

A REVISION OF THE PALEOZOIC BRYOZOA

BY E. O. ULRICH AND R. S. BASSLER

PART II.—ON GENERA AND SPECIES OF TREPOSTOMATA

We have no reason for emending the definition of the order Trepostomata as given in previous works by the senior author. In order to save repetition it is to be understood that, when no remarks follow a family or generic name, we are satisfied with the diagnosis given in the English edition of Zittel's *Textbook of Palaeontology* or in the *Synopsis of American Fossil Bryozoa*.¹

The classificatory value of the structure of the walls separating neighboring zooids, especially the degree in which the calcareous investment of adjoining zooids is either amalgamated or maintains for each its integrity, continues to impress us more and more favorably. According as the walls are amalgamated or retain their duplex character, the seven families recognized under the Trepostomata in the latest classification of Paleozoic Bryozoa, fall four into the first and three into the second division, as follows: (1) (AMALGAMATA) *Monticuliporida*, *Heterotrypida*, *Constellariida*, and *Batostomellida*; (2) (INTEGRATA) *Amplexoporida*, *Calloporida*, and *Trematoporida*.

DIVISION I.—AMALGAMATA NEW DIVISION

Trepostomata in which the boundaries of adjacent zoecia are obscured by the more or less complete amalgamation of their walls.

In a few genera, notably *Prasopora* and *Aspidopora*, referred to families of this division, the amalgamation of the walls is sometimes difficult to establish.

Family MONTICULIPORIDÆ Nicholson (Emend. Ulrich) ,

Genus MONTICULIPORA D'Orbigny

Our revised conception of *Monticulipora* is essentially as that published in volume III of the *Palaeontology of Minnesota*. However, a few forms previously referred to the genus, principally because there was no other group to receive them, are here removed to the new genus *Orbignyella*. The peculiar granulose walls, the very

¹ *Bull. U. S. Geological Survey*, No. 173.

slight development or total absence of the laminated secondary deposit, and the presence of cystiphragms in both the axial and peripheral regions, are the principal diagnostic characters of *Monticulipora* as now understood by us. Our reasons for distinguishing the new generic group *Orbignyella* will be found under the discussion of that genus.

Through the kindness of Dr. M. Boule of the Museum d'Histoire Naturelle, Paris, we have recently procured a fragment of the specimen upon which D'Orbigny based his description of *Monticulipora mammulata*, the first of the four species and the accepted type of the genus *Monticulipora* established by him at the same time. The fragment received from Dr. Boule was carefully sectioned, and the internal characters of the species drawn by Mr. Bassler. The reproductions of these drawings on plate VI, 1-3, though adding nothing to the present knowledge, nevertheless serve to fix the status of the genus and species. They show further that Ulrich's interpretation of the species in 1882¹ was correct and that the synonymy given then by that author and later by Nickles and Bassler² is also correct.

The principal features of the genus are the peculiar granulose wall structure and the presence of cystiphragms in both axial and peripheral regions. The range of variation in mode of growth and mature form of the zoarium, from incrusting sheets to irregular or globular masses, and from frondescent to quite regularly ramose forms, as exhibited in the species referred to the genus by Ulrich, is still considered as properly embraced within the limits of a single genus.

The following species are characteristic middle Richmond forms, the first being the only ramose *Monticulipora* known to occur in the Cincinnati group.

MONTICULIPORA CLEVELANDI James

(PLATE VI, 4-6)

Monticulipora (Heterotrypa?) cleavelandi JAMES, Paleontologist, No. 6, 1882, p. 49, pl. i, 7.

Monticulipora cleavelandi JAMES AND JAMES, Jour. Cincinnati Soc. Nat. Hist., XI, 1888, p. 15, pl. i, 4.

Monticulipora cleavelandi J. F. JAMES, Jour. Cincinnati Soc. Nat. Hist., XVIII, 1895, p. 68.

Zoarium irregularly subramose to ramose; branches subcylindrical or flattened, often 10 mm. or more in diameter. Surface smooth.

¹ Jour. Cincinnati Soc. Nat. Hist., v, 1882, p. 234.

² Bull. U. S. Geol. Surv., No. 173, 1900, p. 324.

the maculae generally inconspicuous, but, where composed of mesopores only, quite distinct and slightly elevated. Zoecia small, angular, with rather thick, minutely granulose walls, 8 to 9 in 2 mm. Mesopores very few and generally restricted to the maculae. Acanthopores small and usually not showing at the surface; nor can they be readily distinguished in tangential sections from the granulose wall structure. Cystiphragms in a compact series in the peripheral region, about 3 in a distance equaling the diameter of a tube, while in the axial portion they are large and more infrequent, here varying from once to twice a tube diameter apart. Walls very thin in the axial region but becoming considerably thickened and apparently first developing their granulose character in the peripheral zone.

The only described species with which this need be compared is *M. arborea* Ulrich, a similarly ramose *Monticulipora* from the Trenton of Minnesota and Kentucky. Although agreeing closely in many respects, the absence of monticules and the smaller and less numerous acanthopores distinguish *M. cleavelandi* from the Trenton form. The occurrence of cystiphragms in both the axial and peripheral regions in *M. cleavelandi* distinguishes it from all associated Richmond bryozoans having a ramose mode of growth.

This species was supposed by us to be new, but just before this article went to press, Mr. Bassler obtained the loan of the James' types of Bryozoa from the University of Chicago and discovered the identity of our form with James' *M. cleavelandi*. Judging from the various descriptions of *M. cleavelandi*, one would never suspect that James' species and the form here described were based on the same species.

Occurrence.—James' types are from Lynchburg, Ohio. The species is very abundant in the middle division of the Richmond at Dutch creek, 4½ miles northwest of Wilmington, Ohio, and at Cowan's creek, 7 miles southwest of the same place.

Cat. Nos. 43,170, 43,171, U. S. N. M.

MONTICULIPORA EPIDERMATA new species

(Not figured)

Chaetetes mammulatus QUENSTEDT (not *Monticulipora mammulata* D'ORBIGNY), Roehren und Sternkorallen, 1881, p. 75, pl. cxlvi, figs. 10, 11 (not 12).

This species is so abundant and characteristic of the middle Richmond of Ohio and Indiana and also so easily recognized by the external characters which are clearly shown in Quenstedt's figures (loc. cit.) that we think it desirable to describe its internal characters

Unfortunately these cannot be illustrated at this time. As the species is distinct from *M. mammulata* and marks a different stratigraphic horizon, the above new name is proposed for its future designation.

M. epidermata is readily distinguished from *M. mammulata*, with which it has generally been identified by collectors, by differences in their respective methods of growth. Both are massive species, but the Richmond form grows into large flat or irregularly hemispherical masses, sometimes as much as 300 mm. in width and 150 mm. in height, and always, in the hundreds of specimens seen by us, having a more or less flattened though strongly undulated epithecated base. *M. mammulata* never attains such large proportions, and its masses are irregularly lobate or more or less rounded, instead of depressed hemispheric. Another distinction lies in the mesopores, which are more numerous in *M. epidermata*. The following description sums up the characters of this new species.

Zoarium of broad, thick, lamellate expansions or masses, sometimes reaching the dimensions mentioned above. Base always lined with an epitheca and more or less flattened and concentrically wrinkled. Surface with rather closely arranged maculæ which sometimes form sharp tubercles and again rounded monticules. Zoëcia small, rather thin-walled, angular where mesopores are less common and rounded where they are abundant; 10 to 11 zoëcia in 2 mm.

In tangential sections the zoëcial walls exhibit the usual granulose structure characteristic of the genus. Acanthopores small, rather inconspicuous, appearing more like granules. The mesopores are small, 2 or 3 usually to each zoëcium. Vertical sections show the mesopores tabulated with straight diaphragms one-half to one tube-diameter apart. Cystiphragms line the zoëcial tubes in both regions and are accompanied by a corresponding number of diaphragms.

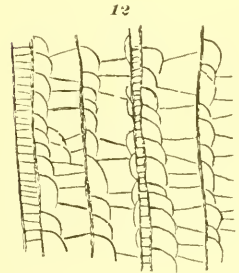
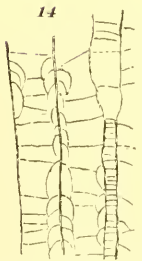
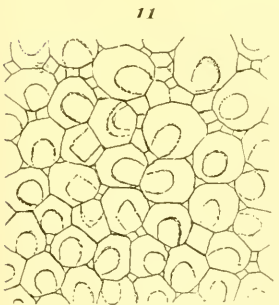
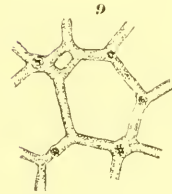
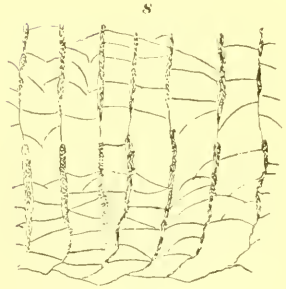
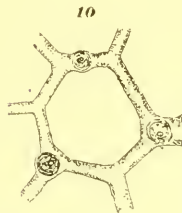
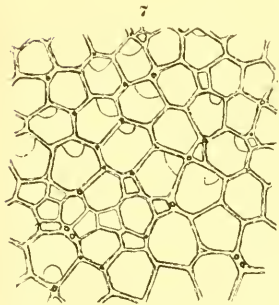
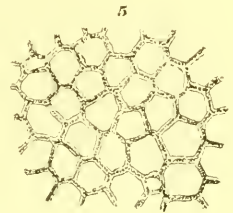
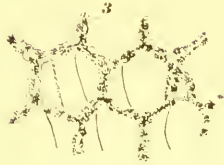
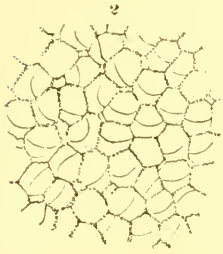
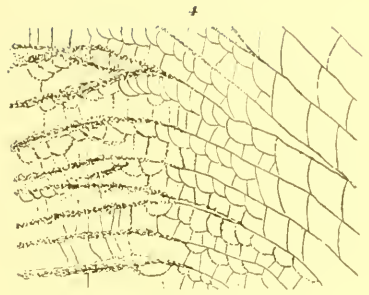
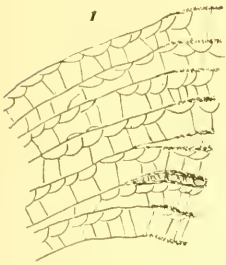
Occurrence.—Abundant in the nodular argillaceous limestones, of Middle Richmond age, exposed along Whitewater river at Richmond, Indiana. Occurs also wherever these strata are exposed at other localities in Indiana and Ohio, good specimens being found at Oxford, Ohio, particularly.

Cat. Nos. 43,172, 43,173, U. S. N. M.

GENUS ORBIGNYELLA new genus

Monticulipora (pars) ULRICH, Jour. Cincinnati Soc. Nat. Hist., v, 1882, pp. 153, 232.—Geol. Surv. Illinois, VIII, 1890, pp. 370, 407.

The recent close study of all the species of *Monticulipora* has shown that, despite previous restrictions, the genus still includes



GENERA AND SPECIES OF TREPOSTOMATA

forms that do not agree strictly with the genotype; and when it was found that these doubtful species formed a reasonably distinct and apparently genetically related group, it seemed no more than serving the best interests of classification to apply a new generic term. This new genus for which we propose the name *Orbignyella*, in honor of the author of *Monticulipora*, is distinguished from the latter genus in wanting its peculiar, irregularly granulose wall structure, in having less clearly defined cystiphragms, these structures appearing more like merely curved diaphragms, and in possessing more or less well developed and sharply defined true acanthopores. The wall structure of this new genus is more like that prevailing among the *Heterotrypidæ* than the *Monticuliporidae*, and it is only on account of curved diaphragms that we place *Orbignyella* with the latter family. At best the reference is doubtful, and the ultimate position of the genus, which should depend upon its genetic relations, may be quite different.

The following new species, *O. sublamellosa*, from the Stones River formation of Tennessee, being the most abundant form showing all the generic characters, we have adopted as the genotype. Of described species, *Monticulipora wetherbyi* and *M. lamellosa* Ulrich, of the Ordovician, are referred here with certainty, while *Chatetes expansus* Ringueberg, of the Rochester shale and *Monticulipora billingsi* Foord are doubtful members. Four or five additional, but as yet undescribed, Ordovician species are known.

Certain Devonian species now referred to *Monticulipora*, of which *M. winchelli* Ulrich is a good example, may possibly belong to *Orbignyella*, but we prefer for the present to leave them where they are, despite our conviction that they are generically distinct from *Monticulipora*. In common with practically all the known Devonian Trepostomata they have certain peculiarities that are as yet little understood and that require a special investigation before it may be deemed wise to reclassify the species.

ORBIGNYELLA SUBLAMELLOSA new species

(PLATE VI, 7-9)

Zoarium of wide lamellate expansions formed of superposed layers varying from 3 to 10 mm. in thickness; subconical masses sometimes result from the continued piling up of these layers. Maculae not elevated but conspicuous because they are composed of aggregations of mesopores and zoecia of larger size than the average. Zoecial apertures small, thin-walled, 8 to 9 in 2 mm. Acanthopores small

but distinct, one or two to each zoecium. Mesopores restricted almost entirely to the maculæ. Curved or oblique diaphragms very frequent, from one-half to nearly one tube-diameter apart.

This species is related to *O. wetherbyi* (Ulrich), but has smaller and less frequent acanthopores. *O. lamellosa* (Ulrich)—see plate VI, 10,—has decidedly larger zoecia besides numerous and larger acanthopores.

Occurrence.—Not uncommon in the Pierce division of the Stones River formation at Murfreesboro, Tennessee.

Cat. No. 43,174, U. S. N. M.

Genus PRASOPORA Nicholson and Etheridge

PRASOPORA PATERA new species¹

(PLATE VI, II-14)

Zoarium of subcircular, almost flattened disks, 30 or 40 mm. in width and usually 3 or 4 mm. thick. Under surface more or less concave, often nearly flat, covered with a concentrically wrinkled epitheca. Near the center of this face there is usually a cicatrix or the body itself (commonly a valve of *Dalmanella*) upon which growth commenced. Surface smooth, the maculæ not raised into monticules but easily distinguished by the large size of some of the zoecia contained in them.

