

A NOTE ON THE BATOSTOMAS OF THE RICHMOND SERIES.

By E. R. CUMINGS and J. J. GALLOWAY.

Four species of the genus *Batostoma* have been reported from the Richmond series, namely: *Batostoma manitobense* Ulrich, from Stony Mountain, Manitoba; *B. (?) rugosum* (Whitfield), (possibly a species of *Callopora*) from Delafield, Wisconsin; *B. Varians* James and *B. variabile* Ulrich from various places in Ohio, Kentucky, Indiana, Illinois and Wisconsin. The two species last named have heretofore been confused, owing to inadequate descriptions and figures, although it appears that they never occupy the same horizon and are really very distinct. *Batostoma variabile*, which has been considered a rare species, occurs in great abundance at Ballstown and Weisburg, Indiana, in the lower part of the Whitewater formation.

Associated with *Batostoma varians*, in the upper Waynesville and lower Liberty formations on Tanner's Creek, Indiana, near Weisburg, is another species of *Batostoma*, not heretofore recognized. This is the form described in the present paper as *Batostoma prosseri* nov. It differs from *B. varians* in its ramose growth, more numerous mesopores, larger acanthopores with a smaller lumen, and the absence of a median lamina. These two species cannot readily be distinguished by external characters alone, but internally they are very different.

Batostoma prosseri and the ramose forms of *B. varians* are difficult to distinguish by external appearance from *Eridotrypa simulatrix* and *Callopora subnodosa* with which they are associated. The encrusting forms of *B. varians* might be confused with certain phases of *Ceramoporella*. In any of these cases, however, close inspection will reveal characteristic differences. The only species occurring with *B. variabile*, with which it might be confused is *Rhombotrypa quadrata*, which it resembles in zoarial characters, and to a less extent in deep tangential and longitudinal sections; but the quadrate zoecia at the growing ends of the branches are sufficient to distinguish the *Rhombotrypa*.

Communication pores, which have heretofore been considered as characteristic of the genus *Homotrypa*, are found in abundance in many speci-

mens of *Batostoma varians* and *B. Prosseri*. They are also typically developed in the following genera of the Trepostomata: *Bythopora*, *Callopora*, *Dekayia*, *Eridotrypa*, *Monticulipora*, *Nicholsonella* and *Peronopora*. It seems quite probable that communication pores are characteristic of all of the Trepostomata. They are most numerous near the surface, but are sometimes found in the deeper portion of the mature region. They are most readily seen in fairly thick tangential sections cut near the surface of well preserved material; but very thin sections show their structure better. Communication pores may also be seen occasionally in longitudinal sections. These pores usually pass through the region where the inter-zoecial wall is narrow, going directly from one zoecium to another. But they are sometimes very irregular in their course. They may be straight, curved, or looped, and are sometimes branched, so as to connect three zoecia. In the sections the pores usually appear clear and empty, but they sometimes are filled with dark colored, opaque pellets.

Batostoma variabile was quite certainly derived from *B. minnesotense* Ulrich, of the middle Trenton formation of Minnesota¹; from which locality it migrated southward during the late Richmond invasion. The two species seem to be almost identical.

B. prosseri, in everything but the possession of imperfect diaphragms, presents striking points of resemblance to *Hemiphragma irrasum* Ulrich.² In *B. prosseri*, however, the diaphragms are always complete, so that it is a true *Batostoma*.

Batostoma varians appears to be more closely related to the Eden forms, *B. jamesi* (Nicholson) and *B. implicatum*. The detailed description of these three Richmond species follows.

BATOSTOMA VARIANS (James).

Plate I, Figs. 1-1e; Plate VII, Figs. 3, 3a.

Chætetes varians. James, Paleontologist, No. 1, 1878, p. 2 (not figured).

Monticulipora (Chætetes) varians. James, Paleontologist, No. 5, 1881, p. 36.

Monticulipora varians. James and James, Jour. Cin. Soc. Nat. Hist., Vol. X, 1888, p. 177, pl. ii, Figs. 4a, 4b.

¹ Geology of Minnesota, vol. iil, pt. 1, p. 297, pl. 26, figs. 38-40; pl. 27, figs. 9-15.

² Ibid., p. 299, pl. xxiv, figs. 5-9.

- Batostoma variable* (pars). Ulrich, Geol. Surv. Ill., Vol. VIII, 1890, p. 460, pl. xxxv, Figs. 4b, 4c (non 4, 4a, 5, or pl. xxxvi, Fig. 1).
- Monticulipora varians*. J. F. James, Jour. Cin. Soc. Nat. Hist., Vol. XVI, 1894, p. 199.
- Batostoma variable*. J. F. James, Jour. Cin. Soc. Nat. Hist., Vol. XVI, 1894, p. 200.
- Batostoma varians*. Nickles and Bassler, Bull. U. S. Geol. Surv., No. 173, 1900, p. 179.
- Batostoma varians*. Nickles, Kentucky Geol. Surv., Bull. No. 5, 1905, p. 57, pl. iii, Figs. 8, 9.
- Batostoma varians*. Bassler, Proc. U. S. National Museum, Vol. XXX, 1906, p. 18.
- Batostoma varians*. Cumings, Indiana Dept. Geol. Nat. Res. 32d Ann. Rept., 1907, p. 778, pl. vii, Fig. 9; pl. viii, Figs. 3-3b; pl. xxvi, Fig. 14.

