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BULLETIN 134

GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

CONTRIBUTIONS TO CANADIAN PALAEONTOLOGY

PART I — Trilobites from Upper Silurian Rocks of the Canadian Arctic Archipelago: *Encrinurus* (*Frammia*) and *Hemiarges*

Thomas E. Bolton

PART II — Ordovician and Silurian Tabulate Corals *Labyrinthites, Arcturia, Troedssonites, Multisolenia,* and *Boreaster*

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PART III — A New Species of *Hemicystites*

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PREFACE

The three papers comprising this bulletin deal with different groups of fossils from the Ordovician and Silurian rocks of Canada. The first describes some trilobites of considerable stratigraphic interest in the Arctic, the second several genera of tabulate corals. The third paper, in addition to describing a new species of the extinct class of edrioasteroids, provides new information on the shell structure of the orthoceroid cephalopod to which the edrioasteroid was attached during its life time.

Studies such as are presented in this Bulletin serve to indicate the diversity of continuing palaeontological research in the Geological Survey, and show, in the case of the trilobites, that a few specimens collected many years ago on the 'Fram' expedition have proved to be of considerable interest and value for the more specialized scientific studies of the present day.

Y. O. FORTIER,
Director, Geological Survey of Canada

OTTAWA, October 2, 1964

Bulletin 134 — Beiträge zur kanadischen Paläontologie

I. Teil: Trilobiten aus obersilurischen Gesteinen des kanadischen Arktischen Archipels: *Encrinurus (Frammia)* und *Hemiarges*
Von Thomas E. Bolton

II. Teil: Ordovizische und silurische Korallen mit Querböden: *Labyrinthites, Arcturia Troedssonites, Multisolenia,* und *Boreaster*
Von Thomas E. Bolton

III. Teil: Eine neue Art von *Hemicystites*
Von G. Winston Sinclair
und Thomas E. Bolton

БЮЛЛЕТЕНЬ 134 — МАТЕРИАЛЫ ПО ПАЛЕОНТОЛОГИИ КАНАДЫ

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ЧАСТЬ II: Ф. Э. Болтон. Ордовикские и силурские ячеистые кораллы **Labyrinthites, Arcturia, Troedssonites, Multisolenia** и **Boreaster.**

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PART I

TRILOBITES FROM UPPER SILURIAN ROCKS OF THE CANADIAN ARCTIC ARCHIPELAGO: *ENCRINURUS (FRAMMIA)* AND *HEMIARGES*

Thomas E. Bolton

Abstract

Type specimens of *Cromus arcticus* Haughton and *Frammia dissimilis* Holtedahl are restudied, and together with new material are assigned to *Encrinurus (Frammia) arcticus.* Distribution of Lower and Middle Ludlovian *Hemiarges aquilonius* Whittington and Late Silurian or Early Devonian *H. bigener* n. sp. within the Canadian Arctic is outlined.

Résumé

L'auteur étudie à nouveau les spécimens-types de *Cromus arcticus* Haughton et de *Frammia dissimilis* Holtedahl, qui sont, ainsi que de nouveaux échantillons, identifiés comme des *Encrinurus (Frammia) arcticus.* Il présente les grandes lignes de la distribution d'*Hemiarges aquilonius* Whittington du Ludlovien inférieur et moyen et d'*H. bigener* n. sp. du Silurien supérieur ou du Dévonien inférieur, dans l'Arctique canadien.

INTRODUCTION

The earliest descriptions of Silurian trilobites from the Canadian Arctic were by Salter (1852, 1853)[1] and Haughton (1858) of specimens collected during expeditions undertaken by Sutherland, Penny, and M'Clintock. From various localities centred around Barrow Strait *Encrinurus laevis* (Angelin), *Proetus* sp., and *Cromus arcticus* were recognized. In the collections made by Per Schei of the Sverdrup Expedition in the *Fram,* 1899-1902, Holtedahl (1914) identified from southwest Ellesmere Island *Frammia dissimilis* and *Encrinurus* sp. from the lower beds of Series B and *Proetus leptorhachis* (Pl. X, fig. 3) from the upper beds [Devonian]. Detailed trilobite investigations were undertaken by Poulsen (1934) from the large fauna characteristic of the Lower Silurian Cape Schuchert Formation of North Greenland; he described *Encrinurus inflatus, E. moderatus, E. princeps,* and *Proetus* (*Pseudoproetus*) *regalis,* as well as specimens of *Aulacopleura, Harpes, Cheirurus,* etc. In the Middle Silurian Offley Island Formation of North Greenland, Teichert (1937) identified *Scutellum magnificum*; this same trilobite associated with a poorly preserved *Encrinurus* sp. pygidium also was recognized much farther south in the Silurian rocks of Southampton Island. Still farther south, a pygidium collected from Silurian limestones exposed on the Fawn River, Severn River area, Hudson Bay Lowlands, Ontario, originally was reported by Parks (1913, pp. 193, 196; Hume, 1925, p. 36) as *E. arcticus*? Salter and *E.* cf. *arcticus* Salter. The specimen was later assigned to *E.* cf. *punctatus* (Brunn) by Parks (1915, p. 80, pl. 4, fig. 20).

The trilobites *Frammia dissimilis, Encrinurus* sp., and *Proetus* sp. aff. *P. regalis* have been recorded in recent years from within unit 53, Member A, of the Upper Silurian Read Bay Formation exposed on Cornwallis Island (Thorsteinsson, 1958). Member C of the Read Bay Formation has yielded *Hemiarges aquilonius*, and *H. ormistoni* Whittington has been described from the upper part of the Cape Phillips Formation. In addition *Encrinurus* sp. has been recorded from the Douro Formation of Colin Archer Peninsula, Devon Island and of southeast Ellesmere Island (Fortier, *et al.,* 1963, pp. 240, 298) and *Proetus* sp. from the middle Ludlovian Devon Island Formation of Goose Fiord, southern Ellesmere Island (Fortier, *et al.*, 1963, p. 300), from Silurian or Devonian transition beds of Devon Island (ibid., p. 241), from Melville Island, and from northwest Stefansson Island (Thorsteinsson and Tozer, 1963, p. 46).

In this report, *H. aquilonus* is further recorded from Member A of the Read Bay Formation of eastern Cornwallis Island (Pl. III, fig. 10) and, in association with *Proetus* (*Cyphoproetus*?) sp., from the lower Ludlovian Douro Formation of southwestern Ellesmere Island (Pl. II, figs. 6, 7, 9). The type specimens of *Cromus arcticus* and *Frammia dissimilis* were re-examined and as a result are assigned to *Encrinurus* (*Frammia*) *arcticus*. This species is widely distributed throughout the Arctic Islands within Read Bay strata. Finally, from very late Silurian or early

[1]Dates in parentheses are those of *References*, p. 12.

Devonian strata exposed on Prince of Wales, Cornwallis, and Ellesmere Islands, a new species of *Hemiarges, H. bigener,* is described.

Dr. J. S. Jackson, Keeper, National Museum of Ireland, Dublin, made available the McClintock Collection containing the type specimens of *Cromus arcticus*. Dr. G. Henningsmoen of the Paleontologisk Museum, Oslo, arranged for the loan of the Schei Collection of trilobites with the type specimens of *Frammia dissimilis* and *Proetus leptorhachis*. Dr. J. L. Usher of Queen's University, Kingston, Ontario, and J. C. Sproule and Associates Limited, Calgary, Alberta, collected and donated the holotype of *Hemiarges bigener*. The assistance of these gentlemen is gratefully acknowledged.

SYSTEMATIC PALAEONTOLOGY

Genus *Encrinurus* Emmrich, 1844

Subgenus *Frammia* Holtedahl, 1914

Type species by original designation *Frammia dissimilis* Holtedahl, 1914

Encrinurus (*Frammia*) *arcticus* (Haughton)

Plate I, figures 1-18; Plate II, figures 1-5, 8; Plate X, figure 2

1852 *Encrinurus* (*Cryptonymus*) *laevis* Angelin, SALTER, p. App. ccxxi, pl. 5, figs. 14, a.
1858 *Cromus arcticus* HAUGHTON, p. 241, pl. 6, figs. 1-5.
1906 *Encrinurus arcticus* (Salter), AMI, p. 329.
1914 *Frammia dissimilis* HOLTEDAHL, p. 35, pl. 8, figs. 17-19.
1924 *Frammia arcticus* (Haughton), HOLTEDAHL, p. 131.
1929 *F. arcticus* (Haughton), FOERSTE, p. 65.
1958 *Frammia* sp. cf. *F. dissimilis* Holtedahl, THORSTEINSSON, p. 59.
1958 *Encrinurus* sp., THORSTEINSSON, pp. 49, 50.
1963 *F. dissimilis* Holtedahl, FORTIER, et al., pp. 132, 143, 205.
1963 *Frammia* sp., THORSTEINSSON and TOZER, p. 48.
1963 *Encrinurus* sp. A, FORTIER, et al., p. 143.

Salter's description (1852, p. App. ccxxi) *Encrinurus laevis*:

"The eyes are rather large and depressed for the genus; the glabella and cheeks covered with large coarse tubercles; the hypostome (preserved in one specimen) is gently convex, and has the usual cucullate base. The body rings and tail are quite smooth. The ten side ribs of the tail are strongly bent down, and towards the blunt apex become crowded, a small ovate convex appendage filling up the space between the two last. The ribs on the axis of the tail, about nine or ten in number and of large size (not small and crowded as usual in the genus), and the three or four upper ones, are continuous across with the first four side ribs: the rest are very slightly interrupted in the middle".

Haughton's description (1858, p. 241) *Cromus arcticus*:

"Capite undique granoso; glabella quadrilobata, antice latiore; genis planis, oculis aliquantulum exsertis; thoracis segmentis (12) levibus, extremis segmentorum axis protinus curvatis, pleuris in medio abrupte deflexis; cauda trigona, in parte posteriori adpressa, pleuris (8) depressis, sulcis trans caudae axem continuis". Species was assigned to *Cromus* rather than to the near relative *Encrinurus* because of its four-lobed glabella and the continuous nature of ribs across the axis of the tail in contrast to more numerous axial ribs characteristic of *Encrinurus*.

Holtedahl's diagnosis (1914, pp. 35-37) *Frammia dissimilis*:

Frammia characterized by very deep and broad dorsal furrows in the head, diverging towards the front, and with distinct lobes at the surface on both sides. Head: glabella reminds one much of *Encrinurus,* it is moderately convex with nicely rounded front and faint pustule-like irregularities; instead of regular straight dorsal furrows, dividing between the glabella (with more or less transverse lobes) on one side and the fused cheeks on the other, two deep depressions are present about 2 mm in depth and projecting at the surface like four highly crenulated lines, with the crenulae or lobes on both sides of each depression arranged in such a way that the lower side of the apex of the outer lobes (five in number) is extremely near to the upper of those on the inner side. Associated fragmentary thorax and pygidium (Pl. X, fig. 2): thirteen strongly convex thoracic segments, moderately convex axis 9 mm wide in middle part and 6 to 7 mm on the last segment, flat, broad pleurae; broad pygidium, strongly tapering axis with nine segments, the anterior ones of which curve slightly and the posterior stronger and more angular forward, nine pleural lobes laterally strongly down-curved, the posterior subparallel ones directed strongly backwards and downwards and the first six or seven lobes well marked, with broad flat surfaces and broad furrows between.

Supplementary description *Encrinurus (Frammia) arcticus.*

Lectotype (Pl. I, figs. 13, 14) a nearly complete exfoliated specimen 65 mm overall length, 30.5 mm maximum width (35 mm, Pl. II, fig. 5), and 9 mm deep. Convex cephalon at least 16 mm long; moderately to highly convex glabella, maximum length of 14 mm expanding rapidly anteriorly from 9 mm at occipital furrow to at least 13 mm at anterior margin (specimen NMI 95:1905/219), with three pair of deep, very short lateral glabellar furrows and four pair of broad, blunt lateral glabellar lobes (nodular tubercles? each about 2 mm wide). All specimens are broken off at this point with the exception of hypotype 17762; in this specimen (Pl. I, figs. 6, 7) the glabella continues uninterrupted into the anterior border, and a fourth lateral furrow (discontinuous anterior or preglabellar?) and a fifth lobe are evident with no distinct preglabellar field or furrow apparent (Hamada, 1959, p. 83; 1961, pp. 214-216; Tripp, 1962, p. 460), anterior margin of glabella narrow upturned rim that extends completely along the lateral margin (Pl. I, fig. 15), anterior surface curving under into the doublure. Occipital and axial furrows deep, the latter continuous into the lateral border furrow; four pair of oval pits within the axial furrow, generally located in line with glabellar furrows (Pl. I, figs. 11, 12);

occipital ring wide, blunt extremities abruptly reduced to half the width (sag.) of the ring, and equal to lateral extent of preoccipital glabellar lobe (Pl. I, figs. 17, 18; Pl. II, fig. 8; hypotype 17771); four pair of small, equal-sized, rounded lobes on inner edge of the fixed cheek located opposite occipital and glabellar furrows (Pl. I, figs. 13, 17, 18; Pl. II, figs. 5, 8; specimen NMI 95:1905/223). A fifth lobe is preserved on hypotype 17762 and is probably the true number in a complete form. Round, elevated eye lobe located opposite middle of preoccipital lobe completely surrounded by deep furrow; anterior trace of facial suture not definite although suggestion on hypotype 17762 that it extends anteriorly between the fifth glabellar lobe and first border lobe; posteriorly, suture apparently extends out in a convex-forward curved furrow (Pl. I, figs. 17, 18), backward either to the genal angle or to the lateral margin (proparian); a disassociated cheek (NMI 95:1905/219) is interpreted to end in a short (2.5 mm) horizontal genal spine surmounted (1.5 mm apart) by a very short (0.5 mm) prolibrigenal spine. Free cheek marked with wide border bearing from one wide (NMI 95:1905/236) to two pair of distinct short deep furrows and two pair of blunt lobes directly following the glabellar lobes with an indistinct shallow third furrow and elongated lobe (Pl. I, fig. 15; hypotypes 17769, 17770). Surface of cranidium covered with two sizes of perforated tubercles in random arrangement (Pl. II, fig. 8; NMI 95:1905/223).

Eleven to twelve thoracic segments [12th of Haughton and 13th? of Holtedahl are the occipital rings], pleurae sharply bent ventrally up to a depth of 12 mm (NMI 95:1905/236) at a distance away equal to the axial width (26 mm between fulcrums on lectotype); no pleural furrows, but pronounced longitudinal axial furrow; small oval apodemal pits, L-shaped in one cross-section and located in outer part of articulating furrow (lectotype; hypotype 17754; NMI 95:1905/236).

