AMERICAN PALÆOZOIC BRYOZOA.

[*Continued from Vol. vi., p. 168.*]

Atactopora, Ulrich, 1879.

(Jour. Cin. Soc. Nat. Hist., Vol. ii., p. 119.)

More recent and thorough investigations, and our more advanced and constantly increasing knowledge of these intricate Palæozoic Bryozoa, have shown me that this genus, as originally defined by me, included at least two, unequal, and in many respects widely different groups of species, besides a single species (*A. septosa*), which I have already referred to the genus *Amplexopora*. The type species, *A. hirsuta*, unfortunately, is a member of the smaller group, the only other described species certainly known to have the characters of the genus, as I now propose to restrict it, being the *A. maculata*, a description of which was published by me in the same paper above referred to. That my subsequent remarks may be the better understood, I will immediately subjoin the emended definition of the genus, to conform with the restriction proposed.

Atactopora (Restricted).

Zoaria parasitically attached to foreign bodies, over which they form thin and expanded crusts, the thickness of which varies according to the number (rarely more than three) of superimposed layers, the latter having an approximately definite thickness. Zoœcia with more or less thick walls, and indented or floriform orifices, due to the position of the numerous spiniform tubuli, which in the thick-walled species are developed almost exclusively in the portion of the walls immediately surrounding the visceral cavity. True interstitial cells are wanting. At regular intervals the surface presents subsolid elevated "maculæ," that are granulose and finely pitted, and apparently composed of peculiarly modified or aborted cells. Diaphragms few, always horizontal.

As before stated, the type of the genus is *A. hirsuta*, the internal structure of which is represented on Plate XII., by figs. 1 and 1*a*. The first represents a portion of a tangential section, enlarged eighteen diameters, and shows very distinctly the characters of the species as they are brought out in a section of this kind. The cell-interspaces are thick, and the walls of adjacent tubes are apparently fused

together, there being no sharply defined lines of contact, though these are rather faintly indicated by an irregular and often confused central zone, of lighter color than that portion of the walls immediately surrounding the visceral cavity of the tubes. Their structure is on the whole quite like that of species of *Monticulipora*, but more like that of some species of *Amplexopora* (*e. g.*, *A. septosa*, Ulrich, and *A. moniliformis*, Nich.)

Figures 2 and 2*a*, on the same plate, represent typical sections of *A. maculata*. Comparing fig. 2 with fig. 1, both representing tangential sections, cutting the zoarium just below the surface, we find that, with the exception of the relative thickness of the cell-interspaces or walls, the two species are precisely alike. In both we find the same peculiarly constructed "maculæ," while in the minute structure of the cell-walls no difference whatever is manifest. In their vertical sections a corresponding agreement of structure is apparent. So far as I have been able to ascertain, the layers of the zoarium of *A. hirsuta* never attain more than perhaps one half the thickness of a fully matured layer of *A. maculata*, while on the other hand, the cell walls of the former are usually about twice as thick as those of the latter. Aside from these specific points of difference, they agree in having remote horizontal diaphragms, and similarly constructed "maculæ." The latter are divided by more or less distinct floors, having an upward curvature, corresponding to the convexity of the outer or exposed portion of the elevated "maculæ." Not infrequently, on the upper side of these floors, some conical hollow projections may be detected, which doubtlessly represent modified spiniform tubuli, or structures of similar value. These do not appear to be continuous from one floor to the other, but the evidence at hand seems to establish as a fact, that each series is separately developed at the successive stages of growth. Further, in many specimens the zoarium is divided into three, rarely four, distinct layers, of very nearly equal thickness, separated from each other by parallel bands of sclerenchyma, that, usually, do not seriously interrupt the further growth of the zoarium, not the direct sequence of the cells.

Of the other forms originally referred by me to *Atactopora*, I now feel satisfied that *A. mundula*, *A. multigranosa*, *A. tenella*, and *A. ortoni*, Nicholson, belong to an entirely distinct genus. To this list I add three new species, so that the genus as at present known, is represented by at least seven distinct species. All of these are from the Cincinnati group, in which the genus is found to range throughout

the formation. The range of each species is however very restricted, being in perhaps no case more than one hundred feet, and usually much less. The genus may be characterized as follows:

ATACTOPORELLA, n. gen.

Zoaria usually incrusting, sometimes lobate, rarely sub-ramose, and generally composed of several superimposed layers. Surface always presenting more or less distinct groups of cells slightly larger, or with wider interspaces than the average, which usually occupy the slopes of more or less elevated, rounded or conical, monticules. Zoœcia tubular, rounded, with more or less distinctly petaloid apertures, due to the inflection of the thin walls, by the numerous spiniform tubuli. Interstitial cells numerous, angular, often completely isolating the true cells. As the layers become mature they are usually filled between the crowded horizontal diaphragms, by a deposit of sclerenchyma. Beside a limited number of straight diaphragms, nearly all of the proper zoœcia are provided with a series of cystoid diaphragms.

Type, *Atactoporella typicalis*, n. sp.

As may have been gathered from the above description, the new genus differs from *Atactopora*, as before restricted, in having numerous closely tabulated interstitial cells, cystoid diaphragms in the proper zoœcia, and thin, instead of thick walls. These are all good generic characters, and serve to remove the genus perhaps farther from *Atactopora* proper, than from either *Monticulipora* or *Peronopora*. *Monticulipora* differs in having no true interstitial cells, while the spiniform tubuli are mainly restricted to the angles of the cells, and only very rarely inflect the tube-walls. In *Peronopora*, however, we have a nearer ally, and it is unquestionable that the true affinities of *Atactoporella* lie in that direction. In both we have interstitial cells, spiniform tubuli, and cystoid diaphragms. On the other hand, the difference in their habits of growth, the zoarium of *Peronopora* being doubled-leaved, and perhaps, occasionally, frondescent, while that of *Atactoporella* is constantly more or less parasitic, the thicker and somewhat differently constructed cell-walls, and less numerous spiniform tubuli of *Peronopora*, are characters that serve to distinguish all the species of the two genera so far known. I can not admit that the fact that the zoarium of both *A. typicalis*, and *A. newportensis*, occasionally assumes a sub-ramose character, in any way nullifies the point of difference in growth, regarded by me as one of the characters separating the proposed genus from *Peronopora*. The few specimens

of those species found in that condition, are so variable in shape, that they can not be regarded as properly ramose or frondescent. I hold that in all truly ramose or frondescent species of the TREPOSTOMATA, the zoarium is permanently either one or the other, and I have never observed such a vacillation of form as pertains to these aberrant specimens of the two species mentioned. We have an entirely parallel case in Nicholson's var. *molesta* of the typically massive species *Monticulipora mammulata.* As I have in another place pointed out, that variety usually assumes a frondescent habit of growth, though individuals of the variety vary extremely in outward form. All these forms differ from truly ramose and frondescent types of the *Monticuliporidæ*, in having both cystoid diaphragms and spiniform tubuli already present in the axial region of the zoarium.

One character of the genus, the importance of which I am at present not yet able to estimate, is developed in an unmistakable manner in at least the three species, *A. multigranosa, A. mundula*, and *A. ortoni*, viz: the secondary deposit of sclerenchyma in the interstitial tubes, and their partial suppression. In the young stages of these species the intertubular spaces are much thicker than they are in the fully matured stage, and the mouths of the interstitial cells can often be detected. Sections prepared from fully matured examples, demonstrate that the interstitial tubes in the deeper levels of the zoarium are open, and of considerable size, their diameter often equaling that of the proper zoœcia. As growth proceeds, the interstitial spaces are narrowed, and a deposit of sclerenchyma around the outer side of the true zoœcia, gradually fills them up, until in the fully matured state they can scarcely be detected any longer. Among the *Monticuliporidæ* I am not acquainted with any form, excepting, perhaps, *Trematopora*, in which a similar filling up of the interstitial cells occurred. Among the *Fistuliporidæ*, however, a similar condition is often present, but how nearly they may be due to the same causes, I am not prepared to say.

ATACTOPORELLA TYPICALIS, n. sp. (Pl. XII., figs. 3-3*d*).

Zoarium, in its typical condition, forming thin parasitic expansions over other bryozoa, having a thickness rarely exceeding .03 of an inch, and then only by the addition of another layer. A few specimens are lobate, and by an excessive development of the lobes, they have become, to a small extent, subramose. At rather unequal intervals, averaging perhaps .1 inch, the surface exhibits groups of cells slightly larger

than the ordinary, which may be raised into low, rounded monticules, or remain on a level with the surrounding plane of the surface. Cells regularly arranged in diagonally intersecting lines, about twelve in the space of .1 inch, separated by interspaces, usually of less width than the diameter of their orifices, which averages about $\frac{1}{150}$th of an inch. When in a good state of preservation (Pl. XII., fig. 3), the cell apertures are distinctly floriform, the wall at each of the indentations, being raised into a small spine, repesenting the surface extension of the spiniform tubuli. Interstitial cells numerous, but not readily recognized externally, being shallow, and much obscured by the spiniform tubuli.

Tangential sections (Pl. XII., figs. 3*a* and 3*b*) show the characters of the genus and species in an excellent manner. The cell walls are very thin, and those of the true zoœcia are more or less strongly indented at from two to five points in their circumference; the indentations are made most distinct by the spiniform tubuli, one of which occurs at each point, where it is developed, in nearly all cases, almost entirely upon the inner side of the wall. Surrounding, and usually completely isolating, the true cells, is a single, rarely double, row of small angular interstitial cells, with thin and rather faintly marked divisional walls. They are generally about half the size of the proper zoœcia, and where three or four of them join, a spiniform tubulum appears always to have been developed, but I have never detected these structures in their walls between the angles. Lastly, the majority of the proper zoœcia show the cut edges of the cystoid diaphragms.

Vertical sections, when cut from one of the typical incrusting examples, are identical with what may be called the peripheral portion of the section represented by figure 3*c*, on Plate XII. All the tubes have equally thin walls, but the two kinds are readily distinguished from each other by their relative size and tabulation. In the interstitial tubes, which first come into existence a short distance above the attached epithecal base, the diaphragms are crowded, and always horizontal. In the larger true zoœcial tubes, a series of rather large cystoid diaphragms is usually present along the concave wall; while, as is nearly always the case in forms of this character, the space intervening between the inner margin of this series and the opposite wall, is crossed by equally numerous straight diaphragms. The intervals between the diaphragms of the smaller tubes are about half as long as those separating these partitions in the larger tubes.

Figure 3*d* represents a specimen in which the free condition of the zoarium is more distinct than in any other seen. However, in the ex-

amples before me, there is a regular gradation from this specimen down to what is nothing more than a pronounced node, and after a careful examination of these specimens, I find that this habit of growth is, apparently, always due to a lack of surface over which the zoarium might spread in its normal fashion. The direction of growth in the examples in question is, in every instance, toward the end of the branch of the ramose bryozoan incrusted. As growth proceeded, the foreign branch was gradually left behind, and in consequence, the tubes in the central portion of the zoarium are forced to remain in an "immature" condition for a much longer time than is the case in the normal parasitic condition. It is true, that with only a few exceptions, all the ramose and frondescent bryozoa are attached to some foreign body by a more or less expanded base ; and I am fully pursuaded that, what I must now regard as aberrant forms of *Atactoporella*, are clearly predictive of truly ramose or frondescent species of like character.