Zoecial apertures generally appearing quite angular, the walls being thin and the mesopores small, relatively few, and, on the whole, quite inconspicuous as external features. Of the intermacular zoecia an average of 7 occurs in 2 mm. The largest in the maculæ attain a diameter nearly twice as great.

Internal structure much as in *P. simulatrix* Ulrich, but not identical. The walls are always thinner in *P. patera* and its zoecia usually more angular, while the mesopores, as a rule, are fewer in number.

Though closely related to *P. simulatrix*—a fact that was not suspected until we prepared thin sections—the discoid or saucer-shaped form so persistently maintained by the hundreds of specimens before us is so strikingly different from the nearly equally constant hemispheric or conical zoarium characterizing that species that it seems

¹ Although the purpose of these papers is to deal only with matters pertaining to the elucidation and variations of generic groups, we have found it desirable to use this opportunity for the introduction of descriptions of a few species which are characteristic fossils of certain Ordovician horizons in the Central Basin of Tennessee. Figures of the external characters of these species are given in the Columbia Tennessee folio, recently issued by the U. S. Geological Survey.

unreasonable to doubt the propriety of drawing a specific distinction between them. When the new species was first collected, we believed it would turn out to be a species of *Mesotrypa*, and possibly the same as the form described on a succeeding page as *Mesotrypa angularis*. Thin sections, however, at once proved the error of this view and at the same time supplied ample internal differences to distinguish it from all species of the latter genus.

Occurrence.—Usually very abundant in the lower part of the Hermitage formation (Safford's *Orthis* bed) of the Ordovician section in middle Tennessee, especially at localities in the vicinity of Columbia and northward to Nashville. The figured specimens are from an exposure about 4 miles north of Columbia.

Cat. Nos. 43,175-43,177, U. S. N. M.

Genus HOMOTRYPELLA Ulrich

We have nothing to offer that affects the standing of this genus, except to say that its usefulness in classification has been confirmed over and over again in the course of our recent studies. Although we have other equally distinct species in our collections that have never been described, the value of the one about to be described as a list fossil, and its desired use in stratigraphic work now under way, have led us to give it a place in this paper. Similar reasons have determined the matter of immediate publication for all other new species that do not modify generic definition.

HOMOTRYPELLA NODOSA new species

(PLATE VII, 1-3)

This very abundant Lorraine species is readily recognized by the closely set, sharp or rounded, often elongate monticules studding the surface of its subcylindrical, frequently dividing branches. These are often 11 mm. in diameter, though usually 1 or 2 mm. less. Under a pocket lens the entire surface appears minutely spinulose, and when closely examined it will be observed that the spines are set about the mouths of the zoecia in such a manner that the latter are given a beautiful petaloid or rayed appearance. The zoecia are smaller than those of other species of the genus, 10 occurring in 2 mm. The acanthopores also are small but very numerous, as many as 12 occurring around a single zoecium.

Tangential sections show a variety of appearances according to the particular zone or zones represented in them. Sections cutting across zoecia just beneath the surface of an old branch often exhibit

no mesopores, the zoecia being polygonal. At deeper levels mesopores can always be detected and generally become so numerous as to isolate the zoecia. The acanthopores impart a degree of beauty to these sections to which no drawing can do justice.

Diaphragms vary from one to two tube-diameters apart in the axial region. As the tubes turn into the peripheral zone, cystiphragms are introduced, first a large one or two, then in a crowded series with three to a tube-diameter. As usual the development of cystiphragms ceases and diaphragms only are found in the more superficial portions. Mesopores numerous, closely tabulated, closing as the surface is approached.

This species is distinguished from all others of the genus by its small zoecia, very numerous acanthopores, and closely set moniticules.

Occurrence.—Abundant in the Lorraine of the Central Basin of Tennessee. The types are from the top of Mount Parnassus, at Columbia, but Negley's hill at Nashville also furnishes specimens in abundance.

Cat. Nos. 43,178, 43,179, U. S. N. M.

Genus MESOTRYPA Ulrich

The species described below, being abundant, widely distributed, and highly characteristic fossils of the Trenton, have proved valuable aids in making stratigraphic determinations.

MESOTRYPA ECHINATA new species

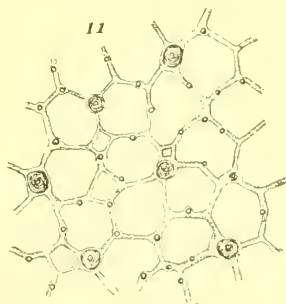
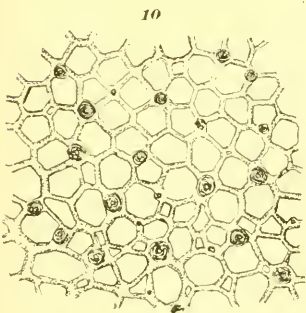
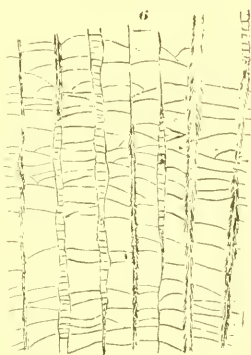
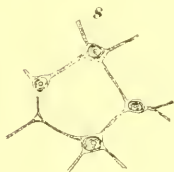
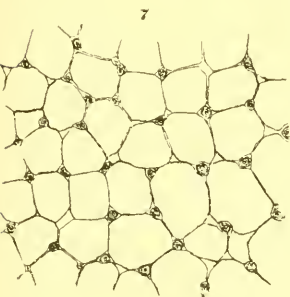
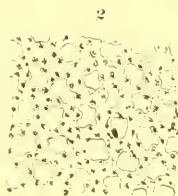
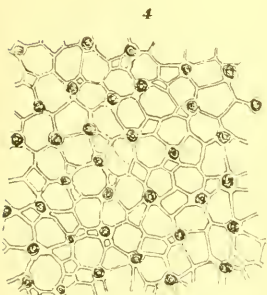
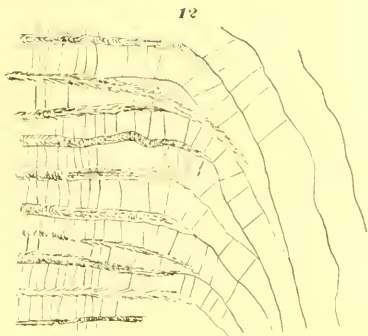
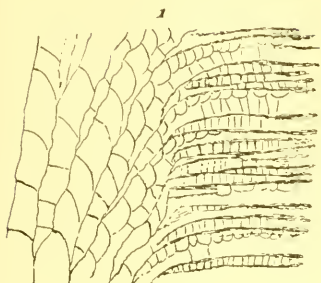
(PLATE VII, 4-6)

In this species the zoarium forms irregular, flattened, or convex disks, 5 or 6 mm. thick and sometimes as much as 50 mm. in diameter. Upper surface smooth, with inconspicuous maculæ. Zoecia small for the genus, angular to rounded, rather thick-walled, about 8 in 2 mm. Mesopores rather numerous, irregular in size and shape. Acanthopores large, giving the surface when well preserved a spiny aspect. Diaphragm 3 to 4 in a tube-diameter in the mature zones, and more than their own diameter apart in the intermediate zones. Mesopores closely tabulated and in the usual manner.

The small zoecia and large acanthopores are the striking features of this species. *M. infida*, the type of the genus, is very similar in certain respects, but its acanthopores are never so large and uniformly developed.

Occurrence.—Not uncommon in the Trenton at Nashville, Tennessee, and at several localities in Kentucky.

Cat. Nos. 43,180, 43,181, U. S. N. M.



MESOTRYPA ANGULARIS new species

(PLATE VII, 7-9)

Zoarium growing from discoid expansions, 3 or 4 mm. thick and 4 cm. or less in diameter, into hat-shaped forms that occasionally attain a diameter of 7 cm. and a height of 3 cm. Surface smooth but characterized by conspicuous maculae composed of zoecia which are often twice the diameter of the ordinary ones. Zoecia angular, thin-walled, 6 in 2 mm. Acanthopores numerous, strong, studding the surface and very conspicuous in thin sections. Mesopores few, usually wanting at the surface and when present generally restricted to the clusters. Diaphragms curved, few in the early stages, more numerous in mature zones where two or three may be found in a tube-diameter. Mesopores comparatively numerous in the immature region, but pinch out as growth continues, closely tabulated.

The zoecia are larger and their walls thinner, the maculae more conspicuous, the mesopores fewer, and the acanthopores more striking than in any of the other species of the genus.

Occurrence.—Not uncommon in the shaly lower half of the Lexington limestone of the Trenton at Frankfort, Burgin, and Curds-ville, Kentucky; and in the Trenton at Ottawa and Peterboro, Canada.

Cat. Nos. 43,182-43,185, U. S. N. M.

Family HETEROTRYPIDÆ Ulrich

Compared with the *Monticuliporidae* this family is distinguished by the very general—almost total—absence of cystiphragms. Of the other families of the suborder in which the tabulation of the zoecial tubes is by diaphragms only, the *Amplexoporidae* are the most likely to offer difficulties in their practical discrimination.

Certain differences in their respective wall-structures have so far proved infallible and generally readily applied criteria. In the *Heterotrypidae*, namely, the zoecial walls have the structure specially designated as amalgamated. As seen in tangential sections of well preserved specimens, the wall separating adjacent zooids consists (1) of a moderately wide, light-colored, transversely dotted or lined, central band, which represents the amalgamated original walls, and (2), bordering it on each side, a concentrically laminated, secondary deposit. In the *Amplexoporidae*, on the other hand, the wall, though similarly composed of two parts, differs decidedly in this, that the usually light-colored inner band is divided by a sharply defined, dark line, which represents the angular outer boundary of adjoining

zoecial tubes. The difference is regarded as fundamental, and doubtless separates the two families farther than was believed formerly.

It is a curious fact that in all essential respects the structures of the walls of *Heterotrypida*, as compared in tangential sections, is practically the same as in the cryptostomatous genus *Escharopora*. At present we see nothing indicating close relationship in this resemblance, but the fact that it is so should not be overlooked by those who have yet to be convinced of the bryozoan nature of the Trepostomata.

For purposes of convenience in classification, the *Heterotrypida* may be divided into two sections or subfamilies, the first, including *Heterotrypa*, *Dekayella*, and *Cyphotrypa* new genus, having numerous diaphragms, and the second, including *Dekayia*, *Petigopora*, *Leptotrypa*, *Stigmatella* new genus, and *Atactopora*, with diaphragms few or wanting.

Synopsis of generic characters

A. Diaphragms numerous:

1. *Heterotrypa* Nicholson:—Zoarium erect, frondescent; acanthopores of one kind; small; mesopores varying in number, generally abundant, sometimes wanting almost entirely.
2. *Dekayella* Ulrich:—Zoarium erect, ramose or frondescent; two sets of acanthopores, large and small; mesopores variable, generally more or less numerous.
3. *Cyphotrypa* new genus:—Zoarium massive or laminar, never erect; acanthopores of one kind; mesopores wanting.

B. Diaphragms few or wanting:

1. *Dekayia* Edwards and Haime:—Zoarium erect, irregularly ramose; acanthopores of one kind, generally of large size; mesopores very few, generally wanting.
2. *Petigopora* Ulrich:—Zoarium forming small, circumscribed patches; acanthopores well developed, of one kind; mesopores wanting.
3. *Leptotrypa* Ulrich:—Zoarium forming thin, evenly spread, parasitic expansions; acanthopores very small, never abundant; no mesopores.
4. *Atactopora* Ulrich:—Zoarium as in *Leptotrypa*: true mesopores wanting; surface studded with subsolid elevated spots; acanthopores small, very numerous, inflecting the walls.
5. *Stigmatella* new genus:—Zoarium incrusting, massive or subramose; mesopores present, often restricted to small spots; acanthopores small, more or less abundantly developed at

intervals between which they are wanting; in ramose forms they are developed in the extreme outer region.

Genus HETEROTRYPA Nicholson

Cumings, in a recent revision of the genera *Dekayia*, *Dekayella*, and *Heterotrypa*,¹ arrived at the conclusion that they represent one and the same generic type. He also believes that Ulrich's identification of *Monticulipora frondosa*, the genotype of *Heterotrypa*, is incorrect. According to his conception, *Monticulipora frondosa* is founded on a species of *Homotrypa* that occurs as a comparatively rare fossil in the upper beds of the Lorraine formation.

To determine the species *Heterotrypa frondosa*, the genotype of *Heterotrypa*, we sought and succeeded in securing specimens from D'Orbigny's type lot and also a fragment of Edward and Haime's figured specimen of *Chaetetes frondosus*. For the first of these we are greatly indebted to Dr. M. Boule of Paris, and for the second to Dr. H. Douvillé of the École des Mines, Paris. To assure us as much as possible of the authenticity of the latter, Dr. Douvillé marked out on a sketch of Edwards and Haime's figure of this species the exact place from which the fragment sent us was nipped. Consequently, we now consider ourselves well equipped to settle beyond dispute the question of what D'Orbigny really meant by *Monticulipora frondosa*.

As can be readily seen from the views of thin sections of this fragment given on plate XI, the species, instead of being a *Homotrypa*, as claimed by Cumings, is the same as that so recognized by Ulrich more than twenty years ago.

The two specimens of *Monticulipora frondosa* selected by Dr. Boule from D'Orbigny's type lot are also of the same species as that represented by Edwards and Haime's figured specimen. The synonymy of *Heterotrypa frondosa* given by Ulrich in his work on the species, and later by Nickles and Bassler, therefore stands with Cumings' new name, *Dekayia perfrondosa*, as an additional synonym.

As to the value of the three genera discussed by Mr. Cumings, we do not deem this the proper place to go into the subject in detail. However, we still consider the three genera distinct and very convenient in classification if not wholly natural groups. It is true that Ulrich some years ago expressed the idea of combining the three genera, but this was at a time when *Dekayella* was the only genus of the three of which species were known in the Mohawkian and

¹ *Amer. Geologist*, XXIX, 1902, pp. 197-217.

zoecial tubes. The difference is regarded as fundamental, and doubtless separates the two families farther than was believed formerly.