Pygidium broadly triangular, 18 mm long and 21 mm wide in lectotype (maximum 29.5 mm, and 35.5 mm wide—Pl. II, fig. 4); axial furrow moderately deep, shallowest posteriorly; axis tapering evenly backward, non-tuberculate rings well defined throughout entire length corresponding in the lectotype to the eight or nine pleural segments, and with a small terminal axial piece; interpleural furrows deep and broad. The syntype of *Frammia dissimilis* (Pl. X, fig. 2) 16 mm long and 20.5 mm wide, consists of ten axial rings and a terminal axial piece 3 mm long; there are eight pleural ribs, the first four of which are confluent with the axial rings, the fifth and eighth encompassing two axial rings, the sixth and seventh one each; terminal axial spine lacking. The number of pleural lobes preserved on the hypotypes varies from eight (Pl. II, fig. 4, lower pygidium) to nine (Pl. I, figs. 9, 16; Pl. II, figs. 1, 3) to ten (Pl. I, figs. 2-5), with the first four to six complete, and the axial rings may increase at posterior end to thirteen; depending upon the degree of weathering eight to eleven deep furrows are continuous across the axis. Smooth pleural ribs of the pygidium are of equal width from axial furrow to blunt free ends; narrow concave doublure; flexure of thorax continuous into pleural region; suggestion of finely tuberculated pleurae surface (Pl. II, fig. 4).

Discussion. The incomplete pygidium and thorax figured by Salter (1852, pl. 5, fig. 14) as *Encrinurus (Cryptonymus) laevis* is very similar to the syntype of

Frammia dissimilis (Holtedahl, 1914, pl. 8, fig. 19) and to specimens of *Encrinurus (Frammia) arcticus* examined during the present investigation (Pl. I, fig. 5). The axial rings number thirteen in Salter's sketch compared to a listing of nine or ten in the text. The separate pustulose cephalon of *E. laevis* (Salter, 1852, pl. 5, fig. 14a) bears three to four lobes on the fixed cheek similar to the lobation present on both *Cromus arcticus* (Pl. I, fig. 13) and *F. dissimilis* (Holtedahl, 1914, pl. 8, fig. 17) but the pustules on the glabella and cheeks are arranged in quite a different pattern; the large eye and proparian-like facial suture trace are similar in all three forms. Thus in all likelihood *E. laevis* of Salter is the same as *C. arcticus* and *F. dissimilis*. Salter considered it probable that his specimens from Cape Riley on the southwest corner of Devon Island, from Griffith, Cornwallis, Seal, and Dundas Islands, and *E. laevis* from the Upper Silurian of Gotland were the same species; as an aside he suggested that the name *E. arcticus* would be appropriate if they proved otherwise.

Haughton (1858) definitely assigned his specimens collected from the same localities to the genus *Cromus* rather than to *Encrinurus,* including Salter's Arctic varieties of *E. laevis* in his new species *C. arcticus*. For the Ellesmere Island material Holtedahl originally erected a new genus *Frammia* with *F. dissimilis* as the type species, but following an examination of Salter's and Haughton's types he decided that the specimens evidently belonged to one and the same species, for which the specific name *arcticus* should be retained (1924, pp. 131-132). The generic assignment was left unchanged.

The type specimens and additional material described herein have many features common to encrinurids. Their only resemblance to the Ludlovian genus *Cromus* (type species *C. intercostatus* Barrande, 1852) is in the presence of four pair of lateral furrows and a pygidium broader than long (i.e., Churkin, 1961, pl. 36, fig. 5); similar shaped pygidia and shallow furrowed cheeks also are present in the Ordovician form *Encrinuroides sexcostata* (Salter). The discontinuous lateral furrows separate this species from the transglabellar furrowed Wenlockian and Ludlovian *Encrinurus (Coronocephalus).* Most characteristics warrant its inclusion in *Encrinurus* s. str., but from specimens of the *E. punctatus* species-group (Tripp, 1962) the Arctic forms differ by: 1) persistent distinct lateral furrows and equal-sized lobes with alternately matching structures on the fixed cheeks; 2) a distinctly lobated wide lateral border continuous from the glabella, and 3) broader than long pygidia with several continuous pleurae and a near equal number of axial rings. These differences are here considered only of subgeneric value; the subgenus *Frammia* Holtedahl is so retained.

Encrinurus (Frammia) arcticus represents another step in the transition from *Encrinurus* s. str. to *Cromus,* being closest to the latter genus. A similar combination of features was observed in the older form *E. princeps* Poulsen from the Lower Silurian Cape Schuchert Formation of North Greenland. Within this species the variation in glabella lobation, form and position of the eye, narrow marginal border, and more segmented pygidial axis, however, are characteristic features of *Encrinurus* s. str. rather than *E. (Frammia).*

Distribution (Figure 1) and age. 1) Prince of Wales Island (GSC Map 37-1963): Read Bay Formation, Young Bay section, lat. 72°40'N, long. 96°40'W (GSC loc. 50762).

2) North shore Somerset Island (GSC Maps 1098A and 37-1963): Garnier Bay (lectotype, Pl. I, figs. 13, 14); Read Bay Formation, gully on east shore small lake just south of Garnier Bay (GSC loc. 26351, Pl. II, figs. 1, 2, 4) and top of section 3 miles west of Cape Admiral M'Clintock (GSC loc. 26345, Pl. 1, fig. 5).

3) Eastern Somerset Island: Read Bay Formation, a) highest beds on shore section 3 miles north of Fury Point (GSC loc. 25973), b) 1 mile north of Fury Beach (GSC loc. 25972, Pl. II, fig. 10), c) Fury Point, and d) 12 miles west of Fury Point (GSC loc. 25965).

4) Southwest Devon Island (GSC Map 1099A): Read Bay Formation, 482 and 620-700 feet above base of section west side Radstock Bay (GSC locs. 26058, Pl. II, fig. 5, and 26018); Cape Riley; Beechey Island.

5) Southern Cornwallis Island (GSC Map 1054A): Member A, Read Bay Formation, a) Resolute Bay (GSC locs. 17345, 17363), b) Assistance Bay (Pl. II, fig. 8), and c) Goodsir Creek section, central-east coast.

6) Griffith Island (GSC Map 1054A): Read Bay Formation (Pl. I, fig. 1).

7) Seal Island (GSC Maps 1054A and 20-1959): Pl. I, figs. 2-4, 6-12, 15-18; Pl. II, fig. 3.

8) Dundas Island.

9) Southwestern Ellesmere Island (GSC Map 1100A): lower part 'Series B' [Douro or Devon Island Formations(?), Fortier, *et al.*, 1963, pp. 295-302], north side Rendalen Valley, southeast Goose Fiord (Pl. X, fig. 2).

10) Northeast Stefansson Island (GSC Map 1135A): lower formation of Read Bay Group.

Most of these specimens are associated with representatives of the Arctic *Atrypella scheii* (Holtedahl) fauna, particularly abundant in Member A of the Read Bay Formation, of Lower Ludlovian age. The type of *Frammia dissimilis* was collected from the lower part of Schei's Series B section on Ellesmere Island. These rocks contain fossils of Lower and Middle Ludlovian age or younger (Fortier, *et al.*, 1963, pp. 298-300); unfortunately, no specimens of *dissimilis* were recognized in the collections made in this area in 1955 by members of Operation Franklin.

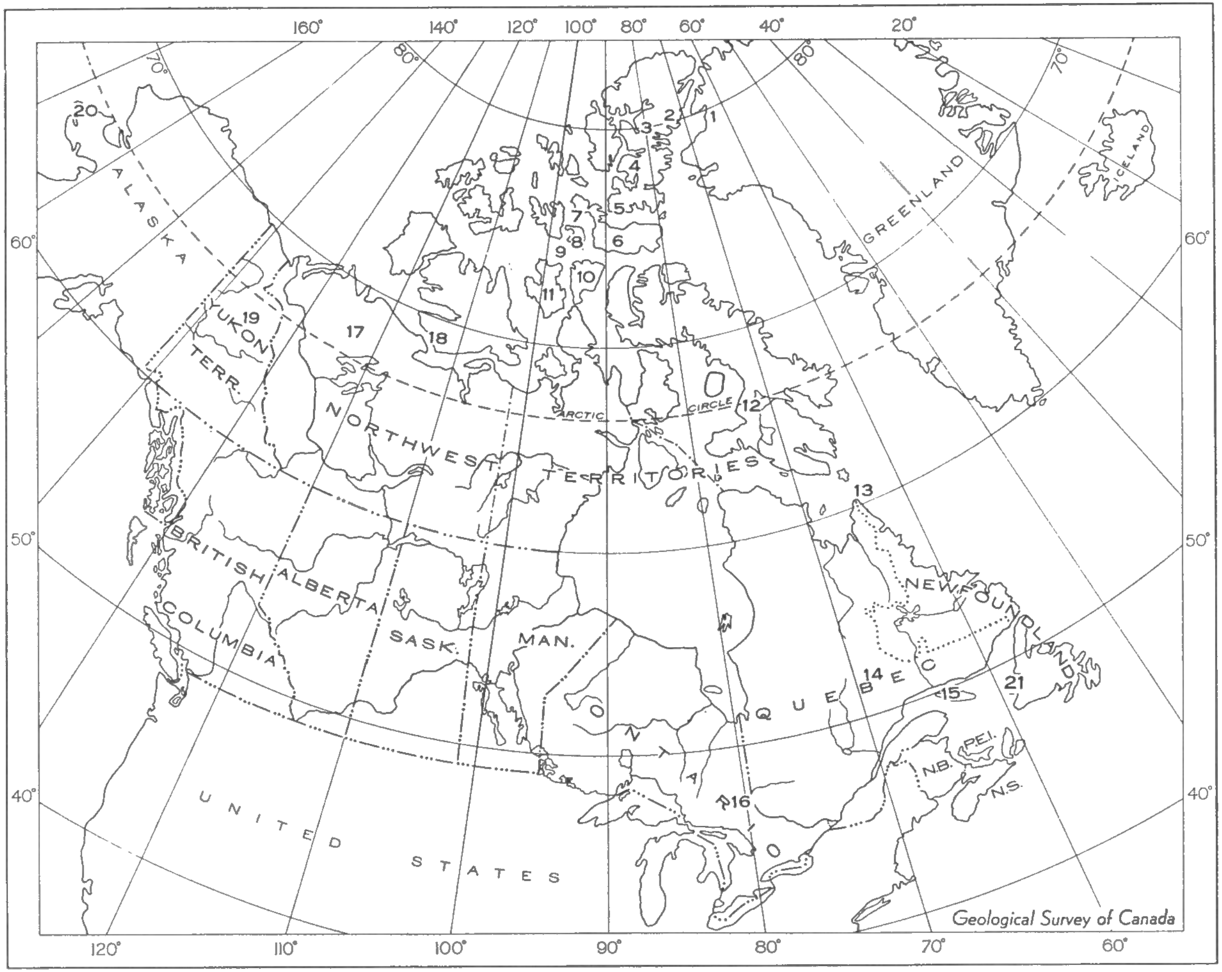
Types. Lectotype, NMI 95:1905/220; paralectotypes, NMI 95:1905/212, 237; hypotypes, NMI 95:1905/219, 221-223 (Garnier Bay), 224, 225 (Fury Point, Somerset Island), 211, 213, 214 (Cornwallis Island), 236 (Griffith Island), GSC Nos. 17754-17757 (Somerset Island), 17758 (Devon Island), 17759-17771 (Seal Island), Paleontologisk Museum Oslo No. A10863 (pygidium and plaster thorax, original of *Frammia dissimilis*, pl. 8, fig. 19).

Genus *Hemiarges* Gurich, 1901

Type species *Lichas wesenbergensis* Schmidt, 1885

FIGURE 1. *Map showing fossil localities.*

1. Eastern Kane Basin, North Greenland.
2. Darling Peninsula, East-central Ellesmere Island, Arctic.
3. Canyon Fiord, West-central Ellesmere Island, Arctic.
4. Strathcona Fiord (North) and Vendom Fiord (South), West-central Ellesmere Island, Arctic.
5. Goose Fiord, Southwestern Ellesmere Island, Arctic.
6. Devon Island, Arctic.
7. Dundas and Seal Islands, Arctic.
8. Cornwallis Island, Arctic.
9. Griffith Island, Arctic.
10. Somerset Island, Arctic.
11. Prince of Wales Island, Arctic.
12. Lake Nettilling, Southern Baffin Island, Arctic.
13. Cape Chidley, Northwest Territories.
14. Lakes Manicouagan-Mouchalagane, Quebec.
15. Anticosti Island, Quebec.
16. Lake Timiskaming, Ontario.
17. Lat. 67° 17′ N, Long. 124° 55′ W, Northwest Territories.
18. Read Island, Northwest Territories.
19. Wind River District, Yukon Territory.
20. Mint River Area, Teller (C-5) Quadrangle, Alaska.
21. Long Point Peninsula, Western Newfoundland.



Hemiarges bigener n. sp.

Plate III, figures 1-9, 11

1958 *Euarges* sp., THORSTEINSSON, p. 109.

Description. Holotype (Pl. III, fig. 1) a nearly complete specimen of low convexity, slightly exfoliated, overall length of 42.5 mm and width of 19.7 mm. Cephalon 10.5 mm long and 18.6 mm wide; forward curving occipital ring 5.8 mm wide (largest 9.3 mm, Pl. III, fig. 6) and a maximum of 1 mm long, anterior margin well defined by forward curving, shallow, broad occipital furrow, deepest behind posterior lateral glabellar lobe; moderately convex glabella 8.5 mm long and a maximum of 9 mm wide both posteriorly and anteriorly, narrowest where the single deep, complete lateral glabellar furrow curves forward into the extremely shallow axial furrow; paratype glabellae length and width equal, with a maximum of 16 mm [paratype 17778]; shallow preglabellar furrow and narrow, convex anterior border; posterior lateral glabellar lobes subcircular in outline and convex; bicomposite lobe longer than wide; the curved longitudinal furrow commencing near anterolateral corners of the glabella as a faint trace on glabella, abruptly deepening posteriorly and curving outwardly into a deep depression in the lateral glabellar furrow located opposite the anterior half of the eye lobe; from these depressions the glabellar furrow abruptly rises axially across the median glabellar lobe and similarly a slightly broader posterior extension of the longitudinal furrow rises across the posterior lateral lobe and descends into the occipital furrow. This convex central unit of the median lobe is only slightly lower than the bounding posterior glabellar lobes; these glabellar lobes either are separated only by very faint axial furrows from the palpebral lobes or are in direct contact; facial suture posteriorly extends backward and strongly outward from the eye lobe to the posterior margin near the genal angle (Pl. III, fig. 11) whereas anteriorly it parallels the axial furrow; eyes crescentic shaped, high; free cheeks gradually slope to lateral borders; surface dotted with many close-spaced low, rounded tubercles of numerous sizes and no symmetrical arrangement.