This species differs from all the other species of the genus now known, in its greater regularity of cell structure, and more numerous interstitial tubes.

Formation and locality: Cincinnati Group. Rather rare in the lower 100 feet of strata exposed at Cincinnati, Ohio, and Covington, Ky.

ATACTOPORELLA NEWPORTENSIS, n. sp. (Pl. XII., figs. 4-4*b*).

Zoarium robust, growing upon foreign objects, lobate, or throwing off subramose shoots. At intervals of about .12 of an inch, measuring from center to center, the surface is elevated into more or less prominent, rounded, and often elongated monticules, the summits and slopes of which are occupied by cells a little larger than the average. Cells rather regularly arranged in intersecting series, from eleven to thirteen of the ordinary size in the space of .1 inch, with subcircular or ovate apertures, having an average diameter of $\frac{1}{150}$th of an inch. On finely preserved examples the apertures are surrounded by a slightly elevated rim or peristome, which is often a little inflected at the points occupied by the numerous, though very small, spiniform tubuli. Interstitial cells numerous, but as usual with species of this genus, they are not readily detected externally.

Internally this species is in many respects precisely like *A. typicalis*. In tangential sections (Pl. XII., fig. 4*a*) the cells are seen to be somewhat unequal, narrower, the walls less inflected, and the spiniform tubuli smaller than in that species. Externally they differ in their

surface markings, the zoarium of *A. typicalis* being prevalently entirely smooth, while that of *A. newportensis* is generally strongly tuberculated, besides being of more robust growth. The cell apertures also are never so distinctly petaloid as in the type species.

The relations between *Atactoporella* and *Trematopora*, suggested by such a specimen as is represented by figure 4, on Pl. XII., will be discussed a few pages hence, under the emended definition of that genus.

Formation and locality : Cincinnati group. I have examined about twenty-five specimens of this species, all of which were obtained from the shaly beds, near the southern line of the city of Newport, Ky. The height of these strata is perhaps 125 feet above low water mark in the Ohio river.

ATACTOPORELLA SCHUCHERTI, n. sp. (Pl. XII., figs. 5-5*b*).

Zoarium parasitically attached to shells and other foreign bodies, over which it forms thin irregular expansions, usually less than an inch in diameter, and rarely more than .03 of an inch in thickness. The surface generally exhibits at intervals of .1 inch or more, slightly raised eminences. When in a good state of preservation (Plate XII., fig. 5), the cellular structure is almost entirely obscured by the innumerable surface extensions of the large spiniform tubuli, in many of which the perforation at the apex is clearly shown. When worn, the cell apertures are rounded, about ten in .1 of an inch, with thick interspaces, occupied by the shallow calices of numerous interstitial cells, which in old examples are not readily detected.

The distinctive characters of the species are well brought out in tangential sections (Pl. XII., figs. 5*a* and 5*b*). The cell walls are thin, and between the numerous and large spiniform tubuli, are of about equal thickness throughout. Excepting when the section cuts the zoarium just beneath the surface, it is difficult to discriminate between the interstitial cells and true zoœcia. But, when near enough to the surface, the former are mostly filled with transparent calcite, while the latter are filled with particles of the surrounding matrix, and when this fails they may be more certainly distinguished by the possession of the crescentic edges of the cystoid diaphragms. The interstitial cells are numerous, but very unequal in size ; as a rule, they completely isolate the true cells. The arrangement, size and character of the spiniform tubuli are well shown in the figures referred to.

In vertical sections, unless they follow the direction of the growth of the colony, the same difficulty of distinguishing the interstitial from

the true cells is experienced. This is mainly due to two reasons. First, the cystoid diaphragms, a series of which is apparently developed in each of the proper zoœcial tubes, are always attached to the concave side of the tube, and unless the section passes along the direction of growth, these diaphragms present the same appearance that those of the ordinary straight kind do. Secondly, we find that the horizontal diaphragms of the interstitial tubes, are but little, if at all, more numerous than the cystoid diaphragms of the true zoœcia. There is one feature, however, by means of which I believe the two sets of tubes may be at all times distinguished: namely, the interstitial tubes are crossed by diaphragms at regular intervals throughout their length, while the true cells, near their apertures, are always filled by the surrounding matrix. The spiniform tubuli are very conspicuous in these sections, and nearly always show the central lucid line, which in several instances appears to be crossed by numerous horizontal partitions.

This species differs from all the others of the genus known to me, in the size and prominence of the spiniform tubuli. Compared more critically with *A. mundula* (Pl. XII., figs. 6 and 6*a*), we find the following differences. In that species the spiniform tubuli are considerably smaller, and less prominent, the intertubular spaces narrower, and, in consequence, the interstitial cells smaller, and less numerous, while the diaphragms in the interstitial tubes are about twice as numerous in a given space.

Named in honor of my esteemed friend, Mr. Charles Schuchert, who kindly gave me, among other interesting forms, a large and most beautifully preserved example of this species.

Formation and locality: Examples of this species are rather rare in the upper beds of the Cincinnati group, but occur perhaps at most the localities exposing these layers. The best specimens, however, were obtained from near Oxford, O.

ATACTOPORELLA MUNDULA, Ulrich (Pl. XII., figs, 6, 6*a*).

Atactopora mundula, Ulrich, Jour. Cin. Soc. Nat. Hist , vol. ii., p. 123, Pl. XII , figs. 4, 4*a*, Oct. 1879.

Zoarium attached to foreign objects, such as *Heterotrypa frondosa*, D'Orb., and *Ptilodictya pavonia*, D'Orb., forming irregularly outlined expansions, usually less than one inch in diameter, that, only when the colony consists of more than one layer, have a thickness exceeding .04 of an inch. Surface exhibiting at rather regular intervals of about .1 inch, more or less prominent monticules, on which both the cells and

interstitial spaces are slightly wider than ordinary.. Cell apertures rounded, with more or less inflected margins, and somewhat unequal interstitial spaces ; twelve to fourteen may be counted in the space of .1 inch; they are arranged in intersecting series, but these are not so regular as in most of the other species. Interstitial cells numerous, though, with the exception of a few instances in the monticules, they never completely isolate the true cells. Spiniform tubuli small, numerous, and apparently only developed on the margins of the true cells.

Tangential sections (Pl. XII., fig. 6) show that the true cells have thin walls, that they are always in contact at one or more of their sides, and occasionally on all sides, that from three to six spiniform tubuli, of moderate size, surround each aperture, and that these structures are not developed in the interstitial spaces, but only within the walls of the proper zoœcia, which, furthermore, are always more or less inflected at each point of their occurrence. The interstitial cells can not always be recognized, as they are often filled, especially just below the surface of fully matured specimens, by a secondary deposit of sclerenchyma. When not so filled, they can be, plainly enough, seen to occupy all the interstices between the thin walls of the true cells. Lastly, the crescentic edges of cystoid diaphragms may be detected in all sections of this kind.

Longitudinal or vertical sections (Pl. XII., fig. 6*a*) show that the true tubes in their initial stages are prostrate, and that, as soon as they begin to assume an erect position, the interstitial tubes, and spiniform tubuli make their appearance. The walls are thin, and near the surface have a peculiar granular appearance (the same as is found in a number of other bryozoa), for which I am not yet able to offer an explanation, unless it should indicate a porous condition of the walls. Numerous horizontal diaphragms cross the interstitial tubes. Beside a short series of cystoid diaphragms, which may be detected in most of the proper zoœcia, a few straight diaphragms are also present. When the colony consists of more than one layer, the characters above described are repeated in each.

By comparing this description, and those following, of *A. multigranosa*, Ulrich, and *A. ortoni*, Nicholson, with my original ones (*loc. cit.*), several differences will be noted. These may or may not be excusable, as they are mainly due to the fact that I was at that time not ingenious enough to prepare satisfactory sections of these thinly expanded bryozoa. Had I done so, I certainly would not have stated that interstitial tubes were entirely absent in *A. multigranosa*, and *A. ortoni*,

as I now know, having since been very successful in preparing sections of these forms, that such cells are numerously present in both of those species. I would also have better understood the relations of what I then called pseudo-septa,* as I could not have failed to see that they are produced by the projection of the spiniform tubuli into the visceral cavity of the zoœcia.

Formation and locality: Cincinnati group. Not uncommon on the hills back of Covington, Ky., and Cincinnati, O., at an elevation of from 300 to 325 feet above low water mark in the Ohio river.

Atactoporella multigranosa, Ulrich (Pl. XII., figs. 8, 8*a*).

Atactopora multigranosa, Ulrich, Jour. Cin. Soc. Nat. Hist., vol. ii., p. 122, Pl. XII., figs. 1, 1*a*.

Zoarium usually attached to species of *Orthoceras*, often consisting of several layers, when the whole surface may become irregularly undulating, or even lobate. The maximum thickness of each layer is about .06 of an inch. In younger specimens the surface is studded with small conical monticules, quite regularly arranged in series, at distances apart of about .08 of an inch, measuring from center to center. In older examples the regularity of their arrangement is somewhat impaired by the general inequalities of the surface. In all, the monticules carry cells with apertures but slightly, if at all, larger than those of the ordinary size, but the interstitial spaces are always appreciably thickened, and for that reason, when a little worn, the monticules appear to have subsolid apices. The cell structure in young and fully matured examples is quite different. In the new layers and young specimens generally, the interspaces between the cell-apertures are considerably wider than they are in the matured layers, being quite solid, and comparatively thin in the latter. This is due to the fact that the interstitial cells are to a great extent suppressed, and filled up by a deposit of sclerenchyma, just as the zoarium enters the fully matured stage. In all cases the interstitial cells are either not at all to be detected, or they are very much obscured by the excessively numerous and very small spiniform tubuli. The cell-apertures are more or less floriform, and arranged in tolerably regular series; about twelve may be counted in the space of .1 inch.

A tangential section before me, shows several gradations between

* By using this word without quotation marks I supposed that I would be understood to mean, simply vertical ridges, that were *false*, so far as they simulated either the true septa, or the "pseudo-septa" of the *Calenterata*.

the two extreme phases above noted. Just after the cells assume an erect habit, they have a thin complete wall, and are separated from each other, often completely, by large interstitial cells. As the section gradually passes into more superficial regions, the cell walls seem to thicken, but, as a closer inspection will prove, it is done entirely at the expense of the interstitial cells, the secondary deposit being made upon the outer side of the walls of the true zoœcia, until, just below the surface, the interstitial spaces having at the same time also become narrower, they (the interstitial cells) can only with difficulty yet be recognized. The true cells are somewhat irregular in outline, of unequal size, and when cut at a level deep enough, always show the curved edges of the cystoid diaphragms. Except in the earlier stages of the zoarium, the spiniform tubuli are very numerous, and increase slightly in size with age. Figure 8*a*, on Plate XII., represents a portion of the section intermediate between the two extremes.

Vertical sections (Pl. XII., fig. 8) show that the tubes at first are prostrate, with thin walls, and a few straight diaphragms. As they assume an erect position, the interstitial tubes are developed, and if these are not too compactly filled by the secondary deposit, numerous, though not crowded, horizontal diaphragms will be observed in them. When, however, the filing is compact, the cell tubes have the appearance of being provided with walls of very unequal thicknesses. Short series of cystoid diaphragms, and a few straight ones, are present in nearly all of the true zoœcia. The spiniform tubuli are easily recognized in well prepared sections of this kind.