It is a curious fact that in all essential respects the structures of the walls of *Heterotrypida*, as compared in tangential sections, is practically the same as in the cryptostomatous genus *Escharopora*. At present we see nothing indicating close relationship in this resemblance, but the fact that it is so should not be overlooked by those who have yet to be convinced of the bryozoan nature of the Trepostomata.

For purposes of convenience in classification, the *Heterotrypida* may be divided into two sections or subfamilies, the first, including *Heterotrypa*, *Dekayella*, and *Cyphotrypa* new genus, having numerous diaphragms, and the second, including *Dekayia*, *Petigopora*, *Leptotrypa*, *Stigmatella* new genus, and *Atactopora*, with diaphragms few or wanting.

Synopsis of generic characters

- A. Diaphragms numerous:
1. *Heterotrypa* Nicholson:—Zoarium erect, frondescent; acanthopores of one kind; small; mesopores varying in number, generally abundant, sometimes wanting almost entirely.
 2. *Dekayella* Ulrich:—Zoarium erect, ramose or frondescent; two sets of acanthopores, large and small; mesopores variable, generally more or less numerous.
 3. *Cyphotrypa* new genus:—Zoarium massive or laminar, never erect; acanthopores of one kind; mesopores wanting.
- B. Diaphragms few or wanting:
1. *Dekayia* Edwards and Haime:—Zoarium erect, irregularly ramose; acanthopores of one kind, generally of large size; mesopores very few, generally wanting.
 2. *Petigopora* Ulrich:—Zoarium forming small, circumscribed patches; acanthopores well developed, of one kind; mesopores wanting.
 3. *Leptotrypa* Ulrich:—Zoarium forming thin, evenly spread, parasitic expansions; acanthopores very small, never abundant; no mesopores.
 4. *Atactopora* Ulrich:—Zoarium as in *Leptotrypa*: true mesopores wanting; surface studded with subsolid elevated spots; acanthopores small, very numerous, inflecting the walls.
 5. *Stigmatella* new genus:—Zoarium incrusting, massive or subramose; mesopores present, often restricted to small spots; acanthopores small, more or less abundantly developed at

intervals between which they are wanting; in ramose forms they are developed in the extreme outer region.

Genus HETEROTRYPA Nicholson

Cummings, in a recent revision of the genera *Dekayia*, *Dekayella*, and *Heterotrypa*,¹ arrived at the conclusion that they represent one and the same generic type. He also believes that Ulrich's identification of *Monticulipora frondosa*, the genotype of *Heterotrypa*, is incorrect. According to his conception, *Monticulipora frondosa* is founded on a species of *Homotrypa* that occurs as a comparatively rare fossil in the upper beds of the Lorraine formation.

To determine the species *Heterotrypa frondosa*, the genotype of *Heterotrypa*, we sought and succeeded in securing specimens from D'Orbigny's type lot and also a fragment of Edwards and Haime's figured specimen of *Chactetes frondosus*. For the first of these we are greatly indebted to Dr. M. Boule of Paris, and for the second to Dr. H. Douvillé of the École des Mines, Paris. To assure us as much as possible of the authenticity of the latter, Dr. Douvillé marked out on a sketch of Edwards and Haime's figure of this species the exact place from which the fragment sent us was nipped. Consequently, we now consider ourselves well equipped to settle beyond dispute the question of what D'Orbigny really meant by *Monticulipora frondosa*.

As can be readily seen from the views of thin sections of this fragment given on plate XI, the species, instead of being a *Homotrypa*, as claimed by Cummings, is the same as that so recognized by Ulrich more than twenty years ago.

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¹ *Amer. Geologist*, XXIX, 1902, pp. 197-217.

otherwise closely related forms, the best interests of classification demand that they be distinguished by a distinct name, whether of generic or subgeneric rank is of little consequence. Furthermore, it is contrary to accumulated knowledge of Nature's laws to expect that any character should remain hard and fast and not grade, at least in some species, toward other genera. However *Dekayella* may stand with respect to *Heterotrypa* in the final revision of these Bryozoa, we think that *Dekayia* will stand as a genus, not in the sense of Ulrich's definition of the genus in 1880,¹ but as defined in our synopsis of the *Heterotrypidae* on a preceding page.

DEKAYELLA FOLIACEA new species

(PLATE VII, 10-12)

The discovery of this flabellate species with its well-developed large and small sets of acanthopores caused us to emend the generic diagnosis so as to include frondescent species. *Dekayella foliacea* grows into erect fronds of varying width and from 5 to 10 mm. in thickness. Externally the zoecia are angular, an average of 8 in 2 mm., the mesopores few, and both sets of acanthopores usually well developed.

Diaphragms are remote in the axial region, indeed are generally wanting, but the peripheral zone is closely tabulated, 2 to 3 diaphragms being found in a distance equaling the diameter of a zoecium. Mesopores are few, although the number is somewhat variable. The larger set of acanthopores is usually well developed, but sometimes, especially in very old conditions, the smaller set is obsolete.

The flabellate growth, rather few mesopores, and the double set of acanthopores form a combination that is readily distinguished from other *Heterotrypidae*. The flabellate form of the zoarium alone suffices in separating it from congeneric species.

Occurrence.—Lexington limestone of the Trenton, Lexington, Kentucky.

Cat. No. 43,187, U. S. N. M.

Genus LEPTOTRYPA Ulrich

The genus *Leptotrypa* as defined by Ulrich in 1890² and 1893³ proved to be quite a heterogeneous assemblage of species and an unwarranted extension of the original diagnosis. In the first place,

¹ *Amer. Pal. Bryozoa.*

² *Geol. Surv. Illinois*, VIII, p. 377.

³ *Geol. Minnesota*, III, p. 316.

our last published conception of the genus is affected by the division of the Trepostomata into the two sections discussed on a preceding page. In the first of these two primary divisions, the Amalgamata, the walls of adjoining zoecia are fused together, or, using a term more commonly employed, amalgamated. In the second division, the Integrata, the walls remain separate, and divide readily along the sharp, dark line which marks the contact between adjoining tubes. Now, the type of *Leptotrypa* clearly belongs to the *Heterotrypidae*, which are good Amalgamata, while other species referred to the genus have the wall structure characterizing the Integrata, so that a splitting up of the genus is necessitated on that ground alone. Besides, we have come to pay more attention to the tabulation of the tubes and with gratifying results in the way of natural classification.

In accordance with the facts brought out by our recent studies, we had to restrict *Leptotrypa* very nearly to the limits originally assigned to the genus in 1883. As revised, the genus includes only three or four parasitic species, *L. minima* Ulrich, *L. ornata* Ulrich, *L. clavacoides* (James), and several undescribed species which form thin expansions made up of tubes in which diaphragms are very few or wanting. This restriction leaves a number of species which find a place naturally enough under *Amplexopora* (e. g., *L. filiosa* (D'Orbigny), *L. petasiformis* (Nicholson), etc.), but for a larger number new generic groups are here established. *Cyphotrypa* is necessary for the reception of the massive *Heterotrypidae* with well-developed diaphragms, while species of the type of *L. clavis* and *L. irregularis* Ulrich are referred to the new genus *Stigmatella*. These removals will be further discussed under their respective genera.

Genus CYPHOTRYPA new genus

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

Genotype.—*Leptotrypa accrevulosa* Ulrich, a characteristic Trenton fossil in Iowa, Minnesota, and Kentucky.

As stated in our remarks on *Leptotrypa*, the restriction of that genus to species agreeing strictly with its type necessitated the erection of a new genus for the massive and well-tabulated Amalgamata that previously had been referred to *Leptotrypa*. The importance of the characters that distinguish these massive forms from the typical species of *Leptotrypa*, and consequently the desirability of the separation, became more and more evident as they grew in number. Up

to this date we have determined, without exhausting our material, no fewer than fifteen species having the characters above ascribed to *Cyphotrypa*. Of this number only four, *Leptotrypa acervulosa*, *L. informis*, *L. semipilaris*, and *L. stidhami*, all of Ulrich, have been described. Only two of the new species are described in this paper. The others must await another opportunity.

Commencing with the Stones River group, the genus is represented in nearly all of the divisions of the Ordovician. A single new species occurs in the Niagaran, while another new form in the Helderbergian of Maryland appears to be the last representative of the genus.

CYPHOTRYPA FRANKFORTENSIS new species

(PLATE VIII, 7-9)

The zoarium in this well-marked species forms large, often undulating expansions usually 7 cm. or more in diameter and 1 cm. in height; but sometimes heaped-up masses, 4 or 5 cm. high, occur as the result of the superposition of several layers of zoecia. The surface usually bears small, sharp monticules. Zoecia small, 9 to 10 in 2 mm., five or six sided, with very thin walls. Acanthopores rather large and distinct but not abundant, averaging only about one to each zoecium. Diaphragm entirely wanting in the immature region and from one to two tube-diameters apart in the mature zone which is distinguished only by the fact that diaphragms are here developed.

The large monticulated masses formed by this species, its small zoecia and few acanthopores, and the absence of diaphragms in the immature regions, distinguish it. Small weathered specimens or fragments may be confused with *C. acervulosa*, which has zoecia of the same size, but as the zoecial tubes are abundantly tabulated in that species, collectors should experience little difficulty in distinguishing even small fragments.

Occurrence.—Common in the shaly limestones at the top of the Trenton on Reservoir hill, Frankfort, Kentucky. Less abundant in the vicinity of Burgin, Kentucky, where it seems to occur in a lower bed of the same formation.

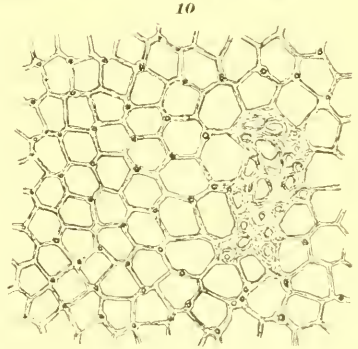
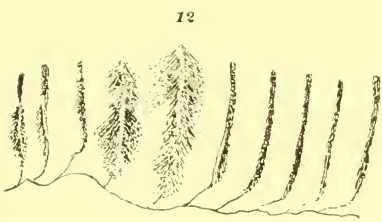
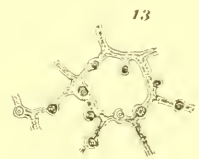
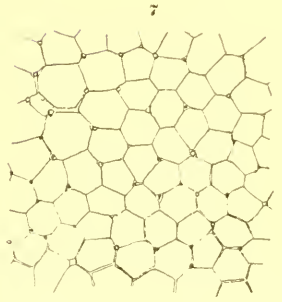
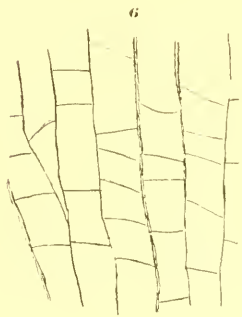
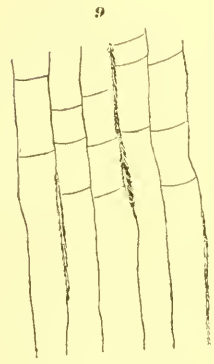
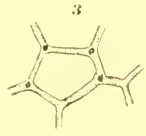
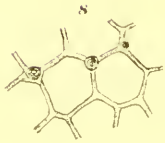
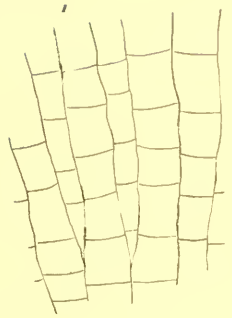
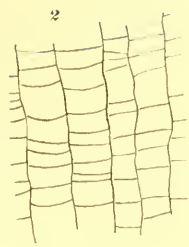
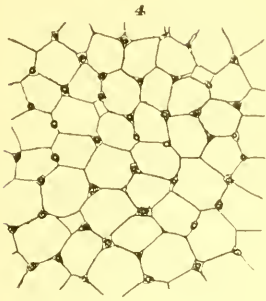
Cat. No. 43,188, U. S. N. M.

CYPHOTRYPA ACERVULOSA (Ulrich)

(PLATE VIII, 1-3)

1893. *Leptotrypa acervulosa* ULRICH, Geol. Minnesota, III, p. 318, pl. XXVII, 24, 25.

This widely-distributed species, which we have made the genotype, forms small, irregular or subglobular, smooth masses, 15 to 20 mm.



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in diameter. Zoecia thin-walled, 9 to 10 in 2 mm. Acanthopores few, small but well marked. In immature regions diaphragms from one to one and a half times their own diameter apart; in the mature regions two or three times as numerous.

The small, usually subglobose, zoarium, few acanthopores and the tabulation characterize this species. An externally very similar species of *Cyphotrypa* occurs in the Richmond formation of Ohio.

Occurrence.—Trenton of Iowa, Minnesota, Kentucky, and Canada.

Cat. Nos. 43,189-43,191, U. S. N. M.

CYPHOTRYPA WILMINGTONENSIS new species

(PLATE VIII, 4-6)

Zoarium of small, smooth, rounded or subglobular masses about 10 mm. in diameter. Zoecia thin-walled, angular, and when well preserved exhibiting strong acanthopores at the junction angles. Zoecia of the maculæ but slightly larger than the ordinary, 7 to 8 of the latter in 2 mm. Thin sections show that the acanthopores are large and distinct, with a well-marked central perforation, and usually occupy only the angles formed by adjoining zoecia. Diaphragms twice their own diameter or more apart in the immature region and two to three times as numerous in the mature.

The size of the zoecia, numerous large acanthopores, and small globular method of growth distinguish this species from most others of the genus. It has much larger acanthopores than *C. acerulosa*.

Occurrence.—In shaly limestone of Richmond age at Wilmington, Illinois.

Cat. No. 43,192, U. S. N. M.

Genus ATACTOPORA Ulrich

Until recently this genus has been classed with the *Amphiroporida*, but since we have come to appreciate the importance of differences in the minute structure of the zoecial walls, we can see that it is more naturally placed with the *Heterotrypida*. The wall structure is precisely as in *Heterotrypa*, the light-colored line or band being present between adjoining zoecia. The incrusting zoaria, with the subsolid elevated maculæ and the numerous small acanthopores inflecting the zoecia, characterize the genus. Two species have been described, *A. hirsuta* the genotype and *A. maculata*. Several new forms are known, the following, though a good *Atactopora*, having fewer acanthopores than usual.