Zoarium irregularly ramose, branches 5 to 10 mm. in diameter, 10 to 80 mm. long; subfrondescent, or encrusting on the shells of brachiopods, Orthoceras, or other bryozoa. The encrusting forms are from one to 5 mm. thick, and frequently cover an area of 20 to 60 sq. cm. Cylindrical branches and knobs may spring from any portion of the zoarium. Surface smooth, no monticules, and only an occasional macula of larger zoëcia and mesopores. On unweathered specimens the knob-like projections of the acanthopores appear at the angles between the zoëcia. The pores at the ends of the acanthopores are funnel-shaped. The zoëcia, at the surface are usually angular or oval, sometimes rounded, and vary much in size and the thickness of the walls. The thin-walled zoëcia are angular, and the thick-walled ones are round or oval. Mesopores fewer than the zoëcia, at the angles of the latter, and in the maculæ; sometimes long and narrow, separating the zoëcia in thick-walled specimens. 6 or 7 zoëcia in 2 mm.

The tangential section shows the zoëcia to be thick-walled and separated by a conspicuous median lamina. Zoëcial apertures oval, mesopores fairly abundant, not so numerous as the zoëcia. Acanthopores abundant, situated at almost every angle between the zoëcia, rather large, thin-walled with wide central canal. Acanthopores sometimes occur in the wall between two zoëcia and then slightly indent the wall. Communication pores abundant in some specimens, but usually absent. In very shal-

low or very deep tangential sections the zoëcia are thinner walled and angular, and in the deep sections the mesopores appear to be more numerous.

In longitudinal sections the zoëcia are seen to be thin-walled and without diaphragms in the axial region, and gradually curving to the surface, they emerge at right angles to the latter. The mature region is fairly deep and here the zoëcia are thick-walled, except very close to the surface. Diaphragms from 2 to 8 in each zoëcial tube, in the mature region, one-half to two tube-diameters apart, the first one usually not nearer than two tube-diameters to the surface of the zoarium: more numerous in the mesopores, which present a chain-like appearance. In the submature region the acanthopores are thin-walled with a wide canal, crossed by numerous diaphragms. The external portion of the walls of the acanthopores as seen in longitudinal sections presents a spiny appearance, due apparently to an interrupted or periodic deposition of sclerenchyma.

According to Bassler, *Batostoma varians* is "abundant in the Arnheim, Waynesville, Liberty and Whitewater formations of the Richmond group in Ohio, Indiana and Kentucky."¹ It occurs in the Tanner's Creek section rarely in the Arnheim and lower sixty feet of the Waynesville, and abundantly in the upper thirty feet of the Waynesville and lower twenty feet of the Liberty formations. It does not occur in the upper Liberty, Saluda or Whitewater formations in Indiana. The Whitewater form is *B. variabile*. *B. varians* occurs in the base of the Liberty near Abington, Wayne County, Indiana, and in the Arnheim and Waynesville near Madison.

BATOSTOMA VARIABLE (Ulrich).

(Plate II, figs. 1-1c; Plate III, figs. 1-1c; Plate IV, figs. 1, 1a; Plate VII, figs. 1-1c.)

Batostoma variabile (pars). Ulrich, Geol. Surv. Ill., Vol VIII, 1890, pl. xxxvi, Fig. 1. (non pl. xxxvi, Figs. 4b, 4c, = *B. varians*).

Batostoma variabile. Bassler, Proc. U. S. Nat. Mus., Vol. XXX, 1906, p. 18, pl. vii, Figs. 9, 10.

Batostoma variabile. Cumings, Indiana Dept. Geol. Nat. Res. 32d Ann. Rept., 1907, p. 777, pl. xxvi, Fig. 13.

Zoarium ramose, robust, cylindrical or subcylindrical, 5 to 20 mm. in diameter, and 10 to 70 mm. long, dividing every 10 to 20 mm. either dichotomously or irregularly. The basal expansion forms large irregular masses

¹ Proc. U. S. National Museum, vol. xxx, 1906, p. 18.

by throwing off numerous large branches, which sometimes anastomose. Surface smooth, but having maculae of conspicuously larger zoëcia, which rise slightly above the surrounding zoëcia. Six maculae in 1 sq. cm. Acanthopores usually not visible at the surface, but sometimes in unweathered specimens, they project as very minute spines. Mesopores absent, except an occasional one in the macule. Zoëcia very thin-walled at the surface in well preserved material, but thick-walled just below the surface. In weathered material the zoëcia appear thick-walled at the surface, owing to the fact that this outer thin-walled zone has been removed. Zoëcia very regular in size, angular or rounded by deposits of secondary sclerenchyma; six or rarely seven in 2 mm., those in the macule one-half larger than the ordinary zoëcia.