Thorax at least 12 mm long; gently convex axis 6 mm maximum width tapering gradually posteriorly to 4.8 mm; axial rings narrow and articulating furrow deep and narrow; eleven broad pleurae sloping downward and backward, with long (approximately half width of pleura), deep, narrow pleural furrows, pleural field equal to or slightly wider than axis; large tubercles scattered about axial rings and usually four prominent tubercles per pleura, in staggered position on every successive pleura and roughly aligned longitudinally (Pl. III, figs. 1, 7).

Pygidium of holotype 20 mm long and 19.3 mm wide anteriorly; blunt, gently convex axis 7.2 mm long composed of two well-defined anterior axial rings marked by deep complete ring furrows, two less distinct rings marked by shallow incomplete ring furrows and a terminal piece 3.8 mm long; axial surface bears at least four longitudinal rows of equal-sized rounded tubercles which on the terminal piece through transverse alignment faintly outline five additional axial rings (in paratypes very shallow ring furrows not extending to axial furrows also define these rings — Pl. III, figs. 4, 7, 9; one or two additional rows of tubercles present on other specimens —

Pl. III, fig. 8); narrow post-axial ridge 12.8 mm long, very sharp for 4.8 mm to junction with border furrow, narrower and lower across border and to tip of wide, short terminal spine; in paratypes two pair of slightly narrower marginal spines not preserved on the holotype flank the terminal spine (Pl. III, figs. 4, 5, 7-9); distinct convex pleural field and wide concave border; two pleurae extend across pygidium to end in short backward-pointing free marginal spines, anterior pleura narrow with long deep furrow and posterior one broad with short deep furrow marginally; two strong, outward and backward curving interpleural furrows; surfaces marked by widely spaced small and large tubercles, the latter in rough alignments paralleling pleural furrows. Length of paratypes range from 17.2 mm to 46.4 mm and the ratio of axis to post-axis varies between 1:1.5 to 1:1.9 with a majority ratio of 1:1.8.

Discussion. The *Hemiarges* specimens described here belong to the group composed of the Upper Ordovician *H. maccullochi* (Reed), Middle Silurian *H. bucklandi* Tripp, and Upper Silurian *H. ptyonurus* (Hall and Clarke), *H. ormistoni* Whittington, and *H. aquilonius* Whittington. All these forms are distinguished by complete lateral glabellar furrows, no occipital lobes, and palpebral lobes situated adjacent to the axial furrow with mid-points in line with or behind the inner end of the lateral glabellar furrows. The moderately convex inward longitudinal furrows characteristic of the new species are more diagnostic, however, of the Upper Ordovician *H. wesenbergensis* (Schmidt) group than of *H. aquilonius* with its straight and subparallel longitudinal furrows.

In comparison of cephalons, the closest resemblance is with *H. ptyonurus* and *H. aquilonius*. The Arctic specimens differ from the former species in possessing deeper, better defined posterior lateral furrows extending across the median lobe of the glabella, smaller lateral lobes and accordingly more posteriorly located lateral furrows (larger bicomposite lobe proportionately), and more diverging median furrows at their junction with the lateral furrows. From the latter species (Pl. II, fig. 7; Pl. III, fig. 10), *H. bigener* is separated by its larger size, smaller lateral lobes and accordingly slightly larger bicomposite lobes, and convex longitudinal furrows. As they approach equality in size the two species become difficult to separate.

In their pygidia, the tubercle and axial ring patterns are the same for all three species but the axis to post-axis average ratios differ from 1:0.7 for *H. ptyonurus,* 1:1.1 for *H. aquilonius* (Pl. II, fig. 6), and 1:1.8 for *H. bigener*. Small pygidia in the same collections proportionately are closer to *H. ormistoni* than any of the small specimens of *H. aquilonius*, but in contrast to the spine-free *H. ormistoni* the new species has very short, broad terminal and flanking marginal spines (Pl. III, fig. 2; hypotypes 17781, 14490).

On the basis of the long post-axial pygidial area, the Arctic mongrels also could be assigned to the genus *Acanthopyge*. Similarly the glabellar lobation approaches that of typical *Acanthopyge,* but the lobation combined with the apparently normal location of the genal spine base on the free cheek are features still more characteristic of the *Hemiarges ptyonurus* group. A similar relationship between *H. aquilonius* and *Acanthopyge* was noted by Whittington (1961, p. 435); *H. bigener* has evolved one step closer towards *Ancanthopyge*. It is quite distinct from the only other Upper

Silurian forms of *Hemiarges, H. ambiguus* (Reed), and *H. heteroclytus* (Barrande) from Bohemia (Vanek, 1959, pp. 152-155).

Distribution (Figure 1) and age. 1) Northeast corner Prince of Wales Island (GSC Map 1098A): within a thin argillaceous limestone band in the midst of massive conglomerate beds near the base of the Peel Sound Formation (holotype, Pl. III, fig. 1).

2) Marshall Peninsula, northwestern Cornwallis Island (GSC Map 1054A — GSC loc. 23362): float on upland surface some 175 feet above solid Late Silurian rocks (Pl. III, fig. 7).

3) Ellesmere Island (GSC Map 39-1962): 10 miles WSW of head of Strathcona Fiord (GSC loc. 47703), 525 to 1,050 feet above base of unnamed formation; eastern Darling Peninsula (GSC locs. 47678, 47681), 3,380 to 3,400 feet and 4,095 feet above base of undifferentiated Allen Bay-Read Bay formation (Pl. III, figs. 2-6, 8, 9, 11).

An exact age for the *Hemiarges bigener* specimens is difficult to assign. Stratigraphically on Cornwallis Island the Peel Sound Formation overlies the Read Bay Formation, middle and probably upper Ludlovian in age (Fortier, *et al.*, 1963, p. 125). On Somerset and Prince of Wales Islands, Peel Sound conglomerates have yielded ostracoderm fragments of Downtonian-Lower Devonian affinities. The float-derived Cornwallis Island trilobite was associated with corals of Middle Devonian affinities and located some 175 feet above Late Silurian strata (Thorsteinsson, 1958, p. 109). In the Darling Peninsula succession, the typically Ludlovian and older coral genus *Halysites* was recognized by Norford (GSC Fossil Report O-S 9-1962-BSN) only in the stratigraphic interval 110 to 1,235 feet above base of the formation. The trilobites were associated with a number of corals that form quite a distinct fauna, brachiopods, pelecypods, gastropods, and *Mesotrypa* sp. cf. *M. suprasilurica* Hennig, a lower and middle Ludlovian bryozoan formerly identified in Members A and C of the Read Bay Formation on Cornwallis Island. Thus the new species of *Hemiarges* is most probably of very late Silurian and only possibly early Devonian age.

Types. Holotype, GSC No. 17772; paratypes, GSC Nos. 17773-17779, 18245; hypotypes, GSC Nos. 17780, 17781 [GSC loc. 47681], 14490 [GSC loc. 47698].

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PART II

ORDOVICIAN AND SILURIAN TABULATE CORALS *LABYRINTHITES, ARCTURIA, TROEDSSONITES, MULTISOLENIA,* AND *BOREASTER*

Thomas E. Bolton

Abstract

The genera *Labyrinthites (Labyrinthites), L. (Arcturia),* and *Troedssonites,* all fasciculate tabulate corals of halysitoid habit, are represented in the Ordovician and Silurian(?) rocks of Arctic Canada. All the available specimens have been re-examined with special reference to their stratigraphic and geographic ranges. It is concluded that the genus *Tetraporella* Sokolov 1947 is a junior synonym of *Labyrinthites* Lambe 1909. Additional specimens of Middle Ordovician *L. (L.) chidlensis* Lambe are described from central Ellesmere Island, the Lake Manicouagan outlier of central Quebec, Port au Port Peninsula in western Newfoundland, and from presumed Ordovician rocks of Alaska. Three additional specimens of the Middle Silurian coral *Multisolenia tortuosa* Fritz collected from the type locality, Lake Timiskaming, Ontario, are described and the distribution of the type and other recognized species reviewed. Thin sections of the Arctic coral *Boreaster lowi* Lambe confirm its assignment to the Upper Silurian genus *Fossopora.*

Résumé

Les genres *Labyrinthites (Labyrinthites), L. (Arcturia)* et *Troedssonites,* tous coraux fasciculés à cloison transversale d'un comportement ressemblant à celui des Halysites, sont représentés dans les roches de l'Ordovicien et du Silurien (?) de l'Arctique canadien. Tous les spécimens disponibles ont été étudiés à nouveau, spécialement en ce qui concerne leur extension stratigraphique et géographique. On a conclu que le genre *Tetraporella* Sokolov 1947 est un synonyme récent de *Labyrinthites* Lambe 1909. Des spécimens supplémentaires de *L. (L.) chidlensis* Lambe de l'Ordovicien moyen sont décrits, et proviennent de la partie centrale de l'île Ellesmere, des buttes entourant le lac Manicouagan dans le Québec central. de la péninsule de Port-au-Port dans l'ouest de Terre-Neuve, et de roches de l'Alaska qu'on suppose ordoviciennes. On a décrit trois autres spécimens de corail du Silurien moyen, *Multisolenia tortuosa* Fritz, recueillis dans la réegion-type, le lac Témiscamingue en Ontario, et on a examiné la distribution de l'espèce-type et des autres espèces reconnues. Les lames minces tirées du corail arctique *Boreaster lowi* Lambe confirment son appartenance au genre *Fossopora* du Silurien supérieur.

INTRODUCTION

Previous descriptions of some of the Ordovician and Silurian corals from the Canadian Arctic have been based principally on external characteristics of one or two specimens only; the need for a re-examination using thin sections has long been recognized. Within this category are a group of fasciculate tabulate corals characterized by the development of halysitoid or chain-like and meandering patterns. An examination of these particular colonies has formed part of a continuing study of Ordovician and Silurian corals. This first report presents details of the genera *Labyrinthites, Arcturia, Troedssonites, Multisolenia,* and *Boreaster (=Fossopora).*

Recent discoveries of well-preserved specimens of *Labyrinthites* in the Ordovician outlier at Lakes Manicouagan-Mouchalagane, central Quebec (Fig. 1), led to an examination of the type specimens of *Labyrinthites, Arcturia,* and related forms with halysitoid habit collected from various localities throughout the Canadian Arctic Archipelago. Descriptions of these corals, based for the first time on thin sections, are included here, and the stratigraphic and geographic distribution of the genera are reviewed. Prior to the present work most of our knowledge of Arctic Ordovician corals had been derived from the studies of Greenland material by Troedsson (1929)[1] and Sokolov (1947, 1955). The true nature and relationship of *Labyrinthites* and *Arcturia* were never fully recognized, however, due to erroneous interpretation of the habit of the former genus. As a result confusion arose in the assignment of specimens to these and other related new genera. Thin-section investigation has shown that *Labyrinthites* is definitely not a halysitid as originally contended but rather a syringoporid, that the Greenland genus *Tetraporella* (Sokolov, 1947) is synonymous, and that *Arcturia* is best recognized as originally proposed, namely a subgenus of *Labyrinthites*. Based on additional specimens from east-central Ellesmere Island, the closely allied Greenland form *Troedssonites* is confirmed as a distinct and valid genus.

In addition, three new specimens of the closely related Silurian tabulate coral *Multisolenia tortuosa* Fritz, discovered in collections from the type locality at Lake Timiskaming, northern Ontario, are described and the distribution of the type and other recognized species is reviewed; the type specimen of *Boreaster lowi* Lambe has been examined in thin section and its assignment to the genus *Fossopora* confirmed.

The assistance of various individuals during the course of this study is gratefully acknowledged: Drs. P. Lesperance of the University of Montreal, J. Berard, L. Kish, and H. W. McGerrigle of the Quebec Department of Natural Resources for the loan of the Ordovician collections from Lake Manicouagan, Quebec, for stratigraphic details, and for permission to publish the *Labyrinthites* material; Dr. J. C. Sproule of Sproule and Associates Limited, Alberta, for the loan of *Arcturia* specimens from Great Bear Lake area, Northwest Territories; and Dr. W. A. Oliver, Jr., of the U.S. Geological Survey, Washington, D.C., for the loan of the type specimens of *Arcturia angularis* Stumm and additional specimens from Alaska.

[1]Dates in parentheses are those of *References*, p. 29.

SYSTEMATIC PALAEONTOLOGY

Family AULOPORIDAE Milne-Edwards and Haime, 1851

Genus *Labyrinthites* Lambe, 1906

Type species by original designation *Labyrinthites chidlensis* Lambe, 1906

Labyrinthites (Labyrinthites) chidlensis Lambe

Plate IV, figures 1, 2, 3, 7; Plate V, figures 1-3; Plate VI, figures 1, 4, 5;
Plate VII, figures 1, 6

1906 *Labyrinthites chidlensis* LAMBE, p. 328, figure.
1929 *L. chidleyensis* Lambe, TROEDSSON, p. 136, fig. 10.
1929 *L.* (?) *monticuliporoides* TROEDSSON, p. 135, pl. 44, figs. 1, 2, 3a,b; text-fig. 9.
1929 *L.*(?) *monticuliporoides* var. *minor* TROEDSSON, p. 137, pl. 45, figs. 1a-c.
1947 *Tetraporella monticuliporoides* (Troedsson), SOKOLOV, p. 470, figs. 2a, b.
1955 *T. monticuliporoides* (Troedsson), SOKOLOV, p. 202, fig. 55b.
1955 *T. minor* (Troedsson), SOKOLOV, pp. 25, 202, fig. 55a; pl. 41, figs. 1,2.
1956 *L. chidlensis* Lambe, HILL and STUMM, p. F469, fig. 354, 2.
1962 *L. chidlensis* Lambe, SOKOLOV, p. 256, fig. 75.
1962 *T. minor* (Troedsson), SOKOLOV, p. 239, fig. 45.
1962 *T. monticuliporoides* (Troedsson), SOKOLOV, p. 239, fig. 46.
1962 *Monotrypa magna* Ulrich, SULLIVAN *in* Riley, p. 69.

Original description. "Corallum massive, composed of slender, straight, upright corallites with numerous interspaces. Corallites a little less than .33 mm. in average diameter, quadrangular or five or six sides in transverse outline, with rather thick walls. Each corallite coalesces along its entire length with two or three adjacent ones, giving rise to a meandering succession of tubes inclosing narrow spaces not wider than the corallites themselves. In the specimens examined the corallites reach a maximum length of .30 mm. In longitudinal sections tabulae, in the form of thin, flat, transverse plates across the corallites, are observed, between .5 and 1.5 mm. apart. There are no tubules between contiguous corallites, and the mural union appears to be complete."