ATACTOPORA ANGULARIS new species

(PLATE VIII, 10-12)

Zoarium, as is nearly always the case in this genus, parasitic upon cephalopods. Surface generally smooth, the solid maculae seldom elevated. Zoecia angular, 8-9 in 2 mm. Acanthopores less numerous than in other species of the genus, these structures being usually limited to the junction angles, while the number to each zoecium rarely exceeds three. Maculae small but as usual composed of small or aborted zoecia which are filled up with age by a secondary deposit of dense, laminated tissue.

Occurrence.—Lower Richmond, Waynesville, Ohio.

Cat. No. 43,193, U. S. N. M.

Genus **PETIGOPORA** Ulrich

To ascertain whether or not certain or all of the species referred to this genus are dwarfed mutations or possibly only young stages of normally ramose or massive forms of other genera of the *Heterotrypidae*, has been a most difficult task. The problem, moreover, still confronts us and its solution seems as difficult as ever. We tried to show, for instance, that *P. gregaria* was merely the beginning of a secondary layer of zoecia on branches of species of *Dekayia*, but when it was found growing on all sorts of Bryozoa, and that it always maintained a reasonably definite size, we realized that some other explanation of its existence was in order. So we let it stand, and with it the genus. The zoecial structure of *P. asperula* Ulrich again is essentially the same as that of the associated *Dekayia appressa*, but among the hundreds of specimens of these species that we have collected there is none to connect them. Finally, *P. petechialis*, or species resembling it, occurs almost throughout the Mohawkian and Cincinnati groups, generally in association with other *Heterotrypidae*. We have, however, found zoaria of *Petigopora* in horizons from which no other similar Heterotrypoids are known. At present we can regard such a fact only as indicating that these small incrustations are species by themselves. The following neat species occupies a well-marked horizon and is of widespread occurrence geographically in the Ohio region.

PETIGOPORA OFFULA new species

(Not figured)

The new species for which we propose this name differs from the previously described species in forming small, usually subglobular

masses, 2 to 4 mm. in diameter, by growth around associated smaller organisms. Occasionally the zoaria are discoid or irregular. The acanthopores are strongly developed and many specimens bristle with them. Zoecial apertures rounded or subangular, 9-10 in 2 mm.

Occurrence.—Very abundant in the uppermost stratum of the Warren beds of the Cincinnati. The types are from Middletown, Ohio; but Clarksville, Oregonia, Lebanon, and other localities in southwestern Ohio furnish exposures where the species can be found in abundance.

Cat. Nos. 43,194-43,196. U. S. N. M.

Genus STIGMATELLA new genus

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

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

Genotype.—*Stigmatella crenulata* new species. Richmond formation, Ohio.

This genus is proposed to receive a few species which from time to time have been referred to *Monticulipora*, *Leptotrypa*, and *Monotrypa* by authors, for the new forms here described and finally for several additional undescribed species whose publication had to be deferred on account of a lack of space. Although differing widely in zoecial habit, these species seem to form a natural group of the *Heterotrypida*, distinguished by the periodic thickening of the walls of the zoecial tubes and the accelerated development of the acantho-

pores in these thickened zones. The incrusting forms without mesopores may be confused with *Leptotrypa*, but the characteristics just mentioned distinguish them from species of that genus. For the same reason and also because of the absence of a second set of acanthopores, the ramose forms with mesopores are distinguished from species of *Dekayella*. The periodic development of the acanthopores and thickening of the walls separate the new genus from *Dekayia* with which it agrees in the sparse development of diaphragms. So far as known the genus is confined to the Cincinnati rocks. Of described forms it includes *Leptotrypa clavis* Ulrich from the Utica, and *Monticulipora (Monotrypa) dychei* James (see plate x, fig. 11), and *Leptotrypa irregularis* Ulrich (see plate x, figs. 5, 6; plate xiv, figs. 6-8) from the Lorraine.

STIGMATELLA CRENULATA new species

(PLATE IX, 1-4; PLATE XIV, 1, 2)

Zoarium composed of cylindrical, subcylindrical or compressed, frequently dividing stems 10 mm. or more in diameter, arising from a broad base and forming a clump probably seldom more than 50 mm. high. Surface even, but in well preserved mature specimens spinulose because of the many acanthopores. Maculæ well marked, generally composed of mesopores which make up the characteristic "spots" but sometimes formed exclusively of zoœcia larger than the ordinary. Zoœcial apertures small, about 9 in 2 mm. with their walls thin and often beautifully inflected by the numerous small acanthopores. Mesopores present, variable in number but usually few and mostly aggregated in the maculæ. In the axial region the zoœcial tubes have thin, finely crenulated walls, and occasionally a diaphragm or two. In the mature region the walls increase slightly in thickness, mesopores and acanthopores develop, and thin diaphragms cross the zoœcial tubes and mesopores at varying though always comparatively remote intervals.

Occurrence.—Very abundant in lower part of the Richmond formation at Hanover, Butler county, Ohio. Less common at the same horizon near Oxford, Waynesville, Clarksville, and other localities in Ohio.

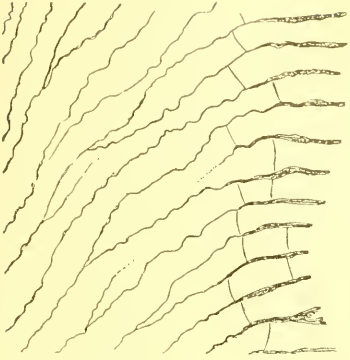
Cat. Nos. 43,197-43,199, U. S. N. M.

STIGMATELLA SPINOSA new species

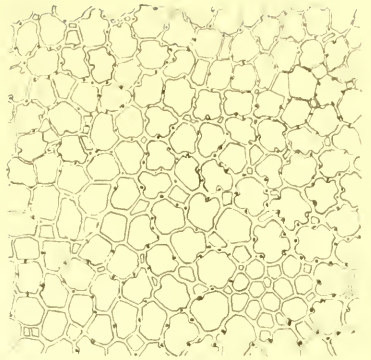
(PLATE IX, 5-8)

The method of growth in this species is similar to that obtaining in *S. crenulata*, but under a lens *S. spinosa* is distinguished at once by

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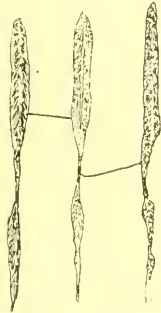
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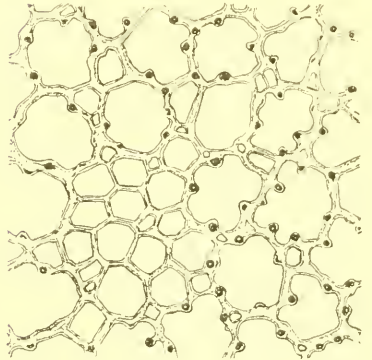
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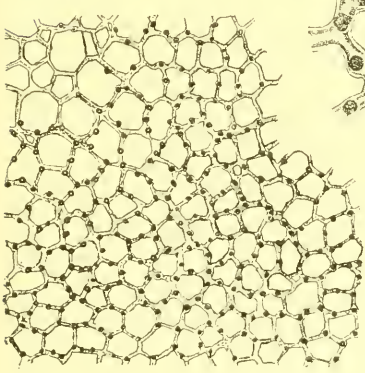
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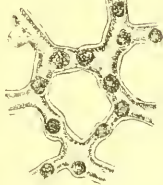
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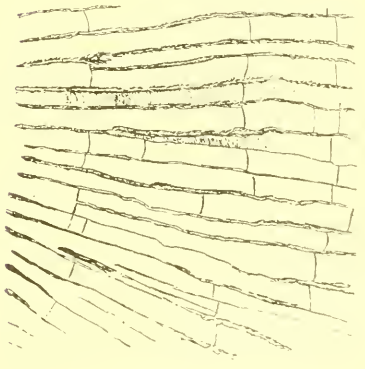
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7



GENERA AND SPECIES OF TREPOSTOMATA

having no mesopores and so many small acanthopores indenting the zoecial walls that the surface appears granulose rather than spinose, which term applies better in other species of the genus. Continuing the comparison with *S. crenulata*, the zoecia are found to be a little smaller, about 10 occurring in 2.0 mm., and the axial portion of the tube walls straighter.

Thin sections of this species are both beautiful and instructive. In vertical sections the periodic development of the acanthopores, which is a feature of the genus, is shown especially well. Diaphragms few and of irregular distribution.

Occurrence.—Richmond formation, Versailles, Indiana.

Cat. No. 43,200, U. S. N. M.

STIGMATELLA PERSONATA new species

(PLATE XII, F-3)

This is one of the non-mesopored species of the genus and forms smooth, branching zoaria very much like *S. crenulata* and *S. spinosa*. From the former it is distinguished by having fewer acanthopores, no mesopores, and in lacking the crenulation of the walls in the immature region. From *S. spinosa* it is separated by its larger zoecia, 7 to 8 being found in 2 mm. while 10 are required in that species to cover an equal distance. The acanthopores in *S. personata* also afford a difference, being but seldom more numerous than the junction angles which they usually occupy. In *S. spinosa*, it will be remembered, they are so abundant that they almost completely surround the zoecium.

Occurrence.—Uncommon in the Richmond formation at Hanover, Ohio.

Cat. No. 43,201, U. S. N. M.

STIGMATELLA INTERPOROSA new species

(PLATE XII, 4, 5)

Associated with *S. crenulata* but distinguished by smaller, more irregular growth, the branches frequently intertwining and being of all shapes from small cylindrical, 3 or 4 mm. in diameter to irregular fronds 10 mm. or more broad. About 9 zoecia in 2 mm.

Mesopores with diaphragms their own diameter apart; zoecial tubes with few diaphragms. Zoecia usually separated by numerous mesopores. Acanthopores small and relatively few in number.

The small zoarium, smooth surface, small and few acanthopores and numerous mesopores are the specific characters.

Occurrence.—Abundant in the Richmond formation at Hanover, Ohio.

Cat. No. 43,202, U. S. N. M.

STIGMATELLA NANA new species

(PLATE X, 7-10; PLATE XIV, 11, 12)

This species has mesopores and is related in other respects to the Richmond form, *S. interporosa*. It may be distinguished, however, by its more numerous acanthopores and less numerous mesopores, and by other, less important, differences. The zoarium of *S. nana* is small and irregularly branched. The surface is often hirsute because of the acanthopores which, although quite numerous, are small. In *S. interporosa* the zoarium, although also of small size, consists of frequently dividing and more regularly formed branches, on which the acanthopores are seldom observable. The tabulation of the zoecia and mesopores is much alike in the two species, the only difference noted being that diaphragms occur more frequently in the zoecial tubes of *S. interporosa*.

Occurrence.—Very abundant in the Utica formation at West Covington, Kentucky, and other localities in the vicinity of Cincinnati, Ohio. The exact horizon is about 25 feet above the top of the Trenton.

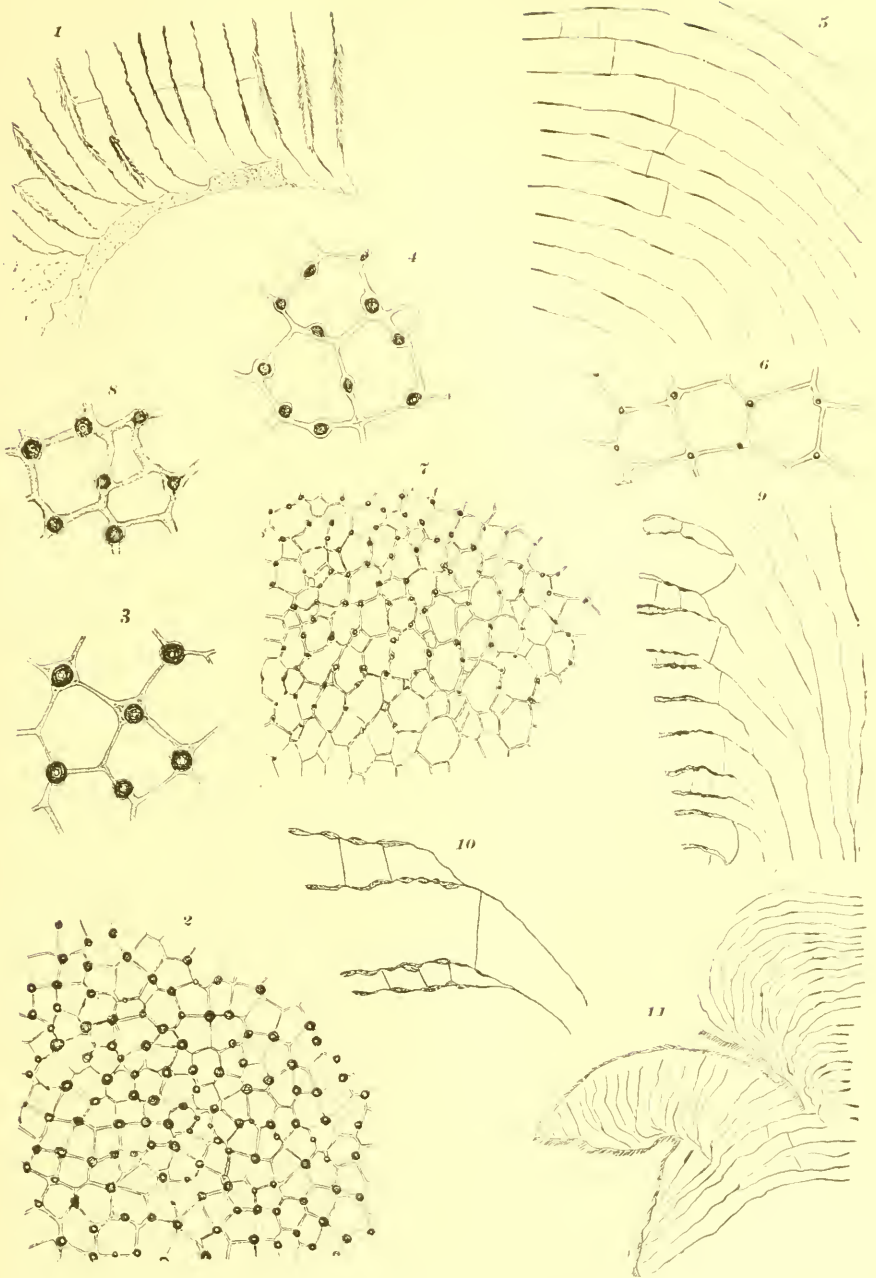
Cat. No. 43,203, U. S. N. M.

