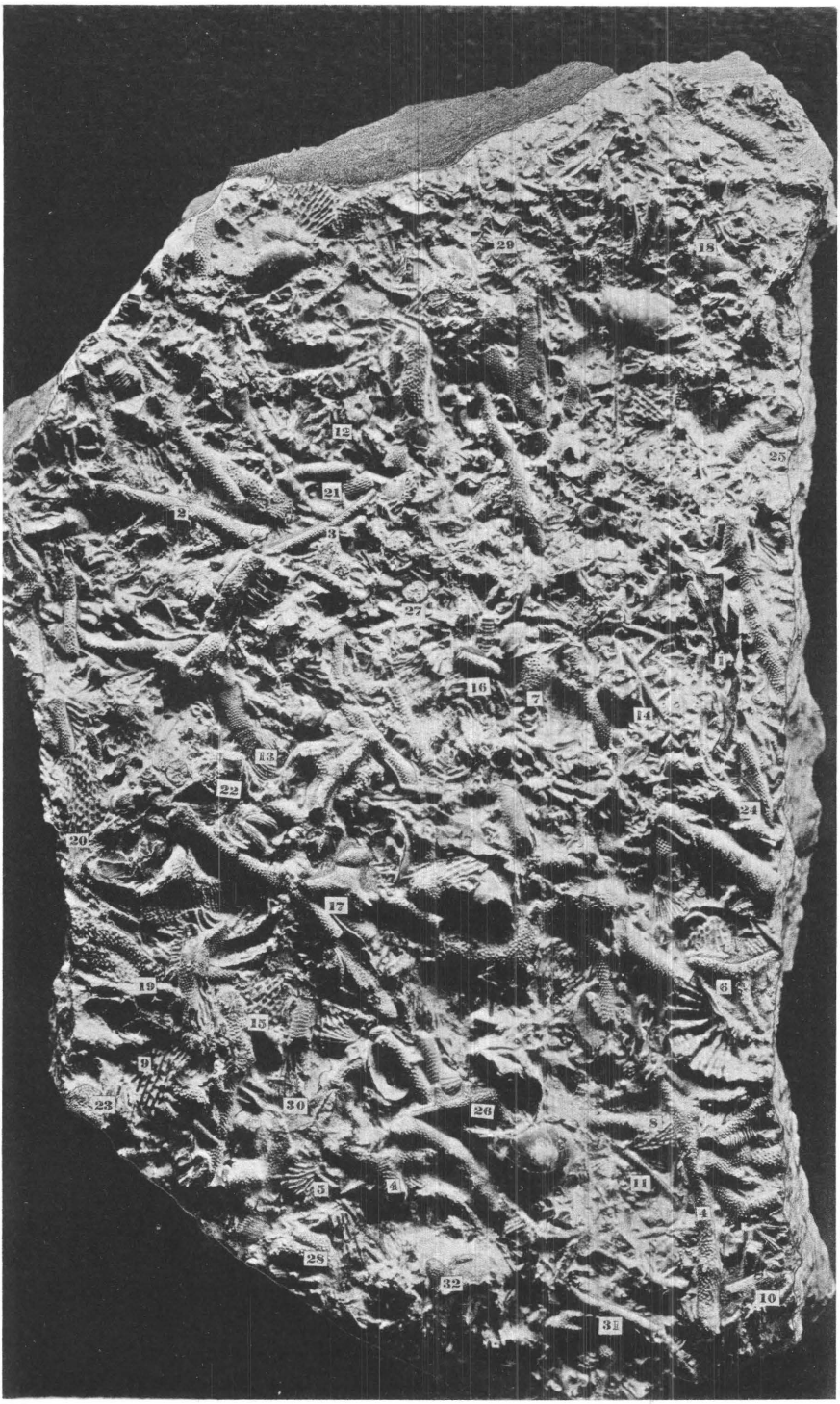
PLATE III.

View of a slab, × 1.4, showing assemblage of species.

Rochester shale, Middleport, N. Y.

All of the species recognized on this slab are designated by numbers, but the duplicate specimens, of which there are many, are left unnumbered. In spite of the numerous species showing upon this specimen, some of the most common forms, such as *Trematopora tuberculosa*, *Pachydictya crassa*, *Phylloporina asperato-striata*, etc., are unrepresented. Following is the list of species with their corresponding numbers:

1. Pseudohornera diffusa (Hall).
2. Diamesopora dichotoma (Hall).
3. Lioclemella maccombi n. sp.
4. Chilotrypa ostiolata (Hall).
5. Semicoscinium tenuiceps (Hall).
6. Bythopora spinulosa (Hall).
7. Callopora elegantula Hall.
8. Fenestella cribrosa Hall.
9. Polypora incepta Hall.
10. Phænopora ensiformis Hall.
11. Thamniscus dichotomus (Hall).
12. Pseudohornera niagarensis (Hall).
13. Stictotrypa punctipora (Hall).
14. Acanthoclema asperum (Hall).
15. Fenestella elegans Hall.
16. Idiotrypa punctata (Hall).
17. Lioclema asperum (Hall).
18. Diploclema sparsum (Hall).
19. Cœloclema cavernosa n. sp.
20. Loculipora ulrichi n. sp.
21. Tæniodictya schucherti n. sp.
22. Allonema waldronense Ulrich and Bassler.
23. Stigmatella globata n. sp.
24. Nematopora minuta (Hall).
25. Trematopora spiculata Hall.
26. Eridotrypa striata (Hall).
27. Ceramoporella orbiculata (Ringueberg).
28. Fistulipora crustula n. sp.
29. Diploclema sparsum argutum n. var.
30. Ptiloporella nervata (Nicholson).
31. Batostomella granulifera (Hall).
32. Lioclema multiporum n. sp.



BRYOZOA OF THE ROCHESTER SHALE

HELIOTYPE CO., BOSTON.

PLATE IV.

PLATE IV.[a]

Vinella? multiradiata Ulrich and Bassler. (Page 13.)

FIG. 1. Part of a colony attached to a crinoid column, exhibiting many nuclei and the intertwining of the numerous radiating stolons, × 9.
Rochester shale, Lockport, N. Y.

Vinella radiciformis (Vine). (Page 12.)

2. Portion of the creeping network of the typical form of this species, × 9, showing several nuclei.
Rochester shale, Lockport, N. Y.
3. A nucleus of another colony, × 20, showing a few scattered pores along the radii.
Rochester shale, Rochester, N. Y.

Rhopalonaria attenuata Ulrich and Bassler. (Page 11.)

4. Part of a colony preserved as an excavated mold, with several branches growing so as to intersect each other, thus causing an apparent irregularity in the growth.
5. Portion of another colony preserved as an excavated mold on a gastropod, showing a more regular arrangement of the zoœcia. Both figures illustrate the extreme tenuity of the connecting stolons and the very slight swelling of the zoœcial part.
Rochester shale, Lockport, N. Y.

Ascodictyon siluriense Vine. (Page 14.)

6. Two isolated clusters of vesicles, × 9, attached to a fragment of *Leptæna rhomboidalis*.
7. A group of clusters, × 9.
Rochester shale, Lockport, N. Y.
8. A single cluster, magnified, figured by Vine (Quart. Jour. Geol. Soc. London, XXXVIII, 1882, p. 52, fig. 1).
Wenlock shales, Shropshire, England.

Allonema waldronense Ulrich and Bassler. (Page 13.)

9. Portion of a colony attached to the dorsal valve of an orthoid.
Waldron shale, Waldron, Ind.

Stomatopora elongata (Vine). (Page 14.)

10. Three zoœcia, × 12, of a specimen identified by Mr. Vine.
11. Portion of a zoarium magnified. (After Vine.)
Wenlock shales, Shropshire, England.

12, 13. Portions of two zoaria, × 12, showing variation in growth and shape of zoœcia.

14. A specimen, × 6, introduced for comparison with figure 19.
Rochester shale, Rochester, N. Y.

Stomatopora dissimilis Vine. (Page 15.)

15. A reduced sketch of one of Vine's figures of this species.
Wenlock shales, England.
16. Zoœcia, × 12, exhibiting transverse annulations and flexuous growth.

17, 18. A portion of a colony, × 6, and parts of four zoœcia of same, × 12.

19. Another colony, × 6.
Rochester shale, Lockport, N. Y.

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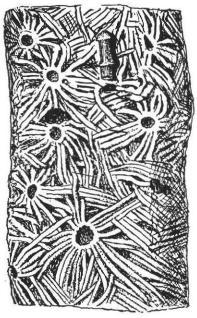
[a] Figs. 1, 2, 4, 5, 6, and 9 are copied from Ulrich and Bassler, Revision of American Paleozoic Bryozoa, Ctenostomata; Smithsonian Miscellaneous Collections (Quart. issue), XLV, 1904.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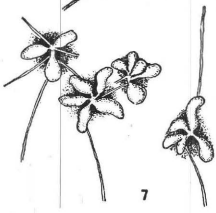
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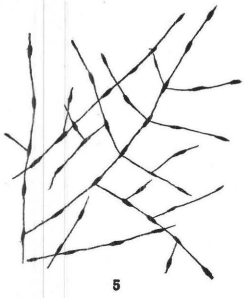
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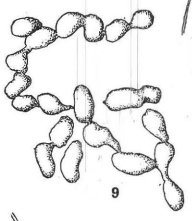
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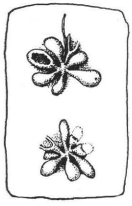
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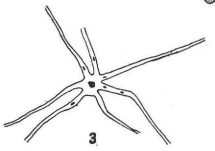
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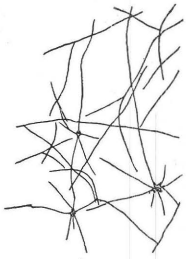
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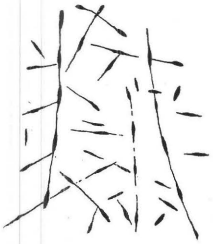
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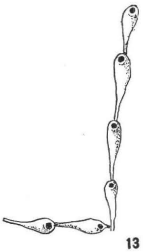
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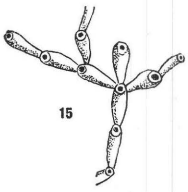
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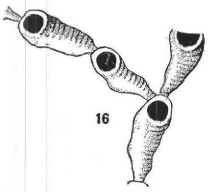
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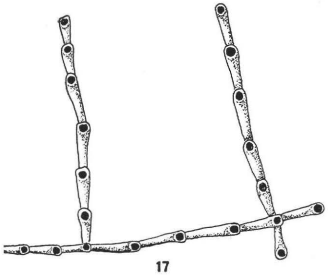
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BRYOZOA OF THE ROCHESTER SHALE.

PLATE V.

PLATE V.

Berenicea consimilis (Lonsdale). (Page 16.)

FIG. 1. Portion of a zoarium, × 6, incrusting a *Meristella* and showing radiate arrangement of zoœcia about centers of growth.
Silurian, island of Gotland.

2. Copy of Vine's illustration of this species.
Wenlock shales, England.

3, 4. Hall's figures of this species published under the name "An incrusting membrano-calcareous Coral" (Nat. Hist. New York, Pal. II, 1852, pl. 40 *E*, figs. 8, 8a).
Rochester shale, Lockport, N. Y.

5. Several zoœcia, × 20, of the Waldron form described by Hall as *Sagenella elegans*.
Waldron shale, Newsom, Tenn.

Diploclema sparsum (Hall). (Page 17.)

[See also Pl. XXXIII figs. 4-6.]

6, 7. Two fragments, natural size and × 9, of this abundant species showing the usual external features.
Rochester shale, Lockport, N. Y.

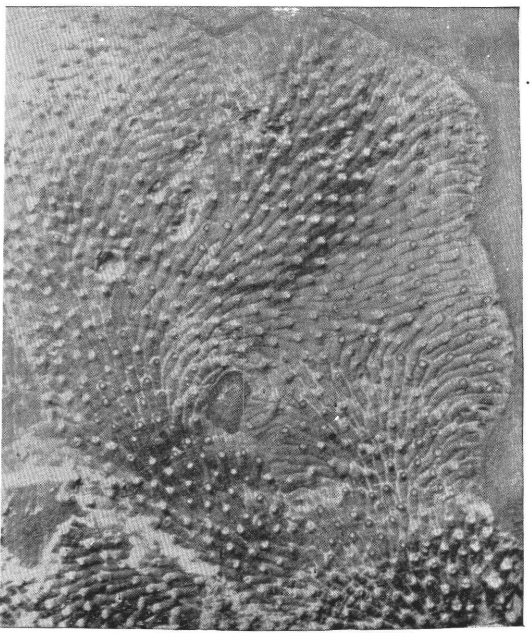
Diploclema sparsum argutum n. var. (Page 17.)

8. A portion of a zoarium, × 12, exhibiting the greater number of ranges of zoœcia and pore in front of the aperture, distinguishing this variety.

9. Several zoœcia of same with apertural pore.
Rochester shale, Lockport, N. Y.

Mitoclema sarlei n. sp. (Page 18.)

10, 11, 12. Three fragmentary examples of this small species, natural size and × 9.
Rochester shale, Rochester, N. Y.



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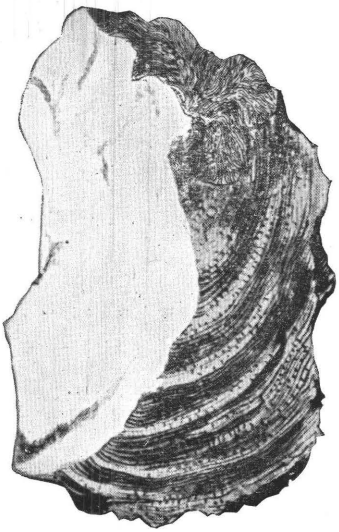

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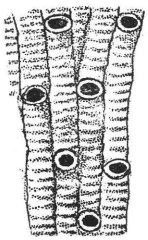

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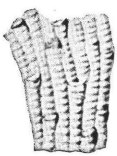

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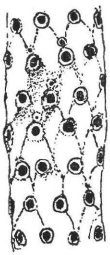

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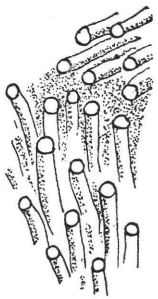

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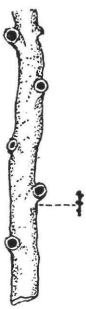

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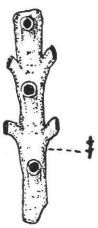

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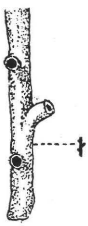

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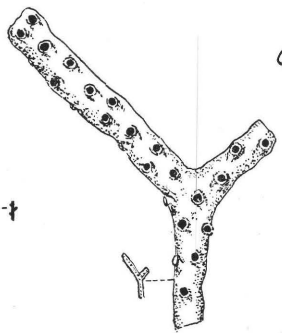

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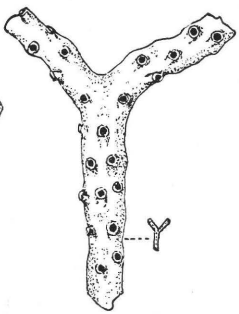


7

BRYOZOA OF THE ROCHESTER SHALE.

PLATE VI.

PLATE VI.

Ceramopora imbricata Hall. (Page 19.)

FIG. 1. Tangential section, × 18, showing the irregular mesopores and peculiar wall structure.

2. Tangential section, × 18, passing through the porous basal layer, showing the cellulose character.

3. Portion of a vertical section, × 8, showing the cellulose basal layer and the openings in the walls of the zoœcia.

Figs. 1–3 are after Ulrich, Geological Survey Illinois, VIII, 1890.

4. A vertical section, × 10, cutting across the zoarium, showing growth about a crinoid column, and the structure of zoœcia and basal layer.

5, 6. Celluliferous surfaces of two zoaria, × 2, composed of single maculæ.

Osgood beds, Osgood, Ind.

7. A zoarium, × 2, showing several maculæ.

8. Basal view of a zoarium, × 2, showing the spongy nature and the cicatrix of attachment.

9, 10. A macula and a portion of another part of the surface of a zoarium enlarged, to show the imbricating character of the zoœcia.

Rochester shale, Lockport, N. Y.

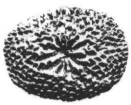
Figs. 9 and 10 are after Hall, Natural History of New York, Paleontology II, 1852.

Ceramopora niagarensis n. sp. (Page 19.)

11. Surface of one of the types, × 8.

12, 13. Vertical and tangential sections, × 20, showing the characteristic ceramoporoid structure.

Rochester shale, Rochester, N. Y.



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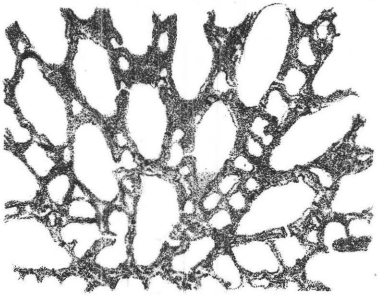

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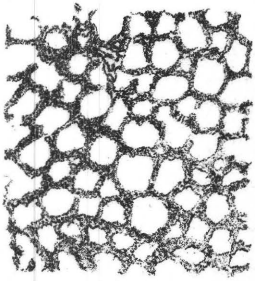

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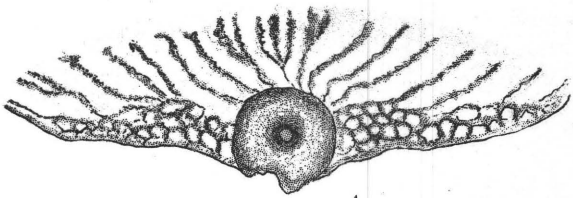

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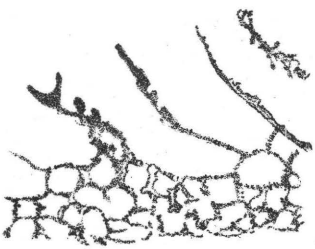

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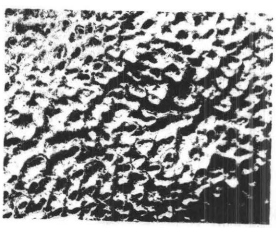

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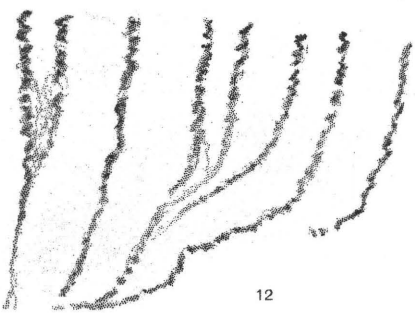

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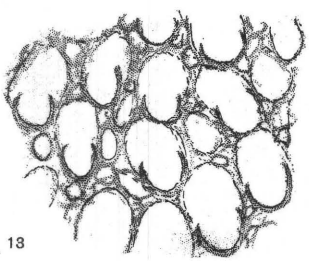

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BRYOZOA OF THE ROCHESTER SHALE

HELIOTYPE CO., BOSTON.