This species is in many respects closely allied to both *A. mundula*, Ulrich, and *A. ortoni*, Nicholson. From the first it is distinguished by its more robust zoarium, more compact monticules, more hirsute intertubular spaces, and less closely tabulated, but more compactly filled interstitial tubes. Nicholson's species is distinguished by its more delicate zoarium, thicker interstitial spaces, more oblique, and regularly arranged cells. Each of the three species is persistent in attaching itself to some particular class of objects. Thus, all of my specimens of *A. multigranosa*, are fixed to the shells of *Orthoceras;* those of *A. mundula*, grow upon other bryozoa of ramose or frondescent form; while those of *A. ortoni*, are all attached to some brachiopod, and in nine cases out of ten, the shells of *Strophomena alternata*, Conrad, have been selected.

Formation and locality: Cincinnati group. This is a rare species, and seems to be restricted to a few feet of strata, having an elevation

of about 425 feet above low water mark in the Ohio river, at Cincinnati, O. My best specimens I found in equivalent strata at Hamilton and Morrowtown, O.

ATACTOPORELLA ORTONI, Nicholson (Pl. XII., figs. 7, 7*a*).

Chætetes ortoni, Nich., Quar. Jour. Geol. Soc., vol. xxx., p. 513, Pl. XXIX., figs. 15-15*b*, 1874; Pal. Ohio, vol. ii., p. 211, Pl. XXII., figs. 3-3*b*.

Monticulipora (*Peronopora*) (?) *ortoni*, Nich. The Genus Monticulipora, p. 228, Pl. III., figs. 4, 4*a*, 4*b*, and 4*d* (not 4*c*).

A detailed description of the external characters of this well-known and beautiful little species is unnecessary, and I would do no more than simply mention it as an undoubted member of this genus, were I better satisfied with the way in which Dr. Nicholson has worked out its internal structure. He does not mention interstitial cells, although in all of my sections of the species, I find more or less clear evidences of their having been present in large numbers. It is true that they are generally partially filled by a deposit of sclerenchyma, which, possibly, in some cases, may have been so dense as to obliterate all traces of the numerous horizontal diaphragms which my sections clearly show. I make no objection to his figure of a tangential section, since in most sections in which the fully matured characters of the zoarium, just below the surface, are laid bare, the interstitial spaces are, from all appearances, compact. In a few tangential sections, however, I was enabled to determine with certainty the outlines of the rather large and angular interstitial cells. These were always shown to better advantage in the monticules (Pl. XII., fig. 7) which appear to be mainly occupied by them. The true zoœcia have, in reality, very thin walls, which, so far as my observation has extended, are never thickened inwardly. The same is true of perhaps all of the species of *Atactoporella*, and in this peculiarity the genus seems to be unique, as I have never noticed such a character in any other of the numerous forms of the *Monticuliporidæ*.

In his work on "The Genus Monticulipora," Dr. Nicholson claims to represent a vertical section of this species, on Plate III., to which I must object. The figure in question (4*c*), if it is at all a fair reproduction of his section, almost certainly belongs to some other bryozoan, perhaps to a species of *Leptotrypa*. I therefore can understand why he should complain in the text of not being able to find cystoid diaphragms in his vertical sections. He could not have failed to see them had he such a section before him, as my vertical sections, which, by the way, are invariably cut from the same specimen that furnishes the tangential

section, show, that with only a few exceptions, all of the true zoœcia have the concave wall lined with a more or less complete series of them. By comparing his tangential section, represented by fig. 4*b*, with fig. 4*c*, I think it will be seen at a glance that they have nothing in common. Aside from the absence of cystoid diaphragms in fig. 4*c*, they differ so widely in the thickness of their intertubular spaces, that I am surprised at its being overlooked by so acute an observer as Dr. Nicholson has often shown himself to be. My vertical sections further show (Pl. XII., fig. 7*a*), that the zoarium often consists of two layers, each with a maximum thickness of .02 of an inch or less. In some parts of a section, especially where it passes through one of the monticules, the spiniform tubuli, and the horizontal diaphragms in the interstitial tubes, have a peculiar intermittent, almost beaded appearance. Such an appearance is also exhibited by other *Monticuliporidæ*, but I can not, as yet, offer an explanation. Besides the cystoid diaphragms, one or two straight ones are usually present in each of the true cells.

Formation and locality: Cincinnati group. This is the only comparatively common representative of the genus. It is restricted to the beds marking the tops of the hills about Cincinnati, and seems to occur at all localities where those or equivalent strata are exposed.

Trématopora, Hall, 1852.

This genus, as it was originally defined in the Pal. N. Y., Vol. II., p. 149, and as Prof. Hall and other authors still use it, is an unwieldy and heterogeneous assemblage of forms, comprising, at the present day, representatives of no less than four distinct genera. The author not having designated a particular species as the type of the genus, I will regard the first species following the generic diagnosis, as the typical one. This course is the one usually adhered to, and, in my opinion, is the only justifiable one in such cases. Having made three series of sections from authentic specimens of *Trematopora tuberculosa*, Hall, I think I am prepared to furnish a clear definition of the genus as typified by that species.

Trematopora, Hall (Emend. Ulrich).

Zoaria ramose, branches solid, sometimes tuberculated, generally smooth. Cells of two kinds, the true zoœcia marked by oval or subcircular apertures, and a more or less elevated peristome. The interstitial cells are numerous, sometimes completely isolating the true cells; in the best preserved mature examples, their apertures, the out-

lines of which are, however, often indicated by shallow depressions, are covered by a minutely perforated interstitial membrane, which, when the zoarium is but slightly abraded, gives the intertubular spaces a subsolid appearance. Spiniform tubuli of moderate size are devolped more or less numerously. Diaphragms are usually wanting in the true zoœcia, but in the interstitial tubes a small number is always present. Between the diaphragms the tube cavity is always more or less inflated, giving this set of tubes a peculiar, but characteristic, beaded appearance. In tangential sections, cutting the zoarium just below the surface, the proper zoœcia are distinguished from the angular thin-walled interstitial cells, by their ovate or subcircular form, and slightly thicker walls.

Type, *T. tuberculosa*, Hall.

Of the numerous other forms referred by Prof. Hall to the genus, I have examined nearly all of the Niagara group species. Of these I find that only three are truly congeneric with the type species. These are *T. coalescens*, *T. spiculata*, and *T. solida*, the last being still somewhat in doubt, as my specimens, although from the typical locality, and agreeing quite closely with the figures and description of that species, are not strictly authentic. I find further, that the common *T. ostiolata*, Hall, belongs to a new genus of the *Fistuliporidæ*, which I propose to define and found upon a Lower Carboniferous species in the next number of this publication. The internal structure of *T. osculum*, *T. infrequens*, and *T. imbricata*, from the same formation in Indiana, proves these species to belong to my genus *Coeloclema* of the *Ceramoporidæ*. Superficially, they greatly resemble *T. ostiolata.*

Of the Lower Helderberg species, I have not yet been able to procure specimens, though I expect shortly to receive a lot from Prof. Hall. I have, however, before me, some proof copies, kindly given me by that eminent authority, of the beautiful plates with which their external characters will be illustrated in a forthcoming volume of the New York State Survey. Judging from these figures, I am very much inclined to doubt that any of them will be found to be correctly referred to the genus as restricted and defined by me. Some are doubtlessly referable to Meek's *Rhombopora* (*e. g. T. rhombifera,*); others (*e. g. T. constricta*) I think will be found to possess the characters of *Coeloclema*; while others again appear to be sufficiently distinct to be regarded as belonging to new genera. Of the remaining Upper Silurian, Devonian and Carboniferous species, I am not prepared to say anything more definite than that, with very few exceptions they will be found to differ generically from *T. tuberculosa.*

The relations of *Trematopora* are perhaps nearer *Atactoporella* than to any other genus of Palæozoic Bryozoa. Taking such a species as *A. newportensis*, Ulrich, we find a decided superficial resemblance to *T. tuberculosa*, Hall. However, when more critically examined, they are found to differ in the following characters: The tube-walls in *Atactoporella* are always more or less inflected, and the spiniform tubuli more numerous, the true zoœcial-tubes are provided with both cystoid and horizontal diaphragms, while in the interstitial tubes the straight diaphragms are numerous, and the tube-cavity is never constricted at the point of their occurrence. On comparing the genus with Hall's *Callopora*, we find that while in *Trematopora* the zoœcial apertures are always open, and the interstitial cell-mouths closed by a minutely perforated pellicle, the opposite is the case in *Callopora*, the proper zoœcia being commonly closed by centrally perforated opercula, and the interestial cells always open. The most striking internal difference lies in their tabulation, diaphragms being very numerous in both kinds of tubes in *Callopora*, and exceptionally few in *Trematopora*. That the character and limits of the genus may be the more fully understood, a full diagnosis of the type sp cies is here appended, and followed by the descriptions of two congeneric species that appear to be new.

TREMATOPORA TUBERCULOSA, Hall (Pl. XIII., figs. 2, 2*a*, 2*b*).

Trematopora tuberculosa, Hall, Pal. N. Y., vol. ii., p. 149, figs. 1*a*-1*g*, Pl. XL. *A*.

Zoarium irregularly ramose, branches stout, generally flattened. Surface at intervals of from .12 to .15 of an inch, measuring from center to center, elevated into rounded monticules, varying in height in different specimens. True cells with oval-apertures, surrounded by a more or less distinct peristome, which carries a variable number, rarely more than two, of rather large spiniform tubuli; longest diameter of aperture about $\frac{1}{120}$th of an inch. Intercellular spaces of very variable width, the true cells being often in contact on one side, and separated from each other on another side, sometimes more than their diameter; cells therefore arranged in more or less interrupted series, in which, across their shorter diameter, from eight to eleven may be counted in the space of .1 inch, and from seven to nine in the same space measuring across their longer diameter. The really large and numerous interstitial cells having their apertures usually closed by a pellicular covering, rarely present stronger evidences of their presence than unequal shallow depressions between the peristomes of the true cells; they are, perhaps, most readily detected on the monticules, where the

interstitial spaces are always wider than on the concave portions of the surface.

Good and satisfactory tangential sections of this species are difficult to prepare, on account of the extreme brevity of the fully matured portion of the zoarium in most specimens. One of my sections gives a fair idea of the characters of the peripheral portion of the zoarium, and shows (Pl. XIII., fig. 2*a*) that just below the surface of matured specimens the true cells are approximately oval, and marked by rather thick, ring-like walls, within the substance of which one or two rather large spiniform tubuli are developed ; they are sometimes in contact, but usually separated by large, somewhat unequal and angular interstitial cells, having much thinner walls. In a few spots the minutely perforated pellicular covering of the latter is shown. When the section passes through a slightly deeper level, the two sets of cells are scarcely distinguishable, both being now polygonal, with thin walls, frequently a little thickened at the angles of junction, and at irregular intervals more strongly so, when occupied by a spiniform tubulum. The lower and left hand sides of figure 2*a*, represents a part of the section in which the cells are just passing from this stage into the more matured phase before described.