STIGMATELLA NICKLESI new species

(PLATE X, 1-3; PLATE XIV, 9, 10)

This species is related to *S. clavis* (Ulrich) and resembles that form in its zoarial characteristic, but the unusually large acanthopores will distinguish it at once. In *S. nicklesi* the acanthopores are generally situated only in the junction angles of the zoecia and are less numerous than in *S. clavis*. The numerous acanthopores of the latter species (see plate x, 4) inflect the walls, giving the petaloid appearance characteristic of several species of the genus. In *S. nicklesi* this inflection has not been observed, the walls being thin and straight, and the large acanthopores confined to the angles. The two species are further distinguished by their methods of growth, *S. clavis* forming neat, tightly adhering, club-shaped zoaria about crinoid columns, while *S. nicklesi* loosely covers similar objects.

The specific name is in honor of Mr. John M. Nickles, of the U. S. Geological Survey, who discovered the species in considerable numbers and recognized its distinctness.



GENERA AND SPECIES OF TREPOSTOMATA

Occurrence.—Upper part of the Fairmount beds of the Lorraine at Cincinnati, Ohio. Common but vertical range limited to less than a foot.

Cat. No. 43,204, U. S. N. M.

Family CONSTELLARIIDÆ Ulrich

Genus CONSTELLARIA Dana

CONSTELLARIA TERES new species

(Not figured)

This new species is readily distinguished from all described forms of the genus by its uniform method of growth. The zoarium consists of rigid subcylindrical to cylindrical solid stems, 5 to 10 mm. in diameter, dividing by bifurcation at intervals of rarely less than 50 mm. The maculæ are usually but slightly elevated and are a trifle smaller than in such forms as *C. florida*, and on account of the regular method of growth often show an arrangement in ascending diagonally intersecting lines. However, when the surface is nearly smooth the maculæ often consist of star-shaped centers from the rays of which long rows of mesopores radiate.

The size and shape of the zoecia are essentially as in *C. florida*, but vertical sections show differences in the tabulation of the zoecia. Diaphragms are almost entirely absent in the axial region of *C. florida*, but in *C. teres* they occur at intervals varying from two to three times the tube-diameter. This difference in tabulation applies also to the peripheral region, the diaphragm in *C. teres* being here again more abundant.

Figures of a group of specimens belonging to this and the following species are given on the plate of characteristic fossils of the Columbia folio recently issued by the U. S. Geological Survey.

Occurrence.—The types are from the shales at the top of the Bigby limestone of the Trenton at Columbia, Tennessee, where the species is very abundant. It also occurs, but in less abundance, in the Catheys limestone. Numerous localities in Tennessee and Kentucky, exposing especially the lower of these two horizons, furnish specimens.

Cat. Nos. 43,205-43,207, U. S. N. M.

CONSTELLARIA FLORIDA var. **EMACIATA** new variety

(Not figured)

This subordinate name is proposed for a very abundant fossil of the Bigby limestone of Tennessee. The form agrees in all essential

internal features with the Lorraine *Constellaria florida*, and differs only in growth and in the arrangement and size of the "stars." The usual growth obtaining in *C. florida* is of rather broad, flat branches, seldom less than 10 mm. in breadth and 3 or 4 mm. in thickness, dividing rather regularly at intervals of several centimeters. *C. florida emaciata*, however, is dwarfed in growth, the branches being usually rounded and from 3 to 5 mm. in diameter, but sometimes reaching a breadth of 6 or 7 mm. Division occurred at short, irregular intervals, and an entire zoarium consisted of a small clump of closely interwoven narrow branches, instead of a rather broad expansion as in *C. florida*. Another difference is in the shape of the stellate maculæ which, although of about the same size in both species and variety, are more sharply and narrowly rayed in the variety than in the species.

Occurrence.—The types are from the *Constellaria* bed at the top of the Bigby limestone at Columbia, Tennessee, where specimens can be found literally by the million. The species occurs abundantly also in the shaly parts of the Catheys limestone. Mt. Pleasant, Nashville, and many other localities in the Central Basin might be mentioned where the variety may be had in abundance.

Cat. No. 43,208, U. S. N. M.

Family BATOSTOMELLIDÆ Ulrich

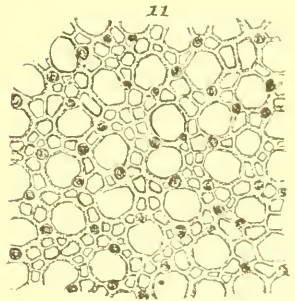
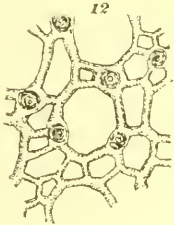
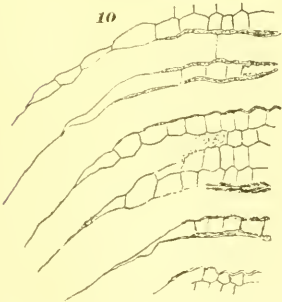
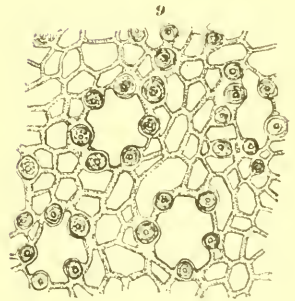
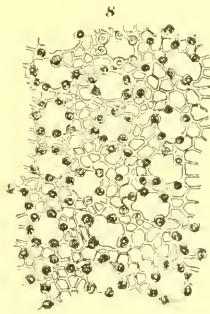
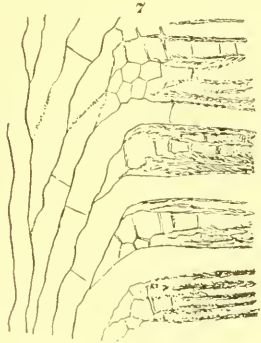
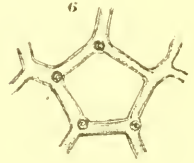
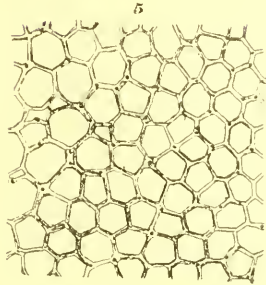
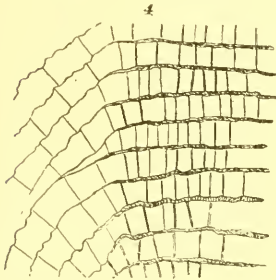
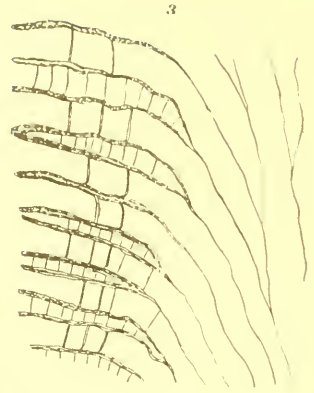
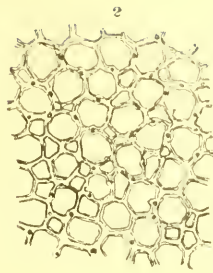
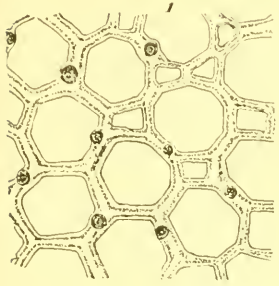
This family stands for the present essentially as defined by Ulrich in 1890¹ and again in 1896.² When worked up with the care bestowed upon some of the other families, notably the *Heterotrypidæ*, doubtless some changes will become necessary. Our present effort consists of a few remarks and figures tending to fix the characters of two genera of the family, namely, *Lioclema* and *Lioclemella*, while a revision of the *Stenoporoids* will form the subject of a future paper.

Genus LIOCLEMA Ulrich

Recent study of a considerable amount of material from several Silurian horizons shows that this generic type, which began with a single species in the Richmond, was more prolific in species in Silurian times than we suspected. Adding these undescribed species to those previously known, and considering that this group ranges in time from the Richmond to the close of the Mississippian, the genus has grown to be the most important of the trepostomatous genera having representatives in the Paleozoic rocks. Under these cir-

¹ *Geol. Surv. Illinois*, VIII, p. 375.

² Zittel, *Text-book Pal.* (Engl. ed.), p. 277.



cumstances, it is thought desirable to fix the essential internal characters of the genus as exemplified in the genotype, *L. punctatum* (Hall), the small illustrations of this species published by the senior author in 1882 being scarcely sufficient for the purpose. We have accordingly prepared the drawings reproduced on plate XI, 7-9.

Lioclema punctatum is a very abundant fossil in the Keokuk formation of the Mississippi valley, and strictly ramose in its habit of growth. It may be readily distinguished from associated ramose bryozoa by its slender branches and the appearance they have to the naked eye of being smooth and as composed of zoecia with small and widely separated apertures. When magnified, the interapertural spaces are seen to be occupied by rows of mesopores and numerous acanthopores.

The publication of most of the Silurian forms is already arranged for in papers by one or both of the writers. The following new Devonian species, having been worked up with the rest, had to be included in this paper, or have its publication postponed indefinitely.

LIOCLEMA MONROEI new species

(PLATE XI, 10-12)

Zoarium subramose, the branches being smooth and cylindrical or compressed, and 10 mm. or less in diameter. Zoecial apertures polygonal, 6 in 2 mm., isolated from each other by small angular mesopores. Diaphragms extremely few in the zoecial tubes, but abundant in the mesopores. Acanthopores large and conspicuous, but rather few, seldom more than three to a zoecium.

The species is in some respects intermediate between the genotype *L. punctatum* and the Chemung species *L. occidentis* (Hall and Whitfield). Compared with the former, the more robust branches, less numerous mesopores and acanthopores, and larger zoecia of *L. monroei*, are features easily recognized. *L. occidentis* has somewhat smaller zoecia and few and smaller acanthopores, and more abundant diaphragms in the zoecial tubes.

This species is named in honor of Mr. Charles E. Monroe of Milwaukee, Wis., who collected the specimens at Bethany, New York.

Occurrence.—Hamilton formation, Bethany, New York.

Cat. No. 43,209 U. S. N. M.

Genus LIOCLEMELLA Foerste

Lioclemella FOERSTE, Geol. Surv. Ohio, VII, 1895, p. 600.

This genus was briefly defined by Foerste in the work above cited and founded upon a common form of the Clinton shales of

Ohio, which he had previously described as a species of *Callopora*. As the internal characters of the genotype have not been figured, we make use of this opportunity to publish illustrations (plate XII, 6-9) of thin sections prepared from authentic examples. The relations of the genus are with *Lioclema*, and it would be difficult to point out satisfactory differences in their internal characters. However, the zoarial habit of growth of *Lioclemella*, consisting of club-shaped or sparsely divided branches, pointed at the proximal extremity for articulation with an attached, expanded base, is deemed of sufficient importance to justify the recognition of the group generically.

Besides the species listed in Nickles and Bassler's *Synopsis of American Fossil Bryozoa*, the genus will contain at least several other good species from the Richmond formation of Ohio and the Rochester shales of New York.

Division II.—INTEGRATA NEW DIVISION

Trepostomata in which the boundaries of adjacent zoecia are sharply defined by a black divisional line.

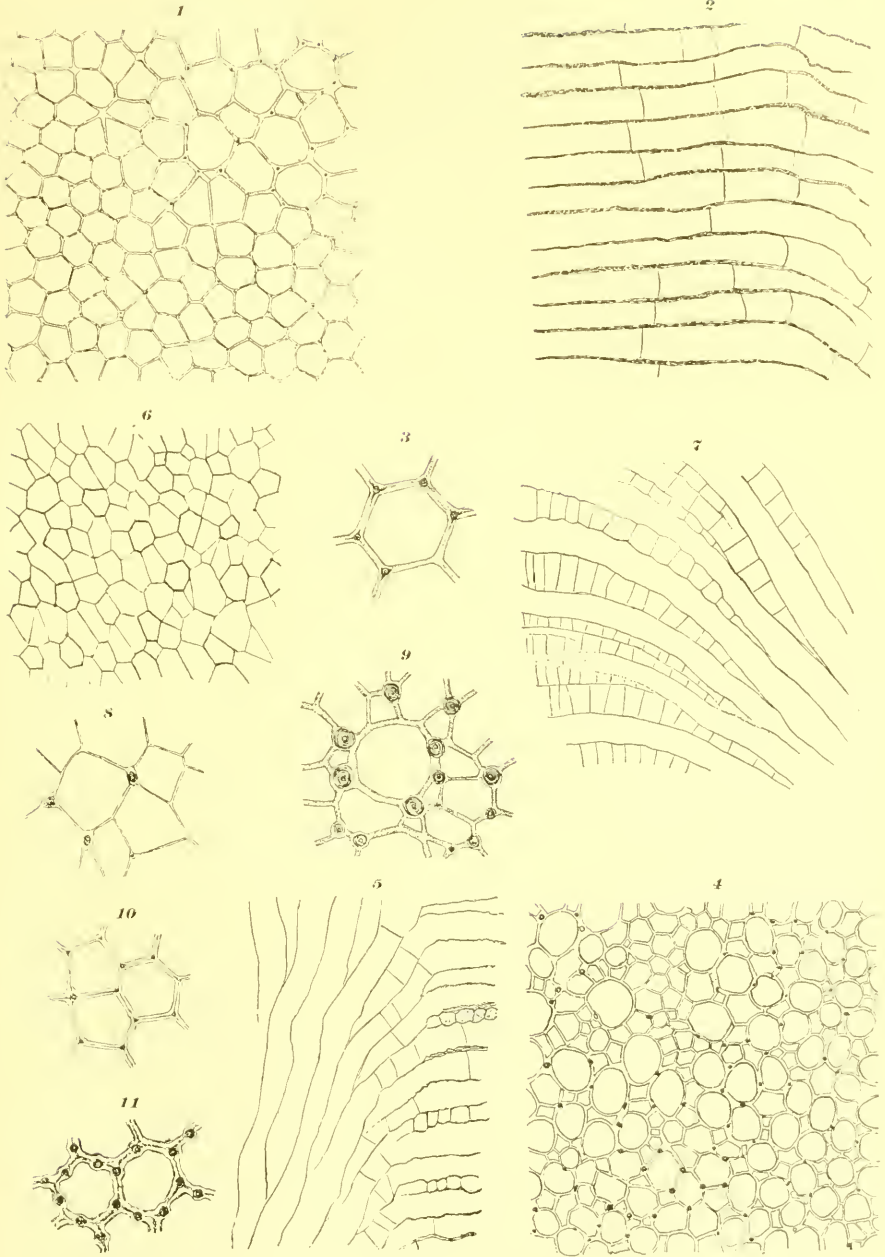
Family AMPLEXOPORIDÆ Ulrich

This family includes the most simple types of the Integrata. On account of this simplicity and the practical absence of mesopores, they also show the duplex character of the wall which separates adjoining zoecia and upon which this division is founded, in a more satisfactory manner than the other families. The black divisional line is always in evidence, while in the *Calloporidæ* and *Trematoporidæ* it is generally obscured by the interposed mesopores and is certainly demonstrable only in those occasional species in which the development of mesopores has been reduced to a minimum.