In his diagnosis of the genus, Lambe (p. 327) stressed the continuous contact of the long, parallel corallites and the absence of tubules. On account of its mode of growth, the genus was provisionally classed with the Halysitidae.

Amended description. Low domed to flat fasciculate colonies, ranging from 46 mm (syntype 7933) to 8½ inches in width and 32 mm (syntype 7933a) to 2½ inches in height. In transverse sections corallites phaceloid, oval to polygonal, four to six sided, 0.3 to 0.35 mm in diameter; walls thick; no septa; individuals connected at one, two, three, or rarely four corners by short, hollow tubules to form chain-like networks; intervening spaces 0.1 to 0.2 mm thick; corallites occasionally coalesce and have a common wall. In longitudinal section tabulae less than 0.1 mm thick, complete, flat to low convex or rarely shallow concave, ranging between 0.4 to 1 mm apart averaging 0.75 mm; horizontal tubules 0.1 mm in diameter, walls continuous between connecting corallites, cut ends of tubules (and/or interspaces) forming vertical rows of 'mural pores' in interspaces, 0.1 mm and less apart. Longest continuous corallite 16 mm long, slightly sinuous.

Types. Lectotype, GSC No. 7933 (specimen and three thin sections); paralectotype, GSC No. 7933a; hypotypes, GSC Nos. 18728-18734 (Lake Manicouagan, Quebec), 14494, 18735, 18736 (Ellesmere Island, Arctic).

Subgenus ***Arcturia*** Wilson, 1931

Type species by original designation *Arcturia complexa* Wilson, 1931

Labyrinthites (Arcturia) complexus Wilson

Plate IV, figures 4-6

1931 *Arcturia complexa* WILSON, p. 295, pl. 3, figs. 1-3.
1955 *A. complexa* Wilson, SOKOLOV, pl. 41, figs. 7, 8.
1956 *A. complexa* Wilson, HILL and STUMM, p. F469, figs. 354, 3a,b.

Original description. "Corallum compound. Corallites polygonal in cross section, number of sides irregular, varying from 4 to 6. A few of the corallites appear to have grown together. Each corallite is attached to its neighbour with a long line of connecting tubes. In cross section it is shown that these lines of tubes are placed at the angles of each corallite, and the space between the tubes is generally three cornered or square in section and filled with a dark matrix. The result is that the angular dark spaces in section appear, at first sight, to be a very fine chain coral. It is an easy matter, however, to trace the true corallite in the longitudinal section, though the illustration is somewhat misleading because the matrix is as hard or harder than the corallite. The connecting tubes in this species are so numerous that the spaces between filled with dark matrix appear as perforations in the angles of the corallites. That such is not the case, however, is shown by the longitudinal section."

In her diagnosis of the genus, Wilson (p. 295) stressed the discontinuous contact of the polygonal corallites and the vertical series of syringoporoid-like tubes to differentiate it from oval-shaped *Halysites* corallites and round-shaped, irregularly connected *Syringopora* corallites.

Amended description. Colonies massive, fasciculate, largest (syntype 6405a) 33 mm wide and 35 mm high. In transverse section corallites phaceloid, oval to subpolygonal, walls slightly indented, 0.6 to 0.75 mm in diameter; no septa; some corallites coalesce at their rounded corners and share a common wall or are connected by very short hollow tubes to form short chains; walls thick and continuous through tubules; intervening spaces range from 0.1 to over 1 mm in thickness. In longitudinal section one flat thick tabula preserved; tubules 0.1 to 0.2 mm in diameter, variably spaced, cut ends developing vertical row of 'mural pores' in intervening spaces.

Types. Syntypes, GSC Nos. 6504, a (parts of same colony?).

Discussion. Basically the genera *Arcturia* and *Labyrinthites* are similar. *A. complexa* differs from *L. chidlensis* only in its larger, indented corallites, fewer tabulae (preservation factor(?) as corallites filled with calcite), and less halysitoid (chain) habit. These might be reasonable differences to define *Arcturia* as a subgenus of *Labyrinthites,* a grouping originally proposed by Wilson (1931), or may only be specific distinctions, but they are hardly sufficient to separate it entirely. Duncan (1956, p. 224) and Hamada (1957, pp. 397, 407) both recognized the possible synonymous relationship of these two genera and their assignment to the Syringoporidae, to which *Arcturia* had been assigned earlier by Sokolov (1950, p. 169) and Hill (1951, p. 10). Sokolov (1955, p. 255; 1962, p. 256) separated *Labyrinthites* entirely, combining it with *Hexismia* Sokolov, 1949 in the Family Hexismiidae, Order Halysitida. With the exception of its halysitoid habit, the genus definitely has more features (i.e. cylindrical corallites connected by hollow tubules) characteristic of the Family Auloporidae, Subfamily Syringoporinae as defined by Hill and Stumm (1956, pp. F469, F472) than of the Family Halysitidae.

In his studies of the Middle and Upper Ordovician faunas of northern Greenland, Troedsson (1929, pp. 135, 137) described *Labyrinthites* (?) *monticuliporoides* and *L.* (?) *monticuliporoides* var. *minor*. Wilson (1931) believed that Troedsson's species and variety were best grouped with *Arcturia complexa.* Because the Greenland forms were of the Family Syringoporidae whereas *Labyrinthites* originally was assigned to the Halysitidae, Sokolov (1947, p. 470) erected the genus *Tetraporella* with *L.*(?) *monticuliporoides* as the type species [Family Tetraporellidae-Sokolov, 1951, p. 18; 1955, p. 201; 1962, p. 237]. *Arcturia* also was included in the Syringoporidae but separated from *Tetraporella* with its tetragonal corallites and very scarce tabulae on the assumed characteristics of regular hexagonal corallites and numerous [?] tabulae for *Arcturia.* As a result of the present studies, both *L.* (?) *monticuliporoides* and its variety are regarded as synonyms of *L. chidlensis* and *Tetraporella* synonymous with *Labyrinthites.*

Age and distribution. L. chidlensis was based on two fragments collected from drift at Cape Chidley on Hudson Strait (Fig. 1) that lithologically resembled other limestone blocks bearing Ordovician fossils. Silurian fossils, however, also were collected from the same locality so that no definite age could be assigned to this species. Similarly, *Arcturia complexa* was erected on two small fragments found loose in the drift on Fossil Island, Lake Nettilling, southern Baffin Island (Fig. 1), in association with forms of both Ordovician and Silurian age. *L.*(?) *monticuliporoides* was collected by Troedsson from talus of the Cape Calhoun Formation at Cape Calhoun, and the variety was collected from talus of the Gonioceras Bay Formation at Gonioceras Bay, northern Greenland (Troelsen, 1950, p. 55). On the west slope of Wright Bugt, Washington Land, however, Troelsen (1950, p. 56) found these forms respectively 60 and 65 metres above the Middle Ordovician(?) Cape Webster Formation associated with fossils (*Gonioceras holtedahli* Troedsson) of Middle Ordovician Black River and/or Trenton affinities [Wilderness Stage].

During the past ten years, specimens of *Labyrinthites* or *Arcturia* have been identified by G. W. Sinclair and the writer in the following collections from the Canadian Arctic Archipelago (Fig. 1):

1. Eastern Darling Peninsula, east-central Ellesmere Island, 800 to 1,500 feet below top of Cornwallis Formation (GSC loc. 47670, collected by J. W. Kerr, 1961); associated fauna includes *Maclurites* sp. and *Gonioceras* sp. of Middle Ordovician age (Pl. V, fig. 1).

2. 8 miles northwest of sharp bend in southern part of Canyon Fiord, 2 miles from north shore, west-central Ellesmere Island (GSC loc. 47656, hypotype GSC No. 18736 collected by J. W. Kerr, 1961); associated with *Calapoecia* sp. of Middle or Upper Ordovician age.

3. Strathcona Bay, west-central Ellesmere Island, 78°03′N, 82°12′W (GSC loc. 48010, collected by R. L. Christie, 1961); associated fauna includes *Streptelasma* sp., *Catenipora* sp., *Encrinurus* sp., etc., of late Middle or early Upper Ordovician age.

4. Vendom Fiord, southwest Ellesmere Island, along crest of ridge extending north from "Meadow" River 6½ miles east of its mouth, top of Cornwallis Formation (GSC loc. 51938, collected by J. W. Kerr, 1962, hypotype GSC No. 14494 nearest to *L.*(?) *monticuliporoides* Troedsson form); associated fauna includes large trilobate *Streptelasma* sp., *Protaraea* sp., *Catenipora* sp., and *Receptaculites* sp., principally an Upper Ordovician assemblage.

5. Herschel Bay, south coast Devon Island, talus Allen Bay Formation (GSC loc. 26477, collected by B. F. Glenister, 1955); associated fauna corals *Palaeophyllum* sp. and *Lindstromia* sp. (Fortier, *et al.*, 1963, p. 199).

6. East Maunoir Ridge area north of Great Bear Lake, 67°17′N, 124°55′W (GSC loc. 38671, courtsey of J. C. Sproule and Associates Ltd., 1959); associated fauna *Palaeophyllum* sp. cf. *P. halysitoides* (Wilson) and *Armenoceras* sp. of Middle or Upper Ordovician age.

All these faunas can be considered Ordovician in age. Those faunas that contain the limited ranging cephalopod *Gonioceras* more precisely are of the Middle Ordovician Wilderness Stage.

Specimens of *L.*(?) *monticuliporoides* var. *minor* Troedsson were reported by A. E. Wilson from amongst Ordovician fossils collected by C. A. Burns (1952, p. 10) from Anderson Island, Foxe Basin, Northwest Territories. In addition, a portion of the surface of a specimen of *Arcturia* sp. from Ordovician rocks of Read Island, southwestern Canadian Arctic Archipelago, was figured by Miller and Youngquist (1947, p. 6, pl. 1, fig. 2). Its true generic assignment is difficult to determine; Hamada (1959, p. 280) has included it in the genus *Manipora*. Associated with this coral are other halysitids of the *Catenipora*-type (Nelson, 1963, p. 57) and a form assigned to *Syringopora*? *(Troedssonites) conspirata* Troedsson (ibid., p. 5).

Poorly preserved specimens of *Labyrinthites* (Pl. VII, fig. 4) also have been collected recently from the klippe forming the top of hill marked "1830′", west side of Mint River, 4.6 miles N81°W (True) of highest point of Brooks Mountain, Teller (C-5) Quadrangle, Alaska (USGS 4280-CO; 63ASn-860 collected by C. L. Sainsbury, 1963; courtesy W. A. Oliver, Jr.). In transverse section the phaceloid, thick-walled, angular and oval corallites range in diameter between 0.15 and 0.3 mm and form a loose chain-like network; in longitudinal section tabulae are widely spaced, short horizontal tubules 0.05 mm in diameter are spaced 0.1 mm or more apart (hypotypes USNM 144876, 144877). This species differs from *L. chidlensis* only in smaller diameter of corallites; the closest form would be specimens assigned to *L. monticuliporoides* var. *minor* Troedsson from the Middle Ordovician of Greenland.

In eastern Canada, at least fifteen colonies of *Labyrinthites* have been collected by Kish (1962) and Berard (1962) of the Quebec Department of Natural Resources and during the past year by K. L. Currie (1964, p. 52) of the Geological Survey of Canada, from widely scattered exposures on Lake Manicouagan, Saguenay County, some 130 miles north of Baie Comeau, Quebec (Fig. 1).

1) Kish collected from three localities on the northwestern shore. *L. chidlensis* (Pl. VI, figs. 1, 5) was found associated with a coiled cephalopod (*Discoceras* sp.) and encrinurid trilobite in about 3 feet of limestone exposed at bay entrance south of the southern boundary of Quertier township (Quebec Dept. Nat. Res. Prel. Map 1461).

2) Currie collected from several localities, but principally from a series of exposures along the eastern shore of a long peninsula, west-central Lake Manicouagan (GSC locs. 56437, 56435). *L. chidlensis* (Pl. IV, figs. 1, 2; Pl. V, figs. 2, 3) was identified in collections from a 40-foot cliff of thin-banded, yellowish siliceous limestone at the northern end of this exposure, and from thin-bedded, yellowish limestone some 60 feet above the Precambrian contact in a section in the centre of this exposure, the lower 35 feet of which is thin-bedded, black limestone. Crinoid columnals, poorly preserved brachiopods and gastropods are present above and below the coral colonies.

3) Berard's collections were mainly from Currie's central section but from a 10-foot interval of thin-bedded, grey limestone with shaly interbeds near the base of the section. These collections contained a *Maclurites-Receptaculites-Hormotoma-Westonoceras* assemblage characteristic of the Middle Ordovician Wilderness Stage. *L. chidlensis* colonies (Pl. VII, figs. 1, 6), associated with a cephalopod fragment, apparently were from a thin section of buff, dolomitic limestone found farther south on the east shore of large bay, southwestern Lake Manicouagan (Berard and McGerrigle, letter of Nov. 15, 1963).

Farther south, a similar sequence of limestones has been described in the Middle Ordovician of the Lake St. John-Chicoutimi region (Sinclair, 1953). The grey limestone of the Simard Formation contains along with halysitid corals the same fauna as the fossiliferous unit at Lake Manicouagan; according to Sinclair this fauna is of Black River-Trenton affinity (Wilderness Stage). The overlying Shipshaw shaly limestone contains a fauna of late Trenton affinities.

Only recently four specimens (hypotypes, GSC Nos. 15307-15310) of *Labyrinthites chidlensis* Lambe have been identified in collections made by H. Corkin of Golden Eagle Oil and Gas Limited and L. M. Cumming of the Survey from Middle Ordovician beds exposed 1½ miles east of Portage Road junction, east coast of Long

Point Peninsula, Port au Prince Peninsula, western Newfoundland. The reefal limestones, beds 1 and 2 of the Long Point Group, contain many hemispheric colonies of what was believed to be either a single species of the bryozoan *Monotrypa, M. magna* Ulrich (Schuchert and Dunbar, 1934, p. 71; Sullivan *in* Riley, 1962, p. 69) or a coral of the *Tetradium*-type (Billings *in* Murray and Howley, 1881, pp. 342, 394). Some colonies grew as much as 3 feet in diameter and 2 feet in height. Thin sections of hypotype 15307 prove that these forms are the coral *L. chidlensis,* identical to colonies from Lake Manicouagan, central Quebec, figured herein (Pl. VI, figs. 1, 5). In transverse section, the thick-walled four- to five-sided corallites range in size from 0.24 to 0.35 mm with most around 0.30 mm; structures are present in four or five corallites that resemble thick discontinuous septa, at least six in number. In longitudinal section, the tabulae are thin, complete, flat to gently concave upward, and spaced 0.6 to 1.1 mm apart; round 'pores' near the surface measure 0.1 mm in diameter; interareas vary from 0.1 to at least 0.3 mm in thickness. The associated fauna includes the brachiopods *Glyptorthis bellarugosa* (Conrad), *Rafinesquina trentonensis* (Conrad), *Triplecia extans* (Emmons), and the cephalopod *Gonioceras,* all forms diagnostic of the Middle Ordovician Wilderness Stage.