Tangential sections show the zoëcia to be angular, thick-walled, and usually separated by a dark conspicuous lamina; their apertures rounded. Mesopores absent, but an occasional very small zoëcium, having the same wall-structure as the larger zoëcia is present. Acanthopores small or large, abundant, from 4 to 16 surrounding a zoëcium. Their walls thin, indistinct, and continuous with the median lamina. The central canal is usually minute, and not sharply defined. Communication pores few or absent.

In the longitudinal section the zoëcia are thin-walled in the axial region, slightly flexuous and crossed by straight diaphragms, from one to three tube-diameters apart. The zoëcia curve gradually till they reach the mature region, where they turn abruptly and go straight to the surface, and emerge at right angles to the latter. Diaphragms more numerous in the mature region, one-half tube-diameter or less apart. Some of the diaphragms are irregular, curved like cystiphragms, infundibular, and either concave or convex upward. Zoëcial walls abruptly thickened in the mature region, except in young zoaria, and becoming very thin again at the surface. Diaphragms thickened in the mature region by a secondary deposit.

Batostoma variabile occurs abundantly in the lower 40 feet of the Whitewater division at Weisburg and Ballstown, Indiana.

BATOSTOMA PROSSERI NOV.

(Plate V, figs. 1-1c; Plate VI, figs. 1-1d; Plate VII, figs. 2-2c.

Zoarium ramose or digitate, cylindrical, or compressed, dividing dichotomously or unequally at intervals of 10 to 20 mm.; 3 to 15 mm. in diameter and 20 to 60 mm. long. Surface smooth, but having maculae of

large zoëcia and mesopores, elevated above, or depressed slightly below the general level of the surface. About 9 maculae in 1 sq. cm. Mesopores abundant at the surface, frequently entirely surrounding the zoëcia; at other times not conspicuous. Zoëcial apertures round, and regular in size. Acanthopores, in unweathered specimens, appearing at the surface as large blunt spines at the angles of the zoëcia, and giving to the surface a decidedly spinose appearance. The zoëcia average 7 in 2 mm.

In tangential sections the zoëcia are thick-walled and round. The angles between the zoëcia are filled with secondary sclerenchyma and acanthopores. Mesopores usually abundant, but nearly absent in some sections. Acanthopores numerous, 4 to 10 surrounding a zoëcium; large and thick-walled, with a small distinct central canal; sometimes indenting the zoëcial walls. No intermural lamina. Communication pores usually absent, but numerous in some sections.

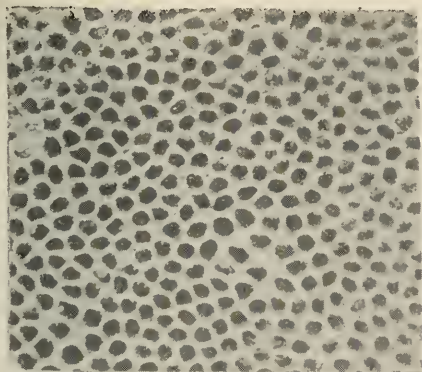
In longitudinal sections the zoëcia are thin-walled and wavy in the axial region, and usually without diaphragms. Diaphragms begin abruptly as the mature region is entered, and become numerous toward the surface, where they are from one-half to one tube-diameter apart. Zoëcial walls much thickened in the mature region, and proceeding directly to the surface, where they emerge at right angles to the latter. In immature specimens the zoëcial apertures are oval, the mature region shallow, and the zoëcia emerge obliquely to the surface. In the longitudinal section the acanthopores are thick-walled, with a small central canal, crossed by an occasional diaphragm. The diaphragms in the zoëcia are usually straight, but are occasionally cystoid. Diaphragms are more numerous in the mesopores.

The distinguishing features of *Batostoma prosseri* are the ramose growth, numerous mesopores and large acanthopores. The species is named in honor of Professor C. S. Prosser of Ohio State University. It occurs in the upper 40 feet of the Waynesville, and commonly in the lower 20 feet of the Liberty, at Weisburg, Indiana. It disappears abruptly at the level of the *Plectambonites sericcus* layer, as does also *B. varians*, with which it is associated.