PLATE VII.

PLATE VII.

Fistulipora lockportensis n. sp. (Page 23.)

FIGS. 1, 2. Tangential and vertical sections, respectively, ×20, illustrating internal characters of the species.

3. Surface view of one of the types, × 8, showing a macula and surrounding zoœcia.

Rochester shale, Lockport, N. Y.

Fistulipora laminata (Hall). (Page 22.)

[See also Pl. VIII, figs. 9, 10.]

4, 5. Vertical and tangential sections, × 20.

6. Surface of Hall's figured type, × 8.

Rochester shale, Lockport, N. Y.

Fistulipora crustula n. sp. (Page 24.)

[See also Pl. VIII, figs. 16, 17; Pl. XXIII, fig. 15.]

7. Tangential section, × 20, including a portion of a macula and showing the small but prominent lunaria.

8. Vertical section, × 20, showing both immature and mature regions.

9. Surface of a typical specimen showing portion of a macula and the surrounding zoœcia.

10. A tangential section, × 20, passing close to the surface where the apertures are inclosed by polygonal areas.

Rochester shale, Lockport, N. Y.

Fistulipora tuberculosa (Hall). (Page 23.)

[See also Pl. VIII, figs. 7, 8; Pl. XXIII, fig. 14.]

11. Tangential section, ×20, exhibiting the small, bi-lobed zoœcia.

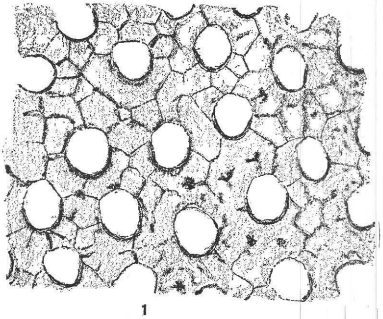
12. Vertical section, × 20, passing through one of the sides of the utricular zoarium.

13. Portion of a tangential section, × 20, prepared from Hall's figured type.

14. Surface of Hall's figured type, × 8.

15. A vertical section, × 6, to show the growth in hollow stems. The sides of the zoarium are brought nearer together than in the specimen in order to save space.

Rochester shale, Lockport, N. Y.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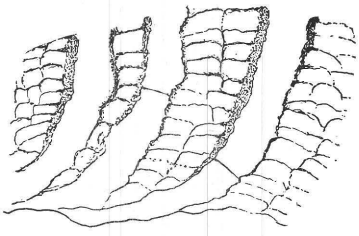
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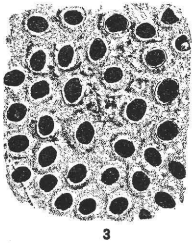
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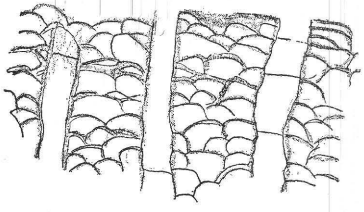
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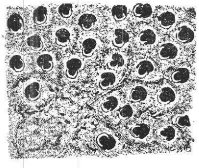
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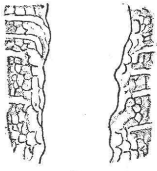
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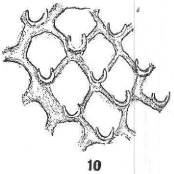
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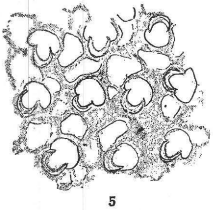
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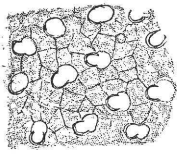
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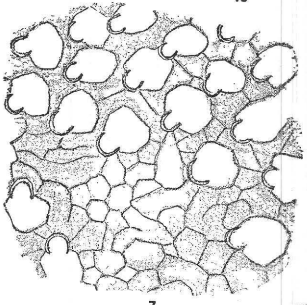
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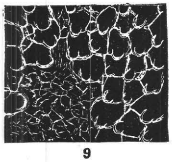
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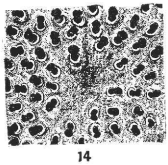
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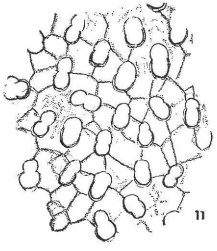
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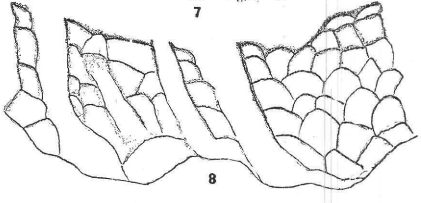
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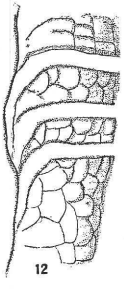
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BRYOZOA OF THE ROCHESTER SHALE.

PLATE VIII.

PLATE VIII.

[Unless otherwise stated, all the figures on this plate are copied from Hall, Nat. Hist. New York, Pal. II, 1852.]

Spatiopora maculata (Hall). (Page 22.)

[See also Pl. IX, figs. 10, 11.]

FIG. 1. One of Hall's types of *Paleschara maculata*, natural size; bryozoan incrusting a *Platyostoma*.

2. Surface enlarged.

(Figs. 1 and 2 after Hall, Eleventh Ann. Rept. Indiana Geol. Nat. Hist. 1882.)

Waldron shale, Waldron, Ind.

3. Zoarium incrusting a *Stephanocrinus*, natural size.

4. Surface of same enlarged.

(Species figured by Hall, but not named.)

Rochester shale, Lockport, N. Y.

Meekopora foliacea (Hall). (Page 25.)

[See also Pl. IX, figs. 5, 6.]

5. Hall's type of *Ceramopora foliacea*, natural size.

6. Surface of same, enlarged, showing arrangement of zoœcial apertures and digitate maculæ.

Rochester shale, Lockport, N. Y.

Fistulipora tuberculosa (Hall). (Page 28.)

[See also Pl. VIII, figs. 11–15; Pl. XXIII, fig. 14.]

7. View of type, natural size, of *Rhinopora tuberculosa* Hall. This zoarium is a crushed utricular specimen.

8. Enlarged view of same showing arrangement of apertures and tubercules.

Rochester shale, Lockport, N. Y.

Fistulipora laminata Hall. (Page 22.)

[See also Pl. VII, figs. 4–6.]

9, 10. Upper (celluliferous) and basal (epithecated) sides, respectively, of the original type of *Callopora laminata* Hall, natural size.

Rochester shale, Lockport, N. Y.

Chilotrypa ostiolata (Hall). (Page 24.)

[See also Pl. IX, figs. 1–4.]

11. Type of *Trematopora coalescens* Hall, natural size, which proves to be the basal portion of *Chilotrypa ostiolata*.

12. Surface of same enlarged.

13, 14, 15. Three typical examples of *Chilotrypa ostiolata*, × 2. (Original.)

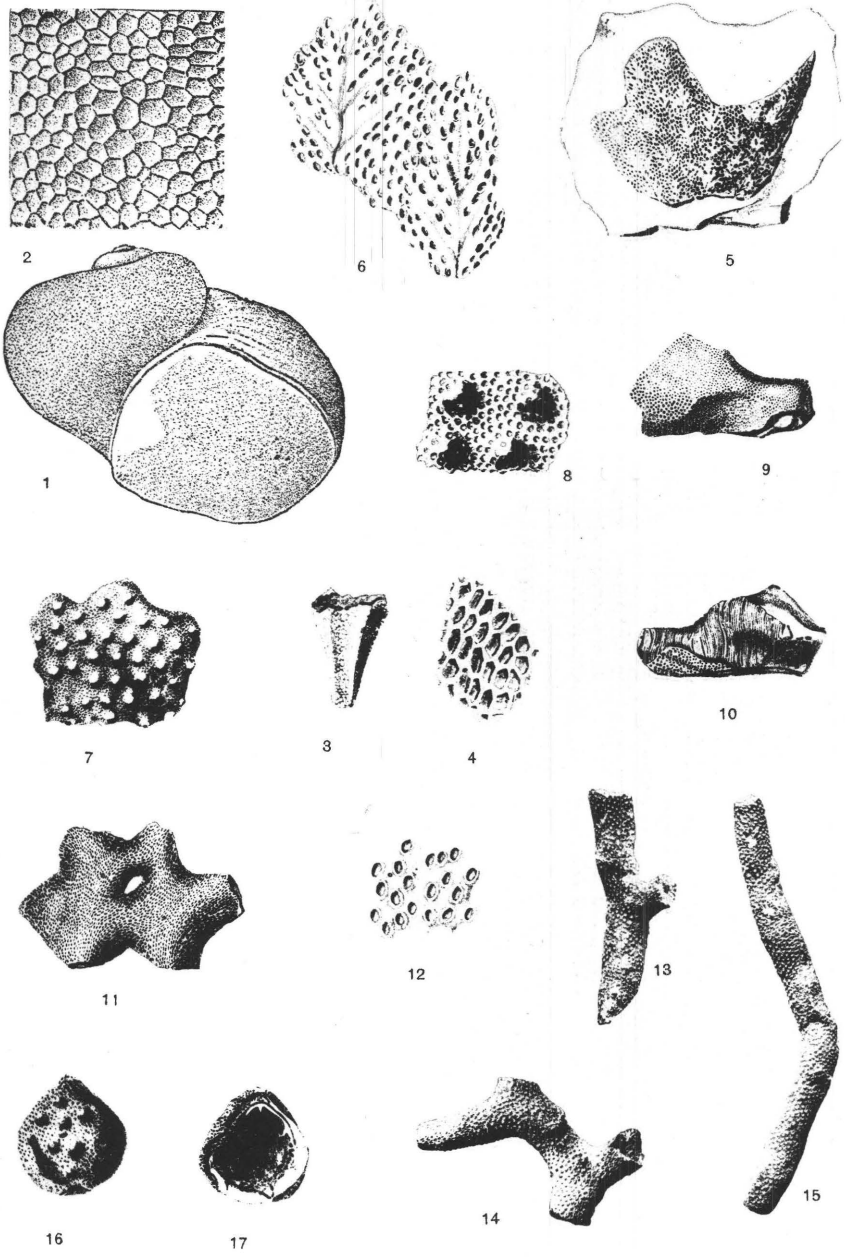
Rochester shale, Lockport, N. Y

Fistulipora crustula n. sp. (Page 24.)

[See also Pl. VII, figs. 7–10; Pl. XXIII, fig. 15.]

16, 17. Views of the surface and of the interior of the shell incrusted of Hall's type of *Ceramopora incrustans*.

Rochester shale, Lockport, N. Y.



BRYOZOA OF THE ROCHESTER SHALE

HELIOTYPE CO., BOSTON.

PLATE IX.

PLATE IX.

Chilotrypa ostiolata (Hall). (Page 24.)

[See also Pl. VIII, figs. 11–15.]

FIG. 1. Surface of a typical example, × 20, showing portion of a macula and the surrounding zoœcia.

2. A transverse section, × 20.

3. Tangential section, × 20.

4. A vertical section, × 20, illustrating the central canal, the peculiar bend of the zoœcia in the immature region, and the vesiculose interspaces of the mature region.

In figs. 2 and 4 the central canal is darkened in order to show it more clearly.

Rochester shale, Lockport, N. Y.

Meekopora foliacea (Hall). (Page 25.

[See also Pl. VIII, figs. 5, 6.]

5, 6. Tangential and vertical sections, respectively, × 20, showing the fistuli-poroid character and bifoliate growth of this species.

Rochester shale, Lockport, N. Y.

Ceramoporella irregularis n. sp. (Page 21.)

7. Tangential section, × 20, illustrating the prominent crescentic lunaria, rather numerous mesopores, and thin-walled zoœcia.

8. Vertical section, × 20, showing two layers of zoœcia

9. Surface of the type specimen, × 8.

Rochester shale, Lockport, N. Y.

Spatiopora maculata (Hall). (Page 22.)

[See also Pl. VIII, figs. 1-4.]

10. A tangential section of an old example, × 20.

11. Surface of a less mature example, × 8, in which the zoœcia show the characteristic lineate arrangement.

Waldron shale, Waldron, Ind.

Ceramoporella orbiculata (Ringueberg). (Page 20.)

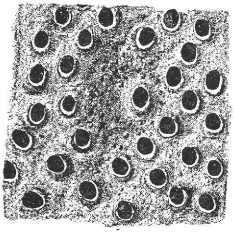
12. Vertical section, × 20.

13. A tangential section, × 20, cutting the zoarium below the surface and showing the usual mesopores at this height.

14. Surface of a typical example, × 8, showing a portion of a macula and the polygonal area marking out the zoœcia in mature specimens.

15. A portion of fig. 14, × 20.

Rochester shale, Lockport, N. Y.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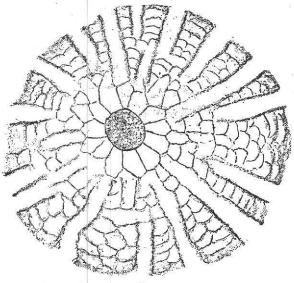
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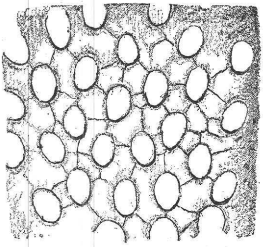
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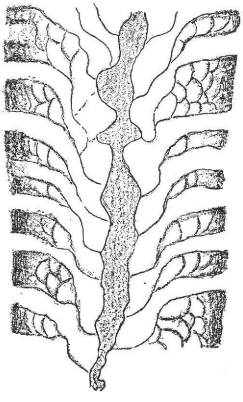
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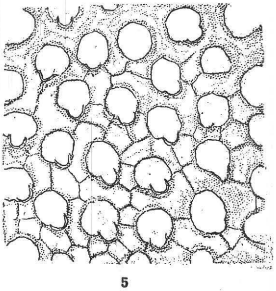
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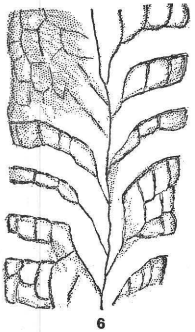
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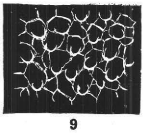
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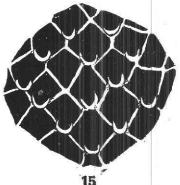
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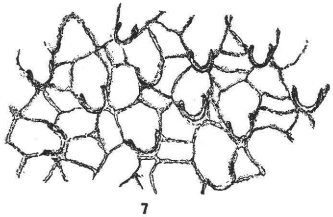
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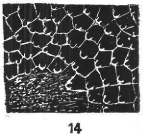
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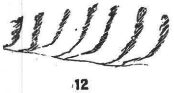
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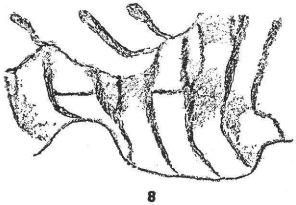
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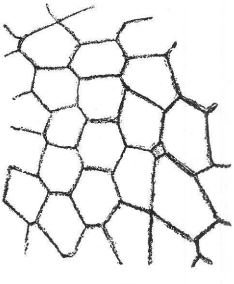
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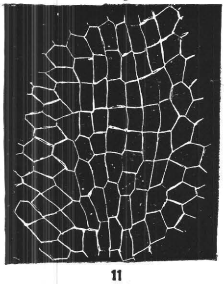
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BRYOZOA OF THE ROCHESTER SHALE.

PLATE X.

PLATE X.

Mesotrypa nummiformis (Hall). (Page 27.)

FIGS. 1, 2. Tangential and vertical sections, respectively, × 20.

3. Top and edge views of specimens, natural size, to show the characteristic growth.

4. Surface of the original of fig. 3, × 8.

Rochester shale, Lockport, N. Y.

Orbignyella expansa (Ringueberg). (Page 26.)

5. Vertical section, × 20, of a typical example with the usual development of curved diaphragms.

6. Tangential section, × 20, through the mature region, exhibiting the large zoœcia of a portion of a macula, and the smaller intermacular zoœcia.

7. Several intermacular zoœcia, × 30, with the characteristic wall structure well developed.

8. Surface of Ringueberg's type, × 8.

Rochester shale, Lockport, N. Y.

Orbignyella magnopora n. sp. (Page 27.)

9, 10. Vertical and tangential sections, × 20, exhibiting the comparatively few curved diaphragms and the large, thin-walled zoœcia characteristic of the species.

11. Several zoœcia of a tangential section, × 20, giving the appearance when the curved diaphragms are cut.

12. Surface of type specimen, × 8, exhibiting the large, thin-walled zoœcia by which externally the species can be separated from the associated *O. expansa*.

Rochester shale, Grimsby, Ontario.

Rhombotrypa spinulifera n. sp. (Page 37.)