Thus in the western hemisphere the genus *Labyrinthites* now has been recognized in Middle and Upper(?) Ordovician rocks of northern Greenland, southwestern, central, and northeastern Ellesmere Island, south Devon Island, Anderson Island, south Baffin Island, Cape Chidley, central Quebec, western Newfoundland, north of Great Bear Lake, and Alaska. In the USSR *Labyrinthites* sp. has been recorded from the Upper Ordovician of Tuva by Sokolov (1955, pl. 64, fig. 3) and *Tetraporella monticuliporoides* from the upper part of the Middle Ordovician or lower part of the Upper Ordovician of Kazakhstan by Sokolov and Mironova (1959).

Representatives of the genus *Tetraporella, T. asiatica* Sokolov, however, have been reported by Sokolov (1947) from the 'Upper Silurian' of Eastern Fergana, USSR (Lower Llandovery — Sokolov, 1955, p. 201; 1962, p. 238, figs. 48a, b).

A Silurian representative of *Arcturia, A. angularis* Stumm, has been described from the Hardwood Mountain Formation (upper Wenlockian or lower Ludlovian age) from northern Maine (Stumm, 1962, p. 6). In this species (Pl. VII, figs. 2, 3, 5), the phaceloid, tetragonal, trigonal to subrounded, thin-walled corallites range in diameter from 0.3 to 0.6 mm, the thin, horizontal to gently concave, complete tabulae are spaced from 0.25 to 0.4 mm apart, there are abundant horizontal, short, cylindrical connecting tubules (in longitudinal section cut tubules appear as 'mural pores') up to 0.1 mm in diameter, and very short spines (Pl. X, fig. 4) are preserved in some corallites both between and at edge of tabulae. This species is closer to *Labyrinthites (Labyrinthites)* than to *L. (Arcturia)* as herein defined, although some of the closer spaced corallites do faintly show a shape typical of *Arcturia.* Spines, however, have not been observed in *Labyrinthites.* The tubules and rough halysitoid habit are reminiscent of the syringoporoid forms *Troedssonites* and *Syringoporinus.* The pronounced angulation of the corallites and the extension of 'mural pores' into short tubules of the *Multisolenia* type are features suggestive of the Silurian genus *Moyerolites* (*M. sibiricus* Sokolov, 1955, pl. 8, figs. 7, 8; 1962, pl. 5, figs. 6a, b, from the Wenlockian of the northern Siberian platform and *M. transitus* Leheshus from Tadzhikistan). Originally this genus was characterized by subpolygonal corallites, thick 'walls' filled with vesicular tissue and pierced by one row of large pores; close set, slightly undulating thin tabulae; and no visible septa. It was included in the Favositidae. On the basis of new material, Sokolov (1963, p. 58) has recognized: 1) the stromatoporoid nature of the vesicular wall structures and the symbiotic relationship of the coral and stromatoporoid organisms; 2) indistinct septa; 3) the development of pores and/or syringoporoid-like connecting tubes; and 4) the questionable taxonomic value of this genus of Favositidae. As now revised, *Moyerolites* has all the attributes of an Auloporidae genus, of which the Silurian form *M. angularis* (Stumm) is the North American representative.

Genus *Troedssonites* Sokolov, 1947

Type species *"Syringopora" conspirata* Troedsson, 1929

Troedssonites conspiratus (Troedsson)

Plate IX, figures 1, 4

1929 *"Syringopora" conspirata* TROEDSSON, p. 134, pl. 43, figs. 2a-c, 3a, b.
1947 *Troedssonites conspiratus* (Troedsson), SOKOLOV, p. 470, figs. la, b.
1955 *T. conspiratus* (Troedsson), SOKOLOV, p. 194, pl. 40, figs. 1, 2; text-figs. 46a, b.
1962 *T. conspiratus* (Troedsson), SOKOLOV, p. 235, figs. 37a, b.

Description. "Corallites 1.5 millimeters in diameter, almost parallel, slightly curved, crowded, sometimes in close contact, though with distinct boundaries, sometimes half a millimeter distant and connected with short horizontal tubuli which are placed close together, 6 in a space of 4 millimeters. Tabulae, or diaphragms, also crowded, 10 in 4 millimeters, more or less concave, not funnel-shaped. Transverse section of corallites circular with local flattenings at the contacts with adjoining corallites. No traces of septa visible".

A fasciculate colony from Ellesmere Island is a perfect match externally for the figured Greenland specimens. The fragment (hypotype, GSC No. 18737) is 70 mm high, 40 mm wide, and 21 mm thick. In transverse section corallites are phacelloid, circular to angular with thick blunt corners and slightly indented walls, 1.8 mm in diameter; walls thick (0.15 to 0.2 mm) from which extend short (0.1 mm) pointed septal spines, at least twelve in number (absence in holotype may perhaps be a matter of preservation); individual corallites connected at one to three corners by short hollow tubules and in appropriate sections short chains can be defined; intervening spaces 0.3 to 2.5 mm thick; some corallites coalesce and have a common wall. In longitudinal section tabulae are numerous, thin, flat complete to incomplete curved, 0.3 to 0.65 mm apart; hollow oval tubules extend between corallites, 0.2 to 0.5 mm in diameter, cut ends of tubules and/or interspaces forming vertical rows of 'pores' 0.3 to 0.5 mm in diameter; some horizontal projections divided by common wall; septal spines short and horizontal or projecting downward, cut spines represented by small black dots arranged in obscure vertical and horizontal rows but never aligned in any complete longitudinal structure (spheres of poikiloplasm? — Flower, 1961, p. 29).

A second hypotype (GSC No. 14495) is 75 mm high, 72 mm wide, and 42 mm thick. In transverse section, mature corallites vary from rounded to angular three- or four-sided, 1.2 to 1.4 mm in diameter; walls up to 0.1 mm thick contain numerous dark spine bases and a rare, very short septal spine extending into the recrystallized central area. In longitudinal section, tabulae are thin, complete horizontal to incomplete convex or concave, 0.2 to 0.8 mm apart; hollow oval tubes connect the sinuous corallites, 0.25 x 0.5 mm in outline and 0.15 to 0.3 mm apart.

Discussion. Because of the presence of horizontal tabulae and vertically oriented (in four series) connecting tubuli, Sokolov removed this species from *Syringopora* (infundibuliform tabulae) and erected the genus *Troedssonites.* This genus has many features in common with his form *Tetraporella* [=*Labyrinthites*]. In its mixture of round and angular corallites, the Ellesmere Island specimen is much like some forms assigned to the genera *Hayasakaia* Lang, Smith and Thomas 1940 and *Tetraporinus* Sokolov 1947; however both genera have predominantly incomplete tabulae. A gross similarity also exists in tangential sections between *T. conspiratus* and specimens of *"Tollina feildeni"* (compare Troedsson, 1929, pl. 41, figs. 3a, b = a new species according to Teichert (1937, p. 57); *Palaeohalysites* [=*Catenipora*] *feildeni* — Sokolov, 1955, pl. 64, figs. 1, 2; *Quepora*? *feildeni* — Hamada, 1957, p. 424; *Manipora* [=*Tollina*] *feildeni* — Hamada, 1959, p. 280; Flower, 1961, p. 43; Nelson, 1963, p. 61; neither discontinuous nor continuous septa, however, are apparent in the hypotype) collected from beds of similar age farther west (GSC loc. 47664; Pl. IX, fig. 2), as well as the Silurian form *Palaeohalysites compressus* (Sokolov, 1955, pl. 65, fig. 5). In turn, the longitudinal sections of both *Troedssonites* and *"T. feildeni"* (Pl. IX, fig. 3) have many features common with the Silurian forms *Syringoporinus irregularis* (Sokolov, 1955, p. 194, fig. 47) and *S. bobini* (ibid., pl. 40, figs. 4, 5). *Syringopora burlingi* Wilson from the Ordovician part of the Beaverfoot-Brisco Formation of southeastern British Columbia, with which Troedsson compared *T. conspiratus,* is a *Sarcinula* and so quite unrelated.

Age and distribution (Figure 1). The holotype and paratype were both collected by Troedsson from talus (?) of the Cape Calhoun Formation at Cape Calhoun, eastern side of Kane Basin, northern Greenland. Hypotype GSC No. 18737 was collected by J. W. Kerr, 1961, from 710 to 800 feet below the top of the Cornwallis Formation, Darling Peninsula, east-central Ellesmere on the western side of Kane Basin (GSC loc. 47671) associated with *Actinostroma* sp., *Lyellia* sp., *Catenipora* sp., *Calapoecia* sp., *Foerstephyllum* sp., *Receptaculites* sp., *Cyrtogomphoceras* sp., and *Charactoceras* sp. This fauna, located above the *Labyrinthites*-bearing strata, is most probably of late Upper Ordovician age. Hypotype GSC 14495 was collected by J. W. Kerr, 1962, from the Cornwallis Formation, 2 miles east of southeast corner of lake at the head of Strathcona Fiord, west-central Ellesmere Island (GSC loc. 51968) associated with an Upper Ordovician fauna including *Cyclocrinites* sp., *Streptelasma* cf. *rusticum* Billings, *Paleofavosites* sp., *Catenipora* sp., *Receptaculites* sp., *Sower-*

byella cf. *sericea* (Sowerby), *Fusispira* sp., *Hormotoma* sp., *Wilsonoceras* sp., and *Bumastoides* sp.

Sokolov (1947, 1949) and Sokolov and Tesakov (1963) report representatives of *Troedssonites* from Ordovician rocks of northeastern Siberia (*T. flexibilis* Sokolov) and southwestern China (*T. compactus* Yoh Sen-Shing). From the Silurian (?) of the latter region *T. multitabulatus* Chen and *T. wonghsiangensis* Chen have been described (Chen, 1959).

Types. Hypotypes, GSC Nos. 14495, 18737.

Family FAVOSITIDAE Dana, 1846

Genus *Multisolenia* Fritz, 1937

Type species by original designation *Multisolenia tortuosa* Fritz, 1937

Multisolenia tortuosa Fritz

Plate VI, figures 2, 3; Plate VIII, figures 1-4

1937 *Multisolenia tortuosa* FRITZ, p. 233, figs. 1-6.
1937 *Palaeofavosites mirabilis* TCHERNYCHEV, p. 13, pl. 2, figs. 1a-c.
1937a *P. mirabilis* Tchernychev, TCHERNYCHEV, pp. 86, 117, pl, 7, figs. 4a-c.
1938a *P. mirabilis* Tchernychev, TCHERNYCHEV, p. 118, pl. 4, figs. 4a, b; p. 149, text-figs. 1a, b.
1939 *Multisolenia tortuosa* Fritz, FRITZ, p. 512, pl. 59, figs. 3, 4.
1941 P. *mirabilis* Tchernychev, TCHERNYCHEV, pp. 68, 149, figs. 1a, b.
1949 *Multisolenia tortuosa* Fritz, SOKOLOV, p. 82, pl. 7, figs. 7, 8.
1950a *M. tortuosa* Fritz, SOKOLOV, p. 222, pl. 4, figs. 1, 2.
1955a *M. tortuosa* Fritz, SOKOLOV *in* Nikiforova, p. 31, pl. 52, figs. 3, 4.
1956 *M. tortuosa* Fritz, STEARN, p. 66, pl. 5, figs. 1-4.
1956 *M. tortuosa* Fritz, HILL and STUMM, p. F464, fig. 349, 8a, b.
1959 *M. tortuosa* Fritz, ZHIZHINA and SMIRNOVA, p. 69, pl. 5, figs. 1, 2.
1961 *M. tortuosa* Fritz, STRUSZ, p. 352, pl. 44, fig. 3.
1962 *M. tortuosa* Fritz, YU, p. 346, pl. 1, figs. la-d.
1963 *M. tortuosa* Fritz, SOKOLOV and TESAKOV, p. 127, pl. 26, figs. 1, 2.

Description. Corallum meandroid, massive, laminar closely resembling a stromatoporoid colony, both colonies from Mann Island 170 mm wide and 100 mm high, and the smaller colony from the north end of Lake Timiskaming 80 mm wide and 40 mm high similar to the holotype; in one layer the corallum is ramose. In transverse sections corallites vary from roughly polygonal to rounded, ranging between 0.35 and 0.75 mm in diameter; walls thick, amalgamated, clear solid, broken by small pores near corners of corallites or completely voided by pores equal to diameter of a corallite producing an irregular or open meandering corallite pattern; septa (?) rarely developed as short blunt spines, at least four within one corallite, their preservation as opposite pairs (Pl. VIII, fig. 3) suggesting a relationship between their growth and the development of corallites, an interpretation advanced by Fritz (1937, p. 233) but rejected for normal intramural increase by Sokolov (1947a, p. 288) and Stearn (1956, p. 65). In longitudinal sections, walls straight to zigzag dependent upon abundance and density of pores; 'mural' pores or 'solenia' (Fritz, 1937) round, situated on exaggerated poral processes (Stearn, 1956), ranging between 0.3 and 0.55 mm in diameter and irregularly spaced from 0.25 to 0.35 mm apart, generally located in the corner of corallites in numerous vertical rows; tabulae complete, flat to slightly arched, variably spaced from 0.2 to 0.5 mm with some 0.6 to 0.7 mm apart.

Discussion. In longitudinal sections of *Multisolenia* the pores are arranged in vertical series as in *Labyrinthites* (Pl. IV, fig. 1) and *Troedssonites* (Pl. IX, fig. 1). There is little evidence, however, that these structures were hollow connecting tubes or solenia as in the syringoporoid genera. Only on weathered surfaces do the large, rimmed pores attain short tubular-like dimensions. The structure essentially is that of the Favositidae as advanced by Stearn (1956, p. 65) and Sokolov (1947a, p. 289) rather than that of Auloporidae. Recently, Yu (1962, p. 351) revived the family Multisolenidae Fritz, 1950 to include *Multisolenia, Mesosolenia,* and *Sapporipora.*

The abundant large pores and resultant meandroid pattern in transverse section serve to distinguish *Multisolenia* from closely related genera *Palaeofavosites, Favosites, Desmidopora* (Fritz, 1939, p. 513, pl. 59, figs. 1, 2), and *Mesosolenia* Mironova, 1960. The last two genera are characterized by mural pores arranged both in mid-wall and in the corner of corallite walls (latter specialized into large solenia in *Mesosolenia* according to Yu, 1962, p. 353).