Longitudinal sections (Pl. XIII., fig. 2*b*) show that the tubes in the axial region are comparatively large, excessively thin-walled, without diaphragms, and that they proceed in their course from their point of origin to the surface, with but a slight degree of curvature, that at no point is abrupt. When near the surface their diameter is somewhat lessened by the development of the more or less rapidly expanding interstitial tubes. The latter present a beaded appearance, being constricted at diminishing intervals, each being marked by a complete horizontal diaphragm. In the true tubes diaphragms are often wanting throughout, and in no case have I ever detected more than two in any one tube, these being placed, in all cases, one near the aperture, and the other near the origin of the interstitial tubes. The section illustrated represents a more matured state than is usual, and in the majority of sections, the outer dense portion will not be observed. This dense terminal portion of the zoarium may consist of only a single layer, or of several more or less obscurely defined layers, each of which is perforated by minute foramina, and properly belongs only to the interstitial tubes, as they represent periodic reproductions of the pellicular interstitial covering. In this, the fully matured stage of the zoarium, also the walls of the proper zoœcia, when a side is laid bare, are apparently perforated by similar foramina.

Specimens of this species vary considerably in the elevation of the monticules, some being nearly smooth, while others are strongly tuberculated. Age also makes a difference in the superficial appearance of the cells, the peristomes being thinner, and the interstitial spaces deeper, in young examples.

Formation and locality: Niagara group. In the shales of the group at Lockport, N. Y. The species apparently does not occur at any western locality.

TREMATOPORA HALLI, n. sp. (Pl. XIII., figs. 3, 3*a*).

Zoarium ramose, slender, branches with an average diameter of about .08 of an inch, dividing dichotomously at intervals of one half inch, more or less. True zoœcia comparatively large, with broadly elliptical apertures, and a faintly elevated peristome. On account of the variable width of the interstitial spaces, they have not always the regular arrangement shown in the figure. At unequal intervals the branches present portions on which the cell-apertures are larger and more widely separated from each other than ordinary. The longer diameter of the apertures varies from $\frac{1}{120}$th to $\frac{1}{90}$th of an inch, while, vertically, from seven to nine may be counted in the space of .1 inch. Interstitial cells, large and numerous, but usually covered by an interstitial membrane. A few small spiniform tubuli may be observed in well preserved examples.

In tangential sections the true zoœcia are seen to be elongate, subangular, comparatively thin-walled, and more or less in contact, the intervening spaces being occupied by the unequal interstitial cells. The spiniform tubuli are small, and easily overlooked.

Longitudinal sections show that the tubes in the axial region are narrow, nearly vertical, and totally without diaphragms. As they near the surface they bend abruptly outward, and in passing into and through the narrow peripheral region, their diameter is considerably increased, and their walls very slightly thickened. The interstitial tubes, which are developed just as the true zoœcia turn outward, expand very rapidly, and have the same beaded character noticed in describing *T. tuberculosa*. The diaphragms too occur at about the same intervals. (See *T. tuberculosa*. Pl. XIII., fig. 2*b*.)

This species differs from the other small branching species of the Niagara group, in its comparatively large, elliptical cells.

The specific name is given in honor of the accomplished palæon-

tologist, and founder of the genus, Prof. James Hall, to whom I am indebted for many kindnesses.

Formation and locality: Niagara group, at Waldron, Shelby county, Indiana.

Trematopora whitfieldi, n. sp. (Pl. XIII., figs. 4, 4*a*).

Zoarium slender, ramose, branches smooth, with an average diameter of .1 inch, and dividing dichotomously at intervals of .4 of an inch, more or less. True zoœcia subequal, with elliptical apertures, surrounded by a thin, more or less distinct peristome, and uniformly arranged in diagonally intersecting series over the entire surface; in these nine or ten occupy the space of .1 inch. The longer diameter of their apertures is about $\frac{1}{120}$th of an inch, while the shorter or transverse diameter averages about $\frac{1}{180}$th. The interstitial cells are numerous, usually completely isolating the true zoœcia. Their apertures vary in depth on different specimens, being in some not readily distinguishable from the true zoœcial orifices, and in others, on account of the interstitial membrane, scarcely detectable, and only indicated by shallow depressions between the peristomes of the true cells, that might be overlooked by a careless observer. Well preserved examples show a number of small spiniform tubuli, whose position is usually on the peristomes.

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

Longitudinal sections show that the true zoœcia are entirely without diaphragms, and that they are larger and more inclined in the axial region, than is the case in *T. halli*, approaching in both respects more nearly to *T. tuberculosa*. The peripheral region is very narrow, and near the surface, always one, and often two interstitial tubes separate the true zoœcia. The interstitial tubes are usually crossed by but a single diaphragm, which is placed about midway between their point of origin, and the apertural covering. The tube is generally a little constricted where the diaphragm occurs.

This species differs from *T. tuberculosa*, Hall, in its much smaller.

smooth and cylindrical branches, which have altogether a more delicate appearance. From *T. halli*, Ulrich, it is distinguished by its larger branches and smaller cell-apertures. A comparison between the tubes in the axial region of the two species, proves that here, those of *T. whitfieldi* are the largest. The species should also be compared with *T. spiculata* and *Callopora (?) singularis*, Hall. From the first it differs in its elliptical cell-apertures, more distinct peristome, making it easier to distinguish them from the interstitial cells. From the latter, specimens of *T. whitfieldi* are separated by their smaller cell-apertures, and, if Prof. Hall is right, by its tubular interstitial spaces, they being stated by that authority to be solid in *C. (?) singularis*.

Named in honor of Prof. R. P. Whitfield, the distinguished curator of the American Museum of Natural History of New York.

Formation and locality: Niagara group, at Waldron, Ind.

Stellipora, Hall, 1847.

(Pal. N. Y., Vol. I., p. 79.)

Since publishing a definition of this genus in my scheme of classification in a preceding number of this Journal (Vol. V., p. 155), I have made another, more thorough, examination of the type species, *S. antheloidea*, Hall, from the Trenton limestone of New York, which, perhaps, is also the only known species of the genus. The zoarium of *S. antheloidea*, being very thin and delicate, and furthermore, very irregular in its thickness and distribution over the foreign body incrusted, I found it a matter of no small difficulty to prepare satisfactory sections. After a number of trials, I at last succeeded in obtaining a series that was in every respect more successful than the first lot. I am, therefore, now enabled to furnish the following detailed description of the species.

Stellipora antheloidea, Hall (Pl. XIV., figs. 1, 1*a*).

(Pal.N.Y., Vol. I., p. 79, Pl. XXVI., figs. 10*a*-10*c*. Not *Constellaria antheloidea*, of Nicholson.)

Zoarium thin, growing over and often completely enveloping some foreign object (oftenest a crinoid column) to which the undulating epithecal membrane adheres, at only limited points. Scattered over the surface are conspicuous, more or less prominent stars, each of which has a diameter of .1 of an inch, sometimes more, rarely less; and is composed of a large central, usually depressed, smooth or slightly pitted, area, and of from six to twelve prominently elevated, more or less wedge shaped ridges, which radiate and slope downward from the

central space ; these occasionally are divided at the outer wide end, or more commonly, have a few shorter rays intercalated between them. The stars are of circular or elliptical shape, and occur at rather unequal intervals, being often almost in contact on one side, and separated on another side by a distance nearly equaling their diameter. The true zoœcia are entirely restricted to the elevated ridges of the stars when they are in close contact. They have subcircular apertures, the diameter of which averages about $\frac{1}{145}$th of an inch. All the depressed portions of the star-shaped monticules, and the spaces left between them, are solely occupied by interstitial cells, the mouths of which are, so far as known, invariably covered by a faintly pitted, sometimes apparently granulose, interstitial membrane.

Tangential sections (Pl. XIV., fig. 1) show that the true cells are aggregated into irregularly wedge-shaped converging groups, that they have a subcircular form, and moderately thick walls, and that they never occur in the inter-monticular spaces, which, like the depressed rays and central area of the monticules or stars, are solely occupied by interstitial cells. These, though of very unequal dimensions, are always smaller than the true cells, from which they are further distinguished by being polygonal, and very thin walled. Often a few of these small cells are wedged in between the true zoœcia.

Longitudinal sections (Pl. XIV., fig. 1*a*) usually show only a very limited number of the true zoœcia, which, when the section passes through any, are distinguishable by their somewhat larger size, thicker walls, and very few horizontal diaphragms. All the tubes proceed more or less abruptly from the wavy epithecal line, to the surface, those of the smaller or interstitial set, being sometimes apparently perpendicular throughout, and without any prostrate portion whatever. I have also noticed a few instances in which but little separated tubes were inclined in opposite directions. The diaphragms in the interstitial tubes are developed at diminishing intervals, the shortest observed equaling about one third of a tube diameter.

In my scheme of classification, I placed *Constellaria*, Dana, as a subgenus under *Stellipora*, Hall. This was, I now think, an error, and I propose hereafter to regard *Constellaria* as entitled to rank as a distinct genus. I am led to this conclusion by a critical comparison between the two species upon which the names were founded. The one, *Stellipora antheloidea*, I have just described, while of the other, I published a partial description in a preceding number of this Journal,

under the new name of *Constellaria florida*. This species had long been current under the name of *Stellipora* or *Constellaria antheloidea*, from which, however, I hold it differs not only specifically but generically. My former definition of *Stellipora* and *Constellaria* above referred to, being deficient in several important particulars, I offer the following more complete descriptions.

Stellipora, Hall.

Zoaria incrusting, forming thin expansions over foreign bodies. Cells of two kinds, true zoœcia with subcircular apertures, and somewhat smaller polygonal interstitial cells. At rather irregular intervals the surface exhibits stellate monticules, each of which consists of a more or less depressed central area, from which a variable number of equally depressed, narrow, and often bifurcated rays radiate in all directions. These rays separate the outer portion of the monticule into an equal number of elevated, irregularly wedge-shaped sloping ridges, to which the true zoœcia are entirely restricted. All the depressed portions of the monticules, and the inter-monticular spaces are solely occupied by interstitial cells, the apertures of which, so far as observed, are always closed by an interstitial membrane. In sections the true cells are marked by their rounded form, larger size, thicker walls, and few horizontal diaphragms. The interstial tubes, with only a few exceptions, are always developed from the epithecal membrane, from which they proceed, more or less directly, toward the surface. They are distinguished from the true zoœcia by being polygonal, thin-walled, of unequal size, and crossed by more numerous diaphragms.

Type, *S. antheloidea*, Hall, from the Trenton limestone of New York.

Constellaria, Dana.

(Zoophytes, p. 537, 1848.)

Zoaria growing from a slightly expanded base, into erect fronds, or more or less flattened, sometimes anastomosing, branches. Cells of two kinds, true zoœcia with subcircular apertures, surrounded by a slight peristome; and angular thin-walled interstitial cells. At subregular intervals the surface exhibits apparently solid stellate "maculæ," that may be more or less elevated above the general plane of the surface, or depressed below it. Between the slender and often bifurcating rays of the maculum, an equal number of small groups of true cells occur, which may be placed on a plane with the surrounding surface, or, as is more commonly the case, be more or less prominently

elevated into a radially divided monticule. The true cells are best developed in the inter-monticular spaces, where they are more or less isolated by interstitial cells, the mouths of which are, however, closed at the surface; in consequence, the interstitial spaces and "maculæ" appear to be solid. In sections, the axial region is seen to be occupied only by the true zoœcial tubes; here they are polygonal, with very thin walls, and few or no diaphragms. As they approach the surface their walls are slightly thickened, and a large number of thin-walled interstitial tubes are abruptly developed. These sometimes have flexuous walls, and are divided by a large number of horizontal diaphragms, which, especially just beneath the surface of fully matured examples, are closely crowded, and placed upon the same level in contiguous tubes. Small spiniform tubuli are numerous, but only in fully matured zoaria.