	Growth.	Size.	Surface.	Number of Zoecia in 2 mm.	Acanthopores. Number and Size.	Mesopores.	Diaphragms in Axial Region.	Diaphragms in Peripheral Region.	Communication Pores.	Diaphragms in Mesopores.	Median Lamina.
BATOSTOMA VARIANS.	Irregularly ramose, subfrondescent, encrusting.	5-10 mm. thick, 10-80 mm. long.	Smooth, rarely spinose. Zoecia thin or thick walled, polygonal or rounded. Mesopores few.	6-7	Numerous, medium sized, thin walled, thorny in longitudinal section.	Few.	Usually Absent.	Few to Numerous.	Absent, few or numerous.	Numerous, chainlike.	Distinct.
BATOSTOMA PROSERRI.	Ramose.	3-15 mm. thick, 20-60 mm. long.	Smooth or spinose. Zoecia thick walled.	7	Numerous, large thick walled.	Abundant.	Few, usually absent.	Numerous, beginning abruptly in a line parallel with the surface.	Absent, few or numerous.	Numerous, rarely chainlike.	Indistinct or absent.
BATOSTOMA VARIABILE.	Ramose robust.	5-20 mm. thick, 10-70 mm. long.	Smooth. Maculae of large zoecia.	6	Numerous, medium size, indistinct.	Absent.	Numerous.	Numerous.	Few or absent.		Usually distinct.

PLATE I.

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1. Surface, x 9. Upper Waynesville.	
1a. A subfrondescent specimen, natural size. Lower Liberty.	
1b. Typical tangential section, showing communication pores. x 18. Upper Waynesville.	
1c. A subramose specimen, natural size. Lower Liberty.	
1d. Longitudinal section, showing deep mature region and spiny acanthopores, x 18. Lower Liberty.	
1e. Typical longitudinal section, x 18. Upper Waynesville. All specimens from Weisburg, Ind.	

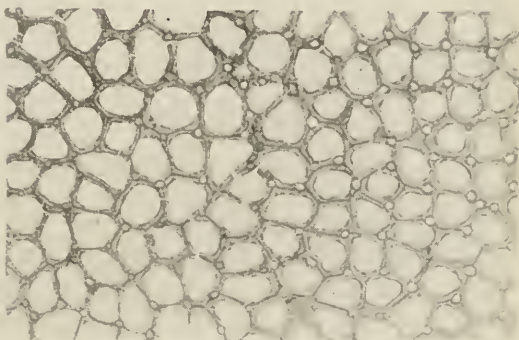


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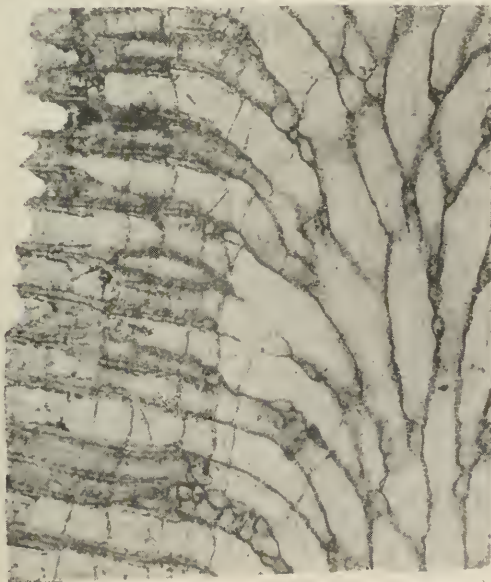
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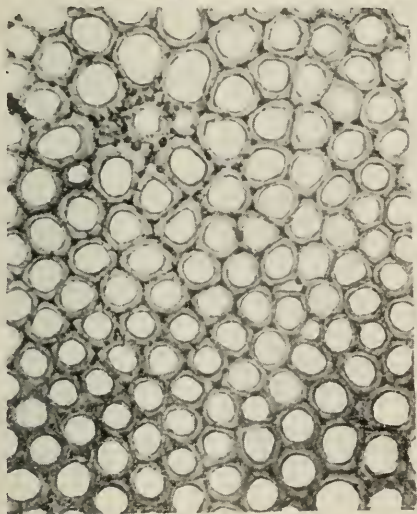


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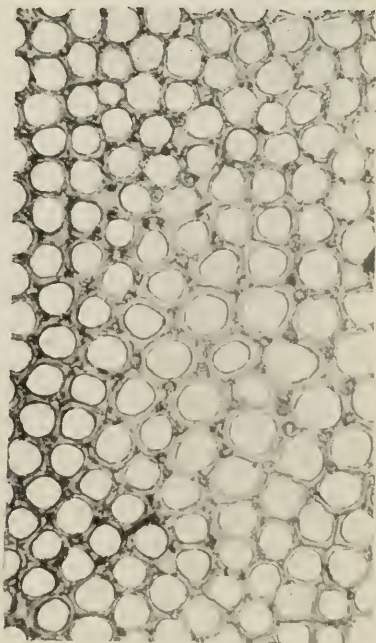


PLATE II.

