CHAZYAN (ORDOVICIAN) LEPTOTRYPELLID AND ATACTOTOECHID BRYOZOA

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ABSTRACT. In Chazyan dolomitized biohermal reef complexes the bryozoans *Atactotoechus chazyensis* sp. nov. and *A. kayi* sp. nov. range throughout the standard Chazyan Series in the type section in north-eastern New York State and also occur on Isle La Motte, Vt. These primitive species of *Atactotoechus* considerably extend the geologic range of this genus (hitherto regarded as Devonian and early Carboniferous?) downward into middle Ordovician strata.

Jordanopora gen. nov. appears to be a primitive representative of the leptotrypellids and the single species, *J. heroensis* sp. nov., occurs in the Chazyan Series near Chazy, on Isle La Motte, and South Hero Island.

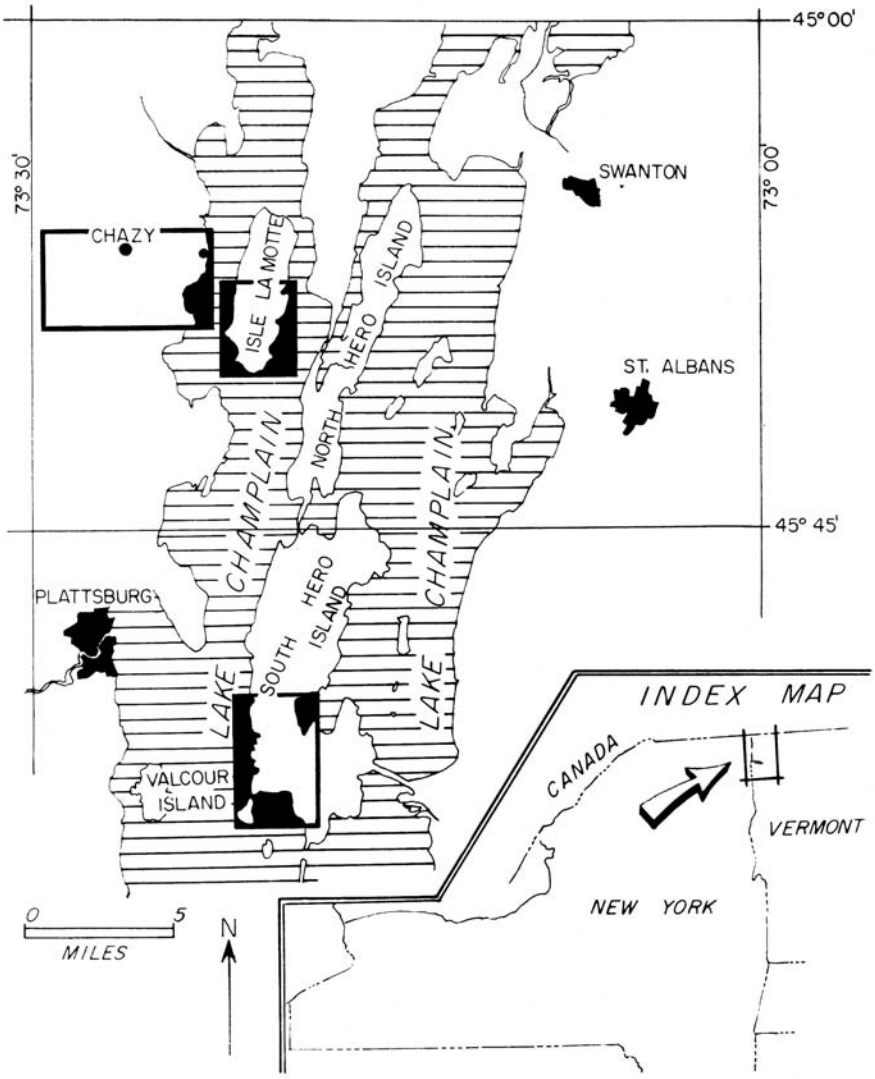
IN north-eastern New York State around Chazy and on Isle La Motte and South Hero Island, western Vermont (text-figs. 1–5), the Chazy Formation contains numerous trepostome and cryptostome Bryozoa (Ross, in press).

The trepostomes are well distributed through the 470 feet of strata in the type Chazy Formation (text-fig. 5). *Atactotoechus chazyensis* sp. nov., the oldest representative of this genus, ranges through member A and the lower part of member B. *A. kayi* ranges from the middle part of member B into the upper part of member C. These species occur principally in dolomitic calcarenites of a biohermal reef complex. The fragments of colonies of Bryozoa and other shell and plant material, and the poor sorting of these algal–bryozoan biosparites (limestone classification of Folk 1959), suggest shallow water deposition of the sediments in a high wave-energy environment such as on a reef flat or on the front slope of a reef. *A. chazyensis* is also present on southern Isle La Motte, and at localities 13 and 14 spectacular colonies 5 to 6 feet in diameter dominate the outcrops. Farther north, at Jordan Point, the species is abundant in a bryozoan bioherm. *A. kayi* sp. nov., which has not been found outside the type Chazy section, is the younger of the two species of *Atactotoechus* and differs from *A. chazyensis* in the sparse number of irregularly arranged diaphragms which are present only in the peripheral region and are absent in the axial region of a colony.

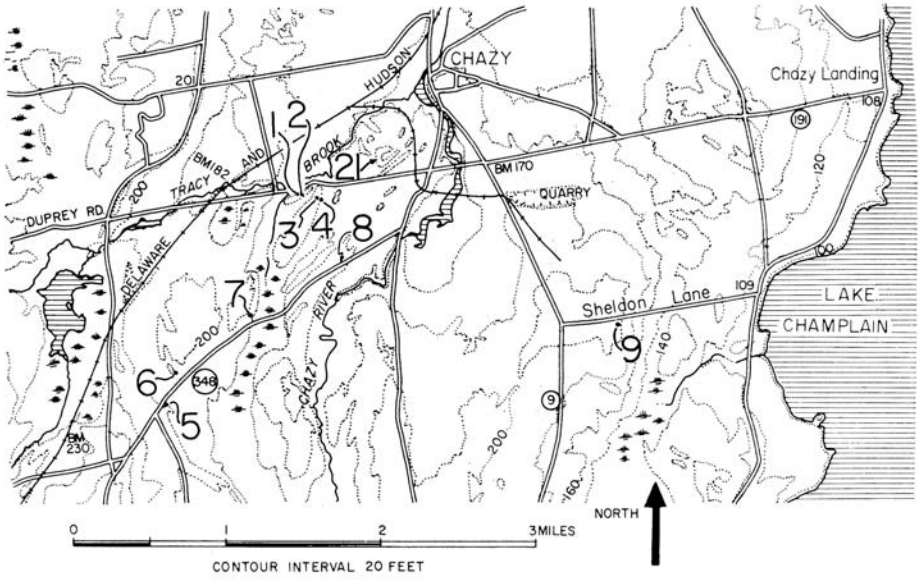
The new genus *Jordanopora*, which appears to be one of the earliest representatives of the leptotrypellids, has not been found in the type Chazy section but occurs in Chazyan strata at Sheldon Lane 2 miles to the east and is again found near Holcomb Point and Jordan Point, Isle La Motte, and at a single locality on South Hero Island.