The removal of *Leptotrypa* and *Atactopora* to the *Heterotrypidæ* has materially affected the status of the *Ampplexoporidæ*. Possibly it would be wise to replace these genera, in part at least, by the recognition of a genus for such permanent integrate Leptotrypids as *L. discoidea* (Nicholson). The genotype of Eichwald's genus *Orbipora*, *O. distincta*, as worked out by Dybowski,¹ seems to belong to this group and future research may show *Orbipora* to be the proper genus for the reception of *L. discoidea*.

The new genus *Rhombotrypa* has been long in contemplation, and

¹*Die Chatetiden der Ostbaltischen Silur.-Form.*, p. 57.



GENERA AND SPECIES OF TREPOSTOMATA

now that the type of structure expressed by it has turned up in the Silurian faunas, we no longer hesitate in defining it.

GENUS AMPLEXOPORA Ulrich

This genus originally included ramose species only, but we now believe it advisable to extend its limits so as to include several *Amplexoporidæ* left over after the restriction of *Leptotrypa* to its typical species and the distribution of the bulk of its species between the new genera *Cyphotrypa* and *Stigmatella*. Among these unplaced species are *L. filiosa* (D'Orbigny) and *L. petasiformis* (Nicholson) which can be shown to be closely related to such typical species of *Amplexopora* as *A. septosa* Ulrich (see plate XII, 10, 11). James' *Monticulipora welshi*, a subramose form or variety of *L. petasiformis*, bridges over the gap between the two groups very nicely. *Leptotrypa discoidea* (Nicholson) is not so easily provided for, we being as yet undecided as to whether it belongs to the Integrata or the Amalgamata. If it is of the former type, then it is still a question whether it would not be advisable to recognize another genus for it.

The propriety of referring massive as well as ramose species to this genus is also confirmed by the close relations of two of the following new species, namely, *A. columbiana* and *A. ampla*.

As to the geological range of the genus, it now appears not to extend beyond the top of the Ordovician. The Devonian species like *Monticulipora moniliformis* Nicholson, that have been referred here, are Amalgamata and must be provided for elsewhere. At some future time we hope to discuss these in connection with the rest of the Devonian Trepostomata.

AMPLEXOPORA COLUMBIANA new species

(PLATE XIII, 1-4)

Zoarium massive, generally subglobose, an inch or more in diameter; rarely the growth is irregular, resulting in shapeless masses several inches in their greatest dimension. Surface without monticules, but exhibiting maculae composed of zoecia reaching nearly twice the diameter of the average cell. No mesopores. Zoecial apertures polygonal, 6 to 7 of those occupying the intermacular spaces in 2 mm.; walls thin, not often exhibiting the acanthopores, which, in the fully matured condition, recurring at intervals during the growth of a colony, are rather large, well defined, and about half as numerous as the angles of junction to which they are almost wholly confined.

In tangential sections the walls present the sharply-defined median line separating adjoining zoecia characteristic of the family *Amplexoporidae*. In deep sections the walls are extremely thin and the acanthopores very small. Vertical sections show repetitions of immature and mature regions, the former being distinguished by thin walls and diaphragms a tube diameter or more apart, the latter by appreciably thickened walls and more crowded diaphragms. In the mature regions many of the diaphragms are further distinguished by being recurved, usually from one wall only, but not infrequently from both sides, the structures in the latter case being infundibuliform.

The zoecia in this fine species are larger than in any other now referred to this genus, and this feature, in connection with the presence of recurved and funnel-shaped diaphragms, distinguishes this form from all other massive or discoid species of the genus.

Occurrence.—This is one of the most characteristic species of the Lorraine formation in the Central Basin of Tennessee. The types are from the top of Mt. Parnassus at Columbia, Tennessee, although many other localities in Maury and other counties furnish an abundance of specimens.

Cat. Nos. 43,210-43,212, U. S. N. M.

AMPLEXOPORA AMPLA new species

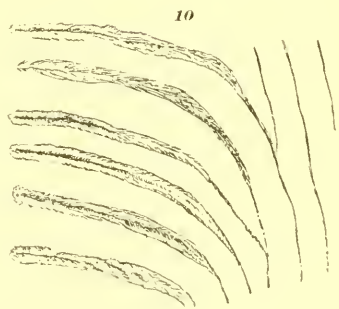
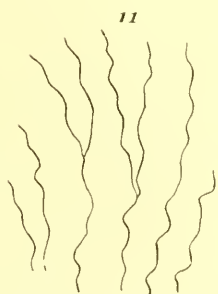
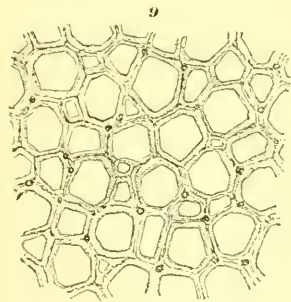
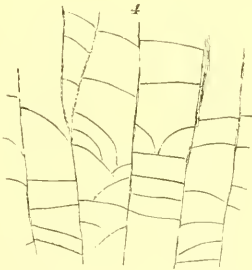
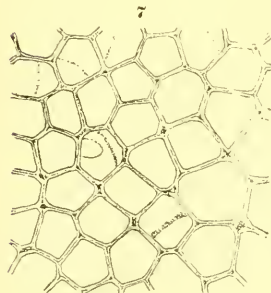
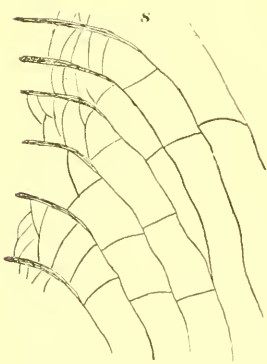
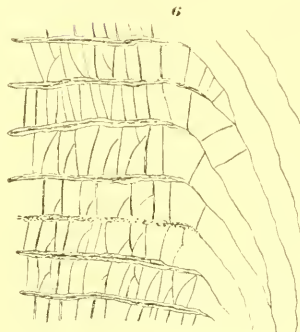
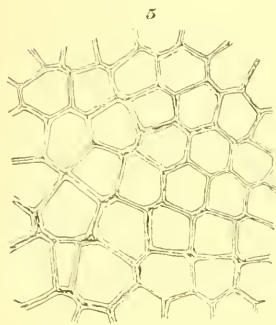
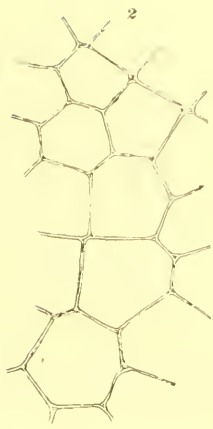
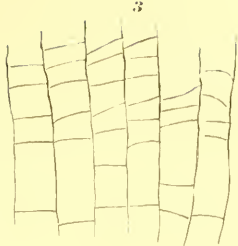
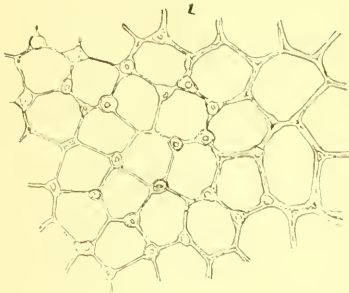
(PLATE XIII, 7, 8; PLATE XIV, 3)

In size of zoecia this species agrees fairly well with the preceding, with which it is also generally associated, but the two are readily distinguished by their different methods of growth. In the hundreds of specimens observed *A. columbiana* is always massive, while *A. ampla* adheres as strictly to the ramose habit of growth. Its branches are smooth, divide frequently, and are usually about 10 mm. in diameter. The zoecia are large, about 7 in 2 mm., with sub-angular apertures and rather thin walls. The acanthopores are small and so far have been observed only in thin sections. They seem never to reach the size of those in *A. columbiana*. Diaphragms occur at intervals of several tube-diameters in the axial region, but in the peripheral they are much more abundant, many of them here also being funnel-shaped.

A. ampla is closely related to *A. cingulata* Ulrich, the type species of the genus, but has larger zoecia and fewer acanthopores.

Occurrence.—Abundant in the Lorraine formation at Nashville and Columbia, and many other localities in Tennessee, where these strata are exposed. Rather rare in the Fairmount beds of the Lorraine at Cincinnati, Ohio, and vicinity.

Cat. Nos. 43,213-43,215, U. S. N. M.



GENERA AND SPECIES OF TREPOSTOMATA

AMPLEXOPORA CYLINDRACEA new species

(PLATE XIII, 5, 6; PLATE XIV, 4, 5)

This species resembles the last two considerably in internal characters, but as it has a decidedly different method of growth, besides several minor peculiarities and, moreover, marks a lower geological horizon, we have decided to recognize it as a distinct species.

Compared with *A. ampla*, the zoarium of *A. cylindracea*, consisting of straight, infrequently-branching, narrow, cylindrical stems, 5 or 6 mm. in diameter, is readily distinguished from the short, thick, frequently-branching stems of that species. The rounded masses of *A. columbiana* are too different externally to be confused with either of the two species.

Occurrence.—Abundant in the lower part of the Catheys limestone of the Trenton at Nashville, Tennessee. Here it occurred in a shaly bed containing many other bryozoa and an abundance of *Orthorhynchula limzeyi* (Nettleroth).

Cat. No. 43,126, U. S. N. M.

Genus MONOTRYPELLA Ulrich

This genus should be restricted to the genotype, *M. aequalis* Ulrich, and such other ramose *Amplexoporidæ* as differ from *Amplexopora* only in wanting acanthopores. Of described species that have been referred to *Monotrypella*, it is doubtful if any but Edwards and Haime's *Monticulipora pulchella*, as redefined by Nicholson under the name *Monotrypa pulchella*, can maintain its position in this genus. The Devonian *Monotrypella simplex* Ulrich has amalgamated walls and must, therefore, be assigned to some other genus.

We are not yet prepared to name the genus to which *M. simplex* should be referred, nor even to decide definitely the family. In fact, aside from a species or two undoubtedly referable to *Batostomella* and the *Batostomella obliqua* Ulrich, in which we now see an *Eridotrypa*, the Devonian Trepostomata are very difficult to classify. Viewed collectively, they seem to form a group of Amalgamata by themselves, with varying relations to *Monticuliporida*, *Heterotrypida*, and *Batostomellida*. Studied individually, first one, then another of these relations seems to be the dominant one, with the result that closely allied species may be widely separated in their systematic arrangement. To secure a more natural and stable classification it is necessary to study the Devonian Trepostomata first as a whole and then no less carefully in connection with their Silurian

progenitors. It is only in this way that we may hope to establish their genetic relations to the Ordovician types.

The genotype, *M. æqualis*, has given us much trouble. While the apparently total absence of acanthopores in the specimen from which the original figured set of thin sections was prepared, has been verified by another set of sections from the same, the lamentable fact remains that none of the numerous specimens hitherto believed to be of the same species is without them. After many failures to identify another specimen of the species, we have been forced to the conviction that the original type is unique. If it is not, then the specimen illustrates a wholly unparalleled abnormal condition of either preservation or structure. A fact opposed to the latter alternatives was brought out by a final comparison of the specimens involved in the question at issue, viz: of the hundreds of specimens of the new *Amplexopora* which, prior to our recent investigations, had been labeled as *M. æqualis*, not one had such broad monticules as the type specimen. Indeed, they cover as much or more space, and this despite the fact that they are lower than in any other type of Trepostomata known to us. The only species approaching or possibly equaling it in this respect is *Discotrypa elegans*. Difference merely in the height of monticules is usually of very little consequence, but the widening of their bases seems to indicate a structural difference, the interpretation of which involves the difficult question of the purposes of the "maculæ" themselves.

On account of the extreme rarity of the genotype, *Monotrypella* has been known to collectors only through the *M. quadrata* section of the genus. As the latter section constitutes a sharply defined natural group and deserves recognition as a distinct genus, we have decided to remove it under the following title and to allow *Monotrypella* either to stand or to fall with the species upon which it was originally based.