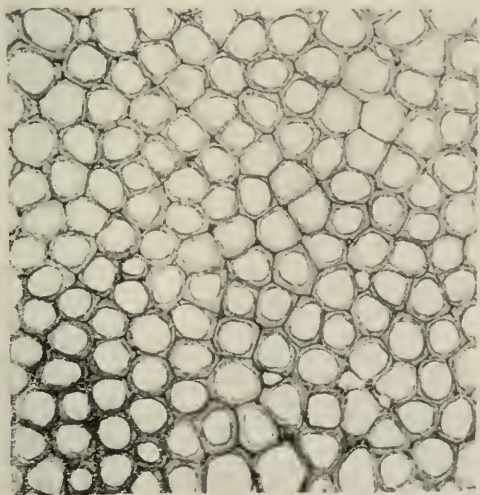
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<i>Batostoma variabile</i> Ulrich.....	150
1. Typical tangential section, x 18. Ballstown, Ind.	
1a. Tangential section, showing unusually large acanthopores and faint median lamina, x 18. Weisburg, Ind.	
1b. Shallow tangential section, showing thin walls and few acanthopores, x 18. Weisburg, Ind.	
1c. Ramose specimen, natural size. Weisburg, Ind.	



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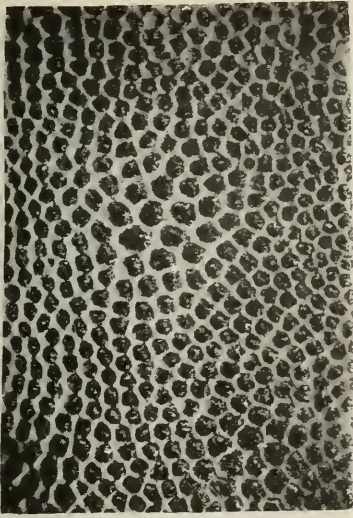
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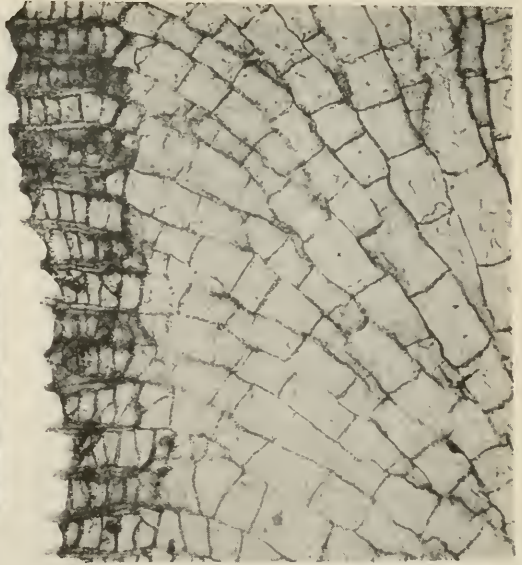
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PLATE III.

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<i>Batostoma variabile</i> Ulrich.....	150
1. Surface, showing a macula and thin-walled zoecia, x 9.	
1a. Longitudinal section, x 18.	
1b. Typical longitudinal section, x 18.	
1c. A compressed specimen, natural size. All specimens from Weisburg, Ind.	