Type, *Constellaria florida*, Ulrich, from the Cincinnati group.

A comparison between the foregoing descriptions will show the grounds upon which I propose to separate *Constellaria* from *Stellipora*. The rule, among both American and European palæontologists, has been to regard these two really distinct genera as synonymous, and, with scarcely a single exception, all drew their diagnosis of *Stellipora*, from Cincinnati examples of what I now call *Constellaria florida*, doubtlessly supposing them, as I did, to be identical with *Stellipora antheloidea*, Hall. That this supposition was erroneous, any one might have detected, by comparing the specimens with Hall's description of that genus and species. He distinctly says, that the zoarium consists of an expanded crust, "apparently attached to some other marine body." He says further, that the spaces between the elevated stars are "almost smooth, or finely granulated." Now, the zoarium of *C. florida* is never thinly expanded, and parasitically attached to foreign objects, but consists of erect flattened branches, that are as truly free as any other ramose form. The inter-monticular spaces too are never smooth or finely granulated (that is, solely occupied by closed interstitial cells), but are occupied by a large number of uniformly distributed true zoœcial apertures. These important differences, if they had not shown the observer that the Cincinnati specimens were generically distinct from the New York Trenton species, he would at least have seen the necessity for a specific separation. From an examination of their internal structure, it becomes evident that they are distinguished by another difference

of just as much importance: namely, the interstitial tubes of *Stellipora antheloidea* originate, the same as the true zoœcia, from the epithecal membrane, while in *C. florida*, and other species of *Constellaria*, they are developed from the true zoœcia as these bend from the axial, and enter the peripheral region. Furthermore, while the "immature" portion of the zoœcial tubes in *Constellaria* is very long, it is exceptionally short in *Stellipora*.

CONSTELLARIA FLORIDA, Ulrich (Pl. XIV., figs. 2-2*f*).

When I described the external characters of this species in an earlier portion of this work, I excused myself from giving the complex internal characters, as I was unable then to illustrate them. I promised to complete the description when the genus, in its turn, should come up for consideration. I now fulfill that promise.

Tangential sections (Pl. XIV., figs. 2*c*, 2*d*, and 2*e*), when they cut the zoarium just below the surface, present two distinct phases, which, in sections exhibiting the two extremes, are connected by gradual intermediate stages. The appearance usually obtained in sections of this kind, is represented by fig. 2*c*. This shows that the maculæ, which at the surface appear to be subsolid, are in reality composed of numerous very thin-walled, often elongated, angular interstitial cells, varying greatly in size from the central portion of the maculum, where they are larger than the true zoœcia, to the extremities of the rays, where they usually are not more than half as large. Between these rays, from five to fifteen of the true cells are aggregated into irregularly elliptical, compact groups. The form of these cells is sub-elliptical, on account of being so compactly wedged together. In the inter-monticular spaces the true zoœcia are distinguished by their circular form, and thicker walls ; they are sometimes completely isolated by a single series of rather large interstitial cells, though it is more common to see them partially in contact. When the section is cut from a sufficiently matured example, the phase represented by fig. 2*d*, may be observed. In this the walls of the true zoœcia are comparatively thick, and (the most noticeable feature) the interstitial cells in the maculæ, can scarcely be recognized. All the spaces known to be occupied by interstitial cells, now appear to be sub-solid and occupied by a mass of sclerenchyma, within the substance of which, numerous small, dark spots are noticed, generally enclosing a smaller lucid one. I am satisfied that these represent minute foramina, which perforated the successive interstitial membranes, and that they are precisely of the same

nature as the similar structures which mark the fully matured stage of *Pachydictya*, *Cystodictya*, and many of the *Fistuliporidæ*. Figure 2*e* represents the appearance of the cells in the inter-monticular spaces, at a level nearer that represented in fig. 2*d*, than 2*c*.

Longitudinal sections (Pl. XIV., fig. 2*f*) show that the axial region is occupied by rather large and excessively thin-walled tubes, in which diaphragms are almost entirely absent. As they approach the surface, they bend outward abruptly, and here a large number of rapidly expanding interstitial tubes are developed, in which horizontal diaphragms recur at diminishing intervals, until at the surface they are crowded. The diaphragms as a rule are complete, and occupy the same level in contiguous tubes. Sometimes those crossing one of the large tubes (interstitial) are incomplete, and appear to form a vesicular tissue. As this, however, has not been noticed in the other species of the genus, I am inclined to regard the feature as probably due to accident, though I am not disinclined to the belief that it perhaps is also predictive. The interstitial tubes would almost appear to have been reproduced by fission, but this is evidently not the case, as in tangential sections, partially divided cells are never met with, and such would doubtlessly be of common occurrence, had the method of reproduction been fissiparous. This false appearance is due to the fact that the young interstitial tube, like those first developed, enlarges very rapidly, often attaining its full dimensions before it is crossed by the first diaphragm. In the section figured, the outer layer of interstitial cells is clear, while several just below it are filled with a deposit of sclerenchyma. This I believe is due to the filling of previous layers of cells, by the zooids of the next succeeding layer.

This species in its typical form, represented by fig. 2, on Plate XIV., is a common fossil in the Cincinnati group. It seems to range between 250 and 400 feet above low water mark in the Ohio river, at Cincinnati, Ohio. Figure 2*a* represents a portion of an example of this species, on which the monticules are remarkably elongated transversely. This variation from the typical form is of common occurrence, but of very little importance, since on other portions of the same specimen the monticules are like those of fig. 2, in form, size and distribution. An exactly parallel case is found in the transverse elongation of the monticules of *Callopora ramosa*, D'Orb., going to make the variety *rugosa* (*Chætetes rugosus*, Ed. & H.) Figures 3 and 4 represent two varieties, which are sufficiently marked by their external characters to render their separation from the more typical forms of the species usually an

easy task. I therefore propose the name of *prominens* for fig. 3. It is distinguished by its large and remarkably prominent monticules, which, so far as observed, never coalesce. Their diameter will average about .15 of an inch; their height about .05 inch; in the space of one half inch square, about sixteen may be counted. The branches are usually sub-cylindrical, with an average diameter of about .4 of an inch.

This variety is apparently restricted to a few feet of strata, and marks an horizon about 200 feet above low water mark.

The variety represented by fig. 4, was catalogued by me in 1880, under the name of *plana*. It has an extended geographical as well as geological range, and is, perhaps, the earliest representative of the genus *Constellaria*, occurring first in the Trenton group of Canada. Next it appears in Tennessee and Kentucky, in Safford's "Orthis Bed." This bed I regard as the upper member of the Trenton group. In the Cincinnati group it is rare near low water mark in the Ohio river. It next appears at a height of nearly 300 feet above that mark, where it again has a range of only a few feet. It is mainly distinguished from typical *C. florida*, by its nearly smooth surface. The Trenton specimens are larger than those from Cincinnati, and their branches frequently anastomose, a feature not observed in specimens from this locality.

Constellaria limitaris, Ulrich (Pl. XIV., figs. 5, 5*a*).

(*Stellipora limitaris*, Ulrich, Jour. Cin. Soc. Nat. Hist., Vol. II., p. 126, Pl. XII., figs. 8-8c.)

My original description and figures (*loc. cit.*) of the minute structure of this species being not as good as they might be, I have refigured the sections, and written the following more complete, and, I believe, reliable diagnosis of the internal characters, as they are shown in carefully prepared thin sections.

Tangential sections (Pl. XIV., fig. 5) show that the true zoœcia are bunched together between the somewhat irregular rays of the "maculæ," and that they are here separated from each other by rather thick, solid interspaces, which usually inclose a variable number of minute cells, that may be of the nature of spiniform tubuli. The "maculæ" are composed of a large number of smaller, thin-walled, polygonal interstitial cells, that only rarely attain half the size of the true cells. In the spaces between the stellar "maculæ," the true zoœcia are circular, with moderately thin walls, and an average diameter of $\frac{1}{120}$th of an inch. They are usually completely isolated by a single row of small, angular interstitial cells.

Longitudinal sections (Pl. XIV., fig. 5*a*) show that the tubes follow a gently curved course from the axial region of the branch to the surface. They are intersected by numerous diaphragms throughout their length; the intervals between them gradually diminish from a little more than a tube diameter in the axial region, to less than one third of a tube diameter in the peripheral region. The interstitial tubes are developed quite near the surface, and are crossed by crowded horizontal diaphragms, at, approximately, the same level in all the tubes of this set.

This species is clearly distinct, and easily distinguished from *C. florida* and its varieties. The zoarium of *C. limitaris* being usually of more robust growth, and comparatively smooth, the "maculæ" being oftener depressed than elevated. The true cells have somewhat thinner walls, are larger, and more completely isolated by the interstitial cells, which again are much smaller, and consequently more numerous than those of *C. florida*. Longitudinal sections of the two species are distinguished at a glance, by noting the difference in the tabulation of the tubes in the axial region, diaphragms being entirely absent in that portion of the tubes of *C. florida*, and very remote even in the peripheral region, while they are numerous throughout in the true tubes of *C. limitaris*.

Formation and locality: Cincinnati group. Fragments of this species are not uncommon in the upper portion of the series, at an elevation corresponding to a height of from 600 to 700 feet above low water mark at Cincinnati, O. These strata are at least 200 feet higher than any certainly known to contain *C. florida*. My best specimens I collected near Blanchester, Ohio.

CONSTELLARIA FISCHERI, n. sp. (P. XIV., figs. 6-6*c*.)

Zoarium somewhat irregularly frondescent or palmate, varying in thickness from .16 to .25 of an inch, with a height of about two inches. Scattered over the entire surface are small, more or less regularly arranged, stellate "maculæ," that sometimes are elevated into small conical monticules, but more commonly remain on a level with the general plane of the surface. In the transverse series the specimens examined show a variation in the number that may be counted in the space of .5 of an inch, of from eight to thirteen, while in the longitudinal series from six to ten occur in the same space. On the specimen figured the maculæ are more widely separated than they are on any other seen. Cells sub-equal, from thirteen to fourteen in the space of

..1 inch, with more or less rounded apertures, that are separated from each other by rather thin interspaces. These, and the stellate maculæ, appear to be solid at the surface, but sections prove them to be occupied by a large number of small interstitial cells.

Tangential sections (Pl. XIV., fig. 6*b*) clearly demonstrate the distinctness of the species. They show that the maculæ are composed of aggregations of very small, sub-equal, interstitial cells, the walls of which are comparatively thin, but never excessively so. The true zoœcia are circular, have a diameter of about $\frac{1}{165}$th of an inch (including their walls), and are in all cases more or less completely isolated by a row of small interstitial cells. The walls of all the cells vary slightly in thickness, according to the depth shown in the section. Just below the surface of fully matured examples, the interstitial cells are at least partially filled, and often much obscured by a secondary deposit. A rather large number of spiniform tubuli may be observed, which, however, on account of their very small size, are but an inconspicuous feature in these sections.