[See also Pl. XXV, fig. 21.]

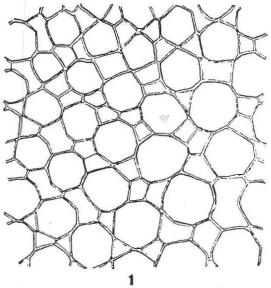
13. Vertical section, × 20, exhibiting the zones caused by the turning of the zoœcia at regular intervals.

14. Tangential section, × 20, cutting the mature region where the mesopores are well developed.

15. A few zoœcia and mesopores, × 35, of a section passing through the most mature portion of the zoarium and showing the acanthopores distinguishing this from other species of the genus.

16. A portion of a transverse section, × 20, exhibiting the quadrate shape of the zoœcia in the immature zone.

Rochester shale, Lockport, N. Y.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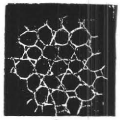
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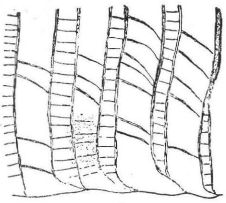
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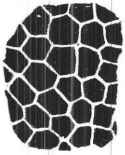
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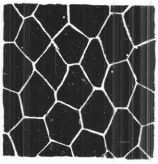
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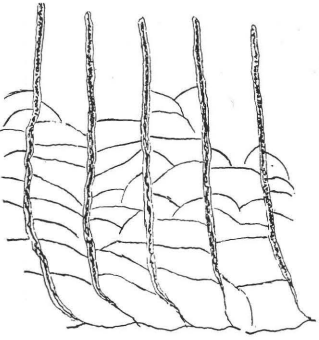
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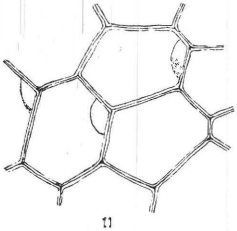
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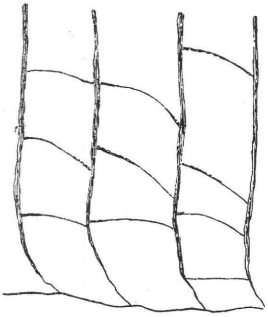
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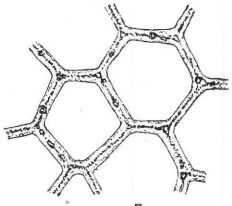
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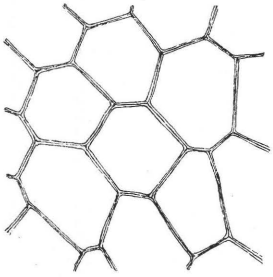
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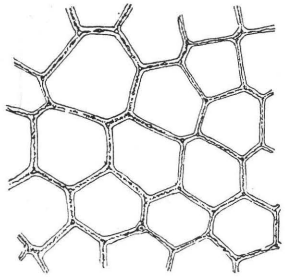
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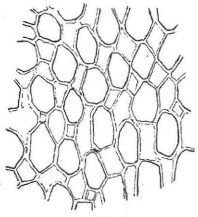
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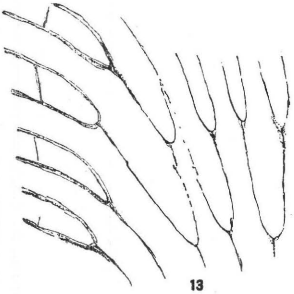
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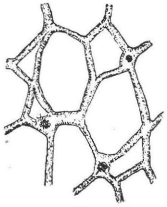
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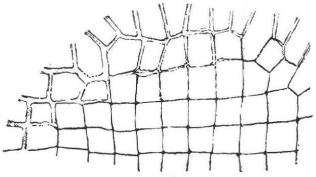
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BRYOZOA OF THE ROCHESTER SHALE.

PLATE XI.

PLATE XI.

Lioclema asperum Hall. (Page 32.)

[See also Pl. XXIV, figs. 14–16.]

FIG. 1. A vertical section, × 20, passing through an immature and portions of two mature regions.

2. Tangential section, × 20, illustrating the general features of the mature region.

3. A portion of a tangential section, × 35, showing the structure of the walls and of the numerous large acanthopores.

Rochester shale, Lockport, N. Y.

Lioclema multiporum n. sp. (Page 34.)

[See also Pl. XXIII, fig. 18; Pl. XXVII, fig. 20.]

4. A small portion of a tangential section, × 20, passing through the mature region.

5. A vertical section, × 20, showing the characters of both immature and mature regions.

6. A portion of the tangential section figured in 4, × 35, introduced for comparison with the corresponding figure of *L. asperum*.

Rochester shale, Lockport, N. Y.

Lioclemella maccombi n. sp. (Page 36.)

[See also Pl. XXV, figs. 5–7.]

7. Vertical section, × 20, with the usual tabulation of zoœcia and mesopores.

8, 9. Tangential section, × 20, and a portion of same, × 30, illustrating the shape of the zoœcia and structure of the walls.

10. Surface of one of the figured types, × 8.

Rochester shale, Lockport, N. Y.

Lioclema ramulosum n. sp. (Page 35.)

[See also Pl. XXV, figs. 9, 10.]

11. Vertical section, × 20, illustrating the apparent absence of diaphragms.

12, 13. Tangential section, × 20, and a portion of same, × 30, showing the general arrangement and structure of the zoœcia and mesopores and of the few but large acanthopores.

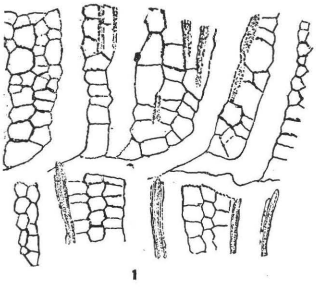
Rochester shale, Lockport, N. Y.

Eridotrypa nodulosa n. sp. (Page 30.)

[See also Pl. XXV, figs. 1–3.]

14, 15. Tangential and vertical sections, respectively, × 20, illustrating the internal characters of a mature example.

Rochester shale, Lockport, N. Y.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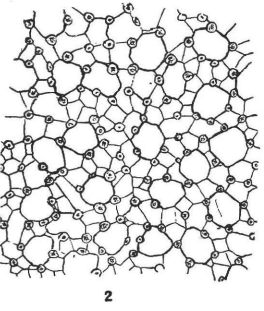
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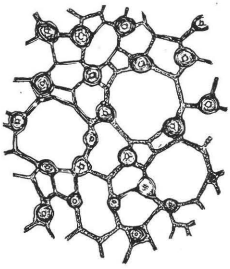
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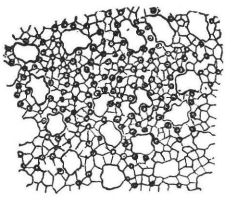
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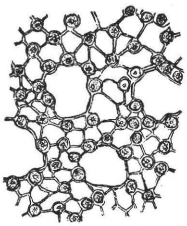
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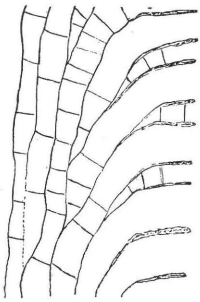
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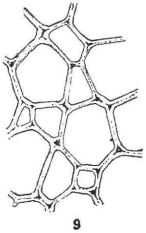
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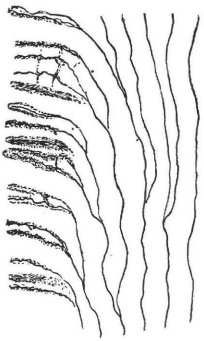
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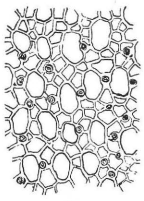
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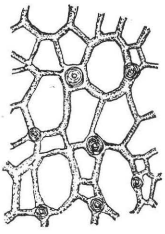
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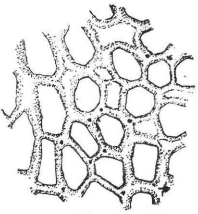
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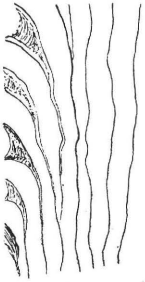

15

BRYOZOA OF THE ROCHESTER SHALE.

PLATE XII.

PLATE XII.

Eridotrypa spinosa n. sp. (Page 29.)

[See also Pl. XXV, fig. 15.]

FIG. 1. Vertical section, × 20, showing the tabulation and the thick zoœcial walls of th mature region.

2, 3. Two portions of a tangential section, × 20, exhibiting the thick zoœcial walls large numerous acanthopores, and the variation in the number of mesopores.

Rochester shale, Grimsby, Ontario.

Eridotrypa striata (Hall). (Page 32.)

[See also Pl. XXIV, figs. 3-6; Pl. XXV, fig. 14.]

4. Vertical section, × 20, showing the characteristic tabulation and the slight thick ening of the walls in the mature region.

5, 6. Portions of two tangential sections, × 20, showing the appearance of the youthfu and aged conditions, respectively, of the mature region.

Rochester shale, Lockport, N. Y.

Eridotrypa solida (Hall). (Page 30.)

[See also Pl. XXIV, figs. 20-23; Pl. XXV, fig. 16.]

7. Vertical section, × 20, showing the usual absence of diaphragms and slight thick ening of walls in the mature region.

8, 9. Two portions of a tangential section, × 20, showing the angular zoœcia and meso pores of the mature zone.

Rochester shale, Lockport, N. Y.

Eridotrypa similis n. sp. (Page 31.)

[See also Pl. XXVI, figs. 1, 2.]

10. A tangential section, × 20, with the usual thick-walled angular zoœcia and meso pores and characteristic acanthopores.

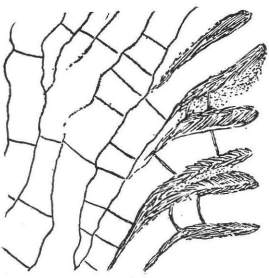
11. Vertical section, × 20, exhibiting few diaphragms in the zoœcial tubes and more numerous ones in the mesopores.

12. A tangential section, × 30, passing through a macula.

13. Another tangential section showing more numerous acanthopores and mesopores than usual.

14. Surface of one of the figured types, × 8.

Rochester shale, Grimsby, Ontario.



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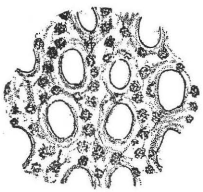

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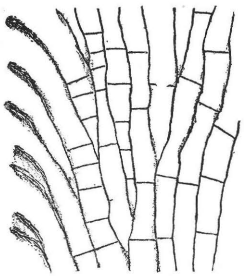

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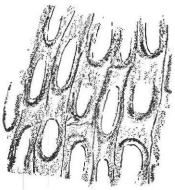

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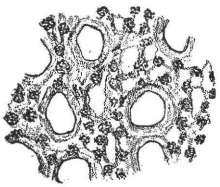

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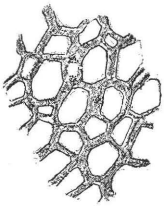

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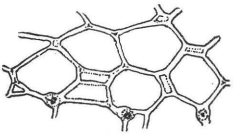

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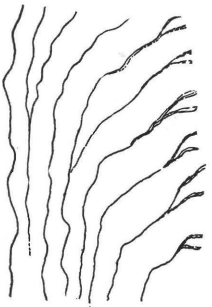

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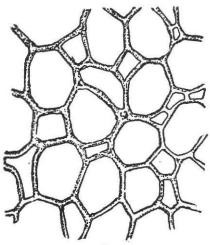

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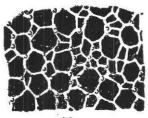

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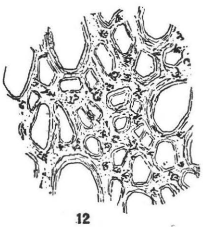

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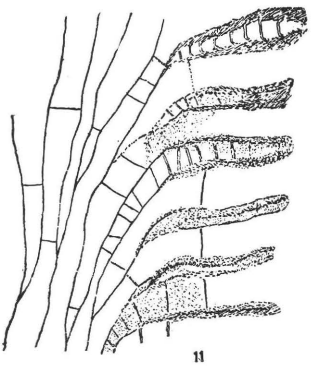

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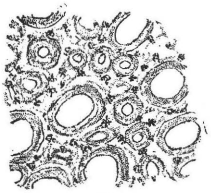

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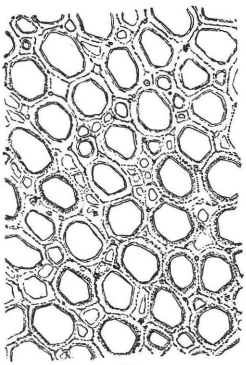


10

BRYOZOA OF THE ROCHESTER SHALE.

PLATE XIII.

PLATE XIII.

Batostomella granulifera (Hall). (Page 28.)

[See also Pl. XXIV, figs. 10, 11; Pl. XXV, figs. 11, 12.]

FIG. 1. Tangential section, × 20, showing the solid interzoœcial spaces and numerous acanthopores.

2. Another tangential section, × 20, taken lower in the mature region where the acanthopores are smaller and the mesopores are visible.

3. Tangential section, × 30, showing the wall structure with the mesopores faintly visible.

4, 5. Vertical section, × 20 and × 30, respectively, exhibiting the usual internal features.

Rochester shale, Lockport, N. Y.

Bythopora spinulosa (Hall). (Page 29.)

[See also Pl. XXIV, figs. 12, 13.]

6, 7. Tangential and vertical sections, × 20.

Rochester shale, Lockport, N. Y.

Lioclema explanatum n. sp. (Page 33.)

[See also Pl. XXVI, fig. 4.]

8. Surface of one of the types, × 16.

9. Tangential section, × 20, showing the thin-walled zoœcia, numerous mesopores, and comparatively few acanthopores.

10. Vertical section, × 20, exhibiting the tabulation of zoœcia and mesopores.

Rochester shale, Rochester, N. Y.

Lioclema circinctum n. sp. (Page 34.)

11. Vertical section, × 20, of the type specimen, showing two successive layers of zoœcia.

12. Tangential section, × 20, bringing out the unusually numerous mesopores and apparent absence of acanthopores.

13, 14. Small portion of fig. 12, × 60, and a portion of wall of same, × 75, exhibiting the peculiar wall structure.

Rochester shale, Lockport, N. Y.

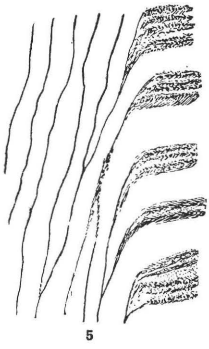
Trematopora tuberculosa Hall. (Page 43.)

[See also Pl. XVII, figs. 1-3; Pl. XXV, fig. 8.]

15. A few zoœcia of a vertical section, × 35, exhibiting the beadlike constrictions of the mesopores.

16. Several zoœcia of a tangential section, × 35, showing the minute structure of the walls and acanthopores.

Rochester shale, Lockport, N. Y.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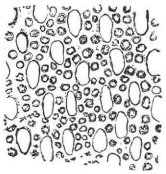
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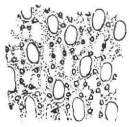
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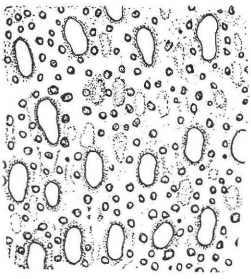
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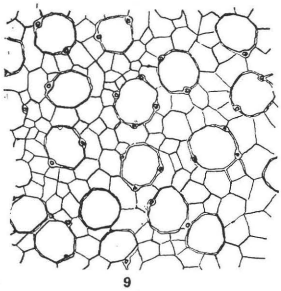
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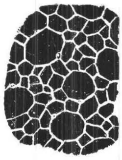
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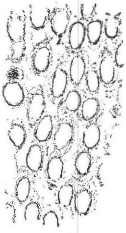
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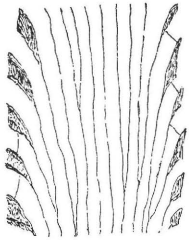
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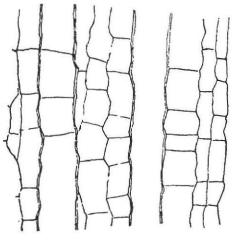
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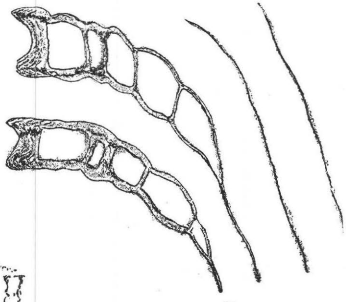
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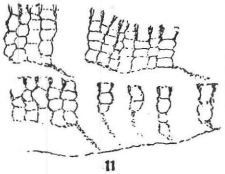
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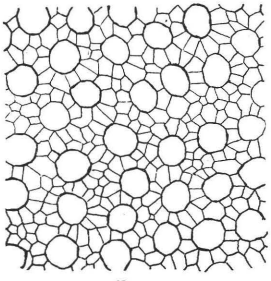
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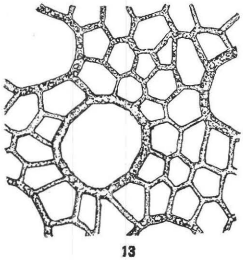
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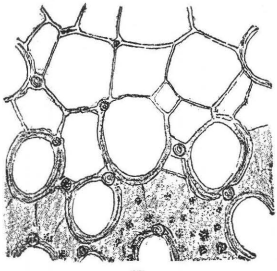

16

BRYOZOA OF THE ROCHESTER SHALE.

PLATE XIV.

PLATE XIV.

Diplotrypa walkeri n. sp. (Page 47.)

[See also Pl. XXV, fig. 4.]

FIG. 1. Tangential section, × 20, showing the usual number of mesopores and the differences in the size of the zoœcia.

2, 3. Vertical sections, × 20, exhibiting slight variations in the tabulation of mesopores and zoœcia.