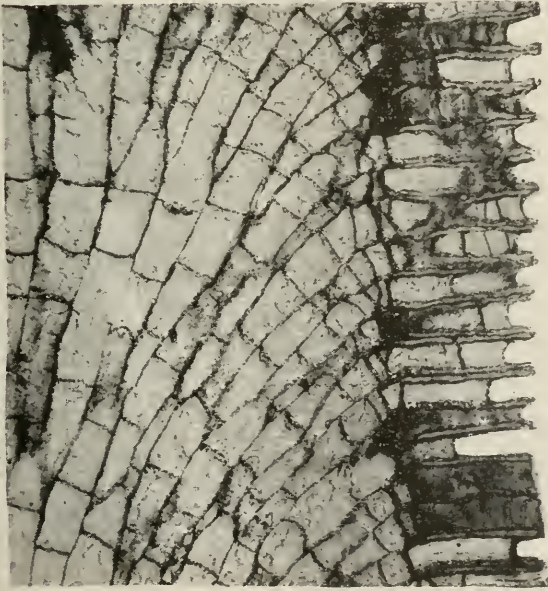


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1a

1b



1c

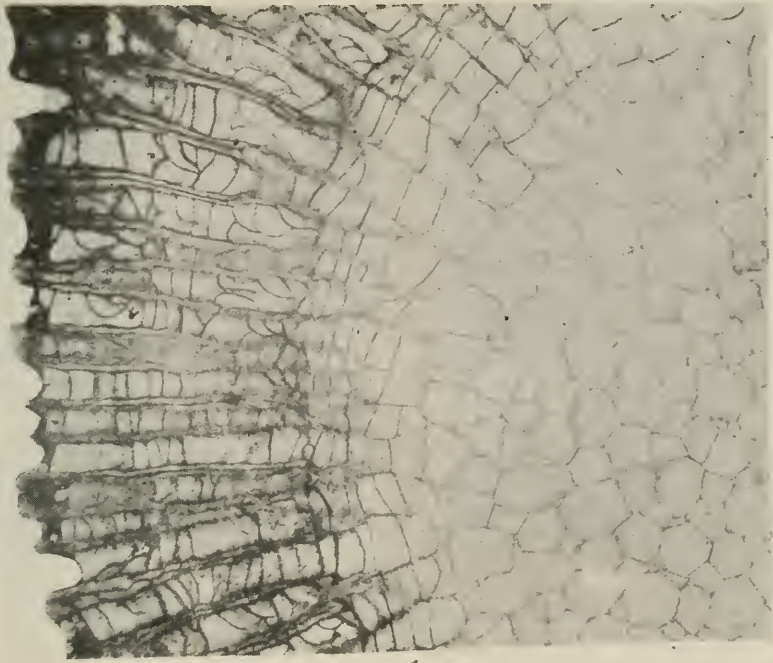
PLATE IV

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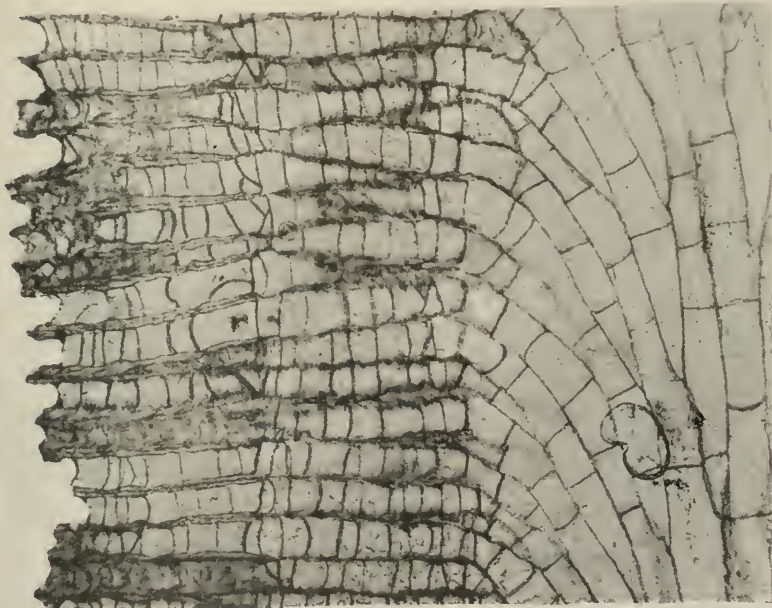
Batostoma variabile Ulrich.....150

1. Cross section, showing an unusual development of cystoid diaphragms, x 18. Ballstown, Ind.

1a. Longitudinal section of a specimen having an unusually deep mature region, x 18. Weisburg, Ind.



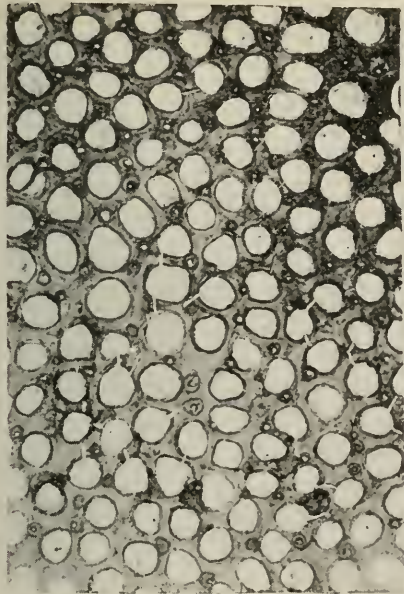
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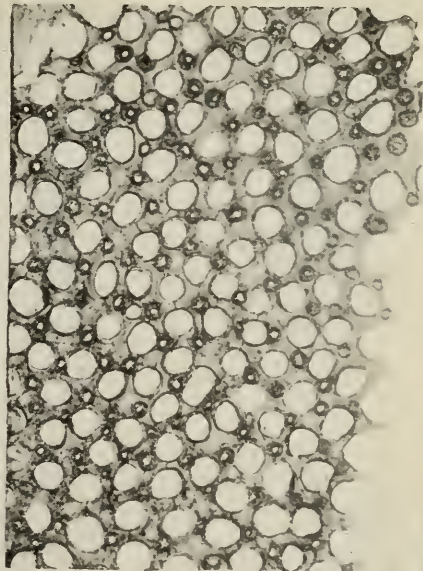
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PLATE V.