Duncan (1939) erected the family Atactotoechidae based on Devonian species of *Atactotoechus* and noted (ibid., p. 184) that this genus was allied to Ordovician and Silurian trepostomes of several different families. Boardman (1960) distinguished the atactotoechid group in his study of Devonian trepostomes from the Hamilton Group of New York State. The Ordovician species of *Atactoteochus* are similar in the microstructures of their integrate zooecial walls to the Devonian species and the morphology of the diaphragms and mesopores is also similar in the two groups of species. The Ordovician species, however, lack acanthopores with steeply inclined laminate walls which are reported in some Devonian species of *Atactotoechus*. *Amplexopora*, in which

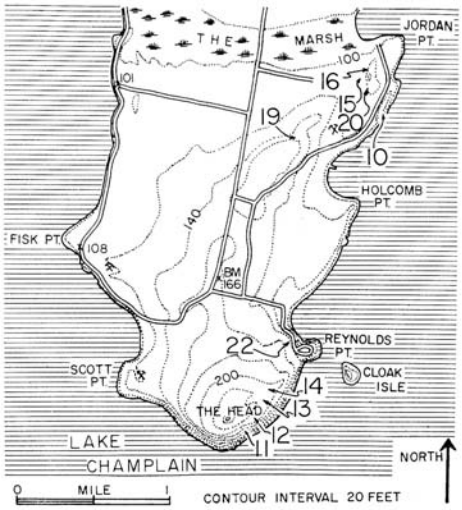
[Palaeontology, Vol. 5, Part 4, 1962, pp. 727–39, pls. 105–108.]



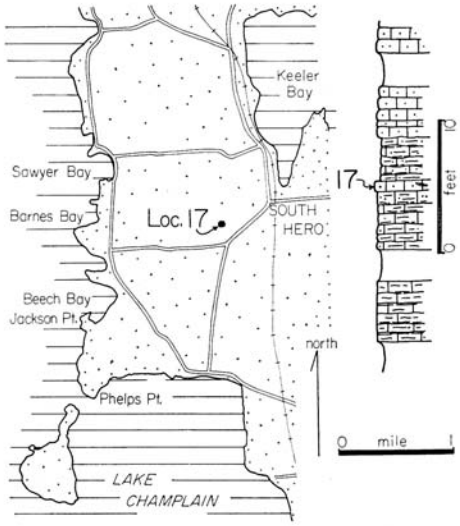
TEXT-FIG. 1. Index maps of Chazy, Isle La Motte, and South Hero Island.



TEXT-FIG. 2. Map of Chazy area showing collection localities.



TEXT-FIG. 3. Map of Isle La Motte showing collection localities.



TEXT-FIG. 4. Map of South Hero Island showing collection locality.

acanthopores are a distinct morphologic feature, appears to be a divergent lineage from the main atactotoechid group.

Jordanopora appears to be a primitive member of the leptotrypellid group and *Anaphragma* may be a later Ordovician offshoot of this group. The main leptotrypellid stock is well defined in the Devonian, where it is represented abundantly in such assemblages as those from the Traverse Group of Michigan (Duncan 1939) and the Hamilton Group of New York State (Boardman 1960).

Acknowledgements. I express my sincere thanks to Dr. G. A. Cooper and Dr. R. S. Boardman of the United States National Museum for the loan of bryozoan specimens and to Dr. C. A. Ross, Illinois State Geological Survey, for helpful discussions on bryozoan taxonomy. I gratefully acknowledge financial support for this study by a grant from the National Science Foundation.

Repository. Peabody Museum, Yale University (abbreviated to YPM).

SYSTEMATIC DESCRIPTIONS

Leptotrypellid group

The microstructure of the zooecial walls was used by Boardman (1960, p. 51) to distinguish the leptotrypellid group. The inner parts of the zooecial walls are composed of steeply inclined, distally sloping laminae which pass indistinctly into the amalgamate outer parts formed by adjacent zooecia. The amalgamate outer parts display distally convex laminae.

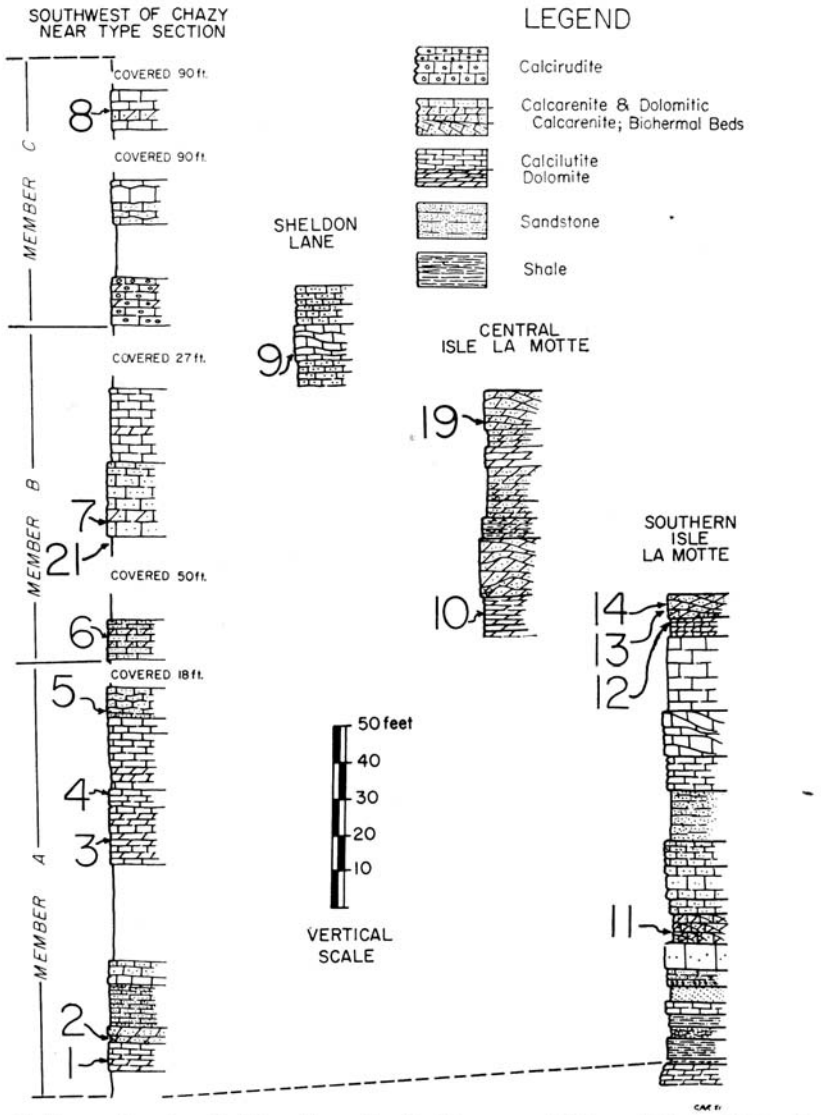
Genus JORDANOPORA gen. nov.