In recent years, several other subspecies and species in addition to the cosmopolitan *M. tortuosa* have been defined, many of which show little difference from the type species. Differentiation has been based on the size and completeness of corallites, the diameter, shape, and distance apart of the pores, the completeness and spacing of the tabulae, and nature of septal spines. Table I gives data comparing these various representatives. Much of the Euro-Asian information was derived from Yu (1962, p. 346). No details were available for *M. mutosa* Leleshus 1959.

Age and distribution. Besides the single type specimen (Roy. Ont. Mus. Palaeo. 1154) collected from the Middle Silurian (Niagaran) Thornloe Formation exposed on Mann Island, Lake Timiskaming, Ontario-Quebec (Fig. 1), and the three additional specimens herein described from the same strata and region, *M. tortuosa* has been identified in the Middle Silurian (Niagaran) East Arm and Cedar Lake Formations of southern Manitoba, Hendricks Formation of Northern Peninsula of Michigan (Ehlers and Kesling, 1957, p. 28; 1962, p. 9), in the Chinese provinces of Xinjiang, Gansu, Ningxia, and Sichuan, in Lower to Upper Silurian deposits located in various districts of Central Asia, Ural Mountains, Siberia, Arctic USSR, and Estonia, and in the Lower and Upper Silurian of New South Wales, Australia. *Multisolenia* has recently been identified from the Harricanaw River area southeast of James Bay (Remick, *et al.*, 1963 p. 15) and from western Canada in collections from the Wind River district, northern Yukon (Norford, 1964).

Types. Hypotypes, GSC Nos. 18739, 18740 (Mann Island, Lake Timiskaming, Ontario-Quebec), 18741 (north end of Lake Timiskaming).

Table I

Comparative Data of Known Species of Multisolenia

Multisolenia species	Corallites Diam. mm	Pores		Tabulae Distance apart mm
		Diam. mm	Distance apart mm	
M. tortuosa Fritz 1937, holotype	0.25-0.6	0.25	2/1 mm	0.13-1.0+
M. tortuosa, hypotype 18740	0.35-0.45	0.30	0.2 -0.3	0.2 -0.3
M. tortuosa, hypotype 18741	0.50-0.65	0.4 -0.45	0.3	0.6 -0.7+
M. tortuosa, hypotype 18739	0.55-0.75	0.4 -0.55	0.3 -0.5	0.3 -0.5
M. tortuosa, Sokolov 1950a	0.2 -0.75	0.3 -0.4	0.17-0.3	0.2 -0.6
M. tortuosa, Sokolov 1955	0.4 -0.6	0.3 -0.4	—	0.2 -0.6
M. tortuosa, Stearn 1956	0.5	0.35+	5/4 mm	—
M. tortuosa, Zhizhina & Smirnova 1959	0.4 -0.6	0.26-0.36	0.2 -0.3	0.2 -0.5
M. tortuosa, Strusz 1961	0.3 -0.4	0.25	10/5 mm	0.25-1.0
M. tortuosa, Yu 1962	0.35-0.45	0.15-0.28	0.14-0.17	0.3 -0.5
M. tortuosa, Sokolov and Tesakov 1963	0.5 -0.7	0.3 -0.45	—	0.2 -0.5
M. tortuosa cylindrica Sokolov 1951a	0.4	0.3 -0.35	—	0.4 -0.7
M. tortuosa gansuensis Yu 1962	0.4	0.15-0.25	0.2 -0.35	0.3 -0.45
M. tortuosa sibirica Sokolov	0.5	0.25	—	0.2
M. anormalis Chekhovich 1954	0.32-0.6	0.17-0.25	0.36-0.42	0.25-0.31
M. confluens Stearn 1956	1.07	0.5	16/1 cm	15/1 cm
M. excelsa Klaamann 1961	0.5 -1.20	0.4 -0.5	< diam.	0.25-0.7
M. formosa Sokolov 1947a	0.65-0.95	0.35-0.4	—	0.4 -0.5
M. formosa Sokolov and Tesakov 1963	0.65-0.75	0.3	—	0.4 -1.0
M.? frivola Klaamann 1961	1.0 -1.75	0.4 -0.45	< diam.	0.5 -1.2
M. labyrinthica Sokolov and Tesakov 1963	0.4 -0.65	0.3	—	0.4-1.2
M. meandrica Barskaja 1962	0.7 -1.2	0.3 -0.37	—	0.8 -1.0
M. mirabilis (Tchernychev) 1937	0.5 -0.7	0.3 -0.35	8- 9/5 mm	14-17/5 mm
M. mirabilis (Tchernychev) 1938	0.5 -0.7	0.3 -0.4	7- 9/5 mm	15-17/5 mm
M. mirabilis (Tchernychev) 1938a	0.4 -0.6	0.2 -0.3	10-11/5 mm	14-20/5 mm
M. mirabilis (Tchernychev) 1941	0.5	0.2 -0.3	10/5 mm	15/5 mm
M. misera Sokolov and Tesakov 1963	0.25-0.4	0.18-0.22	—	0.1 -0.3
M. nikiforovae Sokolov and Tesakov 1963	0.5 -0.8	0.2	—	0.1 -0.4
M. ninae (Tchernychev) 1937a	0.5 -1.0	0.3 -0.35	—	0.2 -1.5
M. prisca Sokolov 1951a	0.8 -1.25	0.45-0.55	—	0.6 -0.8
M. prisca occulata Sokolov 1951a	0.6 -1.15	0.4 -0.5	—	0.6
M. reliqua Sokolov 1952 [= *Mesosolenia*]	1.3 -1.5	0.3 -0.4	—	0.4 -1.0
M. sichuaniana Yu 1962	0.7 -1.0	0.27-0.4	—	0.12-0.4
M. temperans Klaamann 1962	0.45-0.9	0.2 -0.25	0.3 -0.5	0.4 -1.2
M. tenuis Sokolov	0.3 -0.45	0.25	—	0.25-0.4
M. tortuosaeformis Klaamann 1962	0.3 -0.8	0.3 -0.35	0.25-0.3	0.2 -0.6
M. zhongningensis Yu 1962	0.45-0.65	0.28-0.35	0.2	0.28-0.42

Genus *Fossopora* Etheridge, 1903

Type species by original designation *Fossopora wellingtonensis* Etheridge, 1903

Fossopora lowi (Lambe)

Plate X, figures 1, 5

1906 *Boreaster lowi* LAMBE, p. 323, figures.
1914 *B. lowi* Lambe, SCHUCHERT, p. 475.
1944 *B. lowi* Lambe, BASSLER, p. 49, figs. 28, 29.
1955 *B. lowi* Lambe, SOKOLOV, p. 147, figs. 19a, b.
1956 *Fossopora lowi* (Lambe), HILL and STUMM, p. F462, figs. 349, 2a, b.

Description. Corallum irregular masses, largest 70 mm long, composed of small corallites opening in all directions. In transverse section corallites normally five to six sided, but varying from four sided to oval in the smallest and eight sided in the largest, diameter ranging from 0.4 to 0.7 mm in mature corallites (Lambe — 0.75 mm); walls straight to gently curved, unequal lengths, thin, amalgamated clear solid with slight suggestion of beading; six equal stubby (0.2-0.3 mm), spinose laminar septa; suggestion that growth was axial through septal coalescense rather than intermural. In longitudinal section abundant oval to elongate pores, normally one but sometimes two vertical rows to a face, 0.15 to 0.2 mm in diameter; tabulae thin, 0.7 to 1.2 mm apart, varying from flat and complete interrupted only by the laminar septa to curved, oblique and anastomosing; some tabulae even extend through the pores and are common to two corallites.

Discussion. Thin-section examination confirms that the genus *Boreaster* Lambe, 1906 is a subjective synonym of *Fossopora* Etheridge, 1903. The secondary rudimentary spines recognized by Lambe are not distinguishable in thin section. Such structures could be attributed to a local thickening of the corallite walls. The presence of both complete and incomplete tabulae in *F. lowi* also is further evidence of its relationship to *Fossopora.* The Australian Siluro-Devonian *F. wellingtonensis* Etheridge differs from the Arctic Canada Silurian *Boreaster lowi* in its lobate form with well-defined peripheral and axial regions, its thick-walled corallites (½ mm in diameter), and its distally club-shaped or pyriform spines.

Types. Syntypes, GSC Nos. 7849, a. Upper Silurian [Read Bay Formation — Fortier, *et al.,* 1963, pp. 206-207], Lancaster Sound, Beechey Island, Canadian Arctic Archipelago; collector A. P. Low, 1904.

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PART III

A NEW SPECIES OF *HEMICYSTITES*

G. Winston Sinclair and Thomas E. Bolton

Abstract

Hemicystites pleiadae n. sp. is the first agelacrinitid to be reported from the Ordovician of Anticosti Island, Quebec. Details of its ventral anatomy are described. It is suggested that orthoceroid cephalopods had an outer shell capable of persistence after destruction of the septa and inner wall.

Résumé

L'Hemicystites pleiadae n. sp. est le premier agelacrinitide signalé dans l'Ordovicien de l'île Anticosti, au Québec. On décrit les détails de son anatomie ventrale. Les céphalopodes ressemblant aux Orthoceras semblaient posséder une coquille extérieure capable de persister après la destruction des septums et de la cloison intérieure.

INTRODUCTION

Agelacrinitids are so rare in the Ordovician that discovery of representatives of the group in a new region is itself worthy of notice. The specimens described here are the first to be reported east of Ottawa. In the Montreal district and in the St. Lawrence valley up river from Quebec City, a variety of echinoderms are found. Several genera are locally abundant in the Chazyan, *Cheirocrinus* and crinoids are common in the Tetreauville-Terrebonne (Sinclair, 1951)[1], and carpoids and stellaroids are found in the Rosemount. Down river from Quebec City several carpoid genera occur in Trentonian beds, with ophiurians, but throughout this whole region no edrioasterid of any kind has been described. The reason for this distribution is not known.

The present specimens are of interest also because they are well preserved, and permit description of some anatomic details. The method of preservation is peculiar, and has led us to offer some suggestions about the nature of cephalopod tests which may have wider application.

[1]Dates in parentheses are those of *References*, p. 39.

SYSTEMATIC PALAEONTOLOGY

Genus *Hemicystites* Hall, 1852

Type species *Hemicystites parasiticus* Hall, 1852

Hemicystites pleiadae n. sp.

Plate XI, figures 1-6

Types. GSC No. 14680, a group of seven specimens of which one is marked HT, for holotype. T. E. Bolton, collector, 1958.

Locality. Anticosti Island, Quebec, 9 miles northeast of Port Menier where main highway abruptly turns east, road-cut in escarpment at south end of Princeton Lake.

Age. Ordovician, Richmondian Stage, Vauréal Formation, 210 feet below base of Ellis Bay Formation (Bolton, 1961, p. 4).

Description. A hemicystitid of moderate size, the types ranging from 6 to 8 mm in diameter, the holotype being 7.5 mm. Upper surface not known. Food grooves five, short, blunt, not extending past the submarginal ring, floored by a single row of about eight simple, transversely quadrate, non-imbricating plates, which show very little decrease in width distally, except that the terminal plate is rounded and smaller than the others. Each proximal floor plate is expanded and swollen, and its orad edge is depressed to form the peristomial frame. This frame is lenticular, the anterior edge is formed by the anterior, left and right proximal floor plates, the posterior edge by those of the remaining left-posterior and right-posterior grooves. Although not perfectly seen in any specimen, it is apparently entire. Cover plates a little shorter and therefore more numerous than the floor plates, their lower extensions expanded and clavate, strongly recurved, so as to lie against the under side of the interambulacral plates, and so as to continue the contour of the lower side of the floor plates.

Interambulacral plates rather large, about five in the width of an interradius peripherally, imbricating. Submarginal ring of large plates, which lie over the interambulacrals proximally, very strongly radially striate on the under side. Marginal plates much smaller than any other plates of the theca, overlapping the submarginal rings proximally, and mutually overlapping themselves. Valve (anus of authors) rather large, much closer to the right-posterior than to the left-posterior food groove, being about the same distance from the former as from the submarginal ring, and comprising about eight triangular plates with the interambulacrals usually depressed around it (i.e., raised in this ventral view).

Food grooves straight or very gently bent, with no regularity in direction. There may be some slight tendency for the left and left-posterior grooves to bend to the left, the right and right-posterior to the right, but this bending is so slight as to be scarcely noticeable.

Remarks. The full width of the marginal zone of small plates is seen in only one specimen (Pl. XI, fig. 4), in which slumping toward the left-posterior has pulled the submarginal ring away from the opposite side. In this specimen, only, the marginal plates show an extremely fine, faint radial striation. The part of the marginal zone which normally overlaps the submarginal ring has been straightened out, and the surface is continuous.

The specimens are now seen from the under side on the surface of the steinkern of an indeterminate cephalopod. Much of the rest of the steinkern is covered by bryozoans (*Sagenella* sp. ?), also seen from the under side. Clearly, in life the hemicystids and the bryozoans were attached to the inner surface of a broken shell that lay, concave side up, on the bottom. However, at that time the septa of the cephalopod must have already been removed, since neither bryozoans nor echinoderms appear to have been affected by the position of the sutures. The frequency with which steinkerns of orthocerocones are found apparently well preserved, but with no trace of septa or other internal structures, suggests that the outer layer of the conch may have been more resistant to solution than the inner, and so have persisted as such after the septal and siphonal structures had been lost. It is difficult to imagine how the present specimen could have originated unless some such differential destruction of the cephalopod shell had taken place. After lime muds had filled in the shell and became consolidated, the remainder of the cephalopod dissolved away, leaving the steinkern as we now have it, with its cargo exposed in ventral aspect.

Since classification of the edrioasterids is based on features of the upper surface, the generic position of this species must remain in doubt. However, it is sufficiently like the type species of *Hemicystites, H. parasiticus* Hall (*see* Bassler 1936, p. 11, pl. 4, figs. 5, 6) to make reference to that genus probable. Within the genus there is no species so similar to *H. pleiadae* as *H. parasiticus,* which seems to have more plates in each food groove, although close comparison is not possible because of the differences in preservation and the meagre information available about Hall's species.