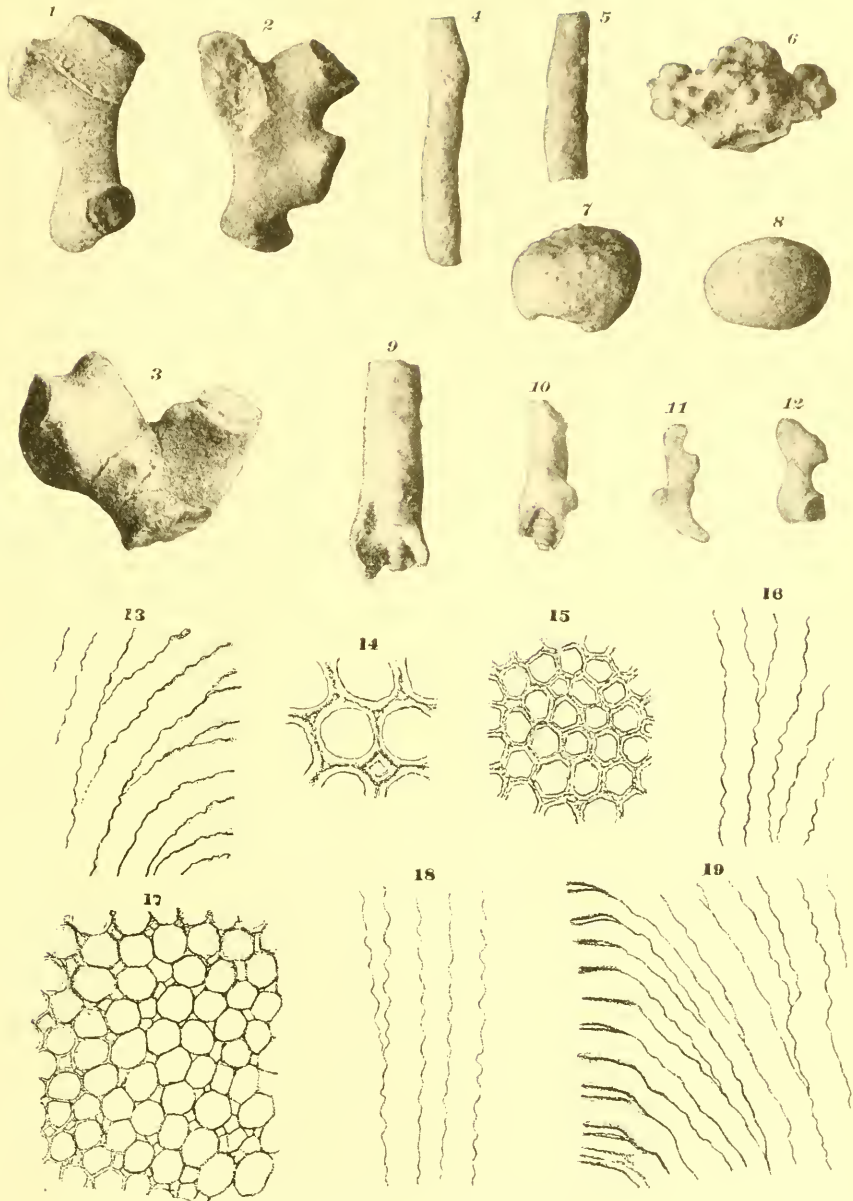
GENUS RHOMBOTRYPA new genus

Generic diagnosis.—Ramosely *Amplexoporidæ* with zoecial tubes in axial region regularly quadrate or rhombic in cross-section. Acanthopores usually wanting, always shallow, rarely distinguishable internally. True mesopore absent, but wall-less tabulated interzoecial spaces occur in several of the species.

Genotype.—*Monotrypella quadrata* (Rominger), a very abundant and one of the most characteristic and widely distributed fossils of the Richmond formation.

This group of species was recognized by Ulrich in 1890¹ when

¹ *Ill. Geol. Surv.*, vol. VIII, pp. 377, 452.



GENERA AND SPECIES OF TREPOSTOMATA

only three species, *M. quadrata* (Rominger), *M. subquadrata* Ulrich, and *M. crassimuralis* Ulrich, were known. Since that time another form, occurring like the others, in rocks of Richmond age, has been discovered. Finally, a fifth species was brought to light through the researches of Mr. Bassler on the bryozoa in the Niagaran Rochester shale of New York. The last species differs from the Richmond species in having acanthopores that may be distinguished in very shallow tangential sections of fully matured zoaria. In all the other species certain acanthopore-like spines, which often occupy the junction angles between the zoecial apertures, leave no definite traces in the interior of the zoarium, so that, if they are really of the nature of acanthopores, neither their presence nor their nature is indicated by tangential sections.

The principal characteristic of the genus is the rhombic form of the axial tubes in cross-sections. In vertical fractures the axial region exhibits alternating smooth and uneven spaces. The smooth spaces represent the flat side of a row of tubes coinciding with the plane of the fracture. In the uneven spaces the angles and two sides of each of the tubes are exposed. In the latter case the plane of the sides of the tubes, and consequently of the rows, forms an angle of about 45 degrees with the plane of the fracture. This change in directions results from a periodic and simultaneous development of new tubes along the margins of those parts of the axial region in which the rows have the same direction. The interpolated new tubes maintain the triangular shape necessitated by the form of the spaces at their disposal until the next period of gemination causes another turn and the interpolation of another set of young tubes.

The development of new tubes ceases entirely with the entrance of the older tubes into the peripheral zone. This is true also of practically all other ramose Trepostomata, and as a rule it is only after the cessation of gemination that the increasing space at the disposal of the zoecia, which naturally results from the peripheral growth in this zone, admits of the development of mesopores and acanthopores. In most cases, probably, the mesopores contained a specially modified kind of zooid, as did also the acanthopores, but when, as in the case of *Rhombotrypa*, the interzoecial spaces have no walls of their own, it may well be doubted if they indicate a degree of dimorphism comparable with those cases in which true and fully developed mesopores occur. It may be admitted at once that it is often very difficult to decide whether these interspaces in a given case are true mesopores or not, but under all circumstances it is a point deserving more serious consideration than has yet been allotted to it.

The increasing space that is divided among the zoëcia as peripheral growth proceeds is variously employed in the complete development of ramose zoaria. In certain types, particularly simple Integrata, the normal width of the zoëcial cavity is maintained solely by deposits of laminated calcareous tissue on the inner sides of the walls. In other types the excess space is in a greater or less degree accounted for by triangular or quadrate open spaces left between adjoining zoëcia, and in these the deposit of tissue on the inner side of the walls is correspondingly thin. In other types, again, a part of the space is taken up by a thickening of the original walls in the process of their amalgamation. Finally, in the more complex Amalgamata, the normal width is maintained partly by the thickening incident to amalgamation, partly by deposit on the inner side, and partly by the development of acanthopores and mesopores.

In *Rhombotrypa quadrata* the excess space is taken up by deposit on the inner side of the walls, in *R. subquadrata* and *R. crassimuralis*, mostly in the same way but also by interzoëcial spaces, while in the undescribed Richmond and Niagaran species it is chiefly by such spaces.

The relative amount of excess space varies with three factors: (1) The diameter of the zoarium; (2) the width of the peripheral zone; and (3) the angle at which the tubes proceed to the surface after bending outward from the axial region. These in turn determine the thickness of the zoëcial walls at the periphery and the number of the mesopores. In a narrow branch the increase is proportionately more rapid than in a larger stem, in a wide peripheral zone the increase continues for a longer time, and when the zoëcial tubes turn abruptly into the peripheral zone and proceed in a direct line toward the surface the increase obviously is more rapid than when the angle is less abrupt. It has probably impressed others, as it has us, as a singular fact that ramose zoaria do not exceed a certain maximum diameter for each species. Primarily it is because no new zoëcia are developed after they have fully entered the peripheral zone. Next it depends upon a definite proportion between the respective sizes of the axial and peripheral zones. This proportion varies with the species, those with thin-walled zoëcia having a proportionally narrow outer zone or slowly curving tubes, and those with thick walls having a correspondingly wider peripheral zone. Finally, it depends upon the capacity of the zoëcia of a particular species to take care of the increase in space allotted to it as growth proceeds. When a certain limit, which varies with the species, is reached, growth must cease, and that part of the zoarium dies. But when

through some irregularity in growth the normal increase is locally retarded, the zoecia always continue to live until the limit of increase is reached.

Family CALLOPORIDÆ Ulrich

At present we have no change to suggest in this family nor in the definition of its genera, except a slight one in *Callopora*, that is made necessary by the erection of the following new genus upon *C. crenulata*, an untabulated species referred to that genus in 1893 by Ulrich. A new genus, agreeing, apparently, with *Callopora* in all respects except that it has indubitable acanthopores, is reserved for some future publication.

Genus CALLOPORINA new genus

Callopora (part.) ULRICH, 1893, Geol. Minn., III, p. 275.

Generic diagnosis.—Zoarium ramose or subramose; zoecia polygonal to rounded with walls thin, iridescent, and crenulated in the axial region, slightly thickened and straight in the peripheral zone; mesopores few to numerous; diaphragms wanting in both zoecia and mesopores; no acanthopores.

Genotype.—*Callopora crenulata* Ulrich, Black River and Trenton formations of Minnesota, Iowa, and Wisconsin.

The most obvious distinction between this new genus and *Callopora*, to which the genotype has heretofore been referred, lies in the total absence of diaphragms, not only in both regions of the zoecial tubes, but also in the mesopores. Another character pertaining to all of the species so far observed is the decided crenulation of the zoecial walls in the immature region. We have also observed, in all of the specimens of the various species examined, a very pretty appearance in vertical fractures. When such fractures are examined under a hand lens in a good light, a beautiful iridescence of the zoecial tubes is seen. Of what importance this may be generically cannot be said, but as all of the species show this feature, we see no reason why it should not be included among the generic characters. That this iridescence has some structural significance is inferred from the fact that it does not occur in such other bryozoa with similarly crenulated walls as *Monotrypa undulata* and *Anaphragma mirabile*.

So far as known, the genus is limited to the Mohawkian group. *Anaphragma*, described in this paper, is a very similar new genus, but, having acanthopores, bears the same relation to *Batostoma* that *Calloporina* does to *Callopora*. *Calloporina crenulata* is rather abun-

dant at a number of localities in the states mentioned above. *C. parva*, described below, occurred in considerable numbers in Tennessee and several additional new species are known to us from the Trenton rocks of Kentucky.

CALLOPORINA PARVA new species

(PLATE XIV, 13-16)

Zoarium small, ramose or subramose; branches cylindrical or compressed, 2 to 4 mm. wide, arising from an expanded base and not reaching a height of more than 20 or 30 mm. Surface smooth with inconspicuous maculæ. Zoecial apertures angular, 9 to 10 in 2 mm. Mesopores small and rather few in number.

Vertical fractures show the crenulated walls and iridescence spoken of under the discussion of the genus. Thin sections show that the number of crenulations in a given space varies somewhat, but 16 in 2 mm. is a fair average. Diaphragms are as required for the genus, wanting in both zoecia and mesopores.

Although agreeing in all essential internal characters with *Calloporina crenulata* (see plate XIV, 17-19), this species is readily distinguished. *C. crenulata* forms large, bushy masses, composed of strong, monticulated branches, with rounded zoecia (8 in 2 mm.) and numerous small mesopores. *C. parva*, on the other hand, has a few narrow, smooth branches, containing smaller zoecia and fewer mesopores.

Occurrence.—Abundant in a thin shaly bed of the age of the Black River formation, 2 miles south of Belfast, Marshall county, Tennessee.

Cat. No. 43,217, U. S. N. M.

Family TREMATOPORIDÆ Ulrich

We have paid some attention to the characters separating this family from the *Calloporidæ*, but as our investigations have not been completed, it is deemed unwise to express ourselves definitely at the present opportunity. We may say, however, that so far as we have gone, the published reasons for maintaining the *Trematoporidæ* have not been impaired. There are differences, when compared with *Calloporidæ*—in the development of the zoecia, in the mesopores, and in the acanthopores—that require some recognition, and as now constituted there is little difficulty in separating the two families. At some future time we shall publish a new genus, represented by several species in the formations of the Stones River group in Tennessee, that may be succinctly described as a group of acanthopored

Calloporas. To what extent, if any, this new genus will affect the relations of the two families we are not prepared to say.

The following new genus necessitates a modification of our previous conception of the family to the extent of admitting untabulated zoecia. Aside from the absence of diaphragms, the new type agrees very well with unquestionable species of *Batostoma*.

Genus ANAPHRAGMA new genus

Generic diagnosis.—Ramosé *Trematoporidae* agreeing in all essential respects with *Batostoma* Ulrich, except that both the zoecial tubes and mesopores are entirely devoid of diaphragms.

Genotype.—*Anaphragma mirabile* new species, Richmond formation, Illinois and Wisconsin.

The specimens upon which this genus and species are founded were collected some years ago and laid aside under the belief that they belonged to a species of *Batostoma*. Though recognized as new, it appeared too near in its specific characters to certain already known species to make it worth while to work out its probably slight internal peculiarities. Subsequently, it became desirable to determine all our material from the Richmond at Wilmington, Illinois, so that this species came up for investigation with many others that had been laid aside for similar reasons. The total absence of diaphragms in the first set of thin sections was so unexpected that we were inclined to reject its evidence. When the same peculiarity was repeated in half a dozen other sets of sections, the features had to be accepted as an established fact.

We do not doubt that all will concede the generic value of this structural difference between *Batostoma* and *Anaphragma*, but some, possibly, may question the propriety of erecting the last-named genus and *Calloporina* upon practically the same peculiarity. The genus *Calloporina* is described on page 47. Critically examined, the latter group of species proves to be as intimately related to *Callopora*, and essentially in the same manner, as *Anaphragma* is to *Batostoma*; hence, if for any reason either of the new genera is united with the other, the same reason would apply with equal force in merging, not merely *Batostoma* and *Callopora*, but their respective families as well.

ANAPHRAGMA MIRABILE new species

(PLATE XIII, 9-11)

Zoarium of smooth, strong, subcylindrical branches, 8 to 10 or more mm. in diameter, dividing rather frequently. Maculae not a

conspicuous feature; distinguished only by the size of their zoëcia, which are somewhat larger than the average. Zoëcial apertures, angular to subangular, with rather thick walls, 5 to 6 zoëcia in 2 mm.; mesopores small, and comparatively few in number; acanthopores small and seldom well shown at the surface, although when observed they show the usual apical perforation.

Internal characters.—In vertical sections the striking feature is the absence of diaphragms in both the zoëcia and mesopores. In the axial region the walls are thin and wavy, the crenulation being long and not so frequent as in species of *Calloporina*. With the inception of the mature region, the walls become greatly thickened and considerable laminated tissue is developed upon the inner sides. Tangential sections show the zoëcial walls to be of considerable thickness and to have the characteristic structure of *Batostoma*. The acanthopores are seen to be small, few in number, and situated at the junction angles.