Type species. Jordanopora heroensis sp. nov.

Definition. Colonies are ramose or incrusting. Round zooecial openings are separated by wide, amalgamate laminate walls. In tangential sections the outer amalgamate parts of the zooecial walls are penetrated by very numerous small pores. Small mesopores are sparse between zooecia. In longitudinal sections the slender, crenulate, longitudinally laminate zooecial walls in the axial region pass into a narrow peripheral region of thickened zooecial walls. These thickened zooecial walls consist of laminae lying for a short distance parallel to the direction of the zooecial tube, then inclining steeply to the zooecial boundary. Near the zooecial boundary the laminae have a distally convex curvature and the boundary of adjacent zooecia consists of an intertonguing of these curved wall laminae. In the peripheral region the boundary is penetrated by small pores that have broadly curved, distally convex laminate wall structure. The laminae of the sparse diaphragms in the zooecial tubes enter the zooecial walls and follow the same pattern as other wall laminae. The numerous laminate diaphragms in the mesopores enter the zooecial walls in a similar manner.

Occurrence. Chazyan of Chazy area, N.Y., Isle La Motte, Vt., and South Hero Island, Vt.

Discussion. The wall structure in *Jordanopora* appears to be a forerunner of the more distinctive wall structure of *Leptotrypella*, in which the intertonguing distally convex laminae of the outer parts of adjacent zooecia are more clearly defined as a single unit than in *Jordanopora*. The steeply inclined laminae of the inner parts of the zooecial walls



TEXT-FIG. 5. Measured sections in Chazy Formation in Chazy area, N.Y., and Isle La Motte, Vt. Locality numbers indicate the position of collections. Members A, B, and C in the section measured at Chazy correspond to the subdivision of strata by Brainerd and Seely (1888).

in *Leptotrypella* are similar to those found in such diverse genera as *Anaphragma*, *Atactotoechus*, *Batostoma*, and *Amplexopora*.

Jordanopora heroensis sp. nov.

Plate 105, figs. 1–8; Plate 106, figs. 1–4, 6, 7

Type material. Holotype YPM 22233 and paratype YPM 22252, Chazy Formation; locality 17. Paratype YPM 22234, Chazy Formation; locality 16. Paratypes YPM 22235, YPM 22253, Chazy Formation; locality 15. Paratype YPM 22254, Chazy Formation; locality 10.

Description. The ramose colonies have slender zoarial stems of greatly variable diameter (Pl. 105, fig. 6; Pl. 106, figs. 1, 3) on which overgrowths are commonly present (Pl. 105, figs. 3, 5, 7; Pl. 106, figs. 3, 4, 6).

In tangential sections the amalgamate zooecial walls are almost as wide as the round zooecial openings (Pl. 105, fig. 1). Numerous very closely spaced and irregularly aligned small pores, about thirty per zooecial opening, are present in the amalgamate outer parts of zooecial walls (Pl. 105, figs. 1–3). The small pores have clear axial regions and very slender, laminate walls. Small polygonal mesopores are sparsely distributed between the zooecial openings. Very deep tangential sections (left side of Pl. 105, fig. 4) display slender walls in which laminae are indistinct and mesopores that are more distinct than in shallower tangential sections.

In longitudinal sections the zooecial walls are very slender, undulate, and longitudinally laminate in the axial region. As the walls curve gently to the periphery they thicken and mesopores appear (Pl. 105, fig. 7; Pl. 106, fig. 6). The typical laminate zooecial wall structure in the peripheral region is displayed (Pl. 105, fig. 8; Pl. 106, figs. 2, 4, 7). The flat or distally concave laminate diaphragms, which are sparse in the zooecial tubes, are commonly thin. In the mesopores, where the flat or distally concave diaphragms are more closely spaced, the laminae are thicker (Pl. 106, figs. 2, 7). The small pores are bounded by low undulations in the zooecial wall laminae (Pl. 106, fig. 2).

Occurrence. In the Chazy Formation *Jordanopora heroensis* is abundant at localities 16 and 22, Isle La Motte, and locality 17, South Hero Island. It is common at localities 10, 19, and 20, Isle La Motte, and rare at localities 9 and 21 near Chazy and locality 15, Isle La Motte.

EXPLANATION OF PLATE 105

Figs. 1–8. *Jordanopora heroensis* sp. nov. 1, Shallow tangential section showing zooecial openings, mesopores, and pores, holotype YPM 22233, ×50. 2, Enlarged view of tangential section showing amalgamate zooecial walls pierced by numerous pores, YPM 22233, ×100. 3, Oblique transverse section showing arrangement of zooecial tubes and mesopores, YPM 22233, ×20. 4, Oblique tangential section showing thin-walled zooecia and mesopores toward the base of the thickened peripheral region, YPM 22233, ×50. 5, Oblique longitudinal section of a zoarial stem with an overgrowth that extends back toward the proximal part of the colony, YPM 22233, ×20. 6, Longitudinal section showing tabulate mesopores in peripheral region of colony, YPM 22234, ×20. 7, Longitudinal section showing slender, crenulate walls in axial region, the thickened peripheral region, and an incrustation, YPM 22233, ×20. 8, Part of a longitudinal section in peripheral region showing laminate structure of zooecial walls, YPM 22233, ×100.

Remarks. The species is characterized by its narrow peripheral regions in which the zooecial walls are moderately but abruptly thickened; the diaphragms are sparse in the peripheral parts of the zooecial tubes, but are more numerous in the small mesopores; zooecial walls are crenulate throughout their length; and zooecia are polygonal and occasionally quadrate in the axial region.

TABLE 1

Measurements of *Jordanopora heroensis* sp. nov. in mm.

Catalogue no.	YPM 22233 *holotype*	YPM 22234
Diameter of zoarium	2·5 to 5·0	2·5 to 3·0
No. of zooecia per 2 mm. longitudinally	6 to 8	7 to 8
Diameter of zooecial opening	*max.* 0·15×0·10	*max.* 0·18×0·10
	min. 0·06×0·05	*min.* 0·12×0·12
Pores per zooecium	30	30
No. of mesopores per zooecium	2 to 3	2 to 4
Diameter of mesopores	*max.* 0·08×0·06	*max.* 0·08×0·08
	min. 0·04×0·04	*min.* 0·04×0·04
No. of diaphragms in a mesopore	7 to 12	8 to 14
No. of diaphragms in peripheral region of a zooecial tube	1 to 3	1 to 4
Width of peripheral region	0·8 to 1·0	0·8 to 1·0
Ratio: width of zooecium in peripheral region/total width of zooecium	0·40 to 0·48	0·42 to 0·44

The zooecial wall structure in *Jordanopora heroensis* appears allied to that in the leptotrypellid group. However, the outer parts of the zooecial walls lack a wide band of convexly curved laminae. The small pores in *J. heroensis* differ markedly from the acanthopores in some Devonian species of *Leptotrypella* which have steeply inclined laminae forming their walls. Such acanthopores are absent in *Jordanopora*. Species of *Jordanopora* have a zooecial wall structure that is similar to *Anaphragma*, but they differ in lacking acanthopores with steeply inclined laminae and in having mesopores and numerous small pores.