In longitudinal sections (Pl. XIV., fig. 6*c*) the tubes in the axial region of the zoarium are nearly vertical, thin-walled, and without diaphragms. As they near the surface they turn abruptly outward, and proceed directly to the same. In the peripheral region they are more or less separated from each other by the small interstitial tubes, according as the section passes through one of the maculæ, or the spaces between them. The intervals between the diaphragms which are developed in this portion of the true zoœcial tubes, diminishes outwardly from about two tube diameters, to one half a tube diameter. The interstitial tubes are traversed by horizontal diaphragms, that are placed upon the same level in all, and excessively crowded just beneath the surface. An interesting fact, that may also be true of other species of the genus, is brought out in one of my sections: namely, all the small cells going to make up one of the "maculæ," are the progeny of a single, frequently multiplied, parent cell.

Although this species is a true *Constellaria*, it differs from the other species and varieties of the genus, in several, more or less important, particulars. First, in never having groups of the true zoœcia wedged together and raised between the rays of the maculæ, but there, as in the intervals between the stellate maculæ, they are separated, more or less completely, by a series of interstitial tubes. Second, the true zoœcia are apparently never raised above the surface, but it is the maculæ that are occasionally elevated. Third, the interstitial cells

occupying the maculæ, and intertubular spaces are decidedly smaller. Fourth, the true zoœcia have a diameter of $\frac{1}{165}$th of an inch, while those of *C. florida*, and *C. limitaris*, measure respectively $\frac{1}{145}$th and $\frac{1}{120}$th of an inch. Fifth, the number of stars on the surface of both *C. florida*, and *C. limitaris*, in the space of one half inch square, never exceeds thirty-six, being, furthermore, usually about twenty-five, and in the var. *prominens*, as few as sixteen. On the other hand, those of *C. fischeri*, I have observed to reach the number of one hundred and thirty in the same space. This large number is sometimes reduced to fifty or sixty, but usually to about eighty. Lastly, *C. fisheri* agrees with *C. florida*, and differs from *C. limitaris*, in the absence of diaphragms in the axial region of the zoarium, while it differs from the former, and agrees with the latter, in having these structures more numerous in the peripheral portion of the true zoœcia.

The specific name is given in honor of Prof. Moritz Fischer, to whose generosity I am indebted for the opportunity of describing this interesting form.

Formation and locality: Cincinnati group. The specimens upon which the species is founded, were collected near Mt. Sterling, Ky. Judging from the associated fossils, I regard the strata as equivalent to those exposed at Cincinnati, O., at an elevation of from 300 to 400 feet above low water mark in the Ohio river.

The family relations of the following three genera are uncertain. Each presents one or more characters in which it differs more or less decidedly from all of the established families of the bryozoa, while at the same time they differ quite as strongly from each other. Believing it unwise to propose at this time new families for their reception, which, it is not improbable the discovery of congeneric forms might prove to have been unnecessary, I think it will be best, under the circumstances, to refer them, provisionally, to the families to which they appear to offer the greatest affinity. Thus, *Idiotrypa* may be placed with the *Monticuliporidæ*, *Anisotrypa* with the *Rhabdomesontidæ* (Vine), and *Heliotrypa* with the *Stictoporidæ*.

Idiotrypa, n. gen.

Zoaria parasitically adhering to foreign objects. Cells of two kinds, the true zoœcia being sub-circular, with a slightly elevated, thin peristome, and more or less completely separated from each other by a series of large, angular interstitial cells. The two sets of cells are not distinguishable

in vertical sections, both being crossed by thick horizontal diaphragms, occurring at short and regular intervals, so as to divide the zoarium into so many equal layers. The spiniform tubuli are numerous, of moderate size, and comparatively thin walled. Beside these a tangential section will show numerous, concentrically arranged, small dark or light spots, within the substance of the horizontal partitions.

I have been obliged to establish this genus for the reception of a most peculiar bryozoan from the Niagara group of Indiana. In its general form and superficial aspect, it does not present any striking differences from species of *Atactoporella*, except in the circular, and not petaloid zoœcial apertures. Thin sections, however, demonstrate, beyond a doubt, that the structural peculiarities of the two are widely different, and that, so far as our present knowledge extends, we have in *Idiotrypa* an uniquely differentiated structural type.

IDIOTRYPA PARASITICA, n. sp. (Pl. XIII., figs. 1-1*c*.)

Zoarium consisting of parasitic expansions, of variable thicknesses, usually attached to ramose bryozoa, but sometimes growing upon other foreign bodies. The true zoœcia have circular apertures, often closed by centrally perforated opercula, of an average diameter of $\frac{1}{120}$th of an inch, surrounded by a slightly elevated, thin, granulose, peristome. They are arranged with considerable regularity in series, in which from eight to ten may be counted in the space of .1 of an inch. The inter-tubular spaces are of somewhat variable thickness, and usually appear to be solid; occasionally, however, the mouths of shallow interstitial depressions may be observed. The spiniform tubuli usually do not constitute a conspicuous external feature.

Tangential sections (Pl. XIII., figs. 1 and 1*c*) show that the walls of the true cells are marked by a dark circular band, equivalent to the peristome surrounding the apertures. Within this band may be noticed, beside a limited number of rather thin-walled spiniform tubuli, a large number of smaller circular structures, usually provided like the spiniform tubuli, with a very minute lucid central spot. These doubtlessly represent the granules above stated to occur on the peristome, in well preserved examples. The visceral cavities of all the cells appear to be more or less filled by sclerenchyma. This is due to the fact (shown in vertical sections) that the horizontal partitions are thicker at their junction with the walls of the tubes than they are more centrally, the cavities left between them being, therefore, of lenticular form. Some of the true

zoœcia show a central, obscurely circumscribed area, that may represent the openings of opercula of previous layers. These sections show further, that whenever the horizontal partitions are brought to light, a large number of concentrically arranged, dark or lucid spots may be detected, which in the true cells gradually increase in size toward the circumference.

Vertical sections (Pl. XIII., fig. 1*b*) show that the tubes arise rather abruptly from the attached basal membrane, near which their walls are comparatively thin. The upward direction of the tubes is often so irregular that a section can not be made to pass through their full length. The most regular portion seen in any of my sections is represented by the figure above referred to. From this section we learn, first, that both the vertical and horizontal partitions are of variable thickness (the extremes are shown in the figure); secondly, that the latter are developed at approximately the same level, and at nearly equal and short intervals, in all the tubes; thirdly, that there are no certain marks by means of which one set of cells may be distinguished from the other; and lastly, that a row of dark spots may often be detected in the lower half of the thick horizontal partitions.

I have not now the time, nor am I perhaps fully prepared, to discuss the affinities of this remarkable form. It presents characters that are at total variance with the *Monticuliporidæ*, and nearly all other bryozoa known to me. My opinion of *Idiotrypa* is, that its zoarium consists of more or less numerous layers of cells, which, just as is the case in some of the *Celleporidæ* (*e. g. Cumulipora*, Mstr. emend. Reuss.), being developed one from the other, in direct sequence, eventually assume a tubular character. Further, I believe, that the horizontal partitions represent the opercula of previous layers which were left behind at successive stages in the growth of the zoarium. These opercular coverings were, I am convinced by the evidences at hand, perforated by minute foramina, which in their subsequent use as the floor of the succeeding layer of cells, have been filled up, and the whole generally thickened by a secondary deposit of sclerenchyma. In the course of this memoir, I have several times stated that a similar method of reproduction, at least in the "matured" or peripheral region of the zoarium, is indicated in several members of the *Monticuliporidæ* (*e. g. Callopora*, Hall, and *Stenopora*, Lonsdale). Between *Idiotrypa parasitica*, and those forms, there is, however, this fundamental difference, that in the new genus the zoarium is not divided

into clearly differentiated "mature" and "immature" regions, such as I have shown to mark, without exception, all of the *Monticuliporidæ*, if, indeed, not all of the TREPOSTOMATA. In this respect, *Idiotrypa* more nearly resembles the *Celleporidæ*, and its affinities with that family of the CHEILOSTOMATA, is strengthened by the apparently poriferous condition of its horizontal and vertical partitions. On the other hand, however, *Idiotrypa* is fundamentally distinguished from *Cumulipora*, and other members of that family, in having, as is clearly proven by tangential sections, two distinct sets of cells. From all of the *Monticuliporidæ*, in which two sets of cells are present, this genus is further distinguished (that is, if we regard the horizontal partitions dividing the zoarium of *Idiotrypa*, as equivalent to the diaphragms of the majority of the TREPOSTOMATA), by the equal tabulation of the interstitial and true cells, the diaphragms in the interstitial tubes of all the dimorphic *Monticuliporidæ* known to me, being more numerous than they are in the proper zoœcia.

Taking these various and important differences into account, I come to the conclusion that *Idiotrypa* should not be placed into the family *Monticuliporidæ*, but not knowing where else it might be more properly placed, and being unwilling to found a new family for the reception of a single species, I am forced, provisionally, to refer the genus to that family.

Formation and locality : Niagara group. I obtained my specimens from the lower calcáreous portion of the formation, at Osgood, Ind., where the species is associated with species of *Holocystites*, *Caryocrinus ornatus*, Say, *Saccocrinus speciosus*, Hall, and *Callopora elegantula*, Hall.

ANISOTRYPA, n. gen.

Judging from the only species known, the generic characters are as as follows :

Zoaria ramose, branches hollow, consisting of one or more distinct thin layers of cells, the inner side of each being lined by a slightly wrinkled epithecal membrane. Zoœcia tubular, short, arising rather abruptly from the basal membrane. Walls in the "immature" region excessively thin, but abruptly thickened as they bend outward, and proceed directly to the surface. At a point marking the termination of the thin portion of the cell-walls, a diaphragm crosses the tubes at a right angle. True zoœcial apertures placed at the bottom of an expanded vestibule. Interstitial cells, and spiniform tubuli, wanting.

At intervals the surface exhibits the apertures of one or two cells, which are much larger than the average, and may represent oœcia.

The typical and only known species of this genus is simple enough in its structure, yet despite its simplicity, I have not been able to determine its affinities in a manner satisfactory to myself. The genus is clearly a member of the TREPOSTOMATA, but of what family of the suborder is not so readily determined. It possesses one point of structure common to all of the *Ptilodictyonidæ* and *Stictoporidæ*; but in all other respects the genus differs so widely from those families that I can not for a moment admit that *Anisotrypa* is referable to either. The point of resemblance is found in the diaphragm crossing the tube-cavity at the base of the erect and thickened portion of the zoœcia, which, I believe, constitutes the floor of the "matured" cell. The same character is also present in the *Rhabdomesontidæ*, though not so strongly developed. This family, lately established by Mr. Vine, for the reception of the genus *Rhabdomeson*, Y. and Y., is, I think, warranted by the peculiarities of cell-structure, and not upon the "central rod," that character being, in my opinion, of only generic value at the most. I have examined the *R. gracile*, Phill., the type of the genus, and find that, aside from the axial tube, the genus differs in no other respect from Meek's *Rhombopora*. As I intend to discuss the relations of this family at some length, in the next number of this JOURNAL, I will not further anticipate my conclusions, than to say that *Anisotrypa* appears to be more nearly related to *Rhabdomeson* and *Rhombopora*, than to any other forms known to me.