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PLATES I to XI

Plate I

Figures 1-18.	*Encrinurus* (*Frammia*) *arcticus* (Haughton) (Page 4)
1.	Two enrolled specimens; x1; Griffith Island. Paralectotypes, McClintock Collection Nat. Mus. Ireland 95:1905/237 [original of *J. Roy. Dublin Soc.*, vol. 1, 1858, pl. 6, fig. 5].
2, 4.	Posterior views pygidia; x2; Seal Island, Wellington Channel. Hypotypes, GSC Nos. 17759, 17761.
3.	Right lateral view pygidium; x1; same locality as figure 2. Hypotype, GSC No. 17760.
5.	Dorsal view pygidium and nine thoracic segments; x1; top of section in gully just west of Cape Admiral M'Clintock, Somerset Island. Hypotype, GSC No. 17754.
6, 7.	Dorsal and oblique views of cephalon showing glabella continuance into lateral border with associated lobation; x2; Seal Island, Wellington Channel. Hypotype, GSC No. 17762.
8-10.	Left lateral, dorsal, and posterior views pygidium; x2; same locality as figure 6. Hypotype, GSC No. 17763.
11, 12.	Dorsal and right lateral views glabella showing four oval apodemal pits; x2; same locality as figure 6. Hypotype, GSC No. 17764.
13, 14.	Dorsal and right lateral views complete specimen; x1; Garnier Bay, north shore Somerset Island. Lectotype, McClintock Collection Nat. Mus. Ireland 95:1905/220 [original of *J. Roy Dublin Soc.*, vol. 1, 1858, pl. 6, figs. 1, 2].
15.	Left free cheek showing position of three lateral border lobes and fourth lateral glabellar lobe, eye, and border curvature; x2; same locality as figure 6. Hypotype, GSC No. 17765.
16.	Dorsal view small pygidium; x1; same locality as figure 6. Hypotype, GSC No. 17766.
17, 18.	Dorsal views incomplete cranidia; x2; same locality as figure 6. Hypotypes, GSC Nos. 17767, 17767a.

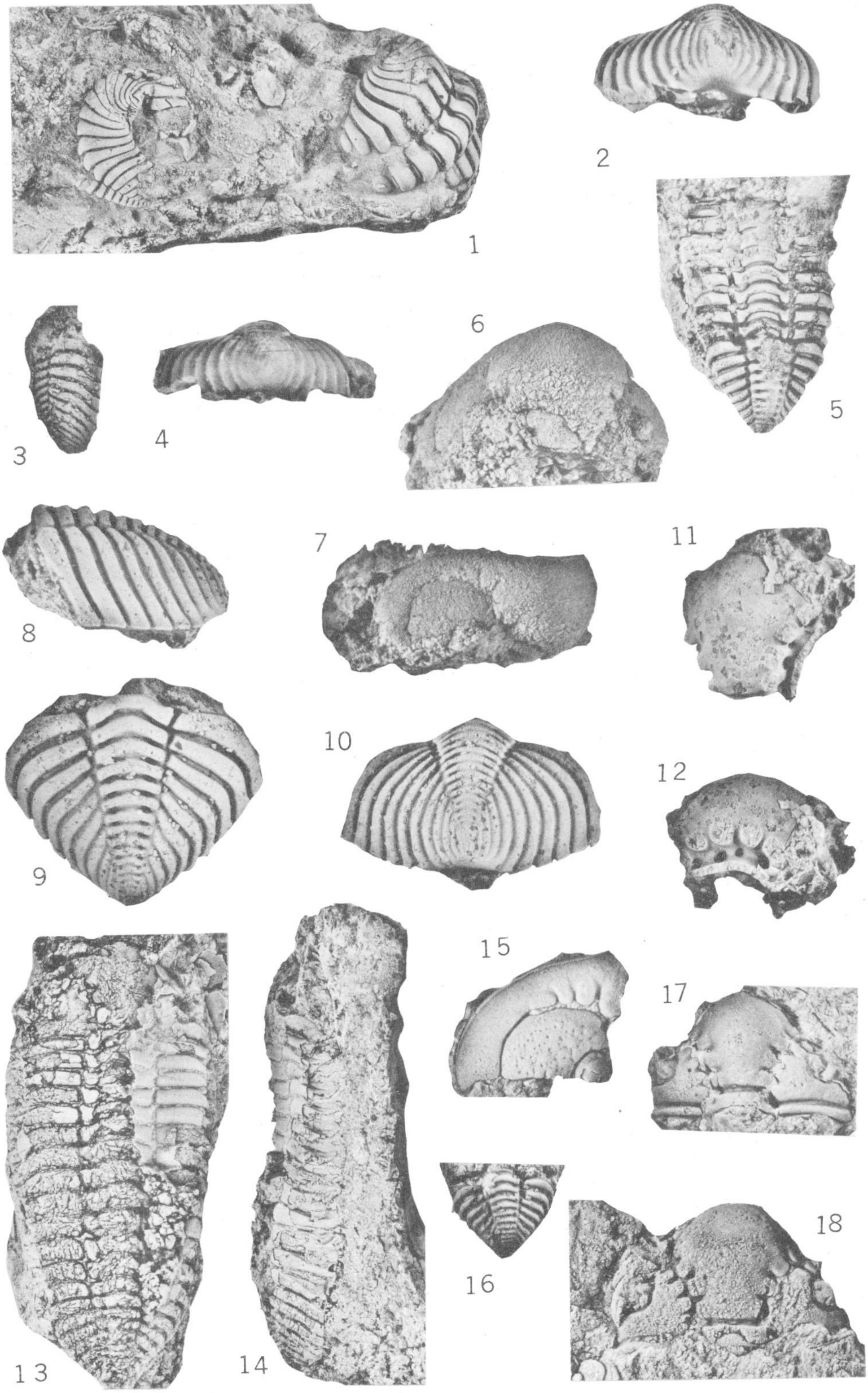
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Plate II

Figures 1, 2. *Encrinurus (Frammia) arcticus* (Haughton). Dorsal and right lateral views pygidium and three thoracic segments; x1; gully on east shore of lake just south of Garnier Bay, north shore Somerset Island. Hypotype, GSC No. 17755. (Page 4)

Figure 3. *E. (F.) arcticus* (Haughton). Posterior view pygidium; x2; Seal Island, Wellington Channel. Hypotype, GSC No. 17768. (Page 4)

Figure 4. *E. (F.) arcticus* (Haughton). Dorsal view two pygidia; x1; same locality as figure 1. Hypotype, GSC No. 17756. (Page 4)

Figure 5. *E. (F.) arcticus* (Haughton). Dorsal view incomplete cranidium and nine thoracic segments; x1; gorge section, elevation 580 feet, Radstock Bay, Southwest Devon Island. Hypotype, GSC No. 17758. (Page 4)

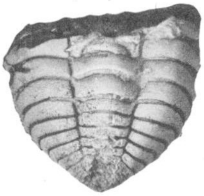
Figure 6. *Hemiarges* sp. cf. *H. aquilonius* Whittington. Dorsal view pygidium; x3; from 200-foot limestone unit above *Monograptus* shale, 2 miles north of peninsula north of large delta, east shore Goose Fiord, southwestern Ellesmere Island. Hypotype, GSC No. 14491. (Page 11)

Figure 7. *Hemiarges aquilonius* Whittington. Dorsal view incomplete cranidium associated with encrinurid hypostome and pygidium; x3; same locality as figure 6. Hypotype, GSC No. 14492. (Page 11)

Figure 8. *E. (F.) arcticus* (Haughton). Dorsal view incomplete cranidium and eight thoracic segments; x2; Assistance Bay, southern Cornwallis Island. Paralectotype, McClintock Collection Nat. Mus. Ireland 95:1905/212. (Page 4)

Figure 9. *Proetus (Cyphoproetus?)* sp. Dorsal view incomplete cranidium; x3; same locality as figure 6. Figured specimen, GSC No. 17782. (Page 3)

Figure 10. *Encrinurus* sp. cf. *E. (F.) arcticus* (Haughton). Dorsal view complete specimen with five large glabellar tubercles overhanging the axial furrow and corresponding smaller tubercle-lobes on free cheek, eleven thoracic segments, nine pygidial pleurae, and thirteen axial rings (some tuberculate); x3; associated ostracod *Leperditia arctica* Jones; 1 mile north of Fury Beach, eastern Somerset Island. Hypotype, GSC No. 17757. (Page 8)



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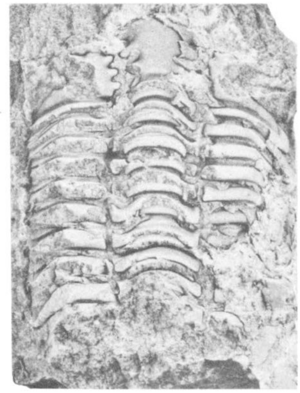

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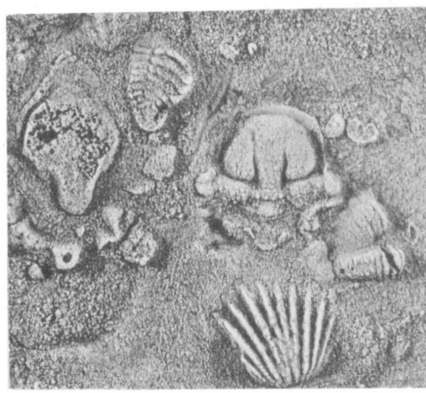

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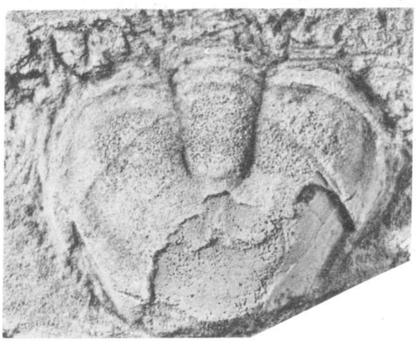

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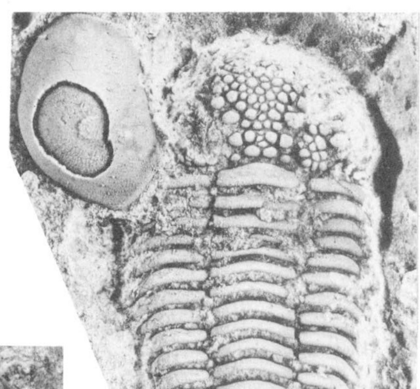

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PLATE III

Figures 1-9, 11. *Hemiarges bigener* n. sp. (Page 10)

1. Complete specimen; x2; Peel Sound Formation, northeast corner Prince of Wales Island. Holotype, GSC No. 17772.

2. Small pygidium with marginal spines; x4; 4,095 feet from base undifferentiated Allen Bay-Read Bay formation, eastern Darling Peninsula, eastern Ellesmere Island. Hypotype, GSC No. 17780.

3. Incomplete cephalon; x4; same locality as figure 2. Paratype, GSC No. 17773.

4, 5, 9. Pygidia; x1; same locality as figure 2. Paratypes, GSC Nos. 17774-17776.

6, 11. Incomplete cephala; x2; same locality as figure 2. Paratypes, GSC Nos. 17778, 17779.

7. Natural cast of pygidium and eight thoracic segments; x1; float on upland surface of Marshall Peninsula, northwestern Cornwallis Island. Paratype, GSC No. 18245.

8. Pygidium; x2; same locality as figure 2. Paratype, GSC No. 17777.

Figure 10. *Hemiarges aquilonius* Whittington associated with two cephala of *Encrinurus* approaching *E. (Frammia)*; x4; member A, Read Bay Formation, unit 53, Goodsir Creek, central-east coast of Cornwallis Island. Hypotype, GSC No. 14493. (Page 11)

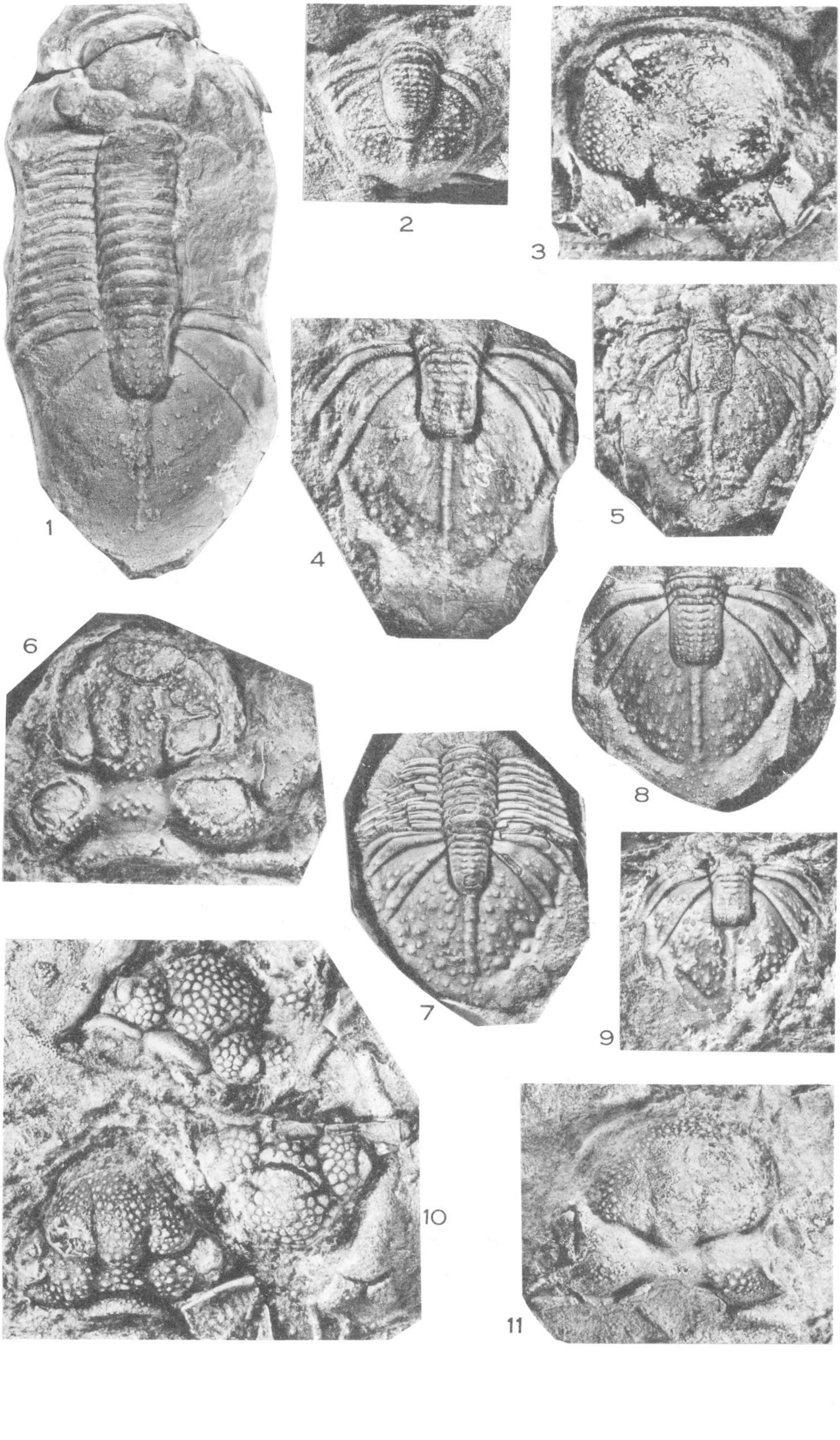
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Plate IV