4. Portion of fig. 1, × 40.

5. Surface view of one of the types, × 8.

Rochester shale, Grimsby, Ontario.

Stigmatella globata n. sp. (Page 28.)

6. Tangential section, × 20, passing through one of the zones of acanthopores and illustrating the thin walls and comparatively few acanthopores and mesopores.

7. A portion of fig. 6, × 40, exhibiting the structure and size of the acanthopores and the characteristic amalgamation of the zoœcial walls.

8. Vertical section, × 20, cutting two zones of acanthopores.

9. Surface view of the sectioned type, × 8.

Rochester shale, Lockport, N. Y.

Nicholsonella florida (Hall). (Page 38.)

[See also Pl. XXIV, figs. 1, 2.]

10. Tangential section, × 20, illustrating the large acanthopores indenting the zoœcial apertures.

11. Vertical section through a small portion of an immature region and all of a mature region, × 20.

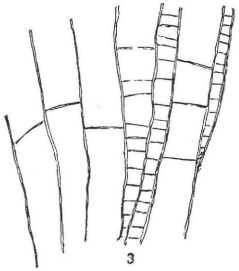
Rochester shale, Lockport, N. Y.

Nicholsonella ringuebergi n. sp. (Page 39.)

12. Tangential section, × 20, through the mature region. The zoœcial cavities are blackened in order to bring out more clearly the indentation of the walls by the acanthopores.

13. Vertical section, × 20, passing through an entire zoarium.

Rochester shale, Lockport, N. Y.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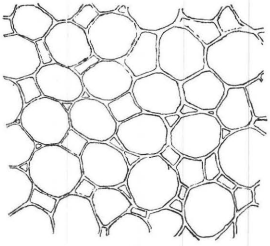
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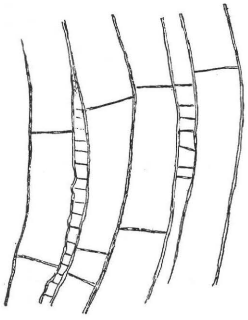
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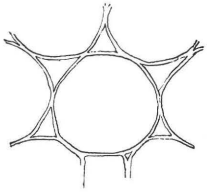
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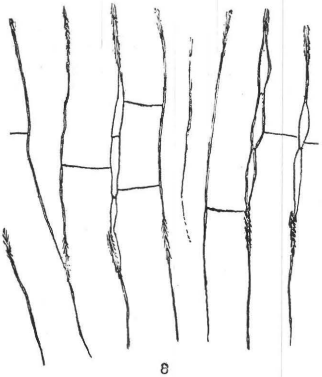
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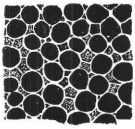
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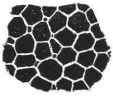
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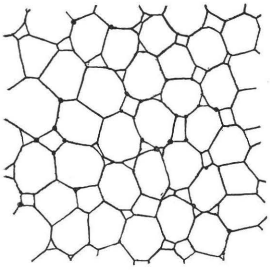
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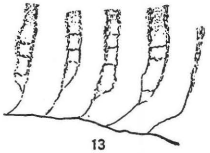
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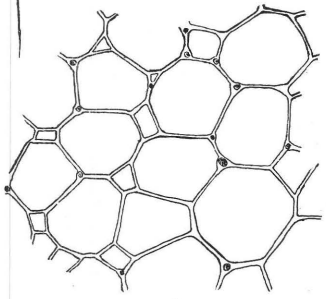
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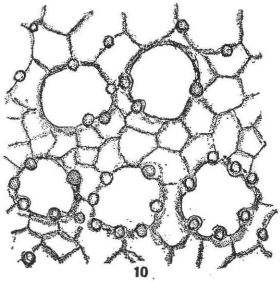
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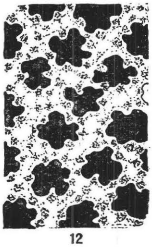
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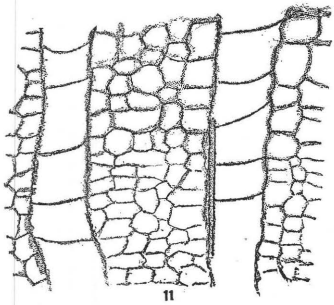
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BRYOZOA OF THE ROCHESTER SHALE.

PLATE XV.

PLATE XV.

Callopora magnopora Foerste. (Page 42.)

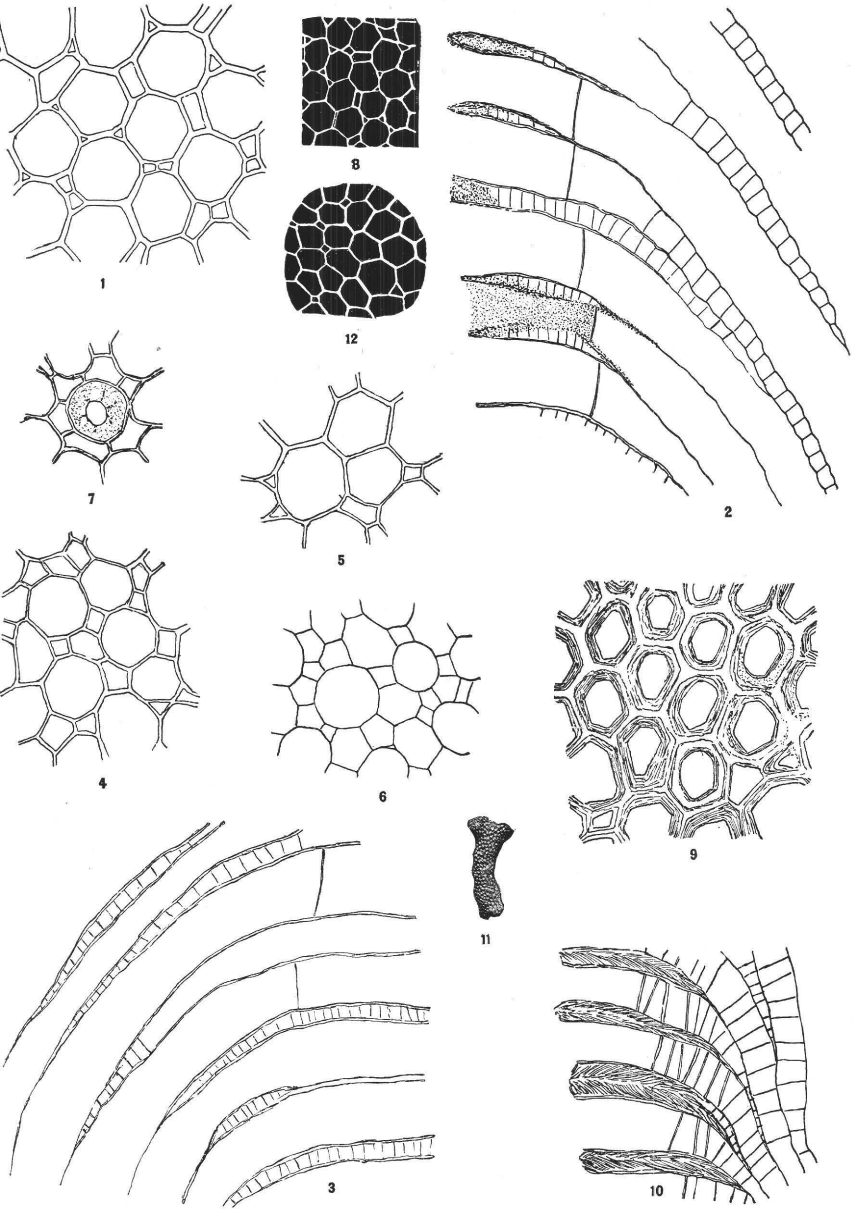
[See also Pl. XXVI, fig. 3.]

FIGS. 1, 2. Tangential and vertical sections, × 20, of an authentic specimen.
Clinton formation, Dayton, Ohio.

3. Vertical section, × 20, showing the characteristic tabulation of the species.
4. A small portion of a tangential section, × 20, cutting the mature region at a zone where the mesopores are well developed.
5. Several zoœcia and mesopores, × 20, of a tangential section taken near the surface of the zoarium where the mesopores are few in number.
6. Portion of a transverse section, × 20, showing the shape of the zoœcia and mesopores in the immature zone.
7. A single zoœcium from a deep tangential section, × 20, passing through a diaphragm and indicating that the opercula seen at the surface became diaphragms as growth proceeded.
8. Surface of a typical example, × 8.
Rochester shale, Grimsby, Ontario.

Callopora clausa n. sp. (Page 42.)

9. Tangential section, × 20, illustrating the polygonal rather thick-walled zoœcia and few mesopores.
10. Vertical section, × 20, showing characteristic tabulation of zoœcia and mesopores and disappearance of the latter as the surface is approached.
11. A typical example, natural size.
12. Surface of same, × 8. Here only the crests of the zoœcial walls are shown, the walls themselves being considerably thicker.
Rochester shale, Lockport, N. Y.



BRYOZOA OF THE ROCHESTER SHALE.

PLATE XVI.

PLATE XVI.

Monotrypa osgoodensis n. sp. (Page 46.)

FIGS. 1, 2. Portions of two vertical sections, × 20, exhibiting the tabulation and other characteristics of the immature and mature zones, respectively.

3. Tangential section, × 20, passing through the mature region.
Osgood beds, Osgood, Ind.

4. Top and side views of a zoarium, natural size.

5. Surface of a typical example, × 8.
Rochester shale, Lockport, N. Y.

Monotrypa benjamini n. sp. (Page 46.)

[See also Pl. XXVI, fig. 11.]

6. Vertical section, × 20, showing the characteristic crenulations of the zoœcial walls.

7. A tangential section, × 20, passing through the immature region.

8. A tangential section, × 20, cutting the mature region. Here the thickness of the walls has been somewhat increased by a secondary deposit.
Rochester shale, Lockport, N. Y.

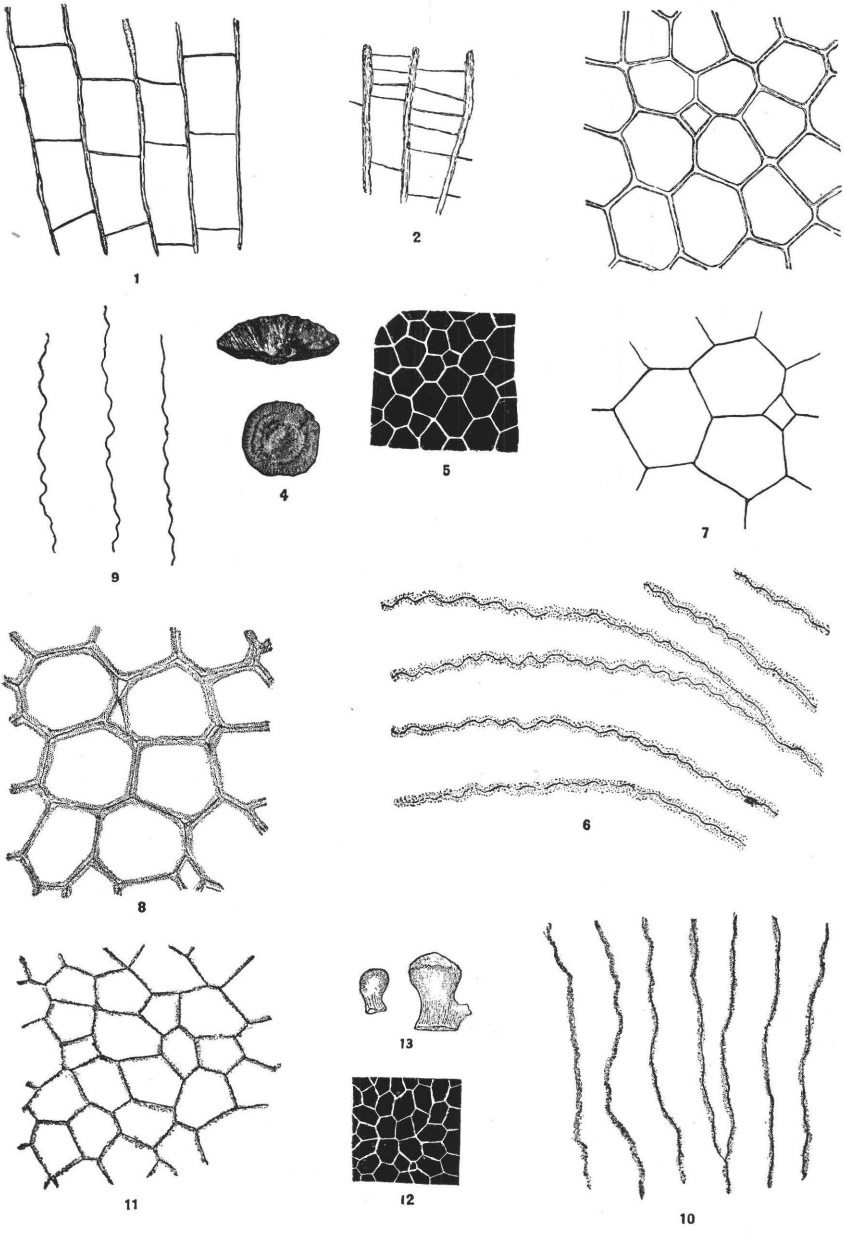
9. A small portion of a vertical section, × 20, passing through the immature region.
Osgood beds, Osgood, Ind.

Monotrypa pediculata n. sp. (Page 47.)

10, 11. Vertical and tangential sections, × 20, showing the internal structure.

12. Surface of one of the types, × 8.

13. Two complete zoaria, natural size, showing the striated basal portion.
Rochester shale, Rochester, N. Y.



BRYOZOA OF THE ROCHESTER SHALE.

PLATE XVII.

PLATE XVII.

Trematopora tuberculosa Hall. (Page 43.)

[See also Pl. XIII, figs. 15, 16; Pl. XXV, fig. 8.]

FIG. 1. Surface of a well-preserved specimen, × 18.
2, 3. Vertical and tangential sections, × 18.
Rochester shale, Lockport, N. Y.

Idiotrypa punctata (Hall). (Page 40.)

[See also Pl. XXIV, figs. 17–19.]

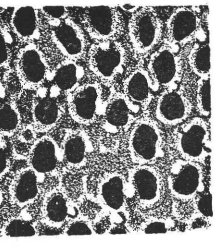
4. A tangential section, × 18, passing close to the surface.
5. A vertical section, × 18, showing the characters of the mature region.
6. A portion of fig. 4, × 50, showing the minute structure.
7. Surface of a specimen, × 18.
8. A tangential section, × 18, passing through a less mature region than that figured in 4.
Osgood beds, Osgood, Ind.
9. A tangential section, × 18, introduced for comparison with fig. 8.
10. A vertical section, × 18, passing through two layers of the zoœcia. This specimen is less mature than Ulrich's type of *Idiotrypa parasitica*, which furnished the sections figured in 4, 5, and 6.
Rochester shale, Lockport, N. Y.

Callopora elegantula Hall. (Page 41.)

[See also Pl. XXVI, fig. 12.]

11. A normal vertical section, × 18.
12. A tangential section, × 18, in which three of the zoœcia show opercula.
13. A transverse section, × 18, illustrating the shape of the zoœcia and mesopores in the immature region.
14, 15. Tangential and vertical sections, × 20, exhibiting slight variations from the above.
Rochester shale, Lockport, N. Y.

Figs. 1–7 and 11–13 are copied from Ulrich, American Paleozoic Bryozoa, Journal Cincinnati Society of Natural History.



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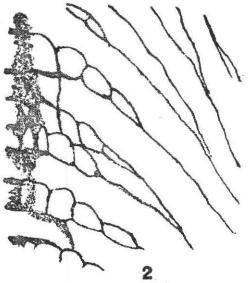

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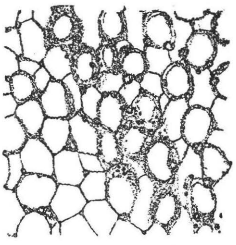

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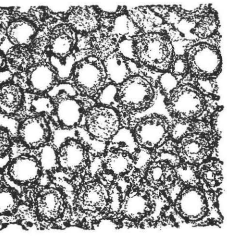

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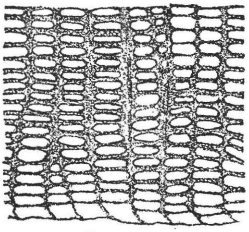

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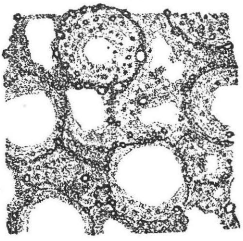

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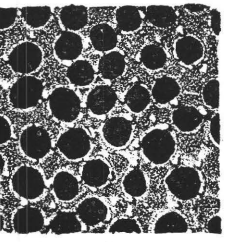

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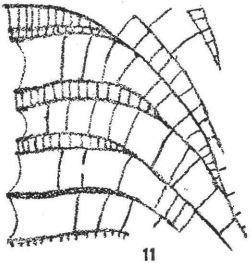

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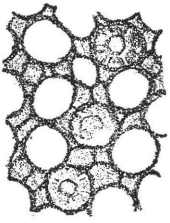

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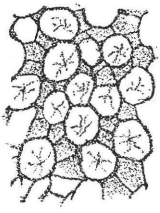

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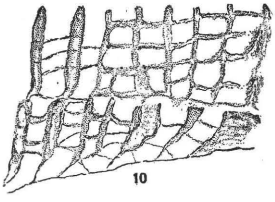

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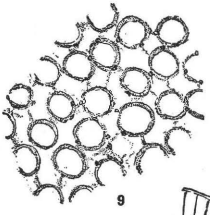

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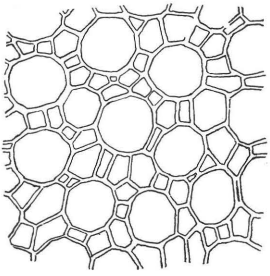

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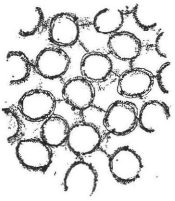

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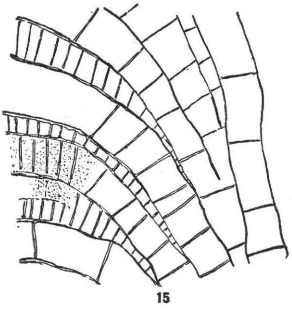

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BRYOZOA OF THE ROCHESTER SHALE.