Atactotoechid group

Emended definition. In longitudinal sections the laminae of the zooecial walls are almost parallel to the well-defined inner boundary of the zooecial tube. They extend distally and develop only a slight inclination so that laminae of adjacent zooecia abut at angles of less than ninety degrees and form a distinct boundary line. Laminae forming the diaphragms enter the zooecial walls and follow the same steep, distal inclination as the other wall laminae.

In tangential sections the walls are generally integrate but the zooecial boundary may be demarcated by a Beckè line instead of a dark boundary.

Acanthopores are sparse or lacking and, if present, are small. Diaphragms are a distinctive feature and are curved, cystoidal, or compound. Cystiphragms may be present. (After Boardman 1960.)

Genus ATACTOTOECHUS Duncan

1939 *Atactotoechus* Duncan, p. 190.
1960 *Atactotoechus* Duncan; Boardman, pp. 69, 70.

Type species. Atactoechus typicus Duncan, 1939, p. 190.

Emended definition. Colonies are ramose, massive, or encrusting. Zooecial walls are laminate and intermittently thickened and display typical atactotoechid wall structure. Mesopores are sparse. Acanthopores having laminate wall structure are few or absent, usually restricted to monticules or groups of larger zooecia. Diaphragms commonly are curved or cystoidal and are present in varying abundance. Cystiphragms are very rare. (After Duncan 1939, and Boardman 1960.)

Range. Chazyan (Ordovician) of New York State and Vermont. Middle Devonian of New York State and Michigan. Upper Devonian of Kuznetsk Basin and Kitar, U.S.S.R. Lower Carboniferous? of the Lingling District, China.

Remarks. In a thorough study of Devonian trepostomes from the Traverse Group of Michigan Duncan (1939) noted that these Devonian trepostomes and certain Ordovician and Silurian trepostomes have various similar morphological features and that this presented possible conflicts in the systematics, depending on which structures were selected as significant. *Atactotoechus chazyensis* sp. nov. and *A. kayi* sp. nov. from the standard Chazyan are two Ordovician species that pose such taxonomic problems. They are ramose colonies which have integrate laminate zooecial walls which display microstructures similar to those observed in Devonian species from the Traverse Group, and both groups of species are closely similar in the arrangement and structure of their diaphragms and in the sparseness of mesopores and cystiphragms. The two Ordovician species lack acanthopores with steeply inclined laminate walls, which are found in some Devonian species. *A. chazyensis* and *A. kayi* appear to be early species of the genus *Atactotoechus*.

Atactotoechus chazyensis sp. nov.

Plate 107, figs. 6–10; Plate 108, figs. 1–11

Type material. Holotype YPM 22249 and paratypes 22250, 22256 to 22259, Chazy Formation; locality 13. Paratypes YPM 22240, 22246, member A of Chazy Formation; locality 1. Paratypes YPM 22260

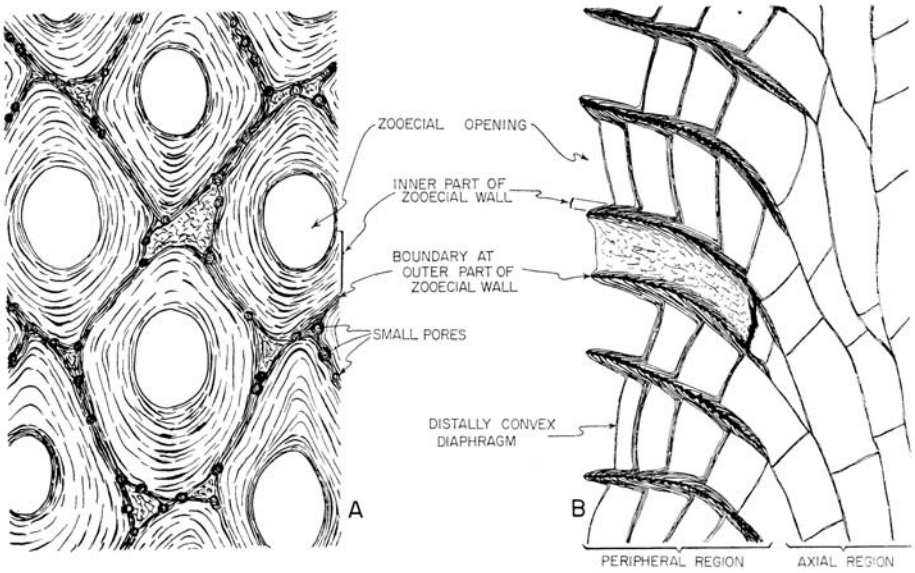
EXPLANATION OF PLATE 106

Figs. 1–4, 6, 7. *Jordanopora heroensis* sp. nov. 1, Oblique transverse section showing narrow axial and peripheral regions of slender zoarial stem, YPM 22235, ×20. 2, Oblique longitudinal section showing laminate diaphragms and pores that pierce thickened zooecial walls, YPM 22233, ×50. 3, Part of a transverse section of a zoarial stem, YPM 22233, ×20. 4, Laminate zooecial walls in peripheral part of colony; note overgrowth covering the zooecial openings, YPM 22233, ×50. 6, Longitudinal section showing slender, undulate zooecial walls in axial region and thickened zooecial walls and mesopores in peripheral region YPM 22233, ×20. 7, Part of longitudinal section at base of peripheral region showing laminate diaphragms and laminate zooecial walls, YPM 22233, ×100.

Figs. 5, 8, 9. *Atactotoechus kayi* sp. nov. 5, Longitudinal section showing irregularly arranged and sparsely distributed diaphragms in peripheral region, holotype YPM 22236, ×20. 8, Oblique tangential section showing arrangement of zooecial tubes and integrate zooecial walls, YPM 22236, ×20. 9, Tangential section showing laminate, integrate zooecial walls and oval zooecial openings YPM 22237, ×50.

to 22263, near base of member A of Chazy Formation; locality 2. Paratypes YPM 22243, 22247, 22251, near top of member A in the Chazy Formation; locality 5. Paratypes YPM 22241, 22244, Chazy Formation; locality 11. Paratypes YPM 22248, 22264, 22265, Chazy Formation; locality 14.

Description. Colonies are ramose or incrusting. Many colonies carry overgrowths of commonly two layers and some of these overgrowths display erratic structures. In shallow tangential sections (Pl. 108, figs. 2, 3, 5; text-fig. 6A) the zooecial walls may be considerably wider than the small oval or round zooecial openings. The polygonal



TEXT-FIG. 6. Microstructures in zooecial tubes and zooecial walls of *Atactotoechus chazyensis* sp. nov. × 60. A, Tangential section. B, Longitudinal section.

boundary between the laminate, integrate zooecial walls is generally identifiable as a dark, irregular line punctuated by small pores (Pl. 108, figs. 2, 3, 5; text-fig. 6A). These pores, at least ten per zooecium, may appear as dense circles (Pl. 108, fig. 2), but in some tangential sections the axial regions of those pores are clear (Pl. 108, fig. 5). In deeper tangential sections the integrate zooecial walls are very distinct and the small mesopores (four to six per 2·5 sq. mm.) are scattered between zooecia (Pl. 108, fig. 1). Acanthopores are absent.