Figures 1, 2. *Labyrinthites (Labyrinthites) chidlensis* Lambe. Longitudinal and transverse sections; x12; Middle Ordovician, northern end of exposure along eastern shore of a long peninsula, west-central Lake Manicouagan, Quebec. Hypotype, GSC No. 18729. (Page 18)

Figures 3, 7. *L. (L.) chidlensis* Lambe. Longitudinal and transverse sections; x12; Ordovician drift at Cape Chidley, Hudson Strait, Newfoundland. Lectotype, GSC No. 7933 (*see* Pl. VI, fig. 4). (Page 18)

Figures 4-6. *Labyrinthites (Arcturia) complexus* Wilson. Longitudinal and transverse sections; x3 and x12; Ordovician or Silurian, drift on Fossil Island, Lake Nettilling, southern Baffin Island. Syntype, GSC No. 6505a. (Page 19)

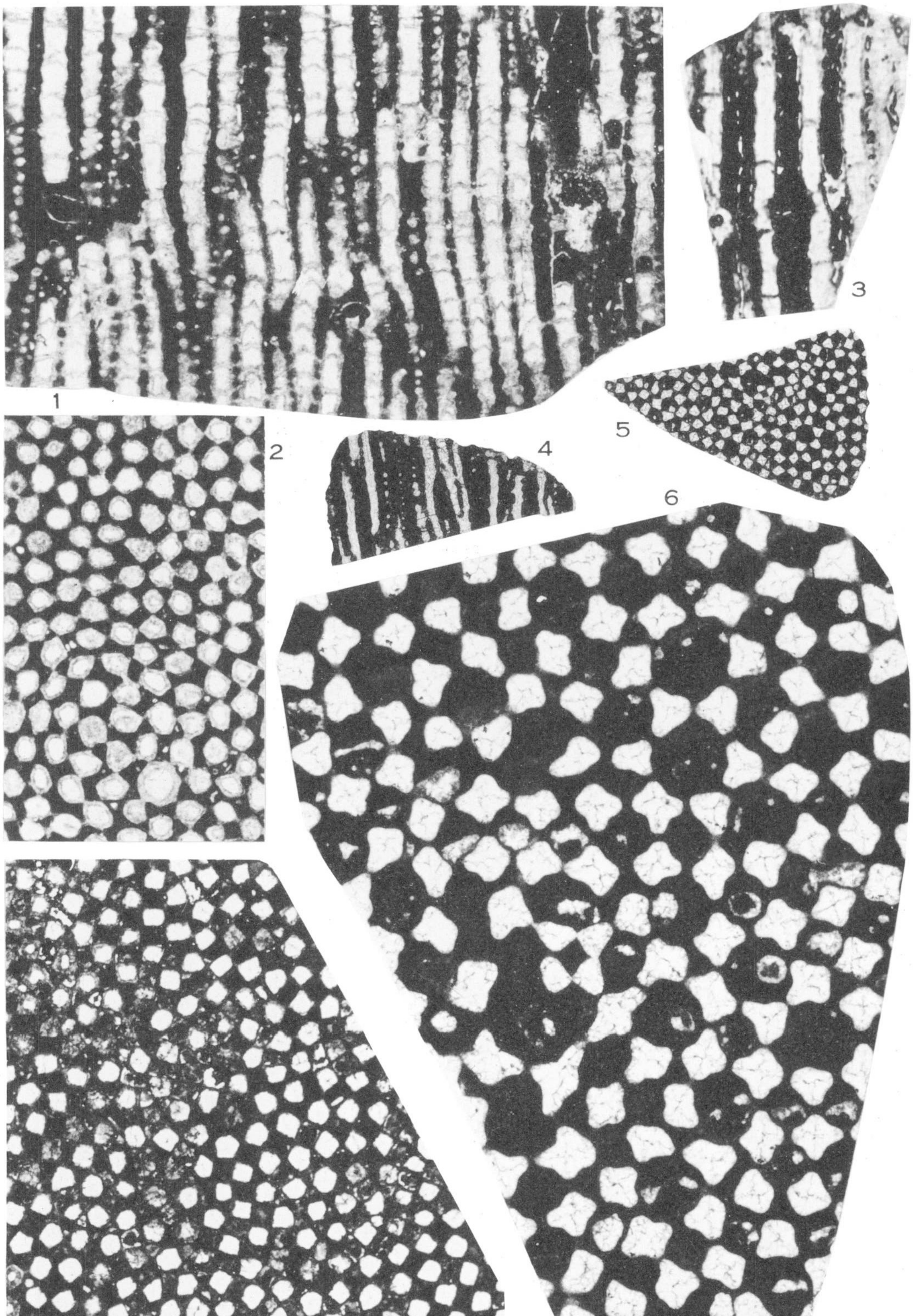
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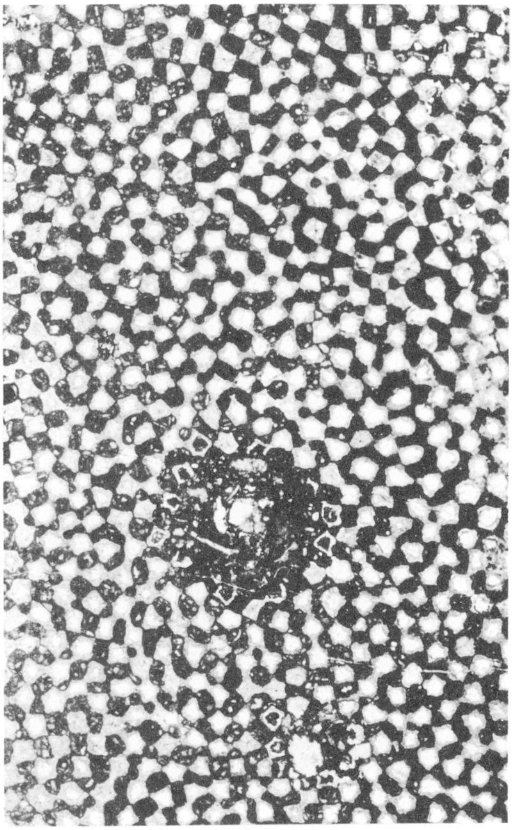
Plate V

Figure 1. *Labyrinthites (Labyrinthites) chidlensis* Lambe. Transverse section; x10; 800-1,500 feet below top of Cornwallis Formation, Middle Ordovician, eastern Darling Peninsula, east-central Ellesmere Island. Hypotype, GSC No. 18735. (Page 18)

Figures 2, 3. *L. (L.) chidlensis* Lambe. Transverse from near base of colony and longitudinal sections; x10; central section of exposure along eastern shore of a long peninsula, west-central Lake Manicouagan, Quebec. Hypotypes, GSC Nos. 18731, 18730. (Page 18)

PLATE V



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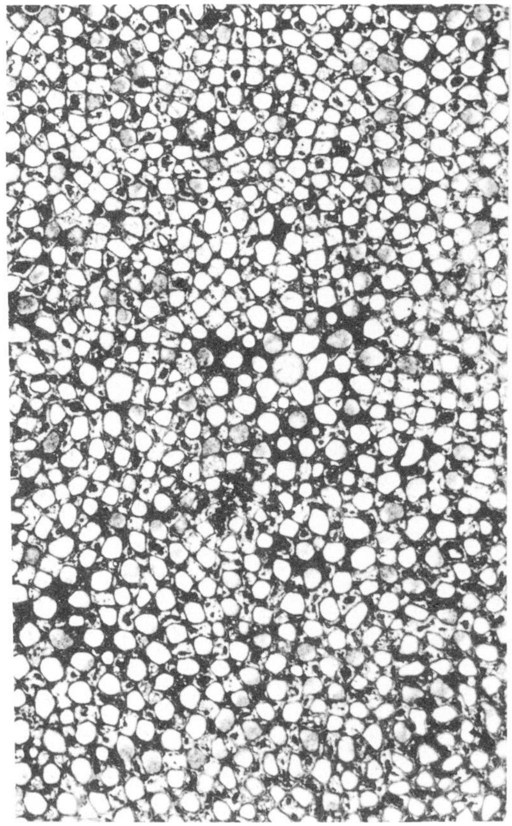

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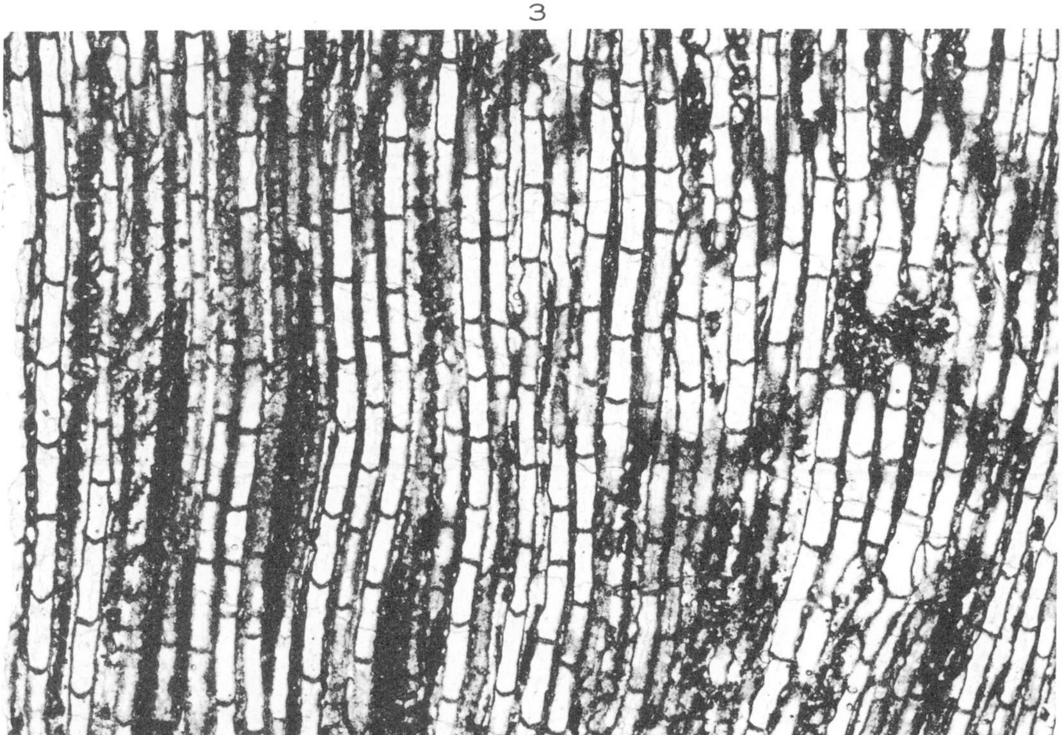
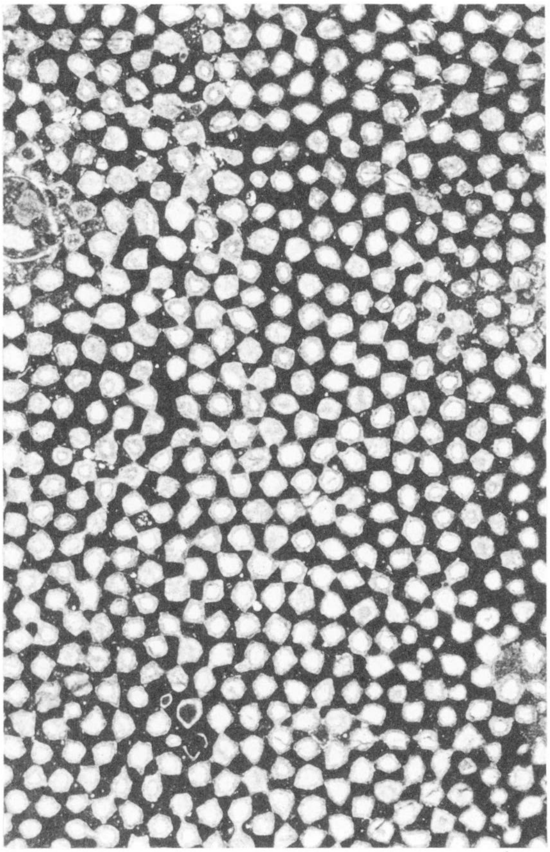


Plate VI

Figures 1, 5. *Labyrinthites (Labyrinthites) chidlensis* Lambe. Transverse and longitudinal sections; x10; Middle Ordovician, south of southern boundary of Quertier tp., northwest shore of Lake Manicouagan, Quebec. Hypotype, GSC No. 15728. (Page 18)

Figures 2, 3. *Multisolenia tortuosa* Fritz. Longitudinal (inverted) and transverse sections; x4; Thornloe Formation, Middle Silurian (Niagaran), Mann Island, Lake Timiskaming, Ontario-Quebec. Hypotype, GSC No. 18740. (Page 26)

Figure 4. *Labyrinthites (Labyrinthites) chidlensis* Lambe. Transverse section; x28; Ordovician drift at Cape Chidley, Hudson Strait, Newfoundland. Lectotype, GSC No. 7933 (*see* Pl. IV, figs. 3, 7). (Page 18)



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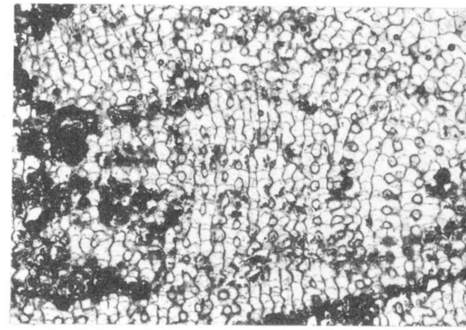

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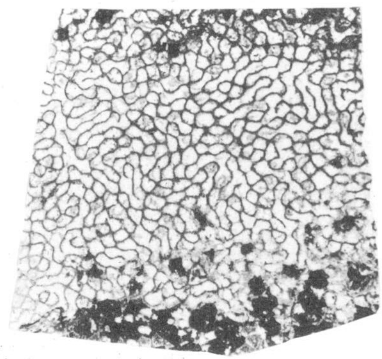

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