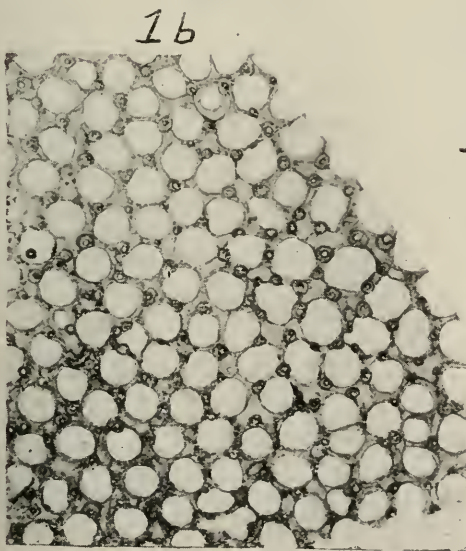
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1. Tangential section, showing communication pores, x 18. Lower Liberty.	
1a. Tangential section, showing unusually large acanthopores, x 18. Lower Liberty.	
1b. Typical tangential section, x 18. Upper Waynesville.	
1c. Surface, showing numerous mesopores and acanthopores, x 9. Lower Liberty. All specimens from Weisburg.	



1



1a



1c

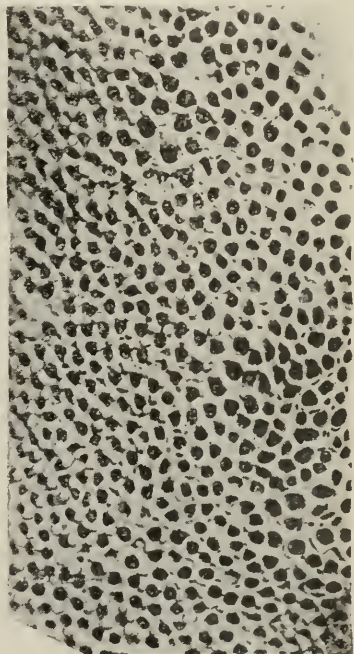
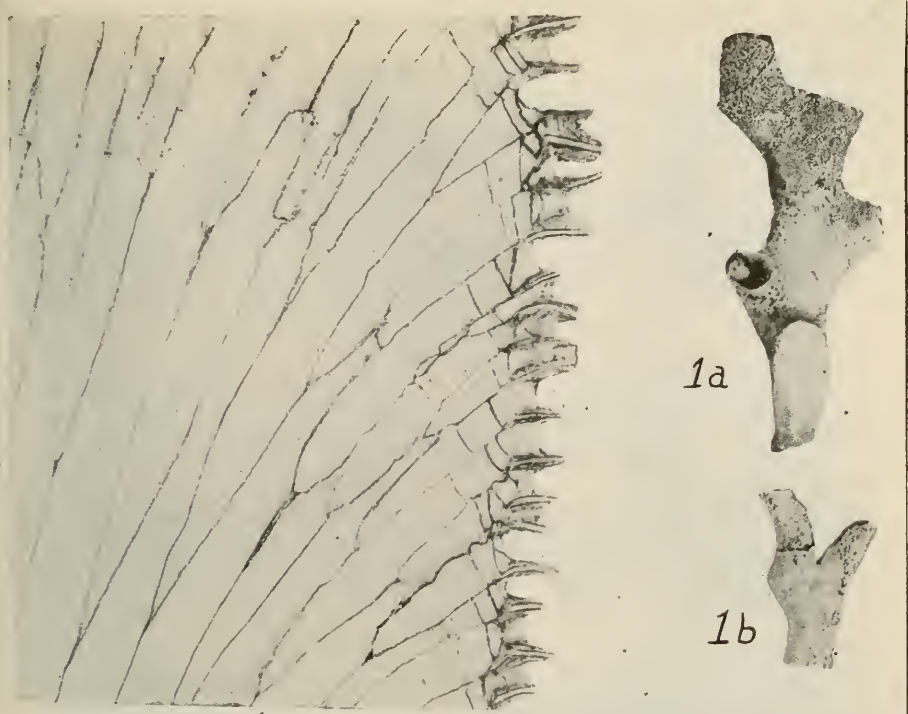


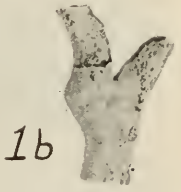
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1. Longitudinal section, showing shallow mature region, x 18. Lower Liberty.	
1a. and b. Two specimens natural size. Lower Liberty.	
1c. Typical longitudinal section, x 18. Upper Waynesville.	
1d. Longitudinal section, showing deep mature region, x 18. Upper Waynesville.	