In transverse sections a colony has varying aspects, depending on whether the colony is cut across zooecial walls (Pl. 107, fig. 9; Pl. 108, fig. 11) or across the zooecial tubes (Pl. 108, fig. 4).

In longitudinal sections the zooecial tubes in the axial region curve broadly to the periphery, where they obliquely meet the zoarial surface. In the axial region the zooecial walls are longitudinally laminate. They thicken as the tubes curve to the periphery, where

they display typical atactotoechid wall structure (Pl. 107, fig. 7; Pl. 108, fig. 7; text-fig. 6B). Flat diaphragms are regularly spaced throughout the zooecial tubes of the axial region, but become more closely spaced and include cystoidal and compound forms in the peripheral region. In colonies where the peripheral region is wide the zooecial walls are more strongly thickened (compare Pl. 107, fig. 6 and Pl. 108, figs. 8, 9, 10, with Pl. 107, fig. 7). The slender mesopores that appear in the subperipheral region and extend to the periphery have closely spaced, flat diaphragms (Pl. 107, fig. 6; Pl. 108, figs. 6, 10).

Remarks. The species is characterized by slender, ramose zoaria that have numerous, flat diaphragms in the axial region as well as in the peripheral region. Comparison with *Atactotoechus kayi* is made in remarks on that species.

Occurrence. *Atactotoechus chazyensis* is abundant at localities 1 and 5 in the type section of the formation, at localities 11, 12, 13, 14, 16, and 22 on Isle La Motte, and at locality 17 on South Hero Island. It is common at localities 2, 6, and 18 near Chazy, and at locality 15 on Isle La Motte and is rare at locality 3 in the type section near Chazy, and locality 10, Isle La Motte.

EXPLANATION OF PLATE 107

Figs. 1–5. *Atactotoechus kayi* sp. nov. 1, Part of longitudinal section showing sparsely distributed and irregularly arranged diaphragms in peripheral region, YPM 22236, ×50. 2, Longitudinal section of cylindrical zoarium showing wide axial region without diaphragms, YPM 22238, ×20. 3, Deep tangential section showing integrate, polygonal zooecial walls, YPM 22239, ×20. 4, Part of longitudinal section showing laminate zooecial walls bounded by irregular, dark line, and cystoidal diaphragms in zooecial tubes, YPM 22238, ×50. 5, Tangential section showing integrate zooecial walls forming polygons around oval zooecial openings, YPM 22237, ×20.

Figs. 6–10. *Atactotoechus chazyensis* sp. nov. 6, Longitudinal section showing abundant diaphragms throughout zooecial tubes, YPM 22240, ×20. 7, Longitudinal section showing strongly thickened zooecial walls in peripheral region, YPM 22241, ×20. 8, Oblique transverse section of slender zoarial stem, YPM 22242, ×20. 9, Transverse section showing integrate zooecial walls in peripheral region, YPM 22243, ×50. 10, Transverse section of cylindrical zoarium encrusted by broad laminate form, YPM 22244, ×20.

EXPLANATION OF PLATE 108

Figs. 1–11. *Atactotoechus chazyensis* sp. nov. 1, Deep tangential section showing laminate, integrate walls between zooecial tubes and mesopores, YPM 22245, ×50. 2, Shallow tangential section showing dense, laminate, integrate walls and small pores penetrating zooecial boundaries, YPM 22246, ×50. 3, Shallow tangential section showing arrangement of zooecia, YPM 22246, ×20. 4, Transverse section showing well-defined axial and peripheral regions and numerous diaphragms (flat, curved, and cystoidal) in zooecial tubes, YPM 22247, ×50. 5, Tangential section showing well-defined pores at zooecial boundaries, YPM 22248, ×50. 6, Part of longitudinal section showing closely spaced diaphragms in zooecial tubes and mesopores, holotype YPM 22249, ×20. 7, Part of longitudinal section showing laminate, integrate zooecial wall structure and laminate diaphragms entering into zooecial walls, YPM 22241, ×50. 8, Part of longitudinal section showing flat diaphragms in axial region and flat, cystoidal, and compound diaphragms in peripheral region, YPM 22250, ×20. 9, Oblique longitudinal section of slender zoarial stem, YPM 22251, ×20. 10, Longitudinal section showing regular arrangement of diaphragms, YPM 22240, ×20. 11, Transverse section showing laminate wall structure and distinctive zooecial wall boundaries, YPM 22255, ×50.

TABLE 2

Measurements of *Atactotoechus chazyensis* sp. nov. in mm.

Catalogue no.	YPM 22249 *holotype*	YPM 22248
Diameter of zoarium	2 to 4	2 to 2·7
No. of zooecia per 2 mm. longitudinally	7 to 8	6 to 7·5
Diameter of zooecial opening	*max.* 0·26×0·20	*max.* 0·19×0·16
	min. 0·17×0·17	*min.* 0·11×0·05
Pores per zooecium	0 to 5	0 to 10
No. of mesopores per zooecium	0 to 3	0 to 2
Diameter of mesopores	*max.* 0·10×0·06	*max.* 0·08×0·05
	min. 0·08×0·04	*min.* 0·05×0·04
No. of diaphragms in a mesopore	6 to 10	7
No. of diaphragms in peripheral region of a zooecial tube	5 to 8	4 to 7
No. of diaphragms in axial region of a zooecial tube	8 to 10	8 to 11
Width of peripheral region	0·44 to 0·50	0·44 to 0·47
Ratio: width of zooecium in peripheral region/total width of zooecium	0·40 to 0·45	0·33 to 0·38
Combined zooecial wall thickness between adjacent zooecial openings	0·05 to 0·09	0·06 to 0·09

Atactotoechus kayi sp. nov.

Plate 106, figs. 5, 8, 9; Plate 107, figs. 1–5

Type material. Holotype YPM 22236, member C of Chazy Formation; locality 8. Paratypes YPM 22237 and 22238, near base of member B in Chazy Formation; locality 18. Paratype YPM 22239, in member B of Chazy Formation; locality 7.

Description. Colonies are ramose (Pl. 107, figs. 2, 5) or encrusting. In tangential sections the integrate zooecial walls are narrower than the zooecial openings. Commonly the round zooecial openings are regularly arranged in longitudinal series around the zoarial stem (Pl. 106, fig. 9; Pl. 107, fig. 5). Acanthopores were not observed and mesopores, if present, are very sparse. The zooecial walls are very distinctly integrate and the boundary between adjacent zooecia is marked by a Beckè line (Pl. 106, fig. 9).

In longitudinal section in the axial region the thin, longitudinally laminate, zooecial walls are undulate and the zooecial tubes lack diaphragms (Pl. 106, fig. 5; Pl. 107, fig. 2). In the subperipheral region the zooecia arch gently and a diaphragm may be present in the zooecial tube. In the peripheral region the zooecial tubes are inclined obliquely to the zoarial surface, the thickened zooecial walls display the atactotoechid microstructure and irregularly spaced, curved, cystoidal, or compound diaphragms are present.