ANISOTRYPA SYMMETRICA, n. sp. (Pl. XIII., figs. 5-5*c*).

Zoarium ramose, branches hollow, consisting of one or two distinct layers of cells, the inner sides of which are lined by a thin, slightly wrinkled epitheca; diameter of branches varying from .15 to .3 of an inch; thickness of each layer of cells, .03 of an inch, or a little less. Zoœcia hexagonal or pentagonal, with a very regular arrangement in groups, the centers of which occur at intervals of about .12 of an inch. From the center of each group, usually marked by an extremely large cell, to a point midway between the groups, they gradually diminish in diameter from $\frac{1}{55}$th to $\frac{1}{90}$th of an inch. The diameter of the large central cell, which is probably an oœcium, may exceed $\frac{1}{36}$th of an inch, though it is usually a little less. The boundary of the zoœcia is marked by a slightly elevated line, from which the walls slope down-

ward, and form what is called a vestibule, at the bottom of which is the true zoœcial aperture. This varies somewhat in size, and is often covered by a centrally perforated operculum. Interstitial cells and spiniform tubuli wanting.

Tangential sections (Pl. XIII., fig. 5*b*) show that the zoœcia have thick walls, and that the line of demarcation between them is sharp and distinct. The structure of the large (?) oœcial cells does not differ in any appreciable manner from that of the ordinary cells.

Longitudinal sections (Pl. XIII., fig. 5*c*) show that at first the tubes are inclined, and separated by very thin walls. At the termination of this, the "immature" region, they assume an erect position, their walls are suddenly much thickened, and a diaphragm is thrown across the tube cavity. The walls now have a thickness equaling, or exceeding the diameter of the true zoœcial aperture, and are composed of a number of $\wedge$ shaped layers of sclerenchyma, each of which doubtlessly marks a previous vestibule. The true apertures are often closed by opercula, which are usually preserved in place, in the tubes of the inner layer, when the zoarium consists of two layers.

Formation and locality: Kaskaskia group. The species occurs at several localities in Kentucky, and, I believe, also in Illinois. The types are from Grayson Springs, and Tateville, Ky.; at the first place, specimens were not uncommon.

Heliotrypa, n. gen.

Zoarium bifoliate. Cells of two kinds; true zoœcia, with vestibules and subcircular orifices, and numerous small interstitial cells. The prostrate, thin-walled, inner portion of the tubes, is divided from the outer, much thickened and erect portion, by an incomplete diaphragm, which springs from the convex wall at the termination of the prostrate or "immature" portion of the tube. In the peripheral or "mature" region of the zoarium, the true zoœcia are subcircular in form, more or less in contact, and provided with thick walls, which are perforated by numerous minute canals, that, on account of their oblique direction, give tangential sections a peculiar rayed appearance. The line of separation between all the cells is marked by a row of vertical tubuli, with which the oblique series seem to communicate. These again appear to be in connection with other canals, that traverse the intervals between the basal membranes of the two leaves, and the comparatively thin walls of the tubes in the "immature" region of the zoarium. The interstitial tubes are developed from the prostrate

portion of the zoœcia, and are crossed by a few diaphragms. Apertures of true zoœcia closed by opercula.

This genus differs from all other bryozoa known to me, by its complicated system of inter-communication.

HELIOTRYPA BIFOLIA, n. sp. (Pl. XIII., figs. 6-6*c*.)

Zoarium consisting of two thin leaves, grown together back to back, by the adhesion of their basal membranes. Each has a thickness of about $\frac{1}{90}$th of an inch, and the largest expansion noticed, has a superficial area of about three square inches. True zoœcia very regularly arranged in quincunx, or in longitudinal and transverse series, with moderate vestibules, and circular apertures. At intervals of .1 inch, measuring from center to center, the surface exhibits small "maculæ," around which the true zoœcia are a little larger than in the intervening spaces. Ten or eleven of the ordinary size occupy the space of .1 inch. The actual orifices are separated from each other by interspaces twice as wide as their diameter, and, on protected spots, preserve the centrally perforated opercular covering. The interstitial tubes are represented by numerous small pits in the "maculæ" and interspaces between the vestibules of the true zoœcia. They are often more numerous than is shown in figure 6. Besides these, the mouths of a vast number of minute pores may be observed in the substance of the walls.

Tangential sections (Pl. XIII., fig. 6*a*) show that the true zoœcia are more or less in contact, the line of contact being marked by a closely arranged series of vertical tubuli, which also define, but less distinctly, the outlines of the thick-walled interstitial cells. The true zoœcia have an average diameter of about $\frac{1}{110}$th of an inch, while that of the visceral cavity is about $\frac{1}{250}$th inch. If the section is not too thin, and cuts the zoarium just below the surface, a large number of minute tubuli are shown to pass through the walls of the cells, in a radial manner around their visceral cavities.

Longitudinal sections (Pl. XIII., figs. 6*b* and 6*c*) show that the zoarium consists of two separate leaves, the basal membranes of which adhere to each other. Between these, as well as between the double cell-walls in the "immature" or inner region of the zoarium, there may be detected a large number of minute tubuli, which, I believe, represent connecting foramina, or "endosarcal passages," as Mr. Vine calls a similar feature in the *Stictoporidæ* and *Ptilodictyonidæ*. The tubes at first are thin-walled, and prostrate. Just as they are about to assume an erect position, they are more or less constricted, or cut in two, by an

incomplete diaphragm. The thickened outer region increased by successive layers, which slope down into the apertures, and are traversed by numerous minute canals, opening into the vestibules and visceral cavities of the cells. These appear to communicate with a vertical series of tubuli, which are placed between, and mark the line of division between adjoining tubes. The interstitial tubes are abruptly developed from the upper wall of the prostrate portion of the zoœcia, and are crossed by two, rarely three horizontal diaphragms.

Formation and locality: Kaskaskia group. I found the types at Tateville, Ky., on the line of the Cincinnati Southern R.R.

[TO BE CONTINUED.]

ADDITIONS TO THE LIBRARY,

During the Year Ending December 26th, 1883.

BY DONATION.

American Academy of Sciences, Boston—Proceedings, New Series. Vols. i., ii., iii., iv.

American Journal of Science, New Haven. Two numbers of Journal, July, 1876, and November, 1877.

Boston Zoological Society—Quarterly Journal. Vol. ii., Nos. 2, 3, 4,

Brooklyn Library, New York—Bulletin of New Books, Sept., 1882, to March, 1883.

Bureau of Education, Washington, D.C.—
- High Schools for Girls in Sweden.
- Maternal Schools in France.
- Technical Instruction in France.
- Circular of Information, No. 4.
- Circular of Information, No. 1, 1883.
- Planting Trees in School Grounds.
- Answers to Inquiries.
- Co-Education of Sexes in the United States.
- Report of Commissioner for 1881.

Canadian Bureau of Agriculture—Report of Fruit Growers' Association of Ontario.

Chicago Acad. Sciences, Chicago—
- Catalogue of Florida Shells.
- Historical Sketch of Academy.
- President's Address, 1878.
- Stimpson's Notes on N. Am. Crustacea, Pt. 3.

Chief Signal Officer, U. S. A., Washington, D.C.—
- Annual Report for 1880.
- Annual Report for 1872.
- Report for 1883.
- Memoir on Use of Homing Pigeons.

PLATE XII.

PAGE.

Fig. 1. ATACTOPORA HIRSUTA, Ulrich. A tangential section showing portion of a "macula." × 18, ... 245

1*a*. Longitudinal section, showing the entire thickness of a layer. × 18.

Fig. 2. ATACTOPORA MACULATA, Ulrich. A tangential section, showing a "macula." × 18, ... 245

2*a*. Longitudinal section, cut from a specimen consisting of three distinct layers of cells. The figure shows the middle one almost entire, and a portion of the upper layer. × 18.

Fig. 3 ATACTOPORELLA TYPICALIS, n. sp. The surface of an incrusting specimen, enlarged to 18 diameters, ... 248

3*a*. A tangential section. × 18.

3*b*. A portion of 3*a*, enlarged to 50 diameters.

3*c*. A longitudinal section, cut from a sub-ramose specimen. × 18.

3*d*. An aberrant example of this species, which has assumed a sub-frondescent form. Natural size.

Fig. 4. ATACTOPORELLA NEWPORTENSIS, n. sp. A ramose example of this species. Natural size, ... 250

4*a*. A tangential section. × 35.

4*b*. A lobate specimen, showing the base of two branches or spurs. Natural size.

Fig. 3. ATACTOPORELLA SCHUCHERTI, n. sp. The surface of a specimen of this species magnified 18 times, ... 251

5*a*. A tangential section. × 18.

5*b*. Part of 5*a*, magnified 50 times.

Fig. 6. ATACTOPORELLA MUNDULA, Ulrich. A tangential section. × 18, . 252

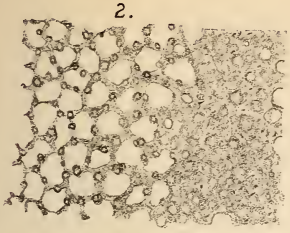
6*a*. A vertical section. × 18.

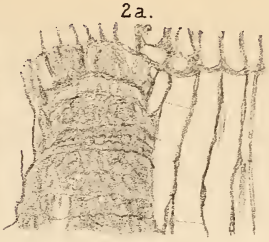
Fig. 7. ATACTOPORELLA ORTONI, Nicholson. A tangential section, showing the filled interstitial cells of a monticule. × 35, ... 256

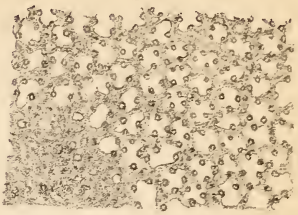
7*a*. A vertical section of a specimen consisting of two layers of cells. On the left a portion of a monticule is represented. × 35.

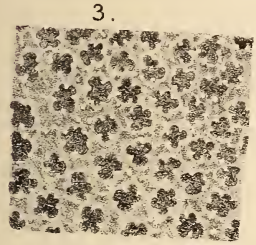
Fig. 8 ATACTOPORELLA MULTIGRANOSA, Ulrich. A vertical section. × 18, 254

8*a*. A tangential section. × 35.

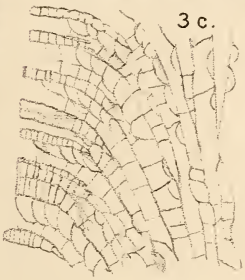

2.

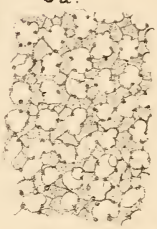

2a.

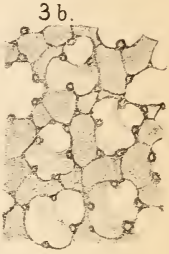

1.

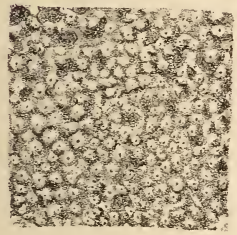

3.