PLATE XVIII.

PLATE XVIII.

Phylloporina asperato-striata (Hall). (Page 48.)

FIGS. 1, 2. A small fragment, natural size, and the surface enlarged.
3. A more complete zoarium, natural size, showing the noncelluliferous side.
4, 5. Two enlargements of the noncelluliferous side, exhibiting the asperate striat character which suggested the specific name.
Rochester shale, Lockport, N. Y.

Pseudohornera diffusa (Hall). (Page 50.)

[See also Pl. XXIII, figs. 1–3.]

6, 7. Views of Hall's types, natural size.
8. A portion of the noncelluliferous striated surface enlarged.
9. An enlargement of the celluliferous face showing the arrangement and for of the zoœcia.
Rochester shale, Lockport, N. Y.

Nematopora minuta (Hall). (Page 58.)

[See also Pl. XXI, figs. 8, 9.]

10. Hall's type, natural size and enlarged.
Waldron shale, Waldron, Ind.

Pachydictya crassa (Hall). (Page 57.)

[See also Pl. XXI, figs. 14–16.]

11, 12. Two enlargements of a fragment of this species, figured by Hall and Simp son as *Stictopora scitula*.
Rochester shale, Lockport, N. Y.

Loculipora ambigua (Hall). (Page 53.)

13. An almost complete zoarium, natural size.
14, 15. Enlarged views of the opposite faces of the same specimen showing sligh differences in the character of each.
16. An enlargement from the edge of specimen illustrated by fig. 13.
Waldron shale, Waldron, Ind.

Thamniscus dichotomus (Hall). (Page 54.)

[See also Pl. XXVII, figs. 1–7.]

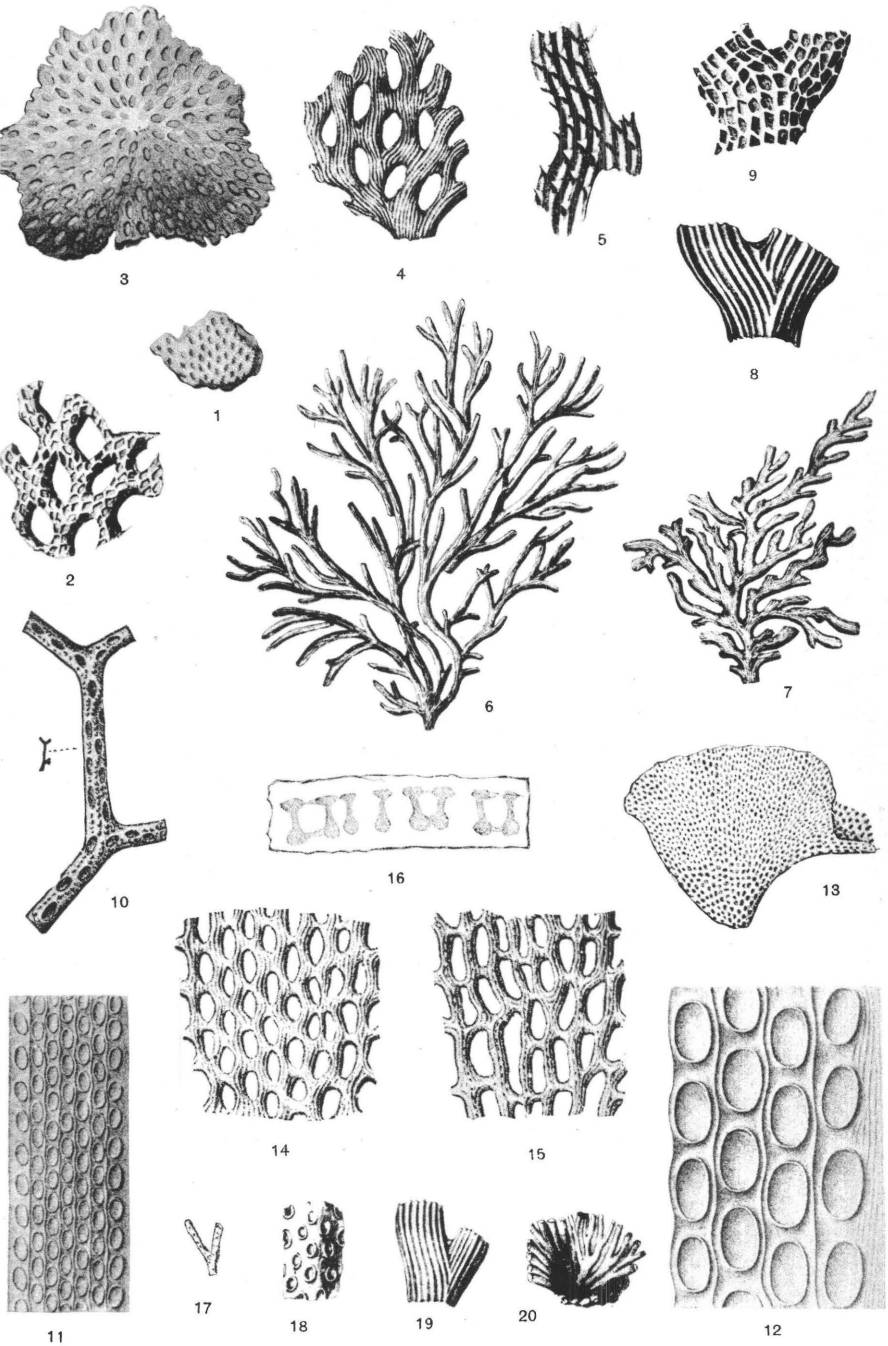
17, 18. One of Hall's types, natural size, and enlargement of the same.
The supposed original of these figures, as stated on page 54, proves to b a small example of *Pachydictya crassa*.
19. An enlarged view of the striated noncelluliferous face of Hall's second typ of the species.
Rochester shale, Lockport, N. Y.

Pseudohornera niagarensis (Hall). (Page 49.)

[See also Pl. XIX, figs. 14–16.]

20. View of a specimen of this species, natural size, figured by Hall as *Fenestella*.
Rochester shale, Lockport, N. Y.

All the figures on this plate are copied from Hall, figs. 1–9 and 17–20 being from Natur History of New York, Paleontology II, 1852; figs. 11 and 12 from Vol. VI of the sam series; and figs. 10 and 13–16 from Eleventh Annual Report of the State Geologist Indiana, 1882.



BRYOZOA OF THE ROCHESTER SHALE

HELIOTYPE CO., BOSTON.

PLATE XIX.

PLATE XIX.

Unless otherwise stated all the figures on this plate are copied from Hall, Nat. Hist. New York, Pal
II, 1852.]

Fenestella elegans Hall. (Page 51.)

FIG. 1. A frond, natural size, showing the noncelluliferous side.
2. Celluliferous side of another specimen, enlarged.
Rochester shale, Lockport, N. Y.

Fenestella cribrosa Hall. (Page 50.)

3. Fragment, natural size, exposing noncelluliferous face.
4. Portion of same enlarged.
5. Celluliferous face of another example, × 20, showing protruding zoœcia, con
spicuous spines on carina, and broad branches. (Original).
Rochester shale, Lockport, N. Y.

Semicoscinium tenuiceps (Hall). (Page 52.)

6. Basal view, natural size, showing funnel-shaped zoarium with carinated cellu
liferous face.
7. Celluliferous surface of a specimen enlarged, with the carina worn or less devel
oped than usual, thus exposing the zoœcial apertures more clearly.
Rochester shale, Lockport, N. Y.

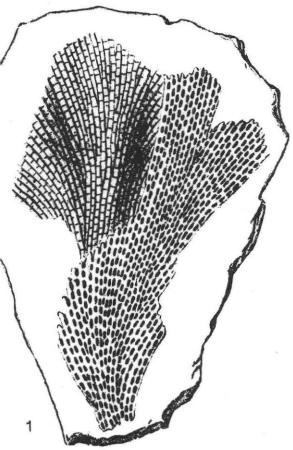
Polypora incepta Hall. (Page 52.)

8, 9. Two zoaria, natural size, both exhibiting the noncelluliferous surface.
10, 11. Noncelluliferous side enlarged to show striated surface.
12. 13. Two enlargements of the celluliferous face, exhibiting number of rows and arrange
ment of zoœcial apertures.
Rochester shale, Lockport, N. Y.

Pseudohornera niagarensis (Hall). (Page 49.)

[See also Pl. XVIII, fig. 20.]

14. Noncelluliferous face, natural size.
15. Celluliferous face of another example, × 2.
16. Fragment of another zoarium, × 3, showing basal attachment and angular crest.
Figs. 14–16 after Hall, Eleventh Ann. Rept. Indiana Geol. Nat. Hist., 1882.
Waldron shale, Waldron, Ind.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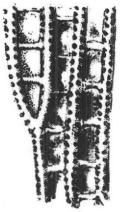
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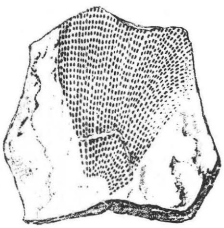
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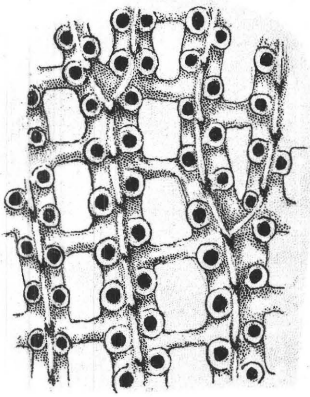
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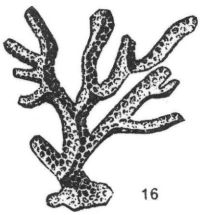
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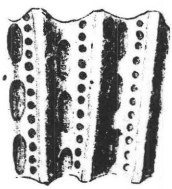
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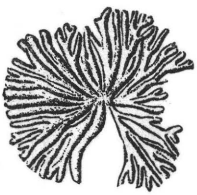
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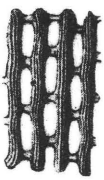
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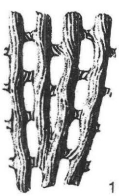
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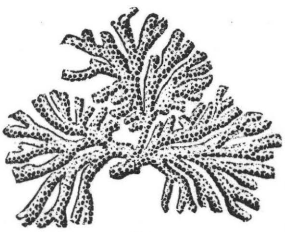
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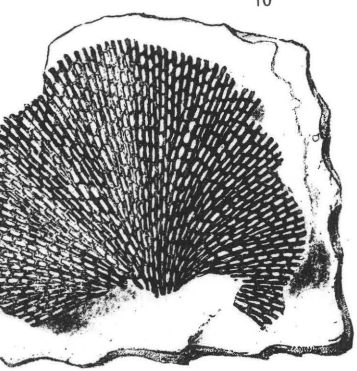
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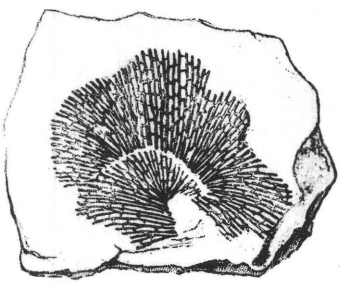
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BRYOZOA OF THE ROCHESTER SHALE

HELIOTYPE CO., BOSTON.

PLATE XX.

PLATE XX.

Clathropora alcicornis Hall. (Page 56.)

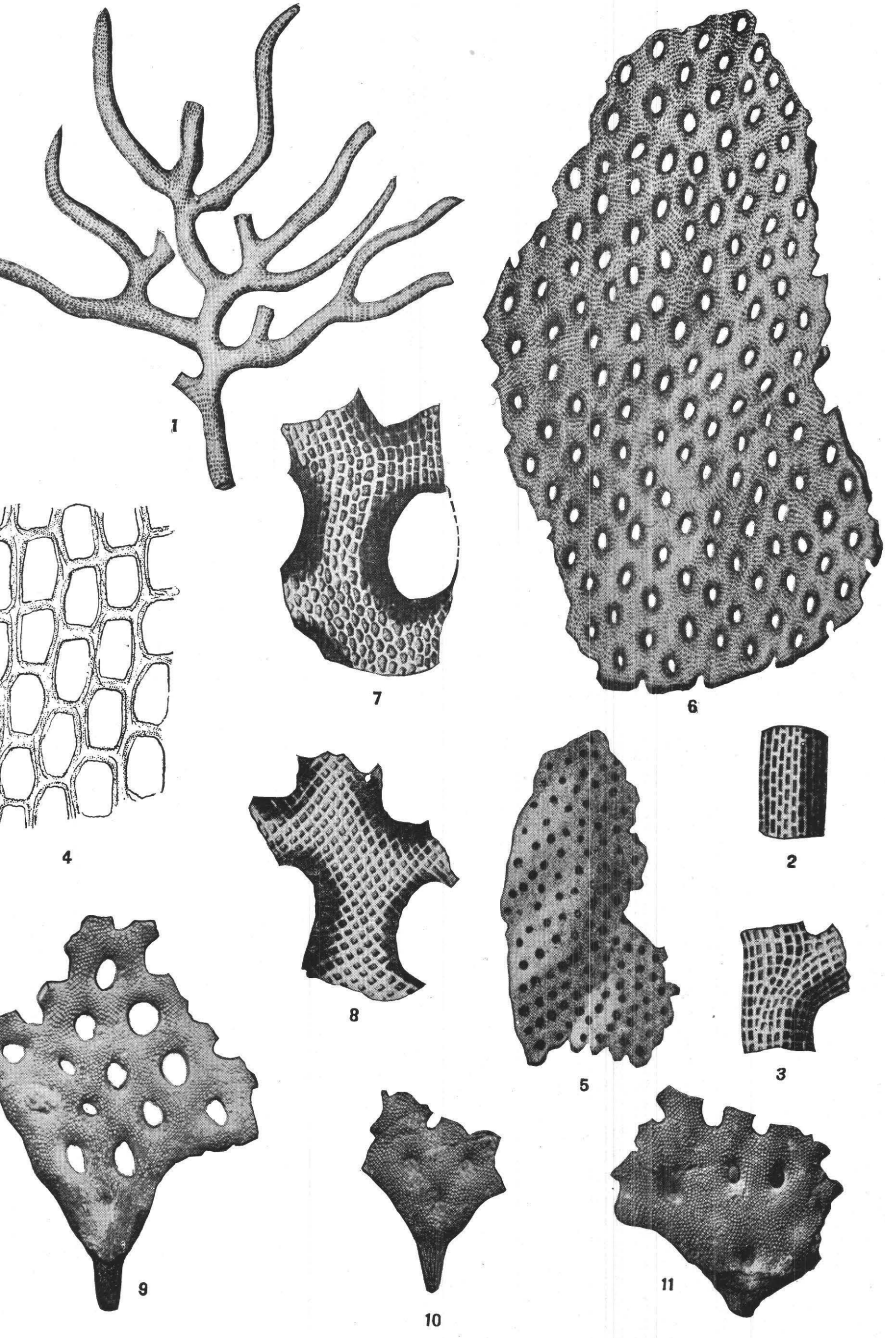
FIG. 1. A view of the type specimen, natural size.
2, 3. Enlarged views of the surface of the same.
4. A tangential section of the type specimen, × 30, showing its generic identity with *Clathropora*.
Rochester shale, Lockport, N. Y.

Clathropora frondosa Hall and var. *intermedia* Nicholson and Hinde. (Page 56.)

[See also Pl. XXI, figs. 6,7.]

5. A view of the type specimen of the small fenestruled form, which Nicholson and Hinde apparently considered as typical *C. frondosa*.
6. Natural-sized view of another of Hall's type specimens, later distinguished by Nicholson and Hinde as var. *intermedia*.
7, 8. Enlarged view of the surface, showing the zoœcial characters in both species and variety.
9, 10, 11. Three fragments of zoaria, showing the pointed basal extremity
Rochester shale, Lockport, N. Y.

Figs. 1, 2, 3, 5, 6, 7, 8 are after Hall, Natural History of New York, Paleontology II, 1852



BRYOZOA OF THE ROCHESTER SHALE.

PLATE XXI.

PLATE XXI.

Loculipora ambigua (Hall). (Page 53.)

FIG. 1. An outline sketch, natural size, illustrating the growth of this species and introduced for comparison with fig. 2.
Waldron shale, Waldron, Ind.

Loculipora ulrichi n. sp. (Page 53.)

2. Sketch of a zoarium, natural size, showing the narrow elongate basal portion.
Rochester shale, Grimsby, Ontario.

Acanthoclema asperum (Hall). (Page 58.)

[See also Pl. XXIV, figs. 7-9; Pl. XXV, figs. 17-20.]

3. Vertical section, × 20, showing the growth of the zoœcia from a central line.
4. Tangential section, × 20, passing through the mature region and illustrating the elongate-oval zoœcia, solid interspaces, and numerous granular-like acanthopores.
5. Transverse section, × 20, exhibiting the zoœcia radiating from the central axis.
Rochester shale, Lockport, N. Y.

Clathropora frondosa Hall. (Page 56.)

[See also Pl. XX, figs. 5-11.]

6. A vertical section, × 20, illustrating the bifoliate growth, the hemisepta, and the general shape of the zoœcia.
7. Tangential section, × 20, with the characteristic wall structure of the genus.
Rochester shale, Lockport, N. Y.

Nematopora minuta (Hall). (Page 58.)

[See also Pl. XVIII, fig. 10.]