Occurrence. The species is common at localities 7, 8, and 18 near Chazy village.

Remarks. The colonies of *Atactotoechus kayi* are small (1·8 to 4·0 mm. diameter) for the genus. The species is characterized by undulate zooecial walls in the axial and peripheral regions; by zooecial walls that are distinctly thickened in the peripheral region; by diaphragms that are generally absent in the axial region and sparse and irregularly arranged in the peripheral regions; and by the lack of acanthopores and mesopores.

The species differs from *A. chazyensis* in lacking diaphragms in the axial region and

TABLE 3

Measurements of *Atactotoechus kayi* sp. nov. in mm.

Catalogue no.	YPM 22236 *holotype*	YPM 22239
Diameter of zoarium	1·8 to 2·5	2 to 2·5
No. of zooecia per 2 mm. longitudinally	8 to 9·5	8·5 to 9
Diameter of zooecial opening	*max.* 0·21×0·14 *min.* 0·13×0·10	*max.* 0·23×0·19 *min.* 0·12×0·07
Combined zooecial wall thickness between adjacent zooecial openings	0·08 to 0·13	0·10 to 0·11
Pores per zooecium	0 to 2	0 to 5
No. of mesopores per zooecium	0 to 2	0 to 2
Diameter of mesopores	*max.* 0·11×0·16 *min.* 0·08×0·05	*max.* 0·10×0·05 *min.* 0·03×0·03
No. of diaphragms in a mesopore	3 to 4	3 to 6
No. of diaphragms in peripheral region of a zooecial tube	2 to 4	6
Width of peripheral region	0·50 to 0·53	0·24
Ratio: width of zooecium in peripheral region/total width of zooecium	0·57	0·46

having only sparse distribution of diaphragms in the peripheral region. *A. kayi* also generally lacks the small pores that are present at the integrate boundaries of zooecial walls of *A. chazyensis*.

The species is named after Professor G. Marshall Kay, who has contributed so extensively to Ordovician stratigraphy in New York State.

COLLECTING LOCALITIES

CHAZY FORMATION

1. 10 feet above the base of Brainerd and Seely's section no. 1 (1888, p. 326); about 50 yards south-west of intersection of Tracy Brook and Duprey Road; near base of member A. *Atactotoechus chazyensis* sp. nov.
2. 16 feet above the base of Brainerd and Seely's section no. 1 (1888, p. 326); about 50 yards south-west of the intersection of Tracy Brook and Duprey Road; near the base of member A. *Atactotoechus chazyensis* sp. nov.
3. 70 feet above the base of Brainerd and Seely's section no. 1 (1888, p. 326); about 220 yards south-west of intersection of Tracy Brook and Duprey Road; in member A. *Atactotoechus chazyensis* sp. nov.
4. 80 feet above the base of Brainerd and Seely's section no. 1 (1888, p. 326); about 220 yards south-west of intersection of Tracy Brook and Duprey Road; near the top of member A. *Atactotoechus chazyensis* sp. nov.
5. East side of N.Y. highway 348, 3 miles south-west of the centre of Chazy village; near the top of member A. *Atactotoechus kayi* sp. nov.; *A. chazyensis* sp. nov.
6. West side of N.Y. highway 348, 2·5 miles south-west of the centre of Chazy village; at the base of member B. *Atactotoechus chazyensis* sp. nov.
7. West side of N.Y. highway 348, 2 miles south-west of the centre of Chazy village; 78 feet above locality 5 in member B. *Atactotoechus kayi* sp. nov.
8. East side of N.Y. highway 348, 1·5 miles S. 25° W. of the centre of Chazy village; in member C and 194 feet above locality 5. *Atactotoechus kayi* sp. nov.
9. On the south side of Sheldon Lane, south-south-east of Chazy village, 0·3 miles east of the intersection of U.S. highway 9 and Sheldon Lane. *Jordanopora heroensis* sp. nov.

10. At lake-level (95 feet elevation) on Lake Champlain, eastern shore of Isle La Motte, 1·2 miles N. 16° E. of Holcomb Point, Isle La Motte. *Jordanopora heroensis* sp. nov.; *Atactotoechus chazyensis* sp. nov.
11. Near lake-level (95 feet elevation) on Lake Champlain, eastern shore of Isle La Motte, Vt., and $\frac{7}{8}$ mile south of Reynolds Point. *Atactotoechus chazyensis* sp. nov.
12. On the eastern slope of The Head, Isle La Motte, Vt.; $\frac{1}{4}$ mile south-west of locality 13. *Atactotoechus chazyensis* sp. nov.
13. On the north-eastern slope of The Head, Isle La Motte, Vt., and $\frac{1}{2}$ mile south-west of Reynolds Point. *Atactotoechus chazyensis* sp. nov.
14. On the north-eastern slope of The Head, Isle La Motte, Vt., and $\frac{1}{2}$ mile south-west of Reynolds Point, 100 yards north of locality 13. *Atactotoechus chazyensis* sp. nov.
15. 1 mile S. 25° E. of Isle La Motte village toward Jordan Point. *Jordanopora heroensis* sp. nov.; *Atactotoechus chazyensis* sp. nov.
16. 1 mile S. 25° E. of Isle La Motte village and 100 yards north of locality 15, toward Jordan Point. *Jordanopora heroensis* sp. nov.; *Atactotoechus chazyensis* sp. nov.
17. On eastern slope of hill, 0·6 mile south-west of Rutland railroad station, South Hero Island, Vt. *Jordanopora heroensis* sp. nov.
18. Float collected near locality 5, east side of N.Y. highway 348, 3 miles south-west of the centre of Chazy village, and near the base of member B. *Atactotoechus chazyensis* sp. nov. and *A. kayi* sp. nov.
19. On south-eastern hillslope, 1·3 miles S. 20° E. of centre of Isle La Motte village, Vt., and west of limestone quarry. *Jordanopora heroensis* sp. nov.
20. 0·95 mile S. 40° W. of Jordan Point, Isle La Motte. *Jordanopora heroensis* sp. nov.
21. From ledge in field north of Duprey road near Chazy village; in member B. *Jordanopora heroensis* sp. nov.
22. 0·17 mile N. 60° W. of Reynolds Point, Isle La Motte. *Atactotoechus chazyensis* sp. nov.