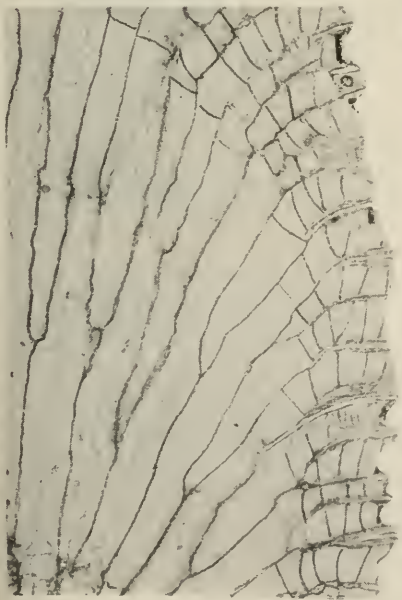
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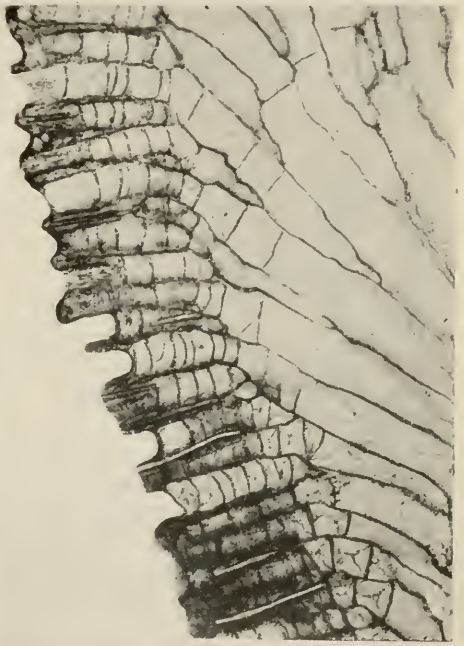
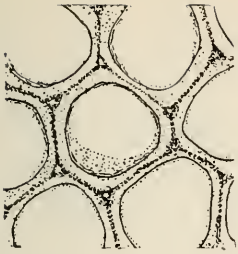


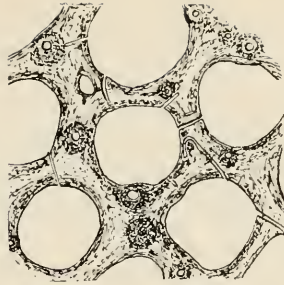
PLATE VII.

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1. Shallow Tangential section, showing thin walls. Weisburg, Ind. ¹	
1a. Deep tangential section, showing thick walls. Weisburg, Ind.	
1b. Tangential section, showing numerous indistinct acantho- pores. Ballstown, Ind.	
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2a. Tangential section, showing communication pores. Weis- burg, Ind. Upper Waynesville.	
2b. Tangential section, showing unusually large and numerous acanthopores. Weisburg, Ind. Upper Waynesville.	
2c. Longitudinal section.	
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3. Typical tangential section.	
3a. Longitudinal section, showing spiny acanthopores crossed by diaphragms.	

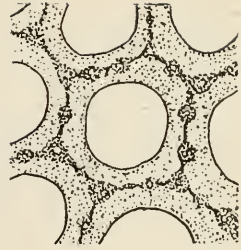
¹All figures magnified 44 diameters.



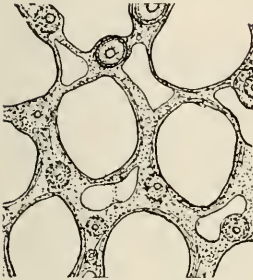
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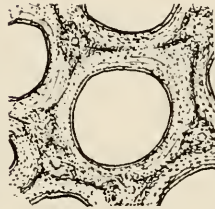
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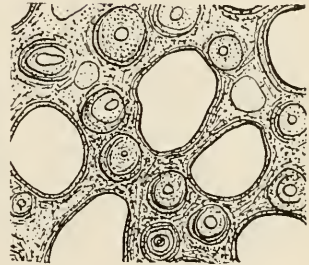
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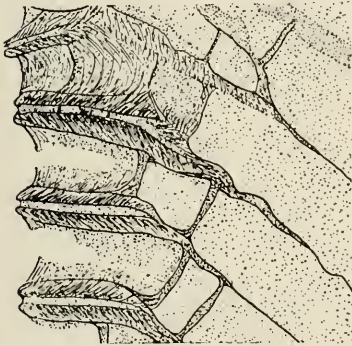
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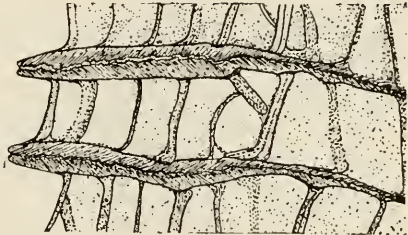
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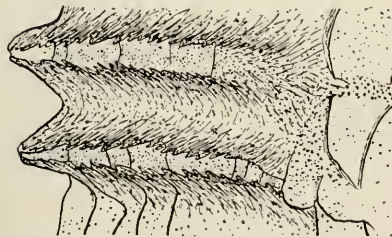
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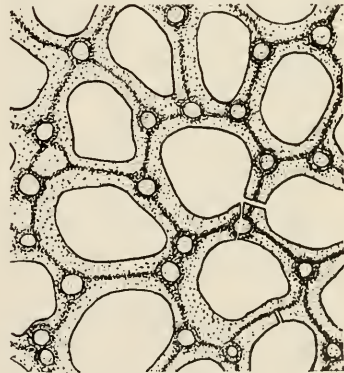
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1c



3a



3

PLATE VII.