8, 9. Two tangential sections passing through portions of mature region and exhibiting the long, oval zoœcia and the numerous small acanthopores.
10. Vertical section, × 20.
11. A portion of fig. 10, × 40, illustrating the acanthopores piercing the interzoœcial thickening.
Rochester shale, Grimsby, Ontario.

Diamesopora dichotoma Hall. (Page 62.)

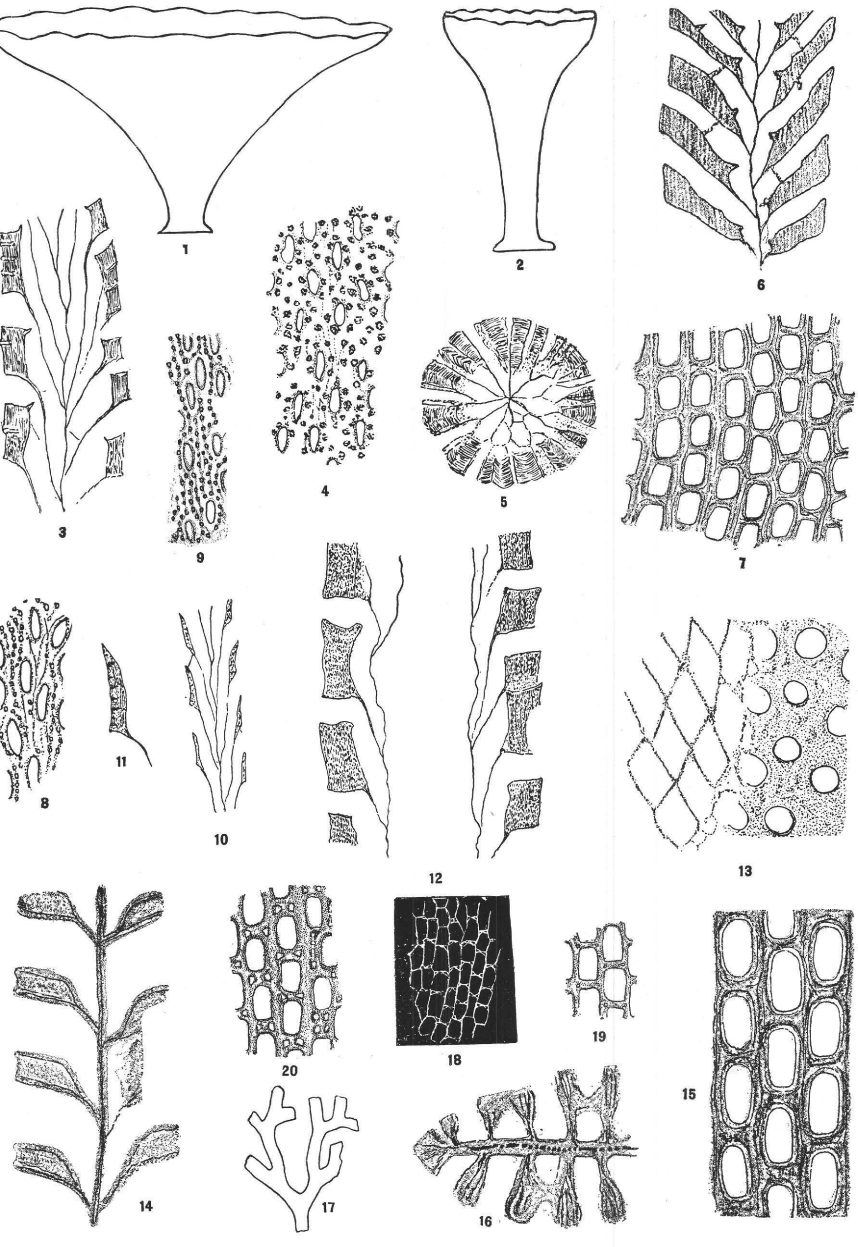
[See also Pl. XXIV, figs. 28-30.]

12. A vertical section, × 20, with the opposite sides brought closer together than in the specimen.
13. A tangential section, × 20, passing through both mature and immature regions and bringing out especially the shape of the primitive zoœcia.
Rochester shale, Lockport, N. Y.

Pachydictya crassa (Hall). (Page 57.)

[See also Pl. XVIII, figs. 11, 12.]

14, 15. Vertical and tangential sections, × 20, illustrating the internal structure of the Rochester form.
16. Portion of a transverse section, × 20, introduced to show the mesial tubuli.
Rochester shale, Lockport, N. Y.



BRYOZOA OF THE ROCHESTER SHALE.

Phænopora fimbriata canadensis n. var. (Page 55.)

FIG. 17. Outline of the most complete zoarium seen, natural size.
18. Surface of same, × 8.
19. Tangential section, × 20, showing the two small pores at the end of the zoœcia. Rochester shale, Grimsby, Ontario.

Phænopora fimbriata James. (Page 55.)

20. Portion of a tangential section, × 20, introduced for comparison with fig. 19. Clinton limestone, Dayton, Ohio.

PLATE XXII.

PLATE XXII.

Lichenalia concentrica Hall. (Page 61.)

[See also Pl. XXVI, figs. 7–10.]

FIG. 1. A tangential section, × 6, passing close to the surface of the zoarium and cutting one of the meandering canals.

2. Portion of a tangential section, × 20, cutting the high anterior end of the peristome and a few of the connecting walls.

3. A tangential section, × 20, passing through a lower portion of the zoarium than in fig. 2. The lower portion of the figure illustrates the zoœcia and mesopore-like structures of the mature region, the middle portion, the oblong or rectangular shape of the zoœcia in the immature zone, while in the upper part of the drawing are shown portions of the concentric rings of the epitheca.

4. A portion of a tangential section, × 20, illustrating the nature of the walls of the mesopore spaces.

5. A vertical section, × 20, illustrating the following characters: *z*, the zoœcia; *c*, one of the canals, covered above; *u b*, undulating base of zoarium; *w*, walls forming the mesopore-like spaces; *p*, the extremely high posterior portion of the peristome; *a*, the low anterior portion of the peristome; and *p'*, a posterior portion of the peristome cut obliquely.

6. A more diagrammatic vertical section, × 20, showing especially the low and high portions of the peristome and the walls of the interzoœcial spaces.

Rochester shale, Lockport, N. Y.

Stictotrypa punctipora (Hall). (Page 61.)

[See also Pl. XXIV, figs. 26, 27.]

7. A nearly complete zoarium, natural size, illustrating the usual method of growth.

8. A portion of the surface of the same, × 20, showing the characteristic notch or cleft in the anterior part of the peristome.

Rochester shale, Grimsby, Ontario.

9. A portion of a tangential section, × 20, passing through both mature and immature regions and illustrating especially the rhomboidal shape of the immature zoœcia.

10. A tangential section through the mature region, × 20.

11. A vertical section, × 20.

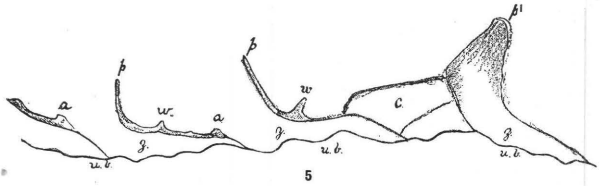
Rochester shale, Lockport, N. Y.

Rhinopora curvata Ringueberg. (Page 60.)

12. A vertical section, × 20, illustrating the bifoliate growth and other characters.

13. Surface of a typical example, × 8.

Rochester shale, Grimsby, Ontario.



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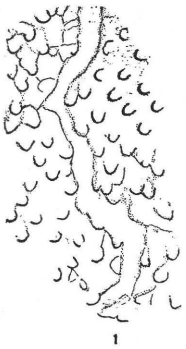

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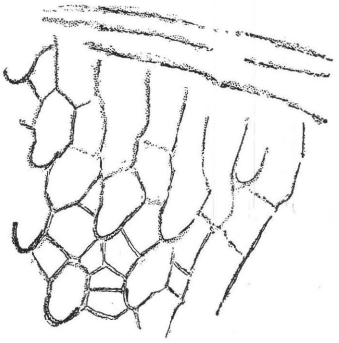

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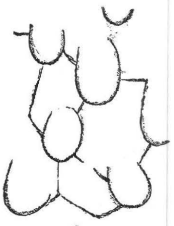

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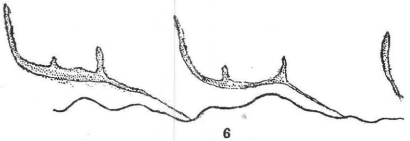

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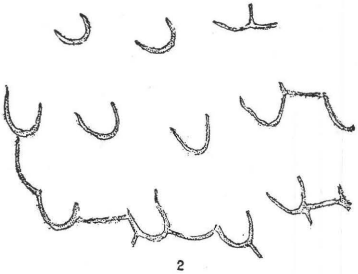

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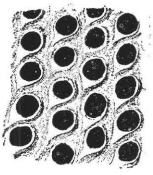

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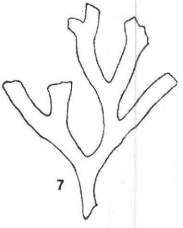

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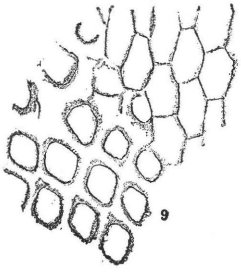

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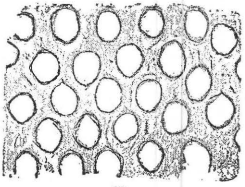

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12

BRYOZOA OF THE ROCHESTER SHALE.

PLATE XXIII.

PLATE XXIII.

Pseudohornera diffusa (Hall). (Page 50.)

[See also Pl. XVIII, figs. 6–9.]

FIG. 1. Transverse section of a branch, × 18, showing central lamina.
2. Tangential section, × 18.
3. Vertical section, × 18, showing thick basal plate, the form of the zoœcia, and the abortive cells beneath the central lamina.
Rochester shale, Lockport, N. Y.

Diploclema sparsum (Hall). (Page 17.)

[See also Pl. V, figs. 6, 7.]

4. Tangential section, ×18, cutting the zoœcia at varying levels between the apertures and the median line.
5, 6. Two transverse sections, × 30, showing the central lamina.
Rochester shale, Lockport, N. Y.

Rhinopora verrucosa Hall. (Introduced for comparison.)

7. Fragment, natural size, showing the covered canals.
8. A fragment in which the canals are apparently absent. This specimen closely resembles the zoarium of *Rhinopora curvata*.
9. Enlargement of fig. 8, showing the arrangement of the zoœcia.
Clinton formation, Flamborough Head, Canada.

Cœloclema cavernosa n. sp. (Page 21.)

10. A zoarium, × 1.5, showing the utricular form of growth.
11. A still further enlargement of the same specimen, exhibiting the arrangement of the zoœcia.
12. A vertical section, × 20, through one of the sides of the zoarium.
13. Tangential section, × 20.
Rochester shale, Lockport, N. Y.

Fistulipora tuberculosa Hall. (Page 23.)

[See also Pl. VII, figs. 11–15; Pl. VIII, figs. 7, 8.]

14. A characteristic specimen, × 2, showing the usual utricular method of growth.
Rochester shale, Lockport, N. Y.

Fistulipora crustula n. sp. (Page 24.)

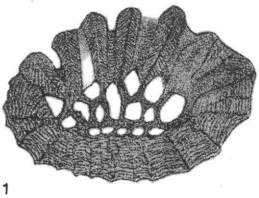
[See also Pl. VII, figs. 7–10; Pl. VIII, figs. 16, 17.]

15. A zoarium, × 2.
Rochester shale, Lockport, N. Y.

Trematopora whitfieldi Ulrich. (Page 44.)

[See also Pl. XXVII, figs. 16, 17.]

16. A fragment, natural size.
17. Surface of same, × 18.
Waldron shale, Waldron, Ind.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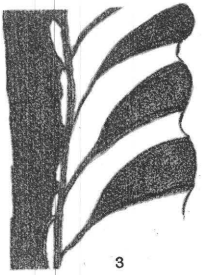
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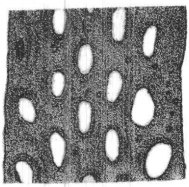
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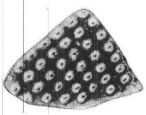
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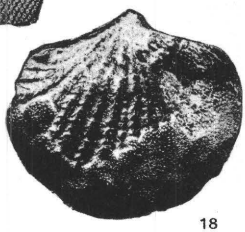
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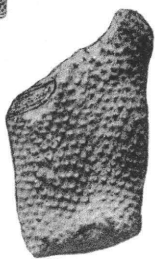
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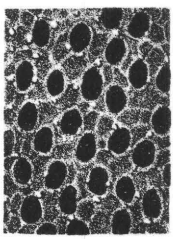
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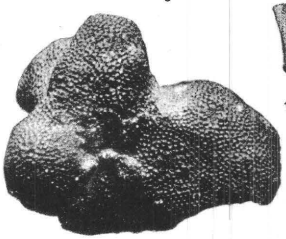
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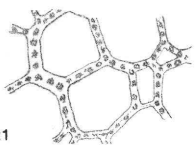
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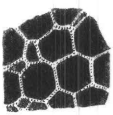
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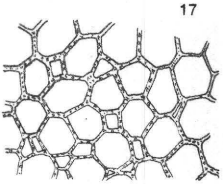
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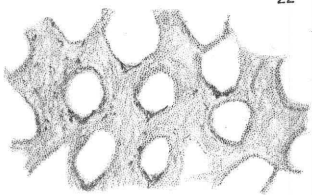
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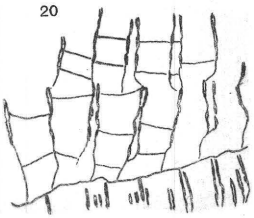
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BRYOZOA OF THE ROCHESTER SHALE

HELIOTYPE CO., BOSTON.

Lioclema multiporum n. sp. (Page 34.)

[See also Pl. XI, figs. 4-6; Pl. XXVII, fig. 20.]

FIG. 18. A zoarium, × 2, incrusting an *Atrypa*.
Rochester shale, Lockport, N. Y.

Lioclema peculiare n. sp. (Page 35.)

[See also Pl. XXV, fig. 13.]

19. A vertical section, × 20, showing two layers of zoœcia.
20. Tangential section, × 20, exhibiting the many small acanthopores.
21. Several zoœcia and mesopores, × 35, showing the wall structure.
22. Surface of one of the types, × 20.
Rochester shale, Lockport, N. Y.

Figs. 1 to 4 are copied from Ulrich, Geological Survey of Illinois, VIII; 7 to 9 from Hall, Natural History of New York, Paleontology II; 16 and 17 from Ulrich, American Paleozoic Bryozoa.

PLATE XXIV.

PLATE XXIV.

[Unless otherwise stated, all the figures on this plate are copied from Hall, Nat. Hist. New York, Pal. II, 1852.]

Nicholsonella florida (Hall). (Page 38.)

[See also Pl. XIV, figs. 10, 11.]

FIGS. 1, 2. Zoaria enlarged and natural size respectively. In upper half of fig. 1 the floriform apertures are shown while a species of *Lioclema* incrusts a portion of the lower half.
Rochester shale, Lockport, N. Y.

Eridotrypa striata (Hall). (Page 32.)

[See also Pl. XII, figs. 4–6; Pl. XXV, fig. 14.]

3, 4. Enlarged and natural-size views of the basal part of a zoarium.
5. A portion of fig. 3 enlarged to show the striated appearance of the zoœcia toward the base.
6. A fragment of a zoarium, natural size.
Rochester shale, Lockport, N. Y.

Acanthoclema asperum (Hall). (Page 58.)

[See also Pl. XXI, figs. 3–5; Pl. XXV, figs. 17–20.]

7, 8. Three fragments of zoaria, natural size.
9. A portion of fig. 7 enlarged, showing the numerous small acanthopores indenting the elongate-oval zoœcia.
Rochester shale, Lockport, N. Y.

Batostomella granulifera (Hall). (Page 28.)

[See also Pl. XIII, figs. 1–5; Pl. XXV, figs. 11, 12.]

10. Fragment of a zoarium, natural size, showing the usual growth.
11. Surface of a fragment, enlarged.
Rochester shale, Lockport, N, Y.

Bythopora spinulosa (Hall). (Page 29.)