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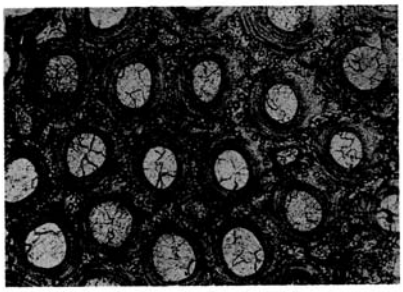
Manuscript received 8 January 1962



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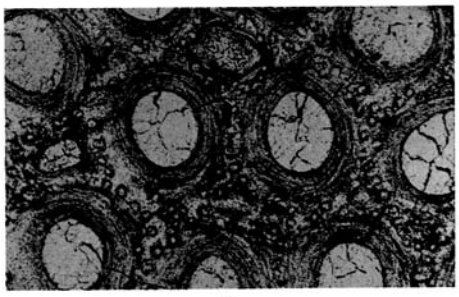

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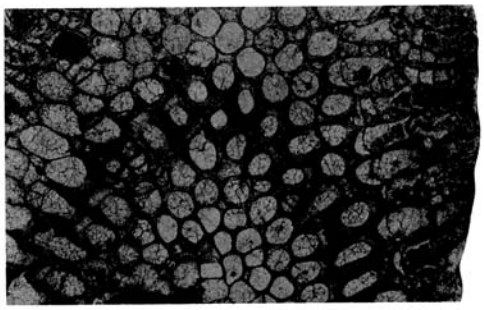

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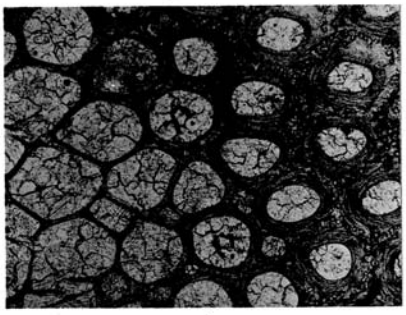

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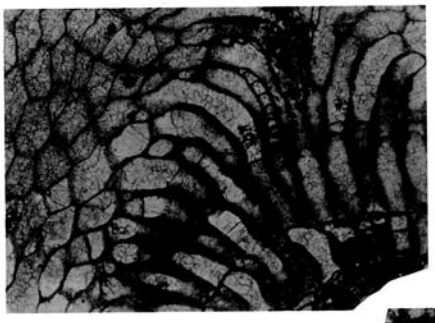

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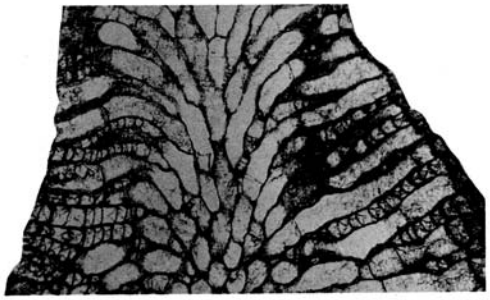

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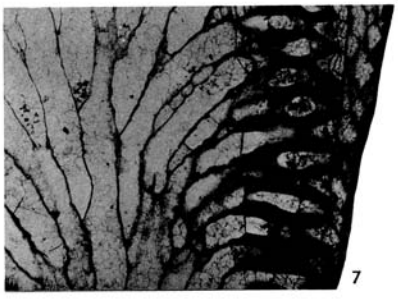

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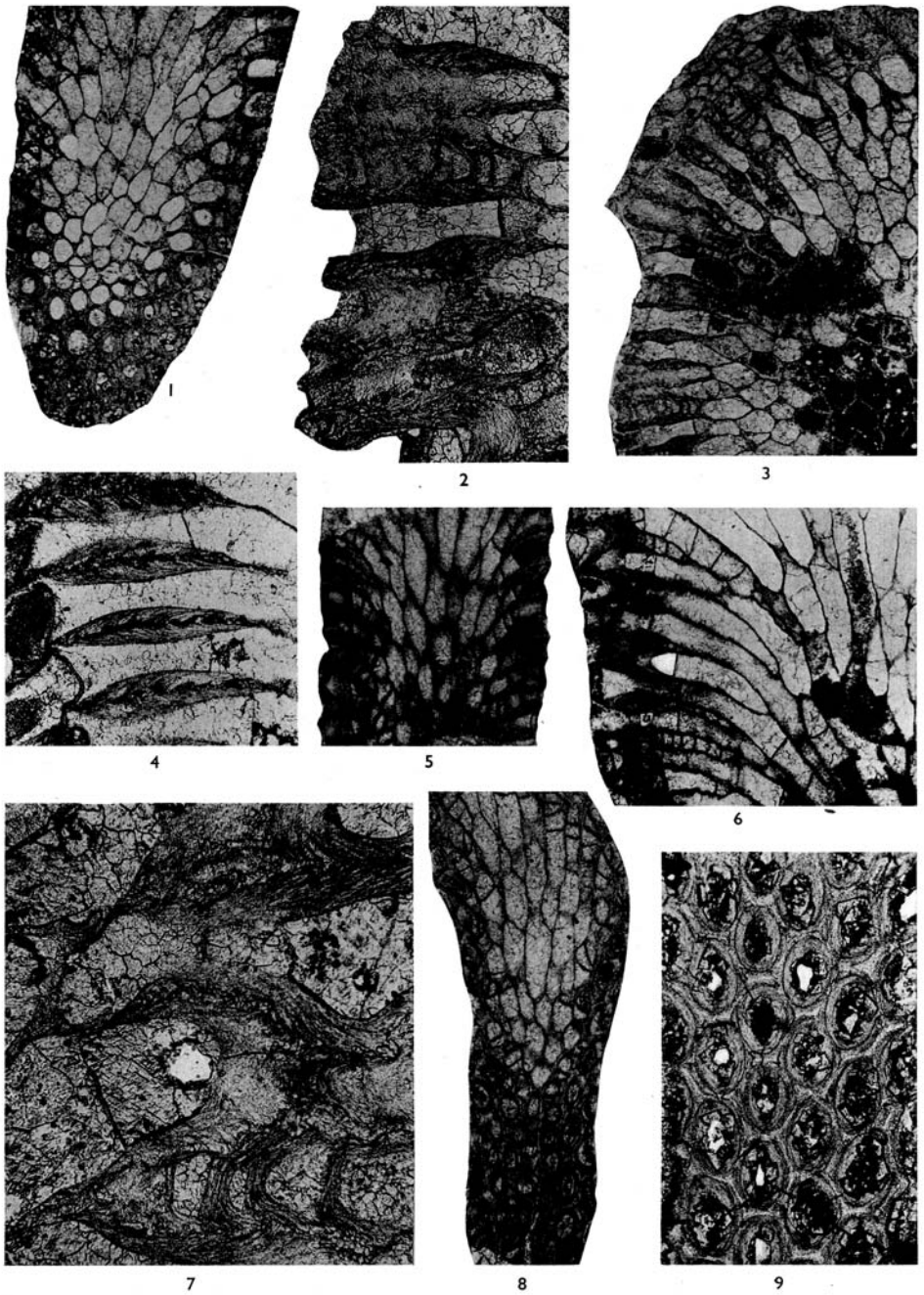