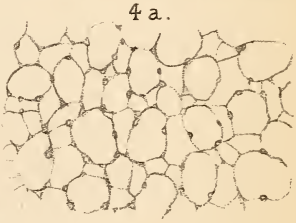
1a.


3c.


3a.

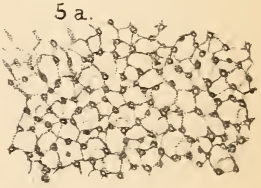

3b.

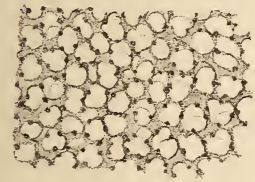

5.


4a.

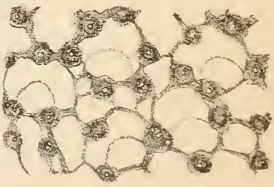
3d.

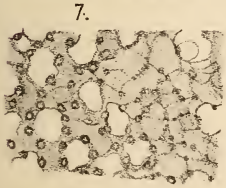
4.

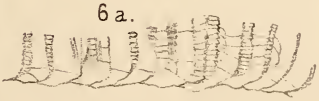

5a.

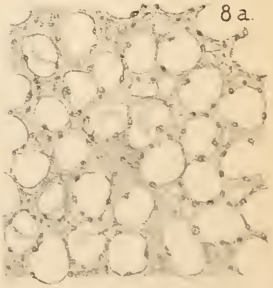

6.

4b.

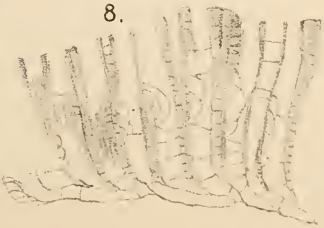

5b.

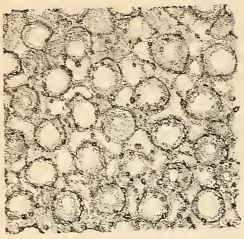

7.

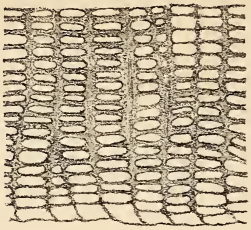

6a.

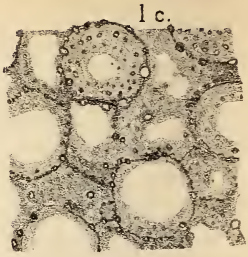

8a.

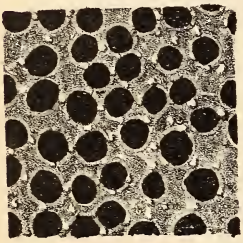
7a.

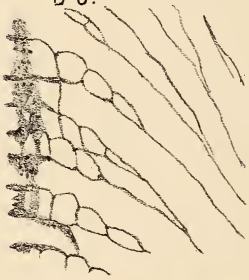

8.

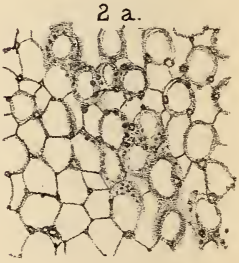

1.

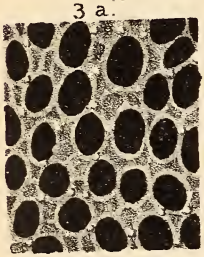

1 b.


1 c.


1 a.

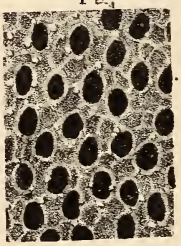

2 b.

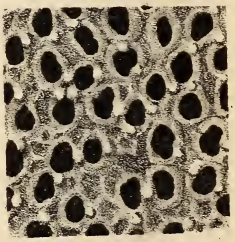

2 a.

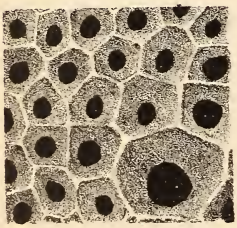

3 a.

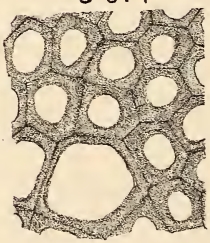
3.

4


4 a.

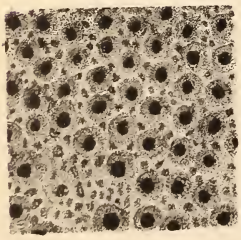

2.

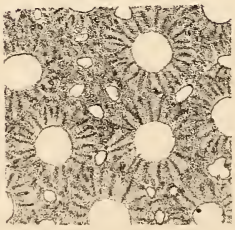

5 a.


5 b.

5

5 c.


6.


6 a.

6 c.

6 b.

PLATE XIII.

PAGE.

Fig. 1. IDIOTRYPA PARASITICA, n. sp. A tangential section. × 18, . . 273

1*a*. Surface of a specimen enlarged 18 diameters.

1*b*. Vertical section, showing the division of the zoarium into numerous layers. × 18.

1*c*. Portion of fig. 1, magnified 50 diameters, showing the perforated opercula or diaphragms, and spiniform tubuli in the thin zoœcial walls.

Fig. 2. TREMATOPORA TUBERCULOSA, Hall. Surface of a finely preserved, mature specimen. × 18, ... 259

2*a*. Tangential section. × 18.

2*b*. Longitudinal section. × 18.

Fig. 3. TREMATOPORA HALLI, n. sp. A branching fragment of this species. Natural size, ... 261

3*a*. Surface of same, enlarged 18 times.

Fig. 4. TREMATOPORA WHITFIELDI, n. sp. A fragment of this species. Natural size, ... 262

4*a* Surface of same enlarged 18 times.

Fig. 5. ANISOTRYPA SYMMETRICA, n. sp. A branch of this species, showing the distribution of the oœcia (?). Below is given a sectional view of the lower end. Natural size, ... 276

5*a*. Surface of a thick-walled specimen, magnified 18 diameters, showing the true zoœcial apertures at the bottom of the vestibules, and an (?) oœcium at the lower right hand corner.

5*b*. A tangential section. × 18.

5*c*. A vertical section, representing, however, only one side of the branch. × 18. The specimen consisted of two layers of cells, growing in opposite directions.

Fig. 6. HELIOTRYPA BIFOLIA, n. sp. Surface of a fine specimen, enlarged 18 times, showing a maculum of interstitial cells at the lower left hand corner, ... 278

6*a*. A tangential section enlarged 50 diameters.

6*b*. A longitudinal section. × 18.

6*c*. Portion of 6*b*, magnified to 50 diameters.

PLATE XIV.

PAGE.

Fig. 1. STELLIPORA ANTHELOIDEA, Hall. A tangential section, showing the rounded true zoœcia, and the smaller interstitial cells in an interspace. × 18, ... 263

1*a*. A vertical section showing the entire thickness of the zoarium. × 18. All the tubes, excepting the two on the left, are interstitial.

Fig. 2. CONSTELLARIA FLORIDA, Ulrich. A typical specimen of this species. Natural size, ... 267

2*a*. A portion of a specimen on which the monticules are transversely elongated.

2*b*. An enlargement of one of the stars. × 18.

2*c*. Tangential section, magnified 18 diameters, and representing the characters of the zoarium when not fully matured. A portion only of one of the stars is shown.

2*d*. Tangential section, showing the fully matured characters. × 18. A little more than one half of a star is shown.

2*e*. Portion of a tangential section, showing the characters and arrangement of the cells in the inter-monticular spaces, at a slightly deeper level than that represented by fig. 2*d*. × 50.

2*f*. Peripheral portion of a longitudinal section, prepared from a fully matured example. × 18.

Fig. 3. CONSTELLARIA FLORIDA, var. PROMINENS, n. var. A fragment of the natural size, ... 269

Fig. 4. CONSTELLARIA FLORIDA, var. PLANA, n. var. A specimen of this variety from Cincinnati, O., ... 269

Fig. 5. CONSTELLARIA LIMITARIS, Ulrich. Tangential section. × 18. The greater portion of a macula is shown, ... 269

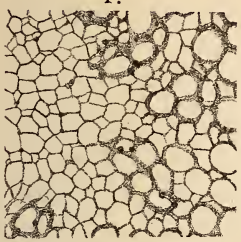
5*a*. Portion of a longitudinal section, showing the numerous diaphragms in the axial region. × 18.

Fig. 6. CONSTELLARIA FISCHERI, n. sp. A specimen of this species in which the stellate maculæ are more widely separated than is usual. Natural size, ... 270

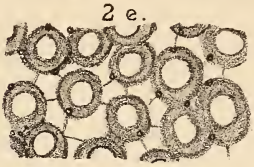
6*a*. Surface of same, magnified 12 diameters, showing one of the stellate maculæ entire, and portions of two others.

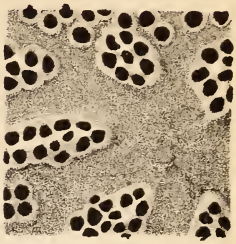
6*b*. A tangential section, showing one of the maculæ. × 18.

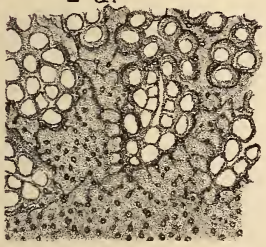
6*c*. A longitudinal section, showing one of the maculæ, and four of the true cells.

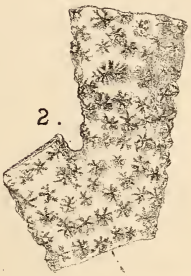

1.

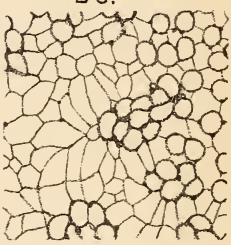
1 a.

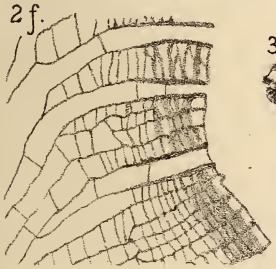

2 e.


2 b.

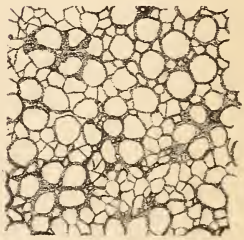

2 d.


2.

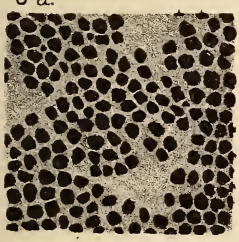

2 c.


2 f.

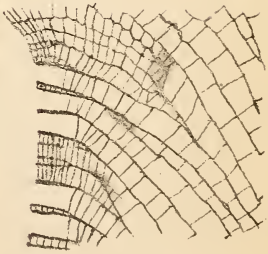
3.


5.

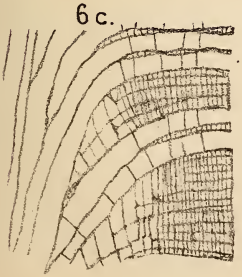
4.

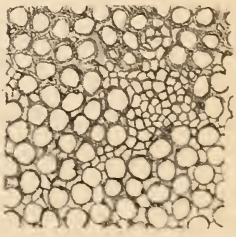

6 a.

2 a.


5 a.

6.


6 c.


6 b.