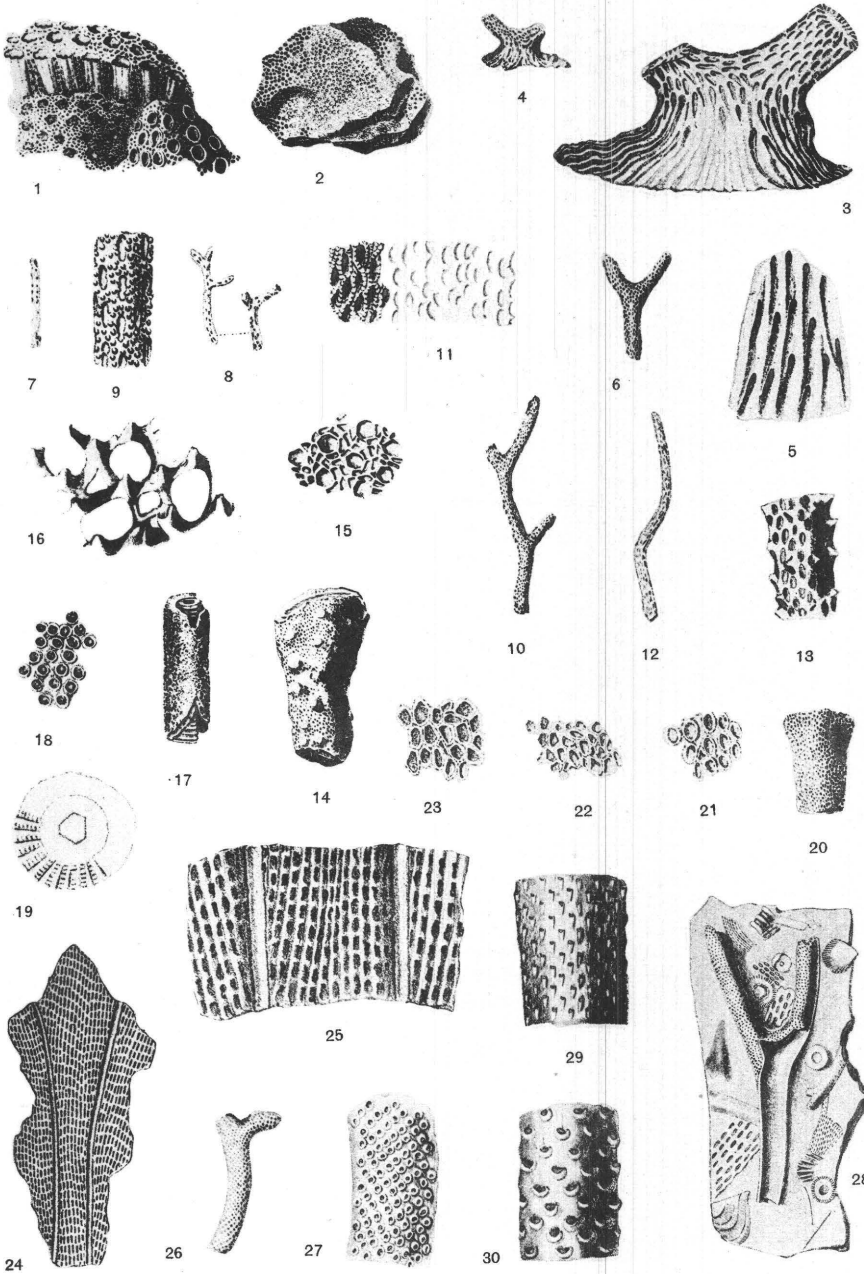
[See also Pl. XIII, figs. 6, 7.]

12. A fragment, natural size, rather more robust than usual.
13. Surface of same enlarged, showing the sharp spines.
Rochester shale, Lockport, N. Y.

Lioclema asperum (Hall). (Page 32.)

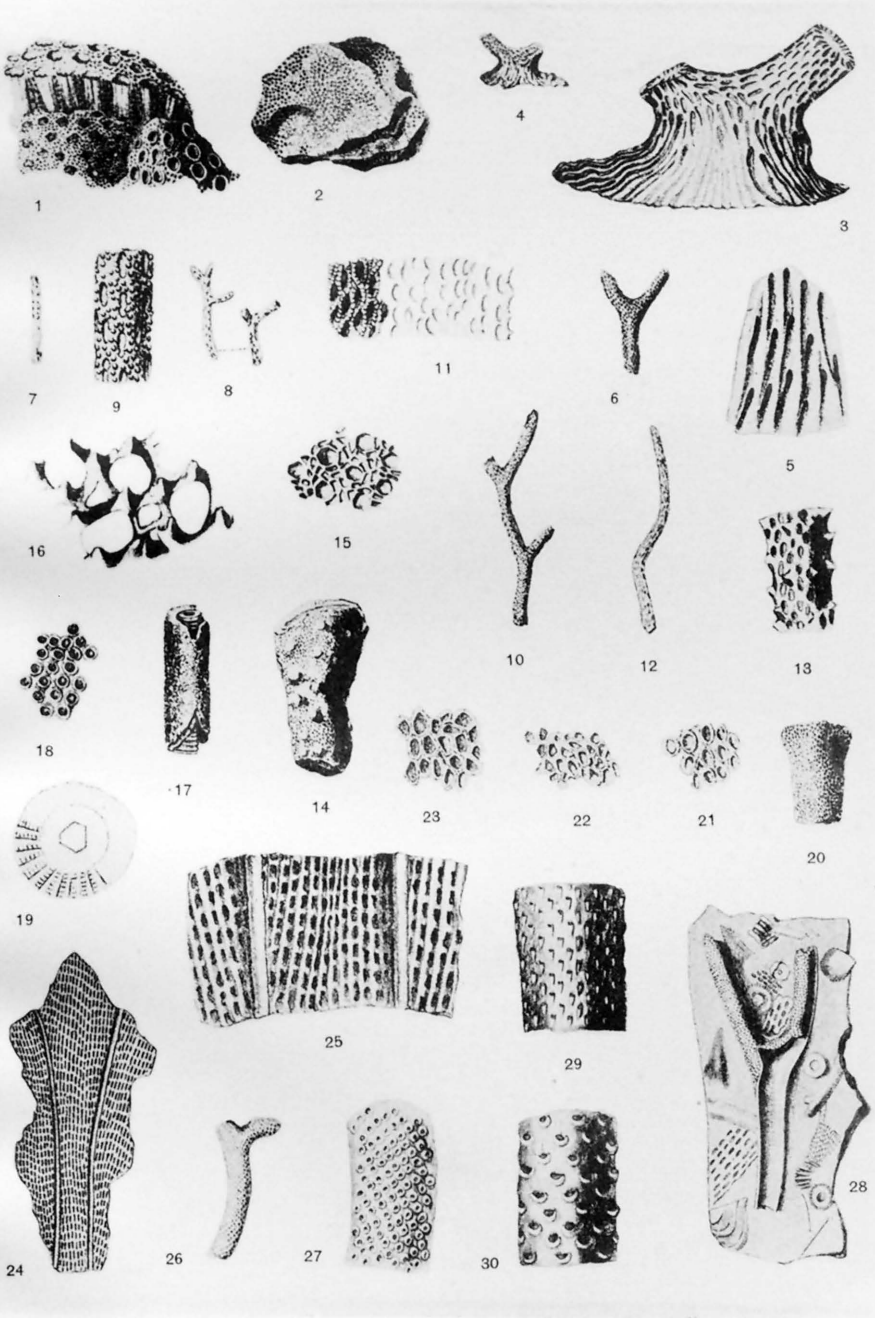
[See also Pl. XI, figs. 1–3.]

14. An undulating expansion of this species, natural size.
15, 16. Two enlargements of the surface, exhibiting the numerous mesopores and large acanthopores.
Rochester shale, Lockport, N. Y.



BRYOZOA OF THE ROCHESTER SHALE

HELIOTYPE CO., BOSTON



BRYOZOA OF THE ROCHESTER SHALE

HELIOTYPE CO., BOSTON

Idiotrypa punctata (Hall). (Page 40.)

[See also Pl. XVII, figs. 4–10.]

FIG. 17. View of Hall's type, natural size, growing about a crinoid column.
18. Surface of same, enlarged.
19. View of a transverse section of the type.
Rochester shale, Lockport, N. Y.

Eridotrypa solida (Hall). (Page 30.)

[See also Pl. XII, figs. 7–9; Pl. XXV, fig. 16.]

20. A small fragment, natural size.
21, 22, 23. Three views of the surface of a zoarium, enlarged.
Rochester shale, Lockport, N. Y.

Ptiloporella nervata (Nicholson). (Page 51.)

[See also Pl. XXVI, figs. 5, 6.]

24, 25. Natural size and enlarged views of the noncelluliferous face. (After Nicholson, Geol. Survey Ohio, Pal. II, Pl. XXV, figs. 11, 11a.
Niagara limestone, Cedarville, Ohio.

Stictotrypa punctipora (Hall). (Page 61.)

[See also Pl. XXII, figs. 7–11.]

26, 27. Natural size and enlarged views of a fragment showing the arrangement and shape of the zoœcia.
Rochester shale, Lockport, N. Y.

Diamesopora dichotoma (Hall). (Page 62.)

[See also Pl. XXI, figs. 12, 13.]

28. Fragment of a zoarium showing the characteristic hollow stems.
29, 30. Two views of the surface, enlarged.
Rochester shale, Lockport, N. Y.

PLATE XXV.

PLATE XXV.

Eridotrypa nodulosa n. sp. (Page 30.)

[See also Pl. XI, figs. 14, 15.]

FIGS. 1, 2, 3. Three fragments, × 2, illustrating the variation in the shape of the tubercles.
Rochester shale, Lockport, N. Y.

Diplotrypa walkeri n. sp. (Page 47.)

[See also Pl. XIV, figs. 1–5.]

4. An average complete zoarium of this species, × 2.
Rochester shale, Grimsby, Ontario.

Lioclemella maccombi n. sp. (Page 36.)

[See also Pl. XI, figs. 7–10.]

5, 6, 7. Three nearly complete zoaria, × 2, showing the unbranched and basally pointed features.
Rochester shale, Lockport, N. Y.

Trematopora tuberculosa (Hall). (Page 43.)

[See also Pl. XIII, figs. 15, 16; Pl. XVII, figs. 1–3.]

8. A fragment of a zoarium, × 2, showing the usual conspicuous tubercles.
Rochester shale, Lockport, N. Y.

Lioclema ramulosum n. sp. (Page 35.)

[See also Pl. XI, figs. 11–13.]

9, 10. Two fragments, × 2, illustrating the usual characters of the species.
Rochester shale, Lockport, N. Y.

Batostomella granulifera (Hall). (Page 28.)

[See also Pl. XIII, figs. 1–5; Pl. XXIV, figs. 10, 11.]

11, 12. Two fragmentary examples, × 2.
Rochester shale, Lockport, N. Y.

Lioclema peculiare n. sp. (Page 35.)

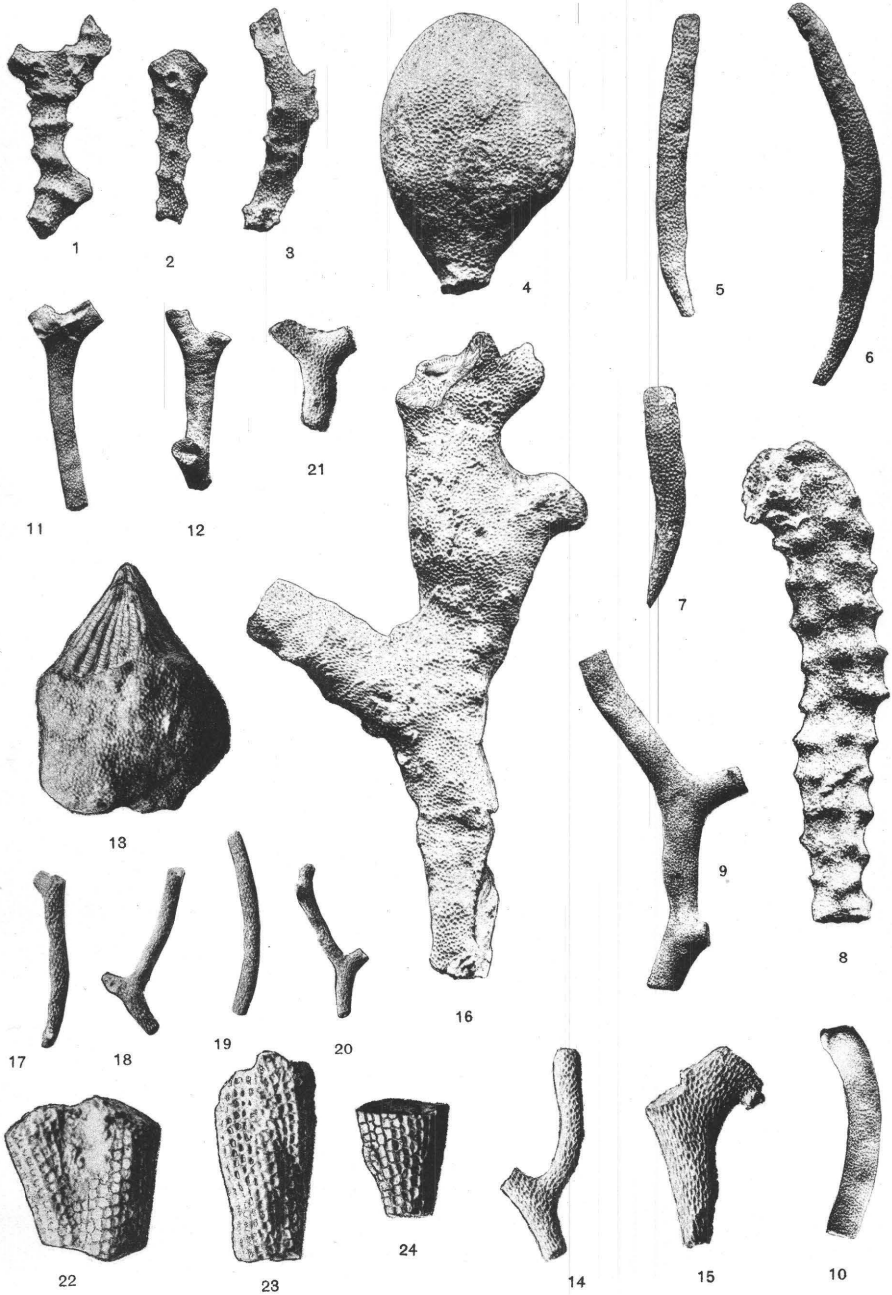
[See also Pl. XXIII, figs. 19–22.]

13. A zoarium incrusting a *Rhynchotreta*, × 2.
Rochester shale, Lockport, N. Y.

Eridotrypa striata (Hall). (Page 32.)

See also Pl. XII, figs. 4–6; Pl. XXIV, figs. 3–6.]

14. A fragment, × 2, introduced for comparison with fig. 15.
Rochester shale, Lockport, N. Y.



BRYOZOA OF THE ROCHESTER SHALE

HELIOTYPE CO., BOSTON.

Eridotrypa spinosa n. sp. (Page 29.)

[See also Pl. XII, figs. 1-3.]

FIG. 15. A fragment, × 2, showing the larger size of the branch and zoœcia distinguishing the species from *E. striata*.
Rochester shale, Rochester, N. Y.

Eridotrypa solida (Hall). (Page 30.)

[See also Pl. XII, figs. 7-9; Pl. XXIV, figs. 20-23.]

16. Portion of a zoarium, × 2.
Rochester shale, Lockport, N. Y.

Acanthoclema asperum (Hall). (Page 58.)

[See also Pl. XXI, figs. 3-5; Pl. XXIV, figs. 7-9.]

17–20. Four fragments, × 2, illustrating the usual characters of specimens found in washings.
Rochester shale, Lockport, N. Y.

Rhombotrypa spinulifera n. sp. (Page 37.)

[See also Pl. X, figs. 13-16.]

21. Portion of a zoarium, × 2, illustrating the usual shape of the fragments found.
Rochester shale, Rochester, N. Y.

Loculipora ulrichi n. sp. (Page 53.)

[See also Pl. XXI, fig. 2.]

22–24. Three fragments of the basal portions of zoaria, × 2.
Rochester shale, Grimsby, Ontario.

PLATE XXVI.

PLATE XXVI.

Eridotrypa similis n. sp. (Page 31.)

[See also Pl. XII, figs. 10–14.]

FIGS. 1, 2. Two nearly complete zoaria, × 1.3.
Rochester shale, Grimsby, Ontario.

Callopora magnopora Foerste. (Page 42.)

[See also Pl. XV, figs. 1–8.]

3. Fragment of a zoarium, × 1.3. showing the thickness of the branch.
Rochester shale, Grimsby, Ontario.

Lioclema explanatum n. sp. (Page 33.)

[See also Pl. XIII, figs. 8–10.]

4. Basal view of a complete zoarium, × 1.3, showing the undulating epitheca.
Rochester shale, Rochester, N. Y.

Ptilopora nervata (Nicholson). (Page 51.)

[See also Pl. XXIV, figs. 24, 25.]

5, 6. Noncelluliferous and celluliferous faces of two zoaria, × 1.3, exhibiting the prominent primary branches.
Rochester shale, Grimsby, Ontario.

Lichenalia concentrica Hall. (Page 61.)

[See also Pl. XXII, figs. 1–6.]

7, 8. Views of two young examples, natural size, showing the subcircular laminar zoœcia.

9. A portion of a zoarium, natural size, exhibiting the characteristic concentric undulations of the epitheca.

10. A portion of the epithecated side, enlarged.
(Figs. 7 to 10 after Hall, Nat. Hist. New York, Pal. II, 1852, pl. 40E.)
Rochester shale, Lockport, N. Y.

Monotrypa benjamini n. sp. (Page 46.)

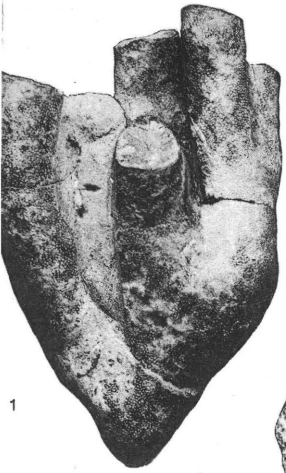
[See also Pl. XVI, figs. 6–9.]

11. A zoarium, × 3, split through its length to show the characteristic crenulated zoœcial walls.
Rochester shale, Rochester, N. Y.

Callopora elegantula Hall. (Page 41.)

[See also Pl. XVII, figs. 11–15.]

12. Fragment of a zoarium, × 3, exhibiting the usual arrangement of zoœcia and mesopores. Many of the zoœcia are closed by opercula.
Rochester shale, Rochester, N. Y.