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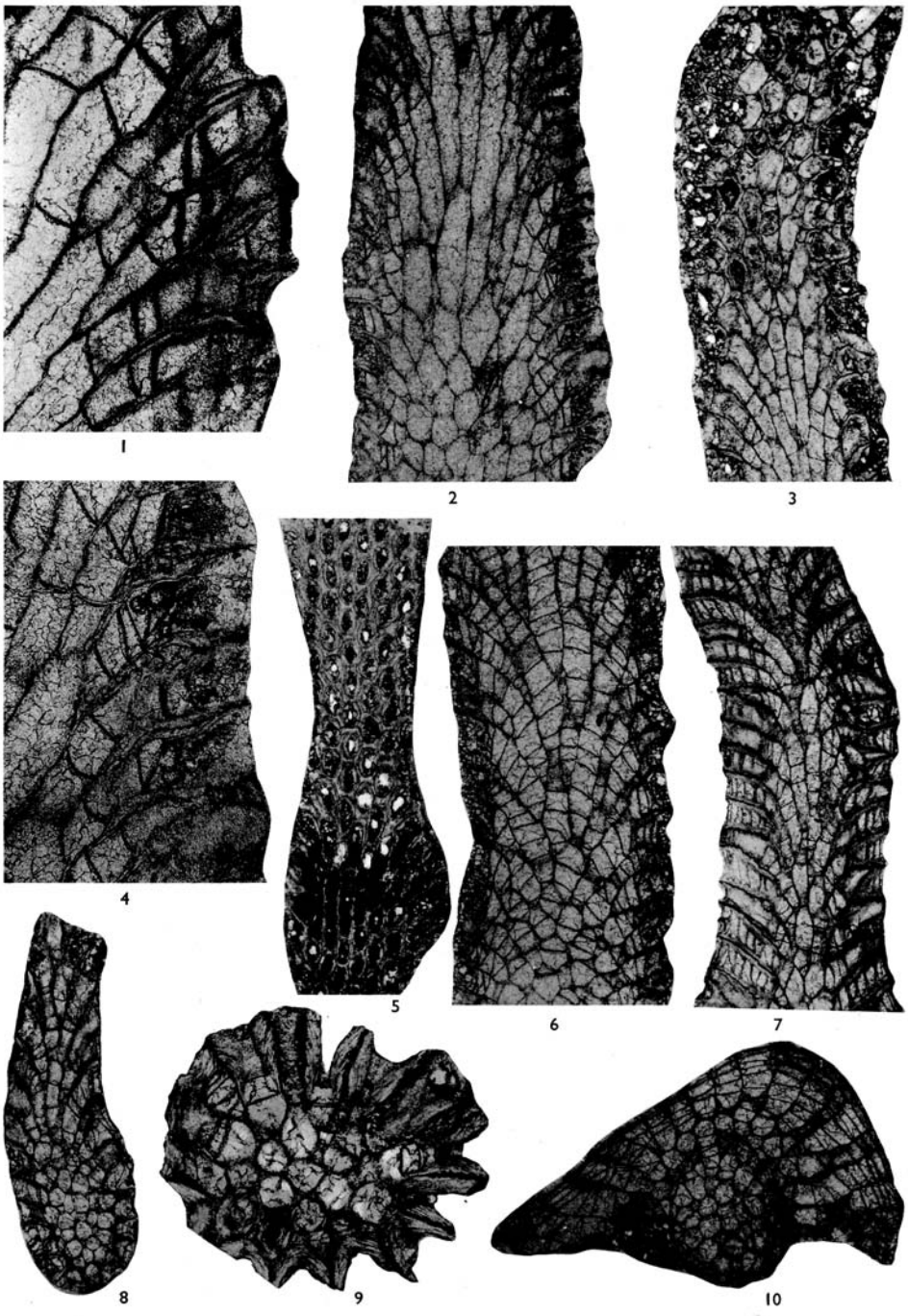

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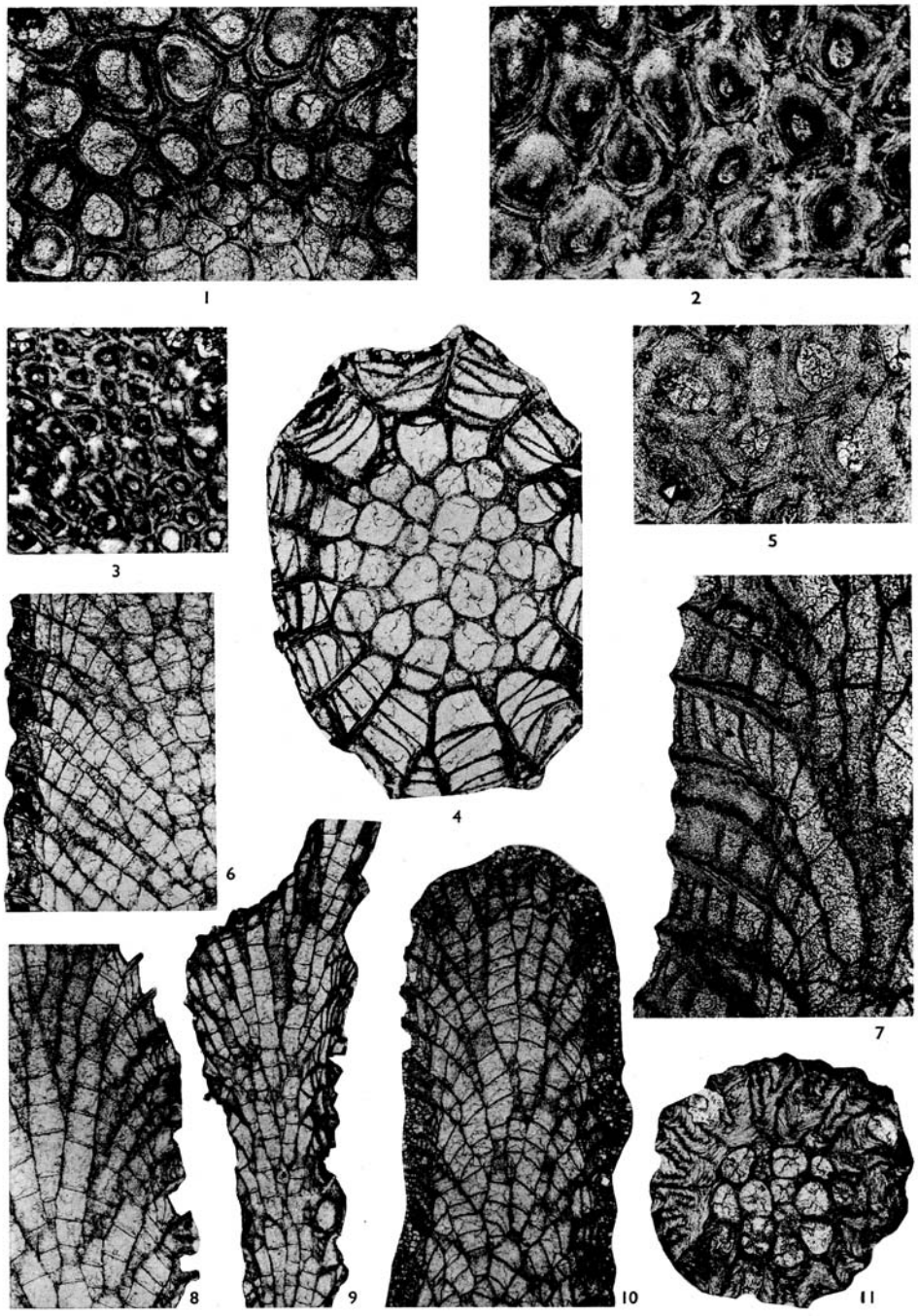

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