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III.

REPORT ON THE LOWER SILURIAN BRYOZOA WITH PRELIMINARY DESCRIPTIONS OF SOME OF THE NEW SPECIES.

BY E. O. ULRICH.

The bryozoa are unusually abundant in the Lower Silurian strata of Minnesota. This is especially true of the Trenton shales, in which they constitute about two-thirds of the entire fauna. Many of the species are extremely abundant, and the thin slabs of limestone are largely composed of their fragments. The shales immediately succeed the "Buff limestone," in which but few remains of this class of fossils occur. Those observed, moreover, are so badly preserved that it was found impossible to determine the species. Just below this limestone and resting on the St. Peter sandstone, is found the building stone commonly used at Minneapolis. This limestone does not appear to belong to the Trenton group, and, judging from the fossils, seems rather to indicate an equivalence with the Chazy, or, perhaps, Black River. These strata are not present in the sections studied in Wisconsin and Illinois, where the "Buff limestone" rests on the St. Peter sandstone, but at High Bridge, Ky., they are represented by a mass of rock several hundred feet in thickness. The beds in the neighborhood of Lebanon, Tenn., seem to belong to the same age. The shales which are here called Trenton, are assigned in some preceding reports to the "Hudson River" group, but the fossils contained in them, notably the bryozoa, show conclusively that that is not their true position. Of the eighty-three species of bryozoa obtained from them, no less than twenty-five are identical

with species occurring in the Trenton of New York, Canada, and Tennessee. That they really belong to the Trenton is further shown by the fact that they are superseded by the Galena.

In the following list are noted all the species so far studied. More extended investigations will, I do not doubt, swell the number some twenty or thirty more. Because of other engagements I did not have the time required to write out descriptions of all the new species, but this is scarcely a cause for serious regret, since the survey proposes to publish, at an early date, full descriptions and illustrations of all the species found in the state.

BERENICEA MINNESOTENSIS, n. sp.

Zoarium attached to foreign bodies, consisting of extremely thin patches, irregular in outline. Zooecia partially immersed, the exposed portion appearing as broadly-elliptical convex spaces, about 1-95th of an inch in their longest diameter. Apertures somewhat oblique, contracted, circular, 1-200 of an inch in diameter, and surrounded by a barely perceptible rim or peristome. The arrangement of the cells is usually more or less regular in curved diagonal lines; not infrequently, however, the specimens show considerable variation in the number occupying a given space, while here and there, a small non-celluliferous spot may be detected. From six to nine may be counted in the length of .1 inch, but the average number is about seven.

The relations of this species appear to be almost exactly intermediate between the two Cincinnati group species *B. primitiva* and *B. vesiculosa*. From the former it differs in having its cells less immersed, and the apertures less prominent but more distinctly contracted. In distinguishing *B. minnesotensis* from *B. vesiculosa*, the same differences become apparent, but reversed in their application.

Formation and locality: Not uncommon in the shales of the Trenton group, at Minneapolis, Minn.

Register No. 5925.

ROPALONARIA PERTENUIS, n. sp.

Zoarium adnate; cells uniserial, very elongate-elliptical, about four in the length of .1 inch; from the proximal end, which is very slender and always more so than the anterior, the cell gradually increases in size until at the center or some point nearer the anterior end, it has assumed a diameter of about 1-130th of an inch. This point is marked by the presence of the subcircular aperture, which is surrounded by a very faint peristome, and has a diameter of less than 1-200th of an inch. At every fourth or fifth cell the series bifurcates; this cell is more abruptly swollen and larger than those intervening, while it differs still further in having its aperture situated quite near the anterior end.

This species is closely allied to the *Stomatopora* (*Ropalonaria*) *elongata*, Vine, from the English Wenlock deposits. Its relation to the type of the genus, *R. venosa*, Ulrich, from the Cincinnati group of Ohio, is however, still more intimate. The former it resembles in its growth, and the latter in the shape of its cells.

Formation and locality: Rare in the Trenton shales, at Minneapolis, Minn.

Register No. 5926.

HELOPORA DIVARICATA, n. sp.

Zoarium segmented; segments cylindrical, poriferous on all sides, obtusely pointed at each end, and varying in length from two to four-tenths of an inch; their diameter varies between .02 and .03 inch. Zooecial apertures oblique, ovate, spreading anteriorly, and arranged in troughs between strong longitudinal ridges, six in the length of .1 inch. Passing around and forming the posterior border of the aperture is a faint ridge that on each side is obliquely directed across the longitudinal keels, where it meets a similar line proceeding from one of the cells in the adjoining series. These divaricating lines give to the strong vertical ridges the appearance of being marked by a succession of Δ -shaped furrows and elevated lines. Eight or nine rows of cells suffice to pass around a segment.

Beyond the fact that the zooecia are tubular and radiate in all directions from a central axis, the internal structure is unknown.

This species is clearly congeneric with *Helopora fragilis*, Hall, and *H. spiniformis*, Ulrich. The last species was originally placed by me in the genus *Arthroclema* of Billings.* At that time I had not yet succeeded in obtaining satisfactory sections of the type species of *Helopora*. Through the kindness of Mr. Arthur H. Foord, who sent me better material of the species than I had yet seen, I have since been enabled to work out its structure. In nearly all respects it is identical with that of *H. spiniformis*. This being the case, the question whether *Arthroclema* could be distinguished from *Helopora* by characters of more than specific importance at once presented itself. While I am not yet prepared to assert that the differential characters observed are really of generic value, still I believe that, provisionally, the best plan is to keep them separate. One of the most striking external features of the three species of *Helopora* now described, and two other species known to me, is found in the arrangement of the zooecial apertures between vertical ridges. These ridges are not obvious in the Canadian specimens of *Arthroclema pulchellum*, nor in the Minnesota examples at present doubtfully identified with that species. Instead, we find two or three more or less flexuous lines and grooves marking the inter-zooecial spaces. A more important difference is found in the reproduction of the segments. In the species of *Helopora* this is only terminal; while in *Arthroclema pulchellum* it is both terminal and lateral, there being two "sockets" situated just opposite each other on the opposite sides of each of the main segments for the articulation of the smaller lateral branches. The form of zoarium resulting from this mode of growth resembles that of a feather in having a strong central rib and more slender lateral branches. On the other hand, the mode of growth of *Helopora* seems to be precisely like that of *Arthronema*, Ulrich, in which each segment gives off from its upper termination one or two similar joints. Whatever course may be finally adopted in the disposition of *Helopora* and *Arth-*

*Amer. pal. bry., Jour. Cin. Soc. Nat. Hist., vol. v. p. 161. pl. 6, fig. 10, 1 u, 10b.

roclema, enough of their structure is known to make their reference to the fam. *Arthronemidæ* almost unquestionable.

Specifically, *H. divaricata* is distinguished from *H. spiniformis* by its slightly larger cells, more distinct longitudinal ridges, and their peculiar ornamentation.

Formation and locality: Rather rare at the base of the Trenton shales, at Minneapolis, Minn.

Register No. 5928.

PHYLLOPORA? CORTICOSA, n. sp.

Zoarium flabellate to funnel-shaped, undulating and irregular in growth, composed of anastomosing branches having a width varying from 0.015 to 0.035 inch. Poriferous side presenting the appearance of a *Fenestella* with carinate and more or less rigid branches, and much depressed dissepiments. On each side of the sharp and usually spiniferous median ridge, there are two rows of rather irregularly alternating circular cell-apertures, thirteen or fourteen of which occur in the length of 0.1 inch. The depressed dissepiments are short and carry two or three rows of cells. In rare instances this division of the frond into rigid branches and dissepiments is not recognizable. In such fragments, or portions of elsewhere normally constructed specimens, the branches anastomose rather irregularly and are simply convex, not carinate, the median ridge being apparently absent. Branches on the non-celluliferous side of frond faintly striated, and tending, though not so obviously as on the poriferous face, to form longitudinal ridges. Fenestrules varying in outline from elongate-elliptical to sub-circular, with a width rarely more, usually a little less than that of the branches, and a length from one to three times the width. Measuring transversely, from six to eight occupy 0.2 inch; longitudinally, from two and a half to four occur in the same distance.

Tangential sections, cutting the frond through the plane of its expansion and near the middle of its thickness, show that the branches are divided into approximate halves by an obscurely double wall, thicker than those of the tubes, diverging from it toward each side. The tubes have thin walls, are long,

and divided by distinct straight diaphragms in their outer portion. Where the section divided the tubes just below their apertures they are seen to be subcircular, with slightly thickened walls, and partially separated from each other by angular interstitial or abortive cells, that may be considerably smaller or even a little larger than the true zooecia. Here and there, along the middle of the branch, one of the spiniform tubuli may be detected.

Vertical sections show that the zooecial tubes also arise from a thick basal membrane, from which they diverge in an upward and outward direction, that their approach to the celluliferous surface is very gradual in the lower half of the branch, and somewhat less so in the upper half. Here they are crossed by two or three unmistakable diaphragms, and their number increased by gemmation. These shorter tubes I am inclined to regard as representing the angular interstitial (abortive?) cells noticed in describing the tangential section.

In transverse sections the branches are sub-rhomboidal, the lateral diameter being the shortest. The median ridge is represented by an obscurely double vertical wall, dividing the branch into two nearly equal portions. Between the two laminae forming this wall I can detect a series of very minute tubuli, such as are found between the median laminae of many of the *Stictoporidae*. The lateral portion of the circumference of the cells, (*i. e.* the half directed toward the sides of the branches,) is rounded or semi-circular, while the opposite half is wedge-shaped.

This species, though in many respects very peculiar, is unquestionably allied to such bryozoa as *Intricaria reticulata*, Hall, *I. clathrata*, S. A. Miller, *Retepora trentonensis*, Nicholson, *R. angulata*, Hall, *R. asperatostriata*, Hall, and *Phyllopora variolata*, Ulrich. These species are all congeneric, but there is no established genus to which they can be referred with certainty. In an earlier writing* I placed two of the species in King's genus *Phyllopora*, but, at present, I am inclined to believe that the type of that genus will prove to be quite a distinct form. Judging solely from Prof. King's figures and description the affinities of *P. ehrenbergi* seem to be not far

*"Amer. pal. bry." Jour. Cin. Soc. Nat. Hist. vol. v, p. 160.

removed from *Polypora*, McCoy, and *Lyropora*, Hall. Should this be the case, then it would be necessary to establish a new genus for the reception of the species above cited, as their relation to those genera is only very slight. In fact, I doubt that their peculiarities of structure will admit of their being arranged in the same family. Still until something further is learned of the structure of *P. ehrenbergi*, I have concluded to defer the erection of a new genus, and will, provisionally classify them with *Phyllopora*, adding the usual question mark.