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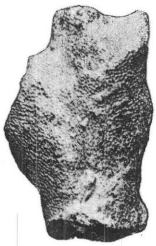

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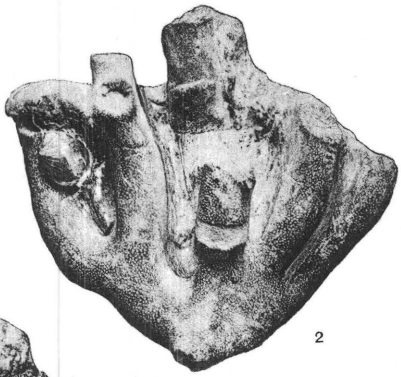

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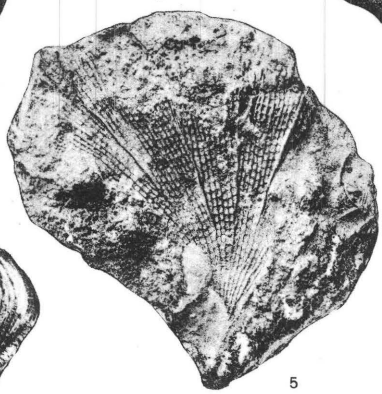

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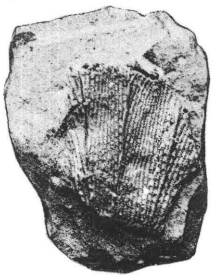

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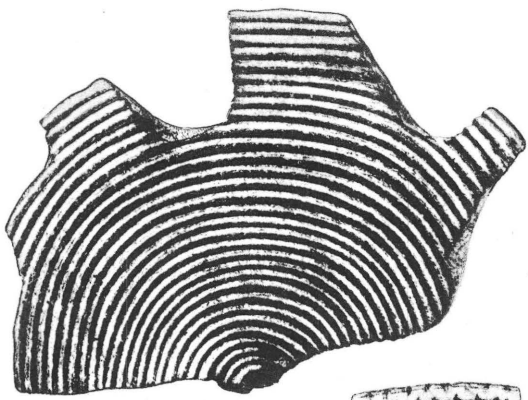

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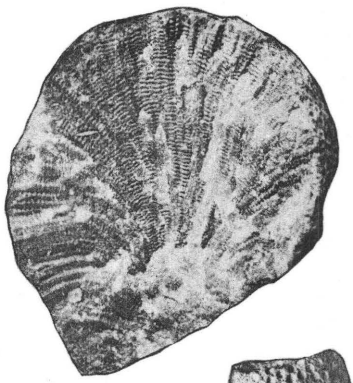

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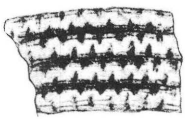

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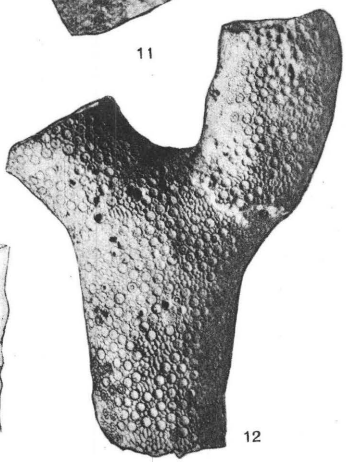

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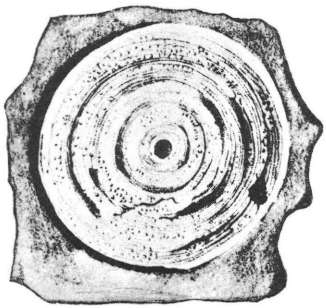

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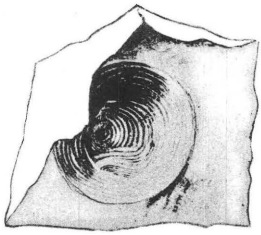


8

BRYOZOA OF THE ROCHESTER SHALE

PLATE XXVII.

PLATE XXVII.

Thamniscus dichotomus (Hall). (Page 54.)

[See also Pl. XVIII, figs. 17–19.]

FIG. 1. Surface view of a young example, × 20, showing the separating ridges.

2. Portion of the surface of a more mature example, × 20, in which the ridges are less marked and the granules more pronounced.

3. View of the noncelluliferous side of a young example, × 20, in which the characteristic granulose striæ are well exhibited.

4. Celluliferous and noncelluliferous faces of two zoaria, natural size, exhibiting the characteristic dichotomous branching.

5. Tangential section, × 20, passing close to the surface of the celluliferous side.

6, 7. Two vertical sections, × 20.

Rochester shale, Grimsby, Ontario.

Phænopora ensiformis Hall. (Page 55.)

8, 9. Tangential and vertical sections, respectively, × 20, showing the internal structure.

Rochester shale, Grimsby, Ontario.

Tæniodictya schucherti n. sp. (Page 57.)

10. Vertical section, × 20.

11. Tangential section, × 20, in which the zoœcia have thickened walls and are arranged less regularly than usual.

12. Portion of tangential section, × 20, showing the usual arrangement of the zoœcia.

13. Outline sketch, natural size, of the type of the species.

Rochester shale, Grimsby, Ontario.

Trematopora spiculata Hall. (Page 45.)

14, 15. Tangential and vertical sections, respectively, × 20.

Rochester shale, Lockport, N. Y.

Trematopora whitfieldi Ulrich. (Page 44.)

[See also Pl. XXIII, figs. 16, 17.]

16, 17. Vertical and tangential sections, × 20.

Waldron shale, Waldron, Ind.

Lioclema globulare n. sp. (Page 35.)

18. Vertical section, × 20, showing the absence of diaphragms in the zoœcia, and the irregular tabulation of the mesopores.

19. Tangential section, × 20, exhibiting the thin-walled zoœcia and few acanthopores.

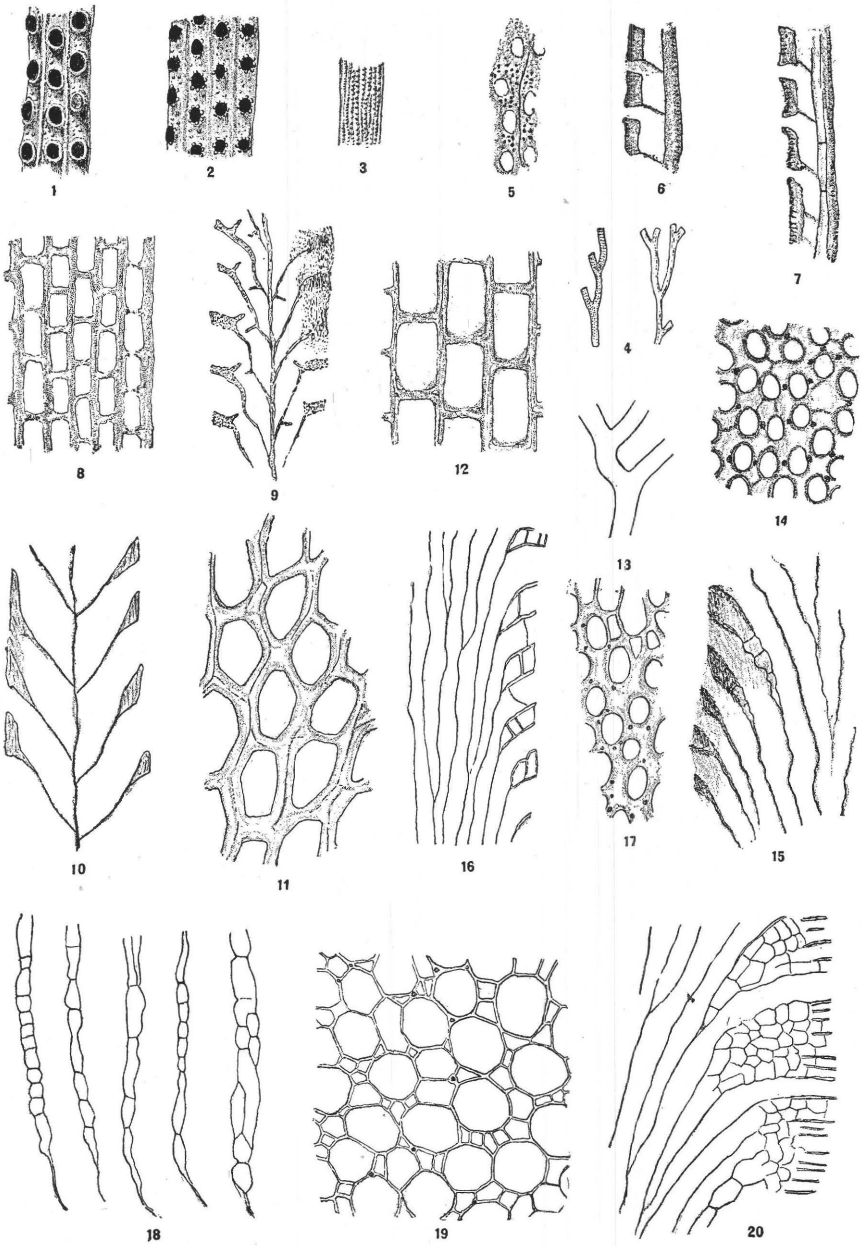
Rochester shale, Lockport, N. Y.

Lioclema multiporum n. sp. (Page 34.)

[See also Pl. XI, figs. 4–6; Pl. XXIII, fig. 18.]

20. A vertical section, × 20, of the subramose form.

Rochester shale, Rochester, N. Y.

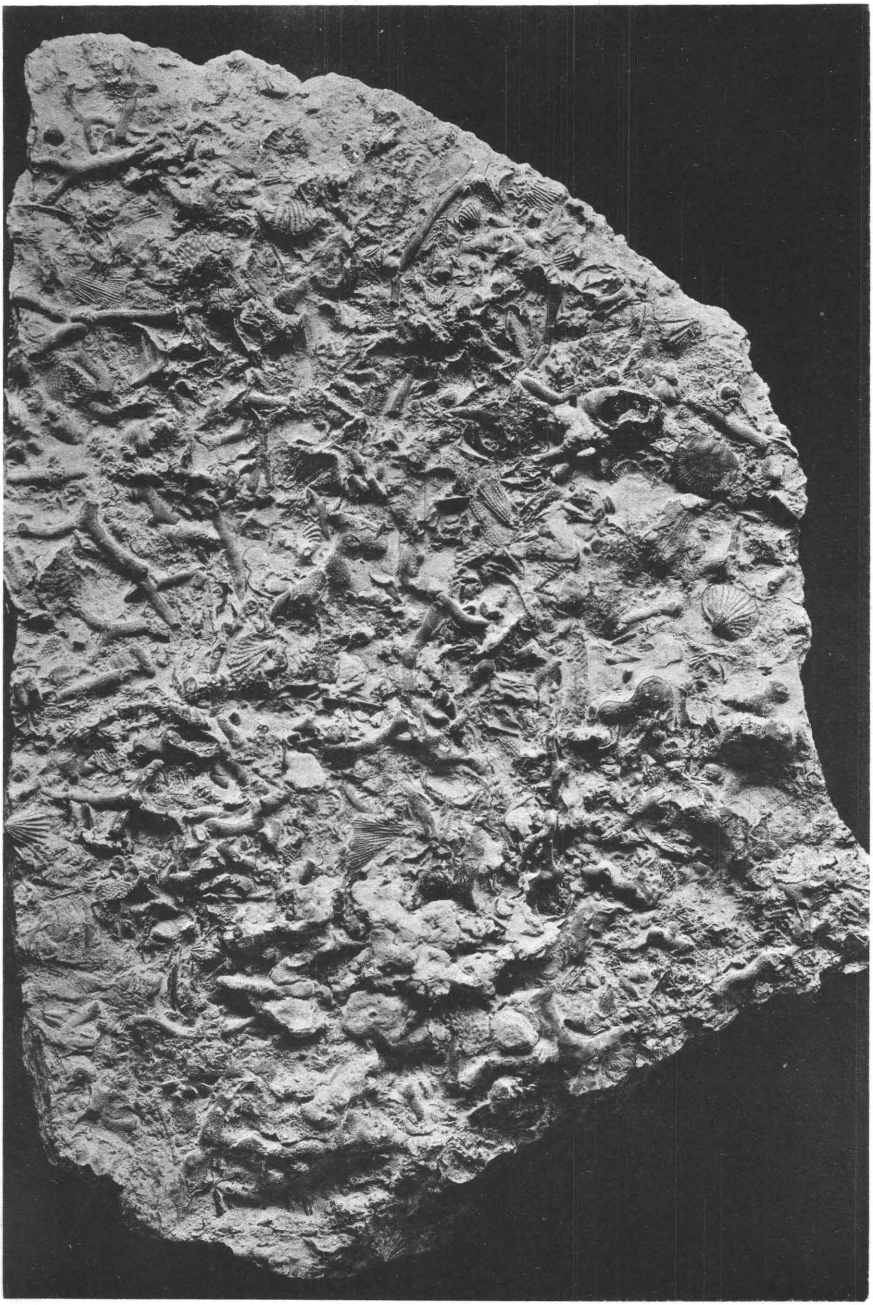


BRYOZOA OF THE ROCHESTER SHALE.

PLATE XXVIII.

PLATE XXVIII.

Slab about two-thirds natural size, showing abundance of bryozoan remains upon surface. The limestone layer, of which this slab is a portion, is made up almost entirely of bryozoa. Rochester shale, pulp mill along Erie Canal, Lockport, N. Y.



BRYOZOA OF THE ROCHESTER SHALE

HELIOTYPE CO., BOSTON.

PLATE XXIX.

PLATE XXIX.

A portion of the surface of slab figured on Pl. XXVIII magnified about one and a half times. In this particular specimen the solid and hollow ramose forms are particularly abundant.

Rochester shale, pulp mill along Erie Canal, Lockport, N. Y.

BRYOZOA OF THE ROCHESTER SHALE

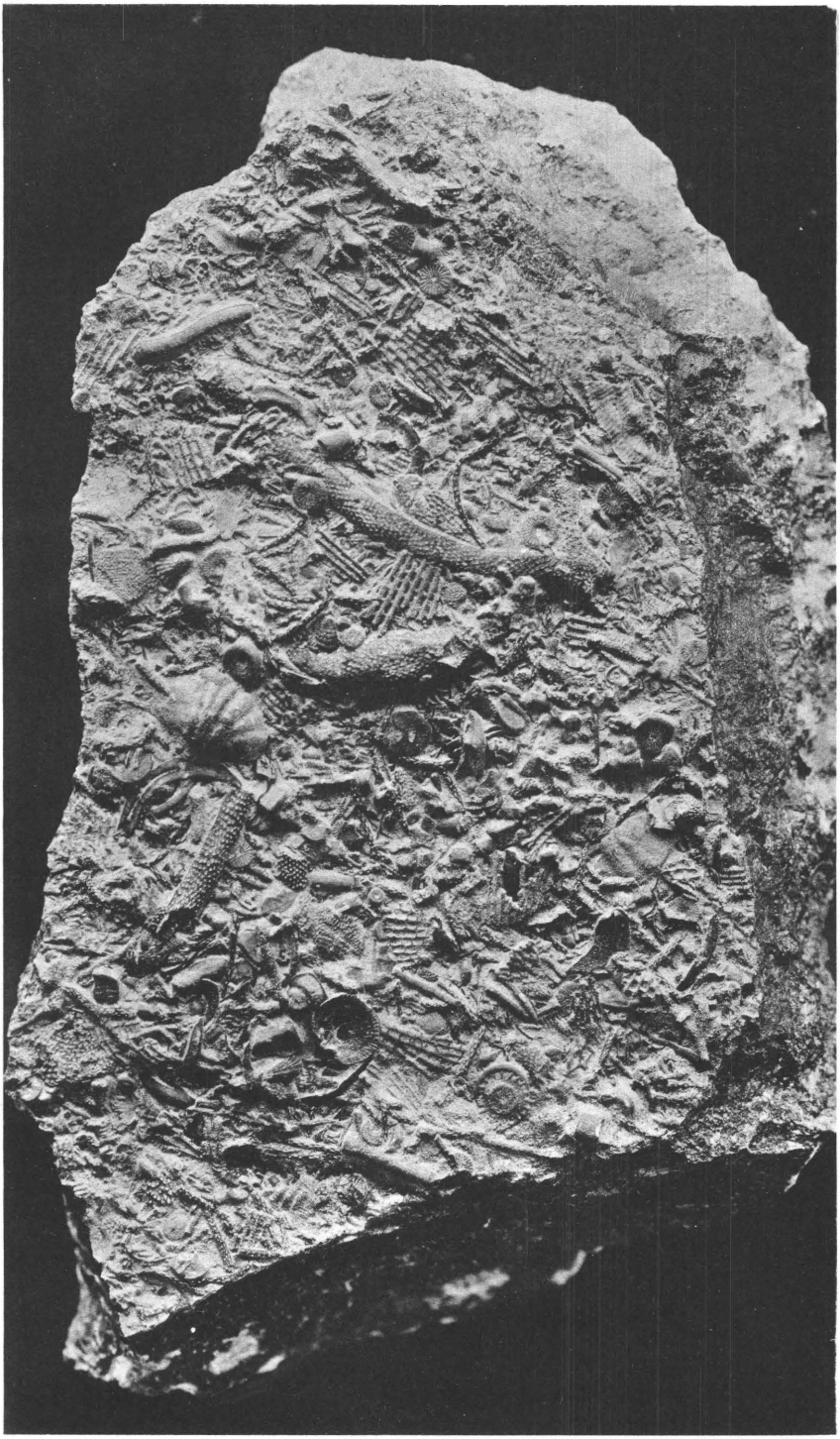
HELIOTYPE CO., BOSTON.

PLATE XXX.

PLATE XXX.

View of a fragment of a thin limestone layer, magnified two diameters. In this layer the slender ramose species such as *Diploclema sparsum*, *Nematopora minuta*, and *Acanthoclema asperum* are particularly abundant.

Rochester shale, near locks of Erie Canal, Lockport, N. Y.



BRYOZOA OF THE ROCHESTER SHALE

HELIOTYPE CO., BOSTON.

PLATE XXXI.

PLATE XXXI.

A portion of the surface of a slab, magnified about two diameters, showing more numerous fenestellids than on the other specimens figured. The ramose specimen in the central part of the plate is a typical example of *Diamesopora dichotoma.*

Rochester shale, Niagara Gorge, New York.

BRYOZOA OF THE ROCHESTER SHALE

HELIOTYPE CO., BOSTON.

INDEX.

[Names in italic are of synonyms; figures in black-face type show location of descriptions; figures in italic refer to illustrations.]

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[Bulletin No. 292.]

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