The rather large angular zoëcia, thick walls, and few mesopores, and, more satisfactorily, the absence of diaphragms, distinguish this species from otherwise similar associated forms.

Occurrence.—Not uncommon in the Richmond formation at Wilmington, Illinois. Less abundant in the same strata at Delafield and Iron Ridge, Wisconsin.

Cat. Nos. 43,218, 43,219, U. S. N. M.

EXPLANATION OF PLATES

PLATE VI

- Monticulipora mammulata* D'Orbigny.....p. 16
- Figs 1, 2. Vertical and tangential sections, $\times 20$, of D'Orbigny's type.
3. Tangential section, $\times 35$, illustrating the peculiar granulose structure.
- Fairmount beds, Lorraine formation, Cincinnati, Ohio.
- Monticulipora cleavelandi* James.....p. 16
4. Vertical section, $\times 20$, showing the wall structure and distribution of cystiphragms and diaphragms.
5. Tangential section, $\times 20$, through a part of the zoarium where the cystiphragms were not developed.
6. Tangential section of a zoëcium, $\times 35$. The inner margin of the walls is unusually definite in this zoëcium.
- Middle division of Richmond formation, Dutch creek, near Wilmington, Ohio.
- Orbigynella sublamellosa* new species.....p. 19
7. Tangential section, $\times 20$.
8. Vertical section, $\times 20$, passing through two layers of zoëcia.
9. Tangential section, $\times 40$, showing the acanthopores and the wall structure with the white median line suggestive of the *Heterotrypida*.

- Pierce limestone, Stones River formation, Murfreesboro, Tennessee.
- Orbignyella lamellosa* (Ulrich).....p. 20
10. Tangential section of a single zoecium, $\times 35$. (Introduced for comparison.)
Richmond formation, Wilmington, Ill.
- Prasopora palera* new species.....p. 20
11. Tangential section, $\times 20$, exhibiting the angular form and thin walls of the zoecia and the comparatively few mesopores.
12. Vertical section, $\times 20$, showing normal characters seen in such a section.
13. Vertical section, $\times 20$, showing the superficial extremities of two zoecial tubes and a case where the mesopores which occur further down in the section appear to have been crowded out.
14. Vertical section, $\times 20$, showing a mesopore succeeded by a rapidly developing zoecium.
Hermitage beds of the Trenton, 4 miles north of Columbia, Tennessee.

PLATE VII

- Homotrypella nodosa* new species.....p. 21
- FIG. 1. Vertical section, $\times 20$.
- 2, 3. Tangential sections, $\times 20$ and $\times 35$, showing the thick, inflected walls and numerous acanthopores.
Leipers division of the Lorraine, Columbia, Tennessee.
- Mesotrypa echinata* new species.....p. 22
- 4, 5. Tangential sections, $\times 20$ and $\times 35$, exhibiting the small angular zoecia and large acanthopores.
6. Vertical section, $\times 20$, passing through two mature regions with an immature zone between and showing the crowded diaphragms, which are characteristic of this species.
Lower part of the Catheys limestone of the Trenton, Nashville, Tennessee.
- Mesotrypa angularis* new species.....p. 23
7. Tangential section, $\times 20$. The large cells on the right belong to a macula, while those on the left are of ordinary zoecia. The figure shows an average in the development of acanthopores, mesopores, and thickness of zoecial walls.
8. A tangential section of an ordinary zoecium, $\times 35$.
9. A vertical section, $\times 20$, with the mesopores limited to the immature (lower) region and the acanthopores strongest in the mature region.
Lexington limestone of the Trenton, Frankfort, Kentucky.
- Dekayella foliacea* new species.....p. 28
10. Tangential section, $\times 20$, showing aged condition in which the walls are thickened, the mesopores reduced to a minimum, and the smaller set of acanthopores nearly obsolete.
11. Tangential section, $\times 35$, exhibiting the normal development of the two sets of acanthopores.
12. Vertical section, $\times 20$.
Lexington limestone of the Trenton, Lexington, Kentucky.

PLATE VIII

- Cyphotrypa accrevulosa* (Ulrich).....p. 30
- FIGS. 1, 2. Vertical sections, $\times 20$, of the immature and mature regions respectively, showing variation in distribution of diaphragms in these two regions (from type sections figured by Ulrich).
3. Small portion of a tangential section, $\times 35$, showing minute structure of walls and acanthopores in mature region.
Clitambonites bed of Galena-Trenton, Decorah, Iowa.
- Cyphotrypa wilmingttonensis* new species.....p. 31
4. Figure of a tangential section, $\times 20$, illustrating the large acanthopores and thin walls.
5. Several zoecia of the same tangential section, $\times 35$.
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Richmond formation, Wilmington, Illinois.
- Cyphotrypa frankfortensis* new species.....p. 30
- 7, 8. Tangential section, $\times 20$ and $\times 35$.
9. Vertical section, $\times 20$, showing distribution of diaphragms.
Top of Trenton formation, Frankfort, Kentucky.
- Atactopora angularis* new species.....p. 32
10. Tangential section, $\times 20$, showing a macula, the ordinary zoecia, and the comparatively few acanthopores characterizing this species.
11. A portion of the same, $\times 35$.
12. Vertical section, $\times 20$, the central portion of the figure showing edge of a macula.
Lower beds of the Richmond formation, Waynesville, Ohio.
- Atactopora maculata* Ulrich.....p. 31
13. A zoecium, $\times 35$; drawn from the type section figured by Ulrich.
Fairmount beds, Lorraine formation, Covington, Kentucky.
- Atactopora hirsuta* Ulrich.....p. 31
14. Tangential section, $\times 35$, of a zoecium from the type section, introduced for comparison.
Utica formation, Covington, Kentucky.

PLATE IX

- Stigmatella crenulata* new genus and species. (See also plate XIV, 1, 2) .p. 34
- FIG. 1. Vertical section, $\times 20$, exhibiting the crenulated walls of the immature region and the few thin diaphragms of the mature region.
2. Portion of a vertical section of mature region, $\times 35$, exhibiting the periodic development of the acanthopores.
3. Tangential section, $\times 20$, showing characters in a mature region.
4. A portion of the same, $\times 40$. The figure contains a macula and illustrates the minute characters of the acanthopores and walls.
Lower beds of Richmond formation, Hanover, Ohio.
- Stigmatella spinosa* new species.....p. 34
5. A tangential section, $\times 20$, showing, as usual in the mature regions, abundant acanthopores and the almost total restriction of mesopores to the maculae.
6. Small portion of same, $\times 40$.
7. Vertical section, $\times 20$, of mature region.

8. A portion of the same, $\times 50$.
Richmond formation, Versailles, Indiana.

PLATE X

- Stigmatella nicklesi* new species. (See also plate XIV, 9, 10) . . . p. 36
- FIG. 1. Vertical section, $\times 20$. The lower curved line represents the outer surface of the crinoid stem over which the colony has grown, while the shaded portion above it represents a clay-filled interspace.
2. Tangential section, $\times 20$, showing the very large and sharply defined acanthopores and thin zoecial walls.
3. Several zoecia of the same section, $\times 50$.
Fairmount beds, Lorraine formation, Cincinnati, Ohio.
4. Tangential section of several zoecia, $\times 50$. Introduced for comparison with *S. nicklesi*.
Stigmatella clavis (Ulrich) p. 34
Lower beds of Utica formation, Covington, Kentucky.
- Stigmatella irregularis* (Ulrich). (See also plate XIV, 6-8) . . . p. 34
5. Vertical section, $\times 20$, illustrating the periodical development of the acanthopores and the extreme infrequency of the diaphragms.
6. Small part of a tangential section, $\times 40$, where it passes through one of the zones of acanthopores. Ordinarily tangential sections show no acanthopores.
Fairmount beds, Lorraine formation, Hamilton, Ohio.
- Stigmatella nana* new species. (See also plate XIV, 11, 12) p. 36
7. Ordinary aspect of tangential sections, $\times 20$.
8. Portion of same, $\times 50$.
- 9, 10. Vertical section, $\times 20$, and portion of same, $\times 40$.
Utica formation, West Covington, Kentucky.
11. Vertical section, $\times 10$, showing adaptation of zoarium to irregularity of the object grown upon.
Stigmatella dychei (James) p. 34
Mt. Auburn beds of Lorraine formation, Lebanon, Ohio.

PLATE XI

- Heterotrypa frondosa* (D'Orbigny) p. 25
- FIGS. 1, 2. Tangential sections, $\times 35$ and $\times 20$, illustrating the wall structure and the distribution and character of the acanthopores and mesopores.
3. Vertical section, $\times 20$, exhibiting the tabulation of zoecia and mesopores.
Sections prepared from the original of Edwards and Haime's figures of the species.
Lorraine formation, Cincinnati, Ohio.
- Heterotrypa parvulipora* new species p. 26
- 4, 5. Vertical and tangential sections, $\times 20$. The almost total absence of mesopores is a noteworthy characteristic of this species.
6. A single zoecium, $\times 50$, exhibiting the wall structure and acanthopores.

Catheys limestone of the Trenton, Love branch, Maury county, Tennessee.

- Lioclema punctatum* (Hall).....p. 39
- 7, 8. Vertical and tangential sections, $\times 20$, exhibiting the normal internal characters of the species.
9. Portion of figure 8, $\times 40$, showing structure of walls and acanthopores.
- Keokuk formation, Keokuk, Iowa.
- Lioclema monroci* new species.....p. 39
10. Vertical section, $\times 20$.
- 11, 12. Tangential section, $\times 20$ and $\times 35$.
- Hamilton formation, Bethany, New York.

PLATE XII

- Stigmatella personata* new species.....p. 35
- FIG. 1. Tangential section, $\times 20$, exhibiting the angular zoecia, comparatively few and small acanthopores, and almost total absence of mesopores.
2. A portion of the mature region of a vertical section, $\times 20$, showing the usual disposition of the diaphragms.
3. A zoecium of fig. 1, $\times 50$, showing structure of walls and acanthopores.
- Lower beds of the Richmond formation, Hanover, Ohio.
- Stigmatella interporosa* new species.....p. 35
4. Tangential section, $\times 20$, showing among other characters the abundance of mesopores characterizing this species.
5. Vertical section, $\times 20$, showing the characters of the mature and immature regions.
- Lower beds of the Richmond formation, Hanover, Ohio.
- Lioclemella ohioensis* (Foerste).....p. 39
6. Portion of an average tangential section, $\times 20$, exhibiting characters deep in peripheral region. The zoecia may be distinguished by having slightly thicker walls.
7. Vertical section, $\times 20$, showing the turn from the axial to the peripheral region.
8. Several zoecia of section of which fig. 6 represents another part, $\times 35$.
9. Portion of another tangential section, $\times 35$, exhibiting an extremely aged development of acanthopores.
- Clinton formation, Dayton, Ohio.
- Amplexopora filiosa* (D'Orbigny).....p. 41
10. Several zoecia, $\times 35$, as seen in the usual tangential section.
11. Tangential section of two zoecia, $\times 35$, showing the full development of acanthopores and the characteristic dark median line.
- Lorraine formation, Hamilton, Ohio.

PLATE XIII

- Amplexopora columbiana* new species.....p. 41
- FIG. 1. Tangential section, $\times 20$, through a part of the zoarium where the acanthopores are best developed.

2. Ordinary aspect of tangential sections, $\times 20$. The lower part of the figure shows the zoecia of a macula, and the upper those of the ordinary kind.
3. Vertical section, $\times 12$, passing through an immature and mature region.
4. Vertical sections, $\times 12$, passing through a macula and showing the funnel-shaped diaphragms which are more abundant than in the intermacular zoecia.
Leipers division of the Lorraine, Columbia, Tennessee.
Amplexopora cylindracea new species. (See also plate XIV, 4, 5) . . . p. 43
- 5, 6. Tangential and vertical sections, $\times 20$.
Catheys division of the Trenton, Nashville, Tennessee.
Amplexopora ampla new species. (See also plate XIV, 3) p. 42
- 7, 8. Tangential and vertical sections, $\times 20$.
Leipers division of the Lorraine formation, Columbia, Tennessee.
Anaphragma mirabile new genus and species. p. 49
9. Tangential section, $\times 20$.
10. Vertical section of peripheral portion, $\times 20$.
11. Vertical section of central part of axial region, $\times 20$.
Richmond formation, Wilmington, Illinois.

PLATE XIV

- Stigmatella crenulata* new genus and species. (See also plate IX, 1-4) p. 34
Figs. 1, 2. Natural size views of two fragments.
Richmond formation, Hanover, Ohio.
Amplexopora ampla new species. (See also plate XIII, 7, 8) . . . p. 42
3. Fragment of a zoarium, natural size.
Lorraine formation, Nashville, Tennessee.
Amplexopora cylindracea new species. (See also plate XIII, 5, 6) . . . p. 43
 - 4, 5. Two specimens, natural size, showing the straight cylindrical form of the zoarial branches.
Trenton formation, Nashville, Tennessee.
 - 6, 7, 8. *Stigmatella irregularis* (Ulrich). (See also plate X, 5, 6) p. 34
Three zoaria, natural size, showing the variation of specimens from irregularly lobate nodose to smooth subglobose masses.
Lorraine formation, Hamilton, Ohio.
 - 9, 10. *Stigmatella nicklesi* new species. (See also plate X, 1-3) p. 36
Two nearly complete zoaria of the natural size.
Lorraine formation, Cincinnati, Ohio.
 - 11, 12. *Stigmatella nana* new species. (See also plate X, 7-10) p. 36
Fragments of natural size.
Utica shales, Covington, Kentucky.
Calloporina parva new species. p. 48
 13. Vertical section, $\times 20$.
 14. Tangential section, $\times 40$, showing wall structure.
 15. Tangential section, $\times 20$.
 16. Vertical section of immature region, $\times 20$.
Black River formation, 2 miles south of Belfast, Tennessee.
Calloporina crenulata (Ulrich), new species. p. 47
 - 17, 18, 19. Tangential section, $\times 20$, and vertical section of both regions, $\times 20$, showing the internal characters upon which the new genus is founded. (After Ulrich.)
Black River formation, St. Paul, Minnesota.