Specifically, *P.?* *corticosa* is readily distinguished from other species of the genus, by the carinated character of the branches. A species, at present doubtfully identified with *P.?* *trentonensis*, Nicholson, occurs in what is called the building rock. These beds are the same as those occurring in the gorge of the Kentucky river at High Bridge, Ky., and at Lebanon, Tenn., and most probably represent the Chazy. The *P.?* *reticulata*, Hall, is quite common in the Trenton shales at Minneapolis.

Formation and locality: Trenton, at Oxford mills, Cannon Falls, Goodhue Co., Minn., where it is associated with *Streptelasma corniculum*, Hall, *Prasopora conoidea*, n. sp., and other fossils characteristic of the Trenton shales about Minneapolis.

Register No. 3495.

PTILODICTYA SUBRECTA, n. sp.

Zoarium consisting of an unbranched, flattened, two-edged, straight or slightly curved frond, that gradually expands from the acutely-pointed articulating "head" upward from 0.2 to 0.5 of an inch, the edges of the rest of the frond being parallel, or nearly so. The greatest width varies in different examples from 0.05 to 0.15 of an inch. The total length is generally about one inch, though it is not uncommon to find specimens of nearly twice that length. The thickness rarely exceeds 0.04 inch. Cells rhomboidal, with acutely-elliptical apertures, arranged in intersecting diagonal lines, the regularity of which is sometimes interrupted along the narrow, but distinct non-poriferous margin, where they are slightly larger than over the central portions of the frond, and have a tendency to form

longitudinal series. For a short distance above the pointed basal termination the zoarium is sub-cylindrical, and the cell apertures, being extremely elongated and apparently confluent, give this portion the appearance of being finely striated. Measuring diagonally, eleven cells occur in the length of 0.1 inch; transversely sixteen, and longitudinally six, occupy the same space.

This form takes the place of *P. (Escharopora) recta*, Hall, in the western exposures of the Trenton group. It is quite rare in Kentucky and Tennessee, but common in Minnesota. If I am right in my identification, it also occurs in the lower beds of the Cincinnati group (Utica shale?) in Ohio. Its geological and geographical ranges are therefore quite extended, and make it desirable that it should be held as distinct, although it is, unquestionably, very closely allied to both *P. recta* and *P. fal-ciformis*, Nicholson. It is narrower and generally smaller than either of those species, while its nearly straight form and more acute basal termination will serve to distinguish it from the latter. The type specimens of *P. recta* are sub-cylindrical, but should this peculiarity prove to be due to extreme age, then the points of difference between the three forms would be reduced to less than specific importance, in which event I should classify them as varieties of the same species.

The genus *Ptilodictya* as defined by me, naturally divides into two groups: (1) the section containing the type species, *P. lanceolata*, Goldf., in which the cells have a plumose arrangement; and (2) another section containing the three species or varieties in question, in which the cells are arranged in intersecting diagonal series. The first or typical section of the genus commences its existence near the top of the Cincinnati group, when the second section has become about extinct, and is best represented in Upper Silurian deposits. That its species are, however, direct descendants from those of the second section, cannot be doubted; *P. plumaria*, James, (as fig. by Ulrich), and *P. magnifica*, S. A. Miller, being clearly transitional forms. Should it become desirable to separate the two groups, Hall's genus *Escharopora* would include the second section.*

* The Lower Helderberg species referred to, *Escharopora*, by Hall are unequivocal members of the typical section of *Ptilodictya*.

Formation and locality: A common species in the Trenton shales, at Minneapolis, and other localities in Minnesota. It also occurs in the Trenton limestone of Kentucky and Tennessee.

Register No. 5929.

ARTHROPORA SIMPLEX, n. sp.

Zoarium jointed, segments fragile, unbranched, acute-elliptical in transverse section, from 0.4 to 0.7 inch long, from 0.04 to 0.07 inch wide and not exceeding 0.04 of an inch in thickness. The first segment is sometimes irregularly branched, but that condition does not appear to be normal. The base of this joint is obtusely pointed and striated, the striae extending above the articulating shoulder one-tenth of an inch or more. The extremities of the succeeding segments are smooth or faintly striated, and slightly swollen. Zooecial apertures, of the younger segments, with the margin distinctly elevated so as to leave a narrow interstitial sulcus between them. Their arrangement is very regular in transverse and intersecting diagonal series; transversely, seven occur in 0.05 inch; diagonally, five occupy the same space; width of interstitial space less than the shortest diameter of the apertures. Non-poriferous margin narrow and obliquely striated. On the older and especially the first segments, the cell-apertures are smaller and circular, and the width of the interstitial spaces from one to three times their diameter, the non-poriferous margin wide, and the whole inter-apertural space marked with fine, flexuous, and faintly granular striae.

In tangential sections the cells are oval, thick-walled, and each surrounded by one or two rows of very minute tubuli.

On account of the condition of the specimens, both the vertical and transverse sections are unsatisfactory.

This species clearly belongs to the genus *Arthropora*, and in the structure and appearance of its cells, differs but little from *A. shafferi*, Meek. The unbranched condition of the segments, however, will distinguish *A. simplex* from that species as well as from any other form of the genus known to me.

Formation and locality: The detached segments of this spec-

ies are very common in the Trenton shales, at Minneapolis and other localities in the state where these beds are exposed. Segments of the Trenton variety of *A. shafferi* are also, though rarely, met with.

Register No. 5933.

STICTOPORA MUTABILIS, n. sp.

Zoarium variable in size and superficial aspect. Typically, it consists of branches dividing dichotomously at intervals of 0.3 to 0.4 of an inch; width of branches varying from 0.10 to 0.18 inch; thickness of same, from 0.03 to 0.06 of an inch; edges somewhat acute, with non-poriferous margin very scant, or wanting. Cells arranged in from sixteen to twenty-five rows, between rounded and but slightly elevated longitudinal lines; walls thick, apertures small, narrow, elliptical.

In old examples the apertures are scarcely recognizable, the surface appearing as simply striated. Measured transversely, sixteen rows occupy the space of 0.1 inch; longitudinally, seven and a half or eight cells suffice to fill the same space.

Sections show that the walls are extremely thick, that they are divided into longitudinal series by straight rows of very minute but distinct tubuli, and that a variable number of the latter also occur between the ends of the cells. In transverse sections these tubuli are quite conspicuous between the median laminae of the zoarium. In vertical sections, the spur or diaphragm occurring at the base of the thick portion of the tube walls, gives to the lower region of the zooecia the form of a semi-circle.

The above sufficiently describes the typical form of this species. The two extremes of variation may be designated, provisionally, as varieties *major* and *minor*.

Var. MAJOR, n. var.

The zoarium of this variety differs from the typical form of the species in having a more robust appearance. The branches attain a width of 0.3 inch, and a thickness of 0.12 inch. Along

the center of the branches, at rather irregular intervals, occur finely striated non-celluliferous spots, which tangential sections show to be occupied by an aggregation of the minute tubuli. The rows of cells in the neighborhood of the edges of a branch are usually directed obliquely outward.

Var. MINOR, n. var.

This variety is distinguished by its smaller size, thinner branches, and more distinctly developed non-poriferous margin. Its branches vary in width from 0.07 to 0.10 inch, while the thickness rarely exceeds 0.02 inch.

This species, as well as the two species next described, are congeneric with *Rhinidictya nicholsoni*, Ulrich. When I proposed the genus *Rhinidictya*, it was under the impression that Hall's *Stictopora fenestrata*, the type of the genus, was closely allied to his *S.?* *acuta*. Although I have failed in obtaining authentic examples of *S. fenestrata* for comparison, I am, nevertheless, convinced by the study of specimens identified with that species from the Chazy limestones of Kentucky and Tennessee, that I was in error, and that the species is really more nearly related to my *R. nicholsoni*. The name *Rhinidictya* may therefore be erased from the list of genera, while *Stictopora* must be re-defined and restricted so that it will cover about the same ground lately occupied by the abandoned genus. In its restricted sense, *Stictopora* is typified by *S. fenestrata*, Hall, *S. mutabilis*, Ulrich, and *S. nicholsoni*, Ulrich. The cells of *S.?* *acuta*, Hall, and its near ally *Ptilodictya fenestelliformis*, Nicholson, have the structure of *Pachydictya*, Ulrich, to which genus I now refer them.

In the upper shaly layers of the Kentucky exposures of the Trenton group, *S. mutabilis* is a common fossil, but the two varieties, *major* and *minor*, seem to be peculiar to the Minnesota beds. Young specimens are not readily distinguished from *S. nicholsoni*, but there is no difficulty in separating the fully matured examples, the cell walls being thicker and the branches larger and much heavier than in that species.

Formation and locality: Extremely abundant in the Trenton shales about Minneapolis, and St. Paul, Minn.

Register Nos. 5938, 5939, 5956.

STICTOPORA FIDELIS, n. sp.

Zoarium branching dichotomously at intervals of about 0.5 inch. Branches from 0.08 to 0.11 of an inch in width; thickness of same varying from 0.03 to 0.06 of an inch; edges less acute than usual; non-poriferous margin narrow. Zoecia with comparatively thin walls and slightly oblique, sub-ovate or quadrangular apertures, arranged in from nine to twelve longitudinal series, between sharp though but slightly elevated lines. Measured longitudinally, eight or nine cells occur in the length of 0.1 inch; transversely, six or seven rows occupy 0.05 inch.

In tangential sections dividing the cells just below their apertures, the cell walls are rather thick, and the tube cavities elliptical, while the longitudinal elevated lines of the surface are represented by a straight dark line. A good section will show this line to contain a series of very minute tubuli, the same as occur between the divisional laminæ of the two sides of the zoarium. At a lower level in the zoarium the cells are subquadrate near the center, and rhomboidal toward the edges of the branch; the walls are thin, the anterior one convex.

Longitudinal sections show that the tubes arise abruptly from the divisional laminæ on each side, and that their course to the surface forms an angle with the median line of about 55 deg.; the anterior side of the walls is concave in the lower portion, while the posterior side is nearly straight throughout. A complete or only partial diaphragm is occasionally developed at the termination of the concave portion of the cell wall.

This species is distinguished from *S. mutabilis* by its slightly wider cells and comparatively thin walls. The cell apertures are consequently much larger than they are in that species, being besides nearly quadrangular instead of narrow-elliptical. Sections show *S. fidelis* to be clearly distinct from, though allied to *S. nicholsoni*, Ulrich.

Formation and locality: Not uncommon in the Trenton shales at Minneapolis, Lanesboro, and other localities in Minnesota.

Register No. 5936.

STICTOPORA PAUPERA, n. sp.

Zoarium small, fragile, very slender below, where it is attached to foreign bodies by a rather diminutive basal expansion; above this it gradually expands until at a distance of about 0.3 of an inch above the base, it has attained its mature width, varying in different examples from 0.06 to 0.09 of an inch; here also occurs the first bifurcation, the second occurring about 0.25 inch above the first, while a third division, at nearly the same distance from the second, is occasionally met with. The entire height of the zoarium is, therefore, rarely more than one inch. The greatest thickness does not exceed 0.02 of an inch. The angle of bifurcation is about 70 degrees, and quite the same in all the specimens. Cells with small, narrow, elliptical apertures, arranged in from ten to twelve longitudinal series, between slightly elevated lines; the cells in one or two of the outermost rows are directed obliquely outward. Measuring longitudinally, nine cells occupy the space of 0.1 inch; transversely, eight rows occur in 0.05 inch. Non-poriferous margin very narrow, only recognizable in good specimens.

This species is also a common fossil in the shaly layers of the Trenton group in Kentucky, where it is associated with *S. mutabilis* and other bryozoa marking this horizon. It also occurs in the Trenton rocks of Canada. The small size of its zoarium will distinguish it from other species of the genus.

Formation and locality: Trenton shales, at Minneapolis and other localities in Minnesota.

Register No. 5935.

STICTOPORELLA? CRIBROSA, n. sp.

Zoarium forming thin flattened expansions, composed of branches which inosculate at short intervals till there is produced a broad frond perforated at rythmical intervals by circular or elliptical fenestrules. Both sides of frond celluliferous and consisting of two equal layers of cells that have grown together back to back, each layer, however, preserving its own concentrically striated epithelial membrane. Fenestrules usually inclined to be elliptical, their longest diameter varying

from 0.03 to 0.10 of an inch, but the prevailing size has a diameter of about 0.06 inch. Width of branches about 0.09 inch; thickness of same, varying from 0.02 to 0.06 inch. Zooecia with subcircular or broadly ovate apertures, arranged in quite regular diagonal series, nine or ten in the space of 0.1 inch. Interstitial spaces becoming thicker with age, till the zooecial apertures are separated by a distance a little greater than their diameter. Interstitial pits numerous interpolated between all the cells. Around the fenestrules there is a band 0.02 of an inch, more or less, in width, solely occupied by them.

Tangential sections show that the polygonal boundary of the zooecia is marked by a dark line, which, the evidence at hand, is not clear enough to prove to have contained a series of extremely minute tubuli. The visceral cavity is small, ovate, or subcircular. The interstitial pits are numerous, of irregular shape and unequal dimensions, often completely filled, or only preserving a very small central cavity.

Vertical sections show that the divisional laminae are flexuous, that the tubes are at first thin-walled and prostrate, that they subsequently bend abruptly outward, and that their walls at the same time are much thickened and marked with oblique lines parallel with the form of the apertures. The interstitial pits, wherever observed, were entirely filled by a concentric deposit of sclerenchyma. No diaphragms appear to have been developed.

The cells of this, and the two species next described, in all the essential points of structure, are precisely like those of *Stictoporella interstincta*, Ulrich. The characters of the genus as typified by that species, are entirely peculiar, and bear but little resemblance to those of *Stictopora*. In fact, so far as the microscopic structure is concerned, *Stictoporella* is more nearly allied to *Ptilodictya* than to *Stictopora*, but whether the peculiarities of the genus will necessitate a removal from the family *Stictoporidae*, I am not yet prepared to assert. At any rate, the structural distinctness of the genus is firmly established by the addition of the three species in question. A most striking peculiarity is presented by these species. I refer to the great difference in the form of the zoaria, when compared

with the remarkable similitude of the internal structure. Indeed it is highly improbable that any one, giving them only a superficial examination, would have classified them as nearly related species. Sections, however, prove beyond any reasonable doubt that their relation to each other is really very intimate, although distinguished from each other by very obvious differences in their respective methods of growth.

An inosculating bryozoan has been described by Hall from the Trenton rocks of Wisconsin, under the name of *Clathropora flabellata*. The description and figures are both entirely inadequate for anything even approaching a positive identification. This style of zoarium pertains to at least three Palaeozoic genera, and the species might belong to any one of these. That the species which I have above described is distinct from Hall's species is evident. His figure represents a more robust zoarium, the branches and fenestrules being over twice as wide as those of *S. cribrosa*.

Formation and locality: Abundant in the Trenton shales at Minneapolis, Minnesota.

Register No. 5944.

STICTOPORELLA ANGULARIS, n. sp.

Zoarium dividing dichotomously at intervals varying from 0.15 to 0.30 of an inch. Branches usually about 0.08 of an inch in width; frequently they are narrower, while on the other hand, a single fragment apparently referable to this species is twice as wide. The thickness is generally about 0.03 inch, and never, so far as observed, exceeds 0.05 of an inch. Transverse section of branch elliptical, the margins being rarely acute, and usually rounded. Cells polygonal or sub-rhomboidal, with sub-circular apertures placed at the bottom of a sloping "vestibule," arranged in somewhat irregular intersecting diagonal series, nine in the space of 0.1 inch; measured longitudinally, seven and one-half cells occupy the same space. Here and there over the central portions of the branch, though never in sufficient number to constitute a conspicuous feature, may be detected an interstitial pit. On the rounded margins of the zoarium, however, they are always present.

Here they form a series on each side of the median laminae. Sometimes they are very shallow and obscured by a secondary deposit of sclerenchyma.

In tangential sections, the visceral chambers of the zooecia are oval, the interspaces thick and divided in the middle by a thin, sharply defined, dark line, marking the boundary line between adjoining cells. Each cell somewhat irregularly hexagonal. A few interstitial pits, here entirely filled by sclerenchyma, may be detected.

Vertical sections demonstrate that the tubes are at first prostrate and with thin walls. At the point of bending outward in their course to the surface, the walls suddenly become very thick and marked with oblique lines, representing the form of the campanulate aperture at previous stages of growth. Diaphragms have not been observed.

The angularity of the cell apertures sufficiently separates this species from *S. interstincta* from the Cincinnati group, while the same character, and the diagonal arrangement of the cells, will serve to distinguish it from a the species of *Stictopora* occurring in the same beds. It cannot be confounded with its much larger and nearest ally *S. frondifera*.

Formation and locality: Not uncommon in the Trenton shales at Minneapolis, Minn., but apparently restricted to the lower portion.

Register No. 5943.

STICTOPORELLA FRONDIFERA, n. sp.

Zoarium, consisting of large, thin, irregularly branching, flabellate or undulate expansions, which are celluliferous on both faces, and have rounded and minutely pitted margins. Cells arranged more or less regularly in diagonally intersecting series nine or ten in the space of 0.1 inch. The cell apertures vary from sub-circular to sub-rhomboidal. Interstitial spaces rather thick. Interstitial pits, variously distributed among the zooecial apertures, or aggregated so as to form clusters or "maculae." These clusters are always quite irregular in both size and distribution. Thickness of frond apparently never exceeding 0.10 inch; usually it is not more

than half that thickness. Entire height of zoarium three or four inches.

The sections of this species are almost exactly like those of *S. angularis*, and do not require a detailed description. One of the tangential sections, however, shows clearly that the boundary line between adjoining cells is occupied by a closely arranged series of very minute tubuli. The evidence afforded by the sections of *S. angularis* and *S. cribrosa* is not sufficiently clear to allow me to assert positively that these tubuli are also present in those species, but that they are is highly probable.

Formation and locality: Rather abundant in the lower part of the Trenton shales at Minneapolis, Minn. It also occurs at Lanesboro and Fountain in Fillmore county.

Register Nos. 5945-5947.

PACHYDICTYA FOLIATA, n. sp.

Zoarium growing from an attached basal expansion into erect, thin, undulating and often palmate fronds, both sides of which are celluliferous; the height and width may be two inches or more, though it is rare to find specimens more than one inch square; their thickness is usually about 0.05 of an inch; very old examples may attain a much greater thickness, it being in some not less than 0.13 inch. Margin of fronds acute, and always more or less distinctly non-poriferous. Cell apertures large, oval, and arranged in regular intersecting series, in which six or seven occur in the length of 0.1 inch. Measuring longitudinally (*i. e.* across their larger diameter) four or five occupy the same space. On a few specimens the zooecial apertures are surrounded by a thin rim or peristome. This feature may indicate a particular stage of development, or only an exceptional state of preservation. Inter-apertural space only moderately thick, generally smooth, it being only in rare instances that the really numerous interstitial cells can be detected at the surface. At intervals of about 0.15 of an inch the surface presents smooth spots or maculæ. Usually, these are not elevated above the general plane of the surface, but in a few cases they are rather prominent.

In vertical sections the tubes arise somewhat abruptly from the median laminae, near which their walls are thin. The interstitial tubes are developed almost immediately, and in their lower portion are crossed by numerous very distinct diaphragms, that, as the surface is approached become entirely obsolete, or at least much obscured by a deposit of sclerenchyma. In the "maculae" which contain only interstitial tubes, the diaphragms are decidedly vesicular. The true zooecia are crossed at intervals about equalling their diameter, by from two to four complete diaphragms. These recur at about the same level in all the tubes.

In tangential sections near the central axis, the zooecia have thin walls, are broadly ovate, and more or less completely separated from each other by a series of angular interstitial cells. Nearer the surface the walls of the tubes become thickened and ring-like, but the original boundary remains distinct as a sharply defined dark line. Within this line there is a series of extremely minute tubuli. Just below the surface of fully matured examples the "maculae" are marked with a number of series of the same kind of tubuli, while in the ordinary interspaces between the zooecia they arrange themselves into two flexuous and often interrupted lines. It is, however, only in exceptionally preserved spots that these tubuli are recognizable, they being generally represented by apparently structureless dark lines.

In good transverse sections dividing the zoarium vertically but at right angles to the direction of growth, these tubuli are very plain between the divisional laminae.

This fine species is clearly distinct from any other species of the genus known to me, while in its generic characters it is as typical of *Pachydictya* as is *P. robusta*, the type of the genus. Its foliaceous zoarium will distinguish it from all the associated species, with the exception of *Stictoporella frondifera*. That species occurs on the same slabs, and a careless collector might confound them. Still, after a little study, the differences in the size and shape of their cells will become so evident that they may be distinguished at a glance.

Formation and locality. Apparently restricted to the lower

layers of the Trenton shale, in which it is abundant, at Minneapolis, Minn.

Register No. 5948.

PACHYDICTYA OCCIDENTALIS, n. sp.

Zoarium ramose, or subpalmate towards the base, dividing above into small branches; width of branches varying from 0.13 to 0.40 of an inch. Cross section of branches acutely elliptical, about 0.05 inch in thickness centrally. Margins sharp with a narrow, smooth or finely striated, non-poriferous border. Cells arranged in longitudinal, and more or less regular intersecting diagonal series; apertures ovate, slightly longer than broad. About six cells in 0.1 inch, measured longitudinally, and eight in the same space measured diagonally. The wider specimens exhibit along the center of the branch a series of smooth and apparently solid spots, which vary considerably in size. All the examples noticed present at least one of these spots, situated just below the bifurcation of the branches.

Internal structure as in other species of the genus.

This species is closely allied to both *P. acuta*, Hall, sp., and *P. fenestelliformis*, Nicholson, sp., and is of interest, principally, because it represents an unequivocal connecting link between those species.

Formation and locality. Not uncommon in the upper layers of the Trenton shales, at St. Paul, Minn.

Register No. 5949.

PACHYDICTYA FIMBRIATA, n. sp.

Zoarium small, ramose, dividing dichotomously at variable intervals. Branches thin, rarely more than 0.02 of an inch in thickness, and from 0.09 to 0.18 of an inch in width. Non-poriferous margin, obliquely striated, very wide, extremely thin and sharp, and wavy or ruffled. Over about one-half the surface along the middle of the branches the cells are arranged in regular alternating or sub-alternating longitudinal series, in which six to seven occupy the space of 0.10 inch; measuring transversely five rows occur in 0.05 inch. The two or three

rows between these and the non-poriferous margin are not so regular in their arrangement, their apertures being, besides, separated by somewhat wider interspaces, and, usually at least, directed obliquely outward. Cell apertures broadly elliptical, longer than wide, and, in perfectly preserved examples, surrounded by a faintly elevated, thin border. Inter-apertural spaces about half as wide as the longer diameter of the cell-mouths, smooth or faintly striated longitudinally.

Internal structure as in *P. acuta*, and other species of the genus.

Good examples of this species cannot be confounded with any other species known to me, as the wavy or ruffled appearance of the wide non-poriferous margin gives them a very peculiar and characteristic aspect. In other respects the species is very closely related to *P. acuta*, Hall, and less closely to *P. occidentalis*, Ulrich.

In the higher layers of the Trenton shales at St. Paul, I have noticed a number of specimens, which, while it does not seem probable, may still prove to belong to a robust variety of this species. In these the non-poriferous margin is wide, but not wavy, and the cell-apertures smaller and narrow, while the walls or interspaces are thick and usually wider than the apertures, and more distinctly striated. The branches have an average width of 0.18 inch, and a thickness of 0.06 inch or more. Should these differences prove constant then they ought to be considered as of specific importance.

Formation and locality: Rather common in the lower part of the Trenton shales, at Minneapolis, Minn.

Register No. 5950.

PACHYDICTYA CONCILIATRIX, n. sp.

Zoarium consisting of triangular stems, celluliferous on the three concave sides, and constructed on the same general plan as *Prismopora*, Hall. Margins sharp, non-poriferous, and faintly striated. Branching takes place by the development of a non-celluliferous ridge in the centre of one of the sides, which, rising gradually, eventually forms one of the non-poriferous margins of the new branch or stem. Cell apertures sub-

circular to oval, arranged in longitudinal series in the central third of the sides, while those nearer the margins are larger and directed obliquely outward and upward. Interstitial spaces of somewhat variable thickness, usually equaling about one-half the diameter of the apertures; surface minutely granular, and where the cells have a regular arrangement, the granules form rows. Measured longitudinally, six or seven cells occupy 0.1 inch. Width of branches varying from 0.13 to 0.18 of an inch.

This very interesting and I might say prophetic species, demonstrates what I have only suspected heretofore. That is, the relationship of *Pachydictya* with the *Cystodictyonidae*. In fact, the genus lacks only the small "lip" to be a typical member of the family, and it is questionable whether this deficiency is of sufficient importance to exclude the genus.

Formation and locality: Trenton group at Cannon Falls, Goodhue county, Minnesota, where it is associated with *Phyllopora? corticosa*, Ulrich, and *Streptelasma corniculum*, Hall.

Register No. 5952.

CREPIPORA IMPOLITA, n. sp.

Zoarium large, solid, irregularly ramose, or simply nodulated. Branches from 0.2 to 0.8 of an inch in diameter. Height from two to four inches. Cells large, and rather regularly arranged, eleven in the space of 0.2 inch. Walls thin. Apertures direct, polygonal to sub-rhomboidal, with the lower margin very slightly elevated, and showing, in good specimens, the ends of the two vertical lamellae or teeth on the inside of the aperture. Interstitial cells, always few, usually absent. When present they are gathered together so as to form small "maculae."

In tangential sections the walls are seen to be thoroughly amalgamated, and the vertical lamellae or "teeth" usually represented by two spots on one side of the tube, that are of a conspicuously lighter color than other portions of the wall. In better sections their normal appearance may be observed. This is crescentic or horse-shoe-shaped, with the ends projecting into the cell-cavity.

In longitudinal sections, the tubes are gently curved, apparently throughout their length, and crossed at remote intervals, by exceedingly thin, straight diaphragms. The walls seem to have been perforated by numerous connecting "foraminae" and are composed of rapidly alternating dark and lighter shades of sclerenchyma.

The transverse section is very nearly like the tangential; proving that the branches are not divided into differentiated "mature" and "immature" regions, but that the zoarium is really of the nature of massive or parasitic species.

This very abundant species is readily distinguished from all the associated forms, by its irregular growth and large cells.

Formation and locality: Trenton shales at Minneapolis, Lanesboro, and other localities in the state.

Register Nos. 5958 to 5962.

MONTICULIPORA GRANDIS, n sp.

Zoarium irregularly massive and often tending to become sub-ramose. Cells polygonal, thin walled. Surface without monticules but exhibiting at intervals of 0.2 of an inch conspicuous groups of large cells, that are often nearly twice the size of those of the ordinary dimensions. Eight or nine of the smaller occupy 0.1 inch; the average diameter of those in the groups is about 1.55th of an inch.

In vertical sections the tubes proceed to the surface in straight or curved lines according to the form of the zoarium. They are provided with thin walls, and usually two, more or less closely arranged series of cystoid diaphragms, one on each side of the tube, the intervening space being crossed by an equal number of straight diaphragms.

Tangential sections show that the cells are polygonal and thin-walled; the opening left by the cystoid diaphragms is large, ovate, or sub-circular, and while it is usually lateral in position, it is not infrequently central. The angles of junction of the cells are a little thickened, and there is some evidence to show that they contained very small spiniform tubuli.

This fine species resembles in its growth the more irregular examples of *M. laevis*, Ulrich, from the Cincinnati group. The

cells of *M. grandis*, are however larger and the internal structure quite different.

Formation and locality: Fragments of this species are rather rare in the lower portion of the Trenton shales, at Minneapolis, Minn. The vertical range of the species is apparently not more than six or eight feet.

Register No. 5969.

HOMOTRYPA MINNESOTENSIS, n. sp.

Zoarium ramose, branches cylindrical or sub-cylindrical, from two to four tenths of an inch in diameter, and branching at rather long intervals, that are rarely less than one and a half inches and often more than two inches. Surface smooth, no monticules having been observed in any of the numerous examples studied. Cells of conspicuously larger size than the average are collected into groups, of which the centers are about 0.13 of an inch apart. The cells composing the groups enlarge gradually, those near the middle being about twice as large as the ordinary cells occupying the intervening spaces. Center of groups often marked by a small sub-solid or pitted space. Ordinary cells polygonal, with thin walls, and, sometimes, very oblique apertures; more commonly they are nearly direct, while in a few of the large specimens they are really so. About eleven of the smaller or ordinary cells occur in the space of 0.1 inch.

Vertical sections show that the peripheral or "mature" region is very narrow, that the tubes are long and vertical in the axial region, and that their course to the aperture forms a very gentle curve. The walls in the axial region are extremely thin and wavy. Near the surface they are appreciably thickened. Diaphragms wanting in the axial region, but present in the peripheral portion of the tubes, where they recur at intervals of from one-fourth to one tube diameter. Along the upper wall is the characteristic series of cystoid diaphragms. The obliquity of the cell-apertures and the extreme brevity of the matured portion of the tubes, render the preparation of satisfactory tangential sections very difficult. The more successful ones show that the cell walls are compar-

atively thin, that a variable number of interstitial cells is interpolated among the ordinary zoëcia, while here and there, somewhat obscure traces of the connecting foraminae may be detected.

Transverse sections show the greatly disproportionate development of the axial region as compared with the peripheral. They also show that in the axial region the tubes are provided with extremely thin walls, and that near the surface they are flattened and their size considerably reduced.

This is a true species of *Homotrypa*, and is nearly related to *H. obliqua*, Ulrich, from the Cincinnati group of Ohio, but still closer in its affinity with an undescribed species occurring in the upper half of that formation. From the first, *H. minnesotensis* is distinguished by its smooth and sub-cylindrical branches, and other less obvious, differences.

Formation and locality; Common in the Trenton shales at Minneapolis, St. Paul, Lanesboro, and other localities in the state.

Register Nos. 5970 to 5975.

HOMOTRYPA EXILIS, n. sp.

Zoarium ramose, branches slender, cylindrical, about 0.15 of an inch in diameter, and dividing at intervals of one inch or more. Entire height of zoarium from one to three inches. Surface smooth. Cells with rounded, direct apertures, and moderately thick walls. Ten or eleven of the ordinary size occur in the length of 0.1 inch. Groups of cells, slightly larger than the average, are present, but do not constitute a conspicuous feature. Interstitial cells rather numerous, especially between the cells of the groups just mentioned. Diaphragms, wanting in the axial region, but present in the short, abruptly bent peripheral region, where the walls are also thickened, and a short series of cystoid diaphragms is developed.

At first I was inclined to regard this species as the young of *H. minnesotensis*. But this is evidently not the case, as the specimens have a more matured look than many much larger specimens of that species. The walls get thicker and the apertures more rounded than is the case in even the most matured examples of *H. minnesotensis*.

Formation and locality: Not uncommon in the lower portion of the Trenton shales at Minneapolis, Minn.

Register No. 5976.

HOMOTRYPA SUBRAMOSA, n. sp.

Zoarium sub-ramose, branches sub-cylindrical or slightly flattened, with the upper extremities rounded and expanded.—Branches varying in diameter from 0.2 to 0.4 of an inch; apparently dividing but once or twice, the entire zoarium being rarely more than one inch and a half in height. Surface without menticules. Cells with moderately thin walls, and polygonal and direct apertures; nine or ten occupy the space of 0.1 inch. At irregular intervals the surface presents inconspicuous clusters of cells that are slightly larger than the average. Well developed spiniform tubuli occur at most of the angles of junction between the cells. They constitute a marked feature on all good specimens.

Longitudinal sections show that the tubes proceed from the axial region to the outer surface in a gentle but gradually increasing curve; that at unequal intervals several parallel convex lines of diaphragms cross the branch; that between these the diaphragms may be absent or scattered and infrequent; that the walls throughout the axial region are thin and decidedly wavy; that they are moderately thickened in the peripheral or "mature" region, and are there provided with a more or less closely arranged series of cystoid diaphragms, the extent of which, of course, depends entirely upon the age of the specimen.

In tangential sections the walls are moderately thin, the cell-cavity is sub-angular, and exhibits usually at one side the crescentic opening left by the cystoid diaphragms. The spiniform tubuli are large, and as the walls are comparatively thin, they are more striking than usual with species of the genus.

This is not closely related to either of the preceding species, but finds its nearest allies in several undescribed species of Ohio and Kentucky.

Formation and locality: Not common in the Trenton group at Minneola, Goodhue Co., Minn.

Register No. 5980.

HOMOTRYPA INSIGNIS, n. sp.

Zoarium sub-ramose, from one to two inches in height; branches sub-cylindrical or flattened, often lobate, or throwing off short branches, the distal extremities of which are concave. Diameter of branches varying from 0.15 to 0.30 of an inch. Surface smooth, without monticules. Cells with very thin walls, and shallow apertures. These two conditions conduce to give the cell-apertures, especially those of the younger specimens, the appearance of being extremely oblique; when in fact they are but slightly so, and in old examples not at all. An explanation of this peculiarity is found in the fact that the cystoid diaphragms occur just beneath the top of the thin cell-walls, and the least wearing will remove the wall all around the cell excepting at the small posterior opening left by the cystoid diaphragms. Groups of cells of larger size than the average, occur at intervals of about 0.12 of an inch. Ten or eleven of the ordinary cells occupy 0.1 inch.

Tangential sections show that the walls are thin, that small spiniform tubuli occupy many of the angles of junction, and that the sub-circular opening or tube left on the posterior side of the cell by the cystoid diaphragms, is comparatively small, and unless sharply defined, may be overlooked.

In vertical sections the tubes in the axial region are not provided with diaphragms excepting in special zones, where they are numerous. In the peripheral region they are crowded, and although greatly resembling ordinary straight diaphragms, they are, nevertheless, of the nature of cystoid diaphragms. Their posterior portion is in most cases abruptly bent inward, but at a point so near the wall of the tube that it may be overlooked.

The distinguishing features of this species are the thin walls, the shallowness of the cells at their apertures, and the large size and number of the cystoid diaphragms. Slightly worn examples are readily identified by the peculiar obliquity of the cell-apertures, which for the reasons given in the description, appear to be very small, the larger portion of the surface being occupied seemingly by wall-substance.

Formation and locality: Rather rare in the Trenton shales near Fountain and Lanesboro, in Fillmore Co., Minn.

Register Nos. 5977 to 5979.

HOMOTRYPELLA, nov. gen.

Zoaria somewhat irregularly ramose, rarely frondescent; moniticules wanting; small maculae of interstitial cells usually present. Zoecia small, with moderately thick walls and cystoid diaphragms. Interstitial cells numerous, often completely isolating the true zoecia; diaphragms straight. Spiniform tubuli very numerous, of medium size, and frequently encroaching upon the visceral cavity of the zoecia.

Type: *H. instabilis*, n. sp.

The above characters are represented in at least six species now before me. They are all new to science with the exception of one, a description of which has been published by me under the name of *Chaetetes grameliferus** It is a common species in the Trenton shaly limestones of Kentucky. Of the remaining five species, three occur in the Cincinnati group of Ohio, one in the same formation in Illinois, and the last in the Trenton shales of Minnesota. Judging from the aggregate of characters, the position of the genus is intermediate between *Peronopora*, Nicholson, and *Atactoporella*, Ulrich, on the one side, and *Homotrypa*, Ulrich, on the other. The genus is also related to *Leioclema* and *Batostomella*, Ulrich, but differs in the tabulation of the zoecia.

HOMOTRYPELLA INSTABILIS, n. sp.

Zoarium ramose, branches rounded, sometimes irregularly nodular or lobate, and varying in size, some being slender and not more than 0.18 of an inch in diameter, while others are much heavier and in several instances exceed 0.3 inch in diameter. Superficial aspect of cells presenting a variety of appearances depending upon the age and preservation of the specimens. In well preserved younger examples the cells are comparatively thin-walled, subcircular, and surrounded by slightly smaller, angular, interstitial cells. When a little worn, and this is especially the case in the larger specimens, the walls appear very thick, the cell-apertures, sub-circular or irregularly inflected, and the interstitial cells scarcely recognizable as such; or the visceral cavities of the latter are filled solid, and the observer is apt to

*Jour. Cin. Soc. Nat. Hist. vol. 2, p. 128.

suppose that they are absent. In well preserved and fully matured examples the interstitial cells are again obscured by the spiniform tubuli. These are rather small but numerous, there being two or three to each cell. Small "maculae" of interstitial cells, usually appearing as non-poriferous smooth spots, may occur at intervals of about 0.12 of an inch. Eleven or twelve of the true zoëcia occupy 0.1 inch; the diameter of their apertures is about $\frac{1}{10}$ th of an inch.

In tangential sections the polygonal line of contact between the cells is nearly always sharply defined. The interstitial cells are numerous and of unequal size, though usually of much smaller size than the true zoëcia. The walls of both kinds of cells are of equal thickness, the portion of same immediately surrounding the visceral cavity, being also of darker hue than beyond. Visceral cavity of true zoëcia often sub-circular or ovate, but more commonly with an irregular outline, due to the encroachment of the conspicuous spiniform tubuli. These are nearly or quite as large as the interstitial cells, and differ from them only in having their central portion entirely filled by a dark deposit of sclerenchyma. Their number varies from one to three times that of the true zoëcia. At unequal intervals the section presents small irregular aggregations of the interstitial cells. The cystoid diaphragms are not present in these sections excepting when they are prepared from very young examples or cut the zoarium at a deep level.

In the axial region of a vertical section the walls of the tubes are thin and undulated, the diaphragms straight and remote, and the direction of the tubes, from their point of origin to where they enter the "mature" or peripheral region, forms an angle of about twenty degrees with the imaginary central axis of the branch. In the peripheral region this angle is gradually increased until the maximum of about seventy-five degrees is attained. At the same time the walls are much thickened, and the numerous interstitial cells and spiniform tubuli are developed. The former are distinguished from the true zoëcia by the fact that they are intersected by straight, complete diaphragms only, while the true zoëcia have the superior wall lined in a portion of their length by a series of cystoid diaphragms. These structures number from eight to fifteen in each tube, and are developed only in the

region intervening between the fully matured peripheral and the immature axial region. Beyond them the diaphragms are crowded and essentially horizontal. In the interstitial tubes they are scarcely more crowded than in the true zoëcia, and, especially in the outer portion, more or less obscured by sclerenchyma.

It is highly probable that the above description embraces more than one species. Both extremes in size present, besides some important differences in internal structure. These have not been noted in the descriptions of the sections, the character of what I regard as the typical form alone being given. Until I can give more time to the examination of the relative importance of the variations noticed, I have deemed it, in the meantime, advisable to describe them under one specific name.

Formation and locality: Rather common in the Trenton shales, at Minneapolis and other localities in the state of Minnesota.

Register Nos. 5025, 5981 and 5982.

PRASOPORA SIMULATRIX, n. sp.

Zoarium discoid when young, hemispheric or depressed sub-conical when adult; base more or less concave, and covered with a concentrically striated epitheca; upper surface celluliferous; height of zoarium varying from one-fourth of an inch to two inches; diameter from one-half of an inch to four inches. Zoëcia or true cells with sub-circular apertures, and comparatively thin interspaces that are occupied by rather numerous small angular interstitial cells. Groups of cells of a slightly larger size than usual occur at intervals of 0.15 inch, measuring from center to center. Between these the interstitial cells are always more numerous than elsewhere, and not infrequently form a small "macula" in the central portion of the clusters. In the spaces between the "maculæ" the interstitial cells might be overlooked, although as shown by sections, they are really numerous. Diameter of apertures of one of the ordinary cells about 1-105th of an inch, while nine of the same occupy 0.1 inch.

In tangential sections the true zoëcia are sub-circular, or more strictly speaking, polygonal, the walls very thin, and the

visceral chamber invariably intersected by the crescentic edge of the cystoid diaphragm. The opening left by the cystoid diaphragms is either lateral or sub-central, but more commonly the former. The zoëcia are in contact only at limited points, and the interspaces between them are filled by the small interstitial cells. These are somewhat variable in number, and greatly so in size, but always decidedly angular. They are furthermore, collected at intervals into small sub-stellate groups or "maculæ."

Vertical sections show that the cystoid diaphragms form a continuous series on one or both sides of the tubes, according as they extend all around the circumference, or take in only a portion of the same, while an equal number of straight diaphragms crosses the remaining portion of the tube. The interstitial tubes are crossed by about twice as many simple horizontal diaphragms. The cell-walls throughout are very thin.

This species in many respects closely resembles *P. Selwyni*, Nicholson, but they differ so decidedly in the internal structure that I must regard them as distinct. In the true, or what Dr. Nicholson calls the typical form of *P. Selwyni*, the cystoid diaphragms are isolated, and never form connected series as they do in *P. simulatrix*, *P. grayæ*, Nich., and Eth. jr., and a number of other species. A similar and even more marked isolation of the cystoid diaphragms pertains to *P. oculata* and *P. affinis*, described by Foord from the Trenton of Canada. None of the Canadian species of the genus, so far as known, occur in the Trenton rocks of Kentucky and Tennessee, nor in the equivalent strata of the northwest, and it is singular that all the American species have the cystoid diaphragms in more or less crowded continuous rows, while in the Canadian species the isolated condition of these structures prevails. Nicholson's variety *hospitalis*, of *P. selwyni*, is more nearly related to *P. simulatrix*, but differs in having spiniform tubuli, and an attached zoarium. But why *P. hospitalis* should be called a variety, is more than I can understand. The parasitic habit of growth, spiniform tubuli, and mode of tabulation distinguish it, at least specifically, from *P. selwyni*.

Formation and locality: In the Trenton shales, but apparently not common in any locality in the state. It has been found at Minneapolis, St. Paul, Lanesboro and Mantorville. In the shaly

limestones of the Trenton in Kentucky and Tennessee the species is exceedingly common, and grows to a larger size than the Minnesota specimens.

Register Nos. 4041, 5124, 5532, 5986 to 5988.

PRASOPORA CONOIDEA, n. sp.

Zoarium depressed, conical; base rather deeply concave, and covered with a concentrically wrinkled epitheca; height varying from 0.2 to 0.6 of an inch; diameter from 0.4 to 0.8 of an inch. Upper surface celluliferous and exhibiting, at intervals of 0.12 inch, more or less prominent monticules, mainly occupied by groups of cells larger than the average. The summits usually appear to be sub-solid, but sections show that this portion of the monticules is occupied by an aggregation of small interstitial cells. Zoœcia with sub-circular or polygonal apertures; ten of the ordinary size occur in the length of 0.1 inch.

Both the vertical and tangential sections resemble those of *P. simulatrix* to a marked degree. In fact they are identical in all respects, excepting that the tangential section of *P. conoidea* shows a few spiniform tubuli, and usually fewer interstitial cells, though the maculæ between the groups of large cells are generally of greater dimensions than we find them in such sections of *P. simulatrix*. As the differences in internal structure are so slight, the external characters, such as the form of zoarium and monticules, must mainly be relied upon in distinguishing the two species. In nearly one hundred specimens of *P. conoidea* examined, the small size, sub-conical form, more or less developed monticules, and concave base, are very persistent characters, and sufficient to distinguish specimens of the two species at a glance.

Formation and locality: At Oxford mills near Cannon Falls, Goodhue county, associated with *Phyllopora? corticosa*, Ulrich, *Streptelasma corniculum*, Hall, and *Pachydictya conciliatrix*, Ulrich.

Register No. 3483.

PRASOPORA CONTIGUA, n. sp.

Zoarium hemispheric, base flat or slightly concave, usually one-

half or three-fourths of an inch in diameter, and rarely one inch or more; a single specimen, apparently belonging to this species, is, however, about four inches in diameter. Zoëcia with thin walls and polygonal apertures; nine of the ordinary size occupy 0.1 inch. Groups of cells of somewhat larger size than usual occur at intervals of 0.15 inch. Their diameter rarely exceeds $\frac{1}{10}$ of an inch. Interstitial cells scarcely detectable at the surface.

Tangential sections show that the zoëcia are polygonal, and thin-walled; that they are in contact excepting at their angles, where one or two small interstitial cells are wedged between them; that in the centre of the groups of large cells there is usually a small aggregation of the interstitial cells; and that a few spiniform tubuli are developed. The tubular opening left by the cystoid diaphragms is of medium size, and more often excentric than central in its position within the tube cavity.

Vertical sections are remarkable mainly, because they exhibit a marked decrease in the number of interstitial cells, when compared with other species of the genus.

The superficial aspect of the celluliferous surface of this species is very much like that of species of *Monotrypa*, and to a less degree, also resembles that of *Prasopora simulatrix*. Still, after a little practice they are readily distinguished by the thinner cell-walls of *P. contigua*. Tangential sections will immediately prove their distinctness. The same species, very slightly modified, occurs in the Cincinnati group at Cincinnati, Ohio, about three hundred feet above the Ohio river.

Formation and locality: In the Trenton shales at localities in Goodhue and Dakota counties.

Register Nos. 5301, 5989, 5534.

DIPLOTRYPA INFIDA, n. sp.

Zoarium discoid, sometimes approaching hemispherical. Base flat or slightly concave; height from one to three tenths of an inch; diameter from one-half an inch to one inch. Zoëcia varying in form from polygonal to sub-circular, the shape depending upon the number and size of the interstitial cells. In some specimens these cells are almost certain to be overlooked, as the

zoëcia are angular and seemingly in perfect contiguity. In others the interstitial cells are large and very obvious between the true zoëcial apertures, which in these specimens are circular. At intervals of 0.15 inch, measuring from center to center, there are conspicuous clusters of zoëcia of larger size than usual, the diameter of the apertures of the ordinary cells being only about 1-110th of an inch, while that of those forming the clusters varies from that size to 1-65th inch. Nine or ten of the ordinary zoëcia occupy the space of 0.1 inch.

Tangential sections vary somewhat in the appearance they present, according to the depth below the surface at which they divide the zoarium. When taken just below the surface of a specimen with angular zoëcial apertures the interstitial cells, although numerous, are small and wedged in between the zoëcia, the walls of the latter being largely in contact with each other. Spiniform tubuli of moderate size are developed at most the points of junction between the zoëcia. At a deeper level the zoëcia are sub-circular, and from their shape alone are necessarily in contact with each other only at limited points. The interstitial cells are, moreover, much larger, and somewhat more numerous than they are in the region just described.

In vertical sections the tubes are everywhere perpendicular to the basal epithelial membrane. Their walls are not excessively thin, being slightly thicker than is usual with species of the genus. The interstitial tubes are more conspicuous in the lower half of the section than in the upper where the true zoëcia are often in contact. That condition is less frequent in the lower region. The diaphragms in the zoëcia are numerous but extremely variable, some being horizontal, some more or less oblique, while others are curved and overlapping, and occasionally present the appearance of short irregular series of cystoid diaphragms. The diaphragms in the interstitial tubes are crowded and horizontal. The thick-walled spiniform tubuli are rather conspicuous in these sections.

It is difficult to determine whether this species has more affinity with *Prasopora* or *Diplotrypa*. The only important character distinguishing the two genera is found in the cystoid diaphragms. These structures are not present in the typical species of *Diplotrypa*, but in *D. regularis*, Foord, the diaphragms are usually

oblique and often curved, while *D. infida* goes but a step farther in having some of them overlap like cystoid diaphragms. In tangential sections, however, the appearances presented are more like those of *Diplotrypa* than *Prasopora*, the interstitial cells being somewhat larger than is usual in the latter genus, and the very striking appearance of the cystoid diaphragms of *Prasopora*, when cut transversely, is either absent or occurs only here and there in isolated instances. So, while the species is undoubtedly intermediate between the two genera, the greater affinity seems still to be with *Diplotrypa*.

Formation and locality: In the Trenton shales of Goodhue and Fillmore counties.

Register No. 5993.

ASPIDOPORA PARASITICA, n. sp.

Zoarium adhering to foreign bodies, upon which it forms thin sub-circular patches usually about one-half an inch in diameter, and from one to three hundredths of an inch in thickness. In a few instances noticed, the shell upon which the zoarium had commenced its growth proved too small, and the under side of the colony, where it projects beyond the encrusted body, is covered by a faintly wrinkled epitheca. Zoœcia with oval or circular apertures, moderately thin walls, and a regular arrangement in curved series around groups of cells larger than usual; about ten of the cells in the spaces between the "clusters" occur in 0.1 inch. Interstitial cells numerous, but, as a rule, they are obscure at the surface and readily overlooked. Spiniform tubuli rather numerous and recognizable at the surface of all well preserved examples.

Vertical sections show the extreme tenuity of the zoarium. The zoœcia are at first somewhat prostrate, but they soon bend upward and open at the surface with direct apertures. One large cystoid diaphragm is, apparently always present at the bottom of the cell, and I do not doubt that with age, a short series of them is developed. The interstitial tubes expand very rapidly above their point of origin, which is just above the basal or epithecal membrane. They are crossed by from five to ten close-set horizontal diaphragms.

In tangential sections the zoëcia are sub-circular or oval, and in contact with each other at two, three, or four points, the sub-rhomboidal or irregular spaces intervening being occupied by the interstitial cells. Walls of zoëcia thin. Spiniform tubuli of moderate size occur at nearly all the points of contact between the zoëcia.

The parasitic habit of the species distinguishes it from all other species of the genus known to me. Otherwise it is closely allied to both *A. newberryi*, (*Prasopora newberryi*, *Nicholson*) and *A. calycula* (*Diplotrypa calycula*, *Nicholson*), from the Cincinnati group of Ohio. I know of no associated species sufficiently resembling it to require a close comparison.

Formation and locality: Not uncommon in the Trenton shales at Minneapolis, St. Paul and other localities in the state of Minnesota.

Register Nos. 5994, 5995.

AMPLEXOPORA WINCHELLI, n. sp.

Zoarium irregularly ramose; branches cylindrical, but oftener more or less flattened, and varying in diameter from 0.2 to 0.35 of an inch. Entire height of zoarium, apparently, not more than two inches. Monticules are absent, though, now and then, the surface is very slightly undulating. The cells are small, thick-walled, of nearly equal size, rather irregular in their arrangement, and when well preserved the walls show at the angles of junction the elevated points of the spiniform tubuli. Interstitial cells sparingly developed, or wanting. On an average nine cells occupy 0.1 inch.

In longitudinal sections the tubes in the "immature" or axial region are thin-walled, and crossed by complete diaphragms from one to three tube diameters distant from each other. In the peripheral or "mature" region they bend outward rather abruptly, and proceed directly to the surface. As they enter this region their walls become much thickened; in some sections this thickening of the walls is extreme. As usual, the diaphragms are also more numerous, often crowded, and not infrequently exhibit a tendency to coalesce with each other.

Tangential sections exhibit considerable variation in the thick-

ness of the cell walls. This variability is due, apparently, to the different ages of the specimens sectioned. In the younger examples the thickness of the walls equals about one third of the diameter of the cell-cavity, while in very old specimens the cavity may be reduced by additional deposits of sclerenchyma to a diameter equaling scarcely more than one-third the thickness of the walls. The boundary line between adjoining cells is distinctly defined by a dark line. Each of the angles, and often points between them, are occupied by a spiniform tubulus of medium size. When in a good state of preservation the central lucid spot of the spiniform tubuli is seen to be larger than usual with species of this genus.

In some respects this species is related to the *A. canadensis*, described by Foord from the Black River and Trenton formations of Canada. But the branches of that species are much larger, while the thickness of the cell walls does not approach that observed in matured examples of *A. winchelli*. They also differ in the tabulation and direction of the tubes, as well as in the size and number of the spiniform tubuli. Associated with this is a common species having all the characters, save one, ascribed to *A. superba*, Foord. In the Trenton rocks of Canada the surface of that species presents small monticules. These are wanting in the Minnesota specimens, but as the presence or absence of monticules, especially in the genus *Amplexopora*, is of small importance, I think I am justified in regarding them as specifically identical with the Canadian specimens. The larger cells and more robust zoarium of *A. superba*, readily distinguish that species from *A. winchelli*.

The specific name is given in honor of Prof. N. H. Winchell, the accomplished chief of the survey.

Formation and locality: Common in the Trenton shales at Minneapolis, Minn.

Register Nos. 5999 to 6001.

BATOSTOMA FERTILIS, n. sp.

Zoarium large, varying from ramose to sub-frondescent, or palmate; branches usually more or less compressed, and varying in thickness from 0.2 to 0.4 inch; width of same, from 0.3 inch

to 1.2 inches; height, so far as observed, not exceeding 2.5 inches. Cell-apertures varying from polygonal to circular, according to the thickness of the walls, and the size and number of the interstitial cells. In some specimens having sub-circular cells and the apertures surrounded by a slight rim, the interstitial cells are very numerous in the depressed inter-zoecial spaces. This condition is, however, not common, yet in no instance have I found it difficult to recognize the interstitial cells, as they are more or less numerous in all the specimens. Spiniform tubuli numerous but very small, and only rarely presenting their superficial terminations. At intervals of about 0.12 inch, the surface usually presents small sub-stellate maculae, around which the zoecia are generally somewhat larger than usual. Seven or eight cells of the ordinary size occupy 0.1 inch.

In vertical sections the tubes have thin, and somewhat irregularly fluctuating walls in the axial region of the zoarium. They proceed toward the surface in a gentle curve, and as they near the same, their walls become appreciably thickened, but never to any great extent. The interstitial tubes are abruptly developed, and constricted at the points where they are crossed by the diaphragms. These occur at but slightly shorter intervals than those in the peripheral regions of the true zoecia, where they are separated by distances equaling from one-third to one tube diameter. In the axial region the diaphragms are either very remote, or more commonly, are entirely absent.

Several tangential sections show that the zoecia are always more or less angular; that they have thin walls, and often are in contact with each other on all sides, but usually more or less separated by angular interstitial cells; that the interstitial cells are especially developed, both in size and number, at rhythmical intervals corresponding to the small "maculae" observed at the surface; and that the spiniform tubuli, though numerous, are small and only faintly defined, so that, unless searched for, they may be overlooked.

This species is not closely related to either of the other species of the genus now known from the Trenton formation of Minnesota. Both *B. ottawaensis*, Foord, and *B. irrasa*, Ulrich, have, when matured, very thick-walled cells, while those of *B. fertilis*, are, except in rare instances, comparatively thin-walled. Their

internal characters are too distinct to require comparison. A more closely allied species occurs in the upper beds of the Cincinnati group of Ohio, and another in the Utica slate of Canada, and the equivalent formation in Kentucky. As no descriptions of these species have yet been made public, it would be useless to institute comparisons.

Formation and locality: Abundant in the lower half of the Trenton shales at Minneapolis and other localities.

BATOSTOMA IRRASA, n. sp.

Zoarium, consisting of small, sub-cylindrical or compressed, and frequently divided branches, usually less, rarely a little more, than 0.3 inch in their greatest diameter. Cells with polygonal apertures and thin walls when young, and with smaller, oval or sub-circular apertures, and thick walls in the fully matured examples; seven or eight occur in the length of 0.1 inch. The spaces between the cell-apertures appear solid in the mature specimens, but in some of the younger examples, with also angular zoecial apertures, a variable number of irregularly shaped interstitial cells may be recognized. Spiniform tubuli numerous, two or more to each cell; they are large and constitute a conspicuous external feature of mature examples. In such specimens, certain small sub-stellate, smooth spots are most distinct.

Vertical sections show that the tubes have thin and irregular fluctuating walls in the axial region, but less thin than usual; that in this region they are crossed by remote complete diaphragms; that near the surface the diaphragms are nearly straight, but often incomplete and less than a tube diameter apart; that their course from the point of origin to their apertures forms a nearly equally curved line; that their walls become but slightly thickened until just below the surface, where the apertures are contracted by a deposit of sclerenchyma, and many of the walls separate to make room for some very short interstitial tubes or cells, the latter are usually filled by a secondary deposit.

The matured region being very shallow, it is difficult to prepare

satisfactory tangential sections. A very good one shows that the cells just below the surface have thick ring-like walls, that their form is oval or sub-circular, and that they may be in contact or separated by very irregular and unequal interstitial cells, which have been more or less completely filled by an homogeneous deposit of light-colored sclerenchyma. The spiniform tubuli are numerous, and, as is usual in this genus, have the central cavity large and distinct. Where the section cuts the zoarium at a deeper level we observe that the cells were angular and mainly in contact with each other, the interstitial cells being as yet small; while the spiniform tubuli are hardly perceptible.

This very neat species is quite distinct from any heretofore described. In having a few incomplete diaphragms it resembles *B. ottawaensis*, Foord, but otherwise they are quite different. In size of zoarium it approaches *B. implicata*, Nicholson, but the cell walls are not inflected by the spiniform tubuli as in that species, nor do they resemble each other in their vertical sections.

Formation and locality: In the lower portion of the Trenton shales at Minneapolis, Minn. In the excavation for the St. Paul and Northern Pacific bridge pier on the eastern bluff of the river, these layers were exposed and many interesting bryozoa were obtained from them. Of these *Pachydictya foliata*, *Stictoporella angularis*, and *S. frondifera* occur on the same slabs of shale with *Batostoma irrasa*.

CALLOPORA UNDULATA, n. sp.

Zoarium ramose, branches small, slender, about 0.12 of an inch in diameter, and dividing dichotomously at intervals of about 0.4 inch or more. Surface with rounded monticules, that usually coalesce laterally and form, more or less complete, transverse ridges, five in 0.4 of an inch. In some specimens the monticules are separate, while in a few they are almost obsolete. Zoecia with moderately thin walls, and sub-angular apertures. Interstitial cells comparatively few, very small, readily overlooked. Zoecial apertures nearly equal in size over all portions of the surface; nine occur in the space of 0.1 inch.

In tangential sections the zoecia are oval or sub-angular, the

walls of moderate thickness, and preserving the original line of junction between adjoining cells. Interstitial cells though small, are yet larger and more numerous than one is led to believe from an examination of the exterior. Nearly all the angles of junction between the true zoëcia are occupied by them.

Vertical sections present no marked differences from other species of the genus. In fact the species of *Callopora* are remarkably persistent in their internal structure, and the points mainly to be relied upon in distinguishing the species are external. As usual the tubes are closely tabulated for a short distance above their point of origin in the axial region of the zoarium. Subsequently the diaphragms are remote, and it is only just below their apertures that they are again numerous developed. The interstitial tubes are short and closely tabulated. The tube walls are some what thinner throughout the zoarium than is usual.

Transverse sections present the characteristic features of the genus. In the axial region the zoëcia are of two sizes, the larger being sub-circular or polygonal, and, from their shape, in contact with each other only at limited points. The intervening spaces are occupied by more angular cells in every stage of development so far as size is concerned. At the periphery the tubes are cut longitudinally. Here the walls are of moderate thickness, and divided in the center by a dark line. But few interstitial cells are to be seen in this style of section.

The rounded, transverse ridges or annulations will distinguish this species from any other form of the genus described. When these are, as is sometimes the case, but faintly developed, care must be taken in distinguishing it from a small undescribed species of *Monotrypella*, occurring in the same beds.

Formation and locality: Not uncommon in the Trenton shales at Minneapolis Minn.

CALLOPORA INCONTROVERSA, n. sp.

Zoarium ramose; branches smooth, sub-cylindrical, from 0.18 to 0.30 of an inch in diameter, and dichotomously divided at intervals of about 0.5 inch. Zoëcia with oval or sub-circular, rarely polygonal apertures, and rather thin walls. Small groups of slightly larger size than the average are occasionally present.

These are never conspicuous and occur at irregular intervals. Eight or nine of the usual size occupy 0.1 inch. Some of the apertures preserve the opercula. The central perforation is larger than usual and surrounded by a distinct rim. Interstitial cells generally numerous, but varying somewhat in distribution and number in different specimens.

Tangential sections show that the zoëcia are nearly circular or broadly elliptical, that their walls are of moderate, but somewhat variable thickness, and that, usually, they are in contact with each other at as many points as their rounded form will admit. The interspaces are occupied by the interstitial cells. At unequal intervals a few of the latter form small irregular groups. The true zoëcia in the immediate vicinity of these groups are also of somewhat larger size than the average.

In vertical sections the tubes form a gradual but rather short curve to the surface. The tabulation and appearance of the proximal ends of the true zoëcia, are so much like that of the interstitial tubes that it is reasonable to believe that their functions were also alike. From the point of origin till it has attained nearly its mature size, the tube is crossed by twelve or more closely and regularly arranged diaphragms; when suddenly they cease. Near the surface they again become numerous but irregular, while in the intervening portion they occur only at remote intervals, or are entirely absent.

When in a good state of preservation, even small fragments of this species are readily recognized by the characters above described. In the worn condition they may be confounded with an associated species of *Homotrypa*. Sections will, of course, immediately distinguish them.

Formation and locality: Rather rare in the Trenton shales at Minneapolis, Minn.

TREMATOPORA PRIMIGENIA, n. sp.

Zoarium ramose; branches sub-cylindrical or compressed, from 0.06 to 0.12 of an inch in diameter, and dichotomously divided at intervals of 0.2 inch or more; the attached basal expansion is comparatively large, and usually supports several branches;

entire height of branches apparently not exceeding one inch. Superficial aspect of zoëcia varying with age. In the younger examples the apertures are oblique, with only the posterior border elevated, and the interstitial spaces of less width than the diameter of the apertures. With age the apertures become somewhat smaller, sub-circular, and more direct, and the peristome or rim nearly equally elevated all around, while the interstitial spaces are widened, till in some examples they are equal to twice the diameter of the zoëcial orifice. Most specimens present irregular spots or maculæ, where the zoëcia are of larger size than usual and separated by wide interspaces. In some the maculæ form circumscribed, seemingly solid, spots, thus furnishing a conspicuous feature to the surface; while, on the other hand, in a few, otherwise typical examples, only traces of them can be detected. On the whole, therefore, the arrangement of the zoëcia is irregular. Diameter of apertures varying from $\frac{1}{50}$ th to $\frac{1}{15}$ th of an inch. From ten to fourteen occupy the length of 0.1 inch, but twelve is the prevailing number. As usual with species of the genus, the orifices of the interstitial cells are closed by a membrane. Sections prove them to be numerous, and that they more or less completely isolate the zoëcia. Spiniform tubuli very small and generally worn away.

Sections present the usual characters of the genus as restricted by me.* In the final report on the palæontology of the state, they will be fully described and illustrated. In this communication it will suffice to state that all the essential characters of *Trematopora* are represented.

The large basal expansion, small branches, rounded cell apertures, and the somewhat depressed, wide, and smooth interstitial spaces, and "maculæ," are the distinguishing features of the species.

Formation and locality: Common at Minneapolis and other localities of the state, in the Trenton shales.

Register Nos. 6010, 6011.

TREMATOPORA ORNATA, n. sp.

The zoarium of this species, in its growth and general appear-

* Jour. Cin. Soc. Nat. Hist., vol. vi, p. 257.

ances, so closely resembles that of *T. primigenia*, that a detailed description will scarcely be deemed necessary. They differ as follows: The zoëcia of *T. ornata* are more closely, as well as more regularly arranged, the interstitial spaces narrower and more depressed, and the "maculæ" absent. When in a good state of preservation, the elevated border around the apertures is surrounded by a closely arranged series of granules or blunt spines, which impart a very ornamental appearance to the magnified surface. A variable number of somewhat larger spines also occurs in the interstitial spaces. The greater development of the spines is the most obvious and important difference, and when preserved, should distinguish the two species immediately.

I am not entirely satisfied that the generic affinities of the species have been correctly determined. Future investigations may prove it to belong to *Bythopora*, Miller.

Formation and locality: Rather rare. Associated with the much more abundant *primigenia*, at Minneapolis, Minn.

BYTHOPORA HERRICKI, n. sp.

Zoarium ramose, less than two inches in height; branches slender, cylindrical, from 0.03 to 0.10 of an inch in diameter, and divided dichotomously at intervals varying from 0.3 to 0.5 of an inch. Zoëcia arranged in somewhat irregular longitudinal series, with thick walls, narrow and very oblique apertures, the upper end of same being drawn out and shallow. Interspaces or walls sometimes channeled, or with elongate shallow pits. Measured longitudinally about seven cell-apertures occur in 0.1 inch; transversely eight rows occupy 0.05 inch. Spiniform tubuli small, few, and but rarely preserved.

The internal structure of the species has not been determined satisfactorily, being obscured, or entirely destroyed by crystallization. Still the superficial characters of the cells are so much like those of *B. fruticosa*, Miller, the type of the genus, that I feel no hesitancy in referring the Minnesota specimens to the same genus. When in a good state of preservation, *B. herricki* can not be confounded with any of the associated species, the extremely narrow cell-apertures being quite distinctive. The

branches are, besides, more slender and cylindrical than those of *Trematopora primigenia* and *T. ornata*.

Formation and locality: Fragments of this species are quite common in the Trenton shales of St. Paul and Minneapolis, Minn.

Register Nos. 6012, 6013.

MONOTRYPELLA MULTITABULATA, n. sp.

Zoarium consisting of irregularly divided, cylindrical or slightly compressed branches, varying in diameter from 0.15 to 0.4 of an inch. Surface usually presenting more or less elevated monticules, at intervals of 0.1 inch, measuring from center to center. In the Minnesota specimens the monticules are often absent, and instead, we find groups of cells of larger size than ordinary. Zoëcia polygonal, eight or nine in the space of 0.1 inch; walls rather thin. Interstitial cells not to be detected at the surface. Spiniform tubuli wanting.

In tangential sections the zoëcia are seen to be regularly polygonal, in contact at all points of their circumference, and provided with only moderately thickened walls. Further, each is separated from the other by a distinct boundary line, which is often conspicuously thickened where three or more cells come in contact, so as to resemble spiniform tubuli. Here and there occurs a small cell whose nature is doubtful. They are most probably abortive or young, though they may prove to be interstitial.

Vertical sections show that the tubes are provided with an excessive number of diaphragms. In the axial region these structures recur at intervals varying from one to three tube-diameters, while in the peripheral portions of the tubes they are extremely crowded. Many of the diaphragms in this region are slightly curved, and they often join with one another. The duplex character of the walls is preserved throughout the "mature" region, where they are also appreciably thicker than in the axial region. In a few instances the section passes through some small tubes, which present the usual appearance of interstitial tubes.

The distinguishing feature of the species is found in the extremely numerous diaphragms. The thin polygonal cells, and absence of spiniform tubuli, will separate it from the associated ramose bryozoa.

Formation and locality: This is a common species in the Trenton formation of Kentucky. It also occurs rather abundantly in the shales at Minneapolis, Lanesboro, and other localities in the state.

DISTRIBUTION OF SPECIES.

	Cincinnati group.	Trenton shales.	Limestone, Chazy, Black River and Birdseye.	Register No.
1. Stomatopora inflata, Hall	*	*	*	5924
2. Berenicea minnesotensis, Ulrich	*	*	*	5925
3. Ropalonaria pertenuis, Ulrich	*	*	*	5926
4. Arthroclema pulchellum? Billings	*	*	*	5927
5. Helopora divaricata, Ulrich	*	*	*	5928
6. Helopora spiniformis, Ulrich	*	*	*?	
7. Helopora, sp. undesc.	*	*	*	
8. Phyllopora? sp. undet.	*	*	*	5954
9. Phyllopora? reticulata, Hall	*	*	*	5955
10. Phyllopora? corticosa, Ulrich	*	*	*	3495
11. Ptilodictya subrecta, Ulrich	*	*	*	5929
12. Ptilodictya nodosa, Hall	*	*	*	5931
13. Ptilodictya ramosa, Ulrich	*	*	*	5933
14. Arthropora shafferi, Meek	*	*	*	5932
15. Arthropora simplex, Ulrich	*	*	*	5933
16. Stictopora fenestrata? Hall	*	*	*	5934
17. Stictopora paupera, Ulrich	*	*	*	5935
18. Stictopora fidelis, Ulrich	*	*	*	5936
19. Stictopora nicholsoni, Ulrich	*	*	*?	
20. Stictopora mutabilis, Ulrich	*	*	*	5938, 5939, 5956
21. S. mutabilis, var. minor	*	*	*	5941
22. S. mutabilis, var. major	*	*	*	5940
23. Stictopora, sp. undesc.	*	*	*	
24. Stictopora, sp. undet.	*	*	*	
25. Phaenopora multipora, Hall	*	*	*	5942
26. Stictoporella angularis, Ulrich	*	*	*	5943
27. Stictoporella cribrosa, Ulrich	*	*	*	5944
28. Stictoporella frondifera, Ulrich	*	*	*	5945-5947
29. Pachydictya foliata, Ulrich	*	*	*	5948
30. Pachydictya acuta? Hall	*	*	*	
31. Pachydictya occidentalis, Ulrich	*	*	*	5949
32. Pachydictya fimbriata, Ulrich	*	*	*	5950
33. Pachydictya conciliatrix, Ulrich	*	*	*	5952
34. Pachydictya, sp. undet.	*	*	*	
35. Phyllodictya frondosa, Ulrich	*	*	*	5953
36. Ceramoporella, sp. undesc.	*	*	*	
37. Ceramoporella? sp. undet.	*	*	*	
38. Crepipora impolita, Ulrich	*	*	*	5958-5962
39. Cheiloporella, sp. undesc.	*	*	*	5963, 5964
40. Spatiopora? areolata, Foord	*	*	*	5965, 5966
41. Crepipora? sp. undet	*	*	*	
42. Monticulipora wetherbyi, Ulrich	*	*	*	5967
43. Monticulipora, sp. undesc.	*	*	*	5968
44. Monticulipora grandis, Ulrich	*	*	*	5969
45. Homotrypa minnesotensis, Ulrich	*	*	*	5970-5975
46. Homotrypa exilis, Ulrich	*	*	*	5976
47. Homotrypa inaequalis, Ulrich	*	*	*	5977-5979
48. Homotrypa subramosa, Ulrich	*	*	*	5980
49. Homotrypa, sp. undet.	*	*	*	
50. Homotrypa? sp. undet	*	*	*	
51. Homotrypa, sp. undesc.	*	*	*	
52. Homotrypella instabilis, Ulrich	*	*	*	5985, 5981, 5982
53. Atactoporella, sp. undesc	*	*	*	5983, 5984
54. Atactoporella, sp. undesc.	*	*	*	5985
55. Prasopora simulatrix, Ulrich	*	*	*	5986, 5987, 5988
56. Prasopora conoidea, Ulrich	*	*	*	3483
57. Prasopora contigua, Ulrich	*	*	*	5301, 5534, 5989
58. Prasopora, sp. undesc	*	*	*	310, 5990-5992
59. Diplotrypa inflata, Ulrich	*	*	*	5993
60. Aspidopora parasitica, Ulrich	*	*	*	5994, 5995
61. Amplexopora superba, Foord	*	*	*	5996-5998
62. Amplexopora winchelli, Ulrich	*	*	*	5999-6001
63. Amplexopora, sp. undesc	*	*	*	

DISTRIBUTION OF SPECIES—*Concluded.*

	Cincinnati group.	Trenton shales.	Limestone, Chazy, Black River and Birdseye.	Register No.
64. Amplexopora, sp. undet.	*
65. Batostoma ottawaensis, Foord.....	*	6002
66. Batostoma irrasa, Ulrich.....	*
67. Batostoma fertilis, Ulrich.....	*
68. Batostoma, sp. undesc.....	*
69. Batostoma? sp. undet.....	*
70. Batostoma sp. undet.....	*
71. Batostomella gracilis, Nicholson	*
72. Batostomella sp. undesc.....	*	5541, 6009
73. Trematopora primigenia, Ulrich.....	*	6010, 6011
74. Trematopora ornata, Ulrich.....	*
75. Bythopora herricki, Ulrich.....	*	6012, 6013
76. Bythopora, sp. undesc.....	*
77. Bythopora? sp. undesc.....	*
78. Callopora, sp. undesc.....	*	6014
79. Callopora, sp. undesc.....	*	6015
80. Callopora incontroversa, Ulrich.....	*	Not entered.
81. Callopora undulata, Ulrich.....	*
82. Idiotrypa, sp. undesc.....	*
83. Dekayia trentonensis, Ulrich.....	*
84. Dekayia, sp. undesc.....	*
85. Dekayella ulrichi, ? Nicholson.....	*
86. Dekayella, sp. undesc.....	*
87. Petigopora petechialis, Nicholson.....	*
88. Petigopora, sp. undet.....	*
89. Leptotrypa, sp. undesc.....	*
90. Monotrypella multitabulata, Ulrich	*
91. Monotrypella, sp. undet.....	*
92. Monotrypa, sp. undesc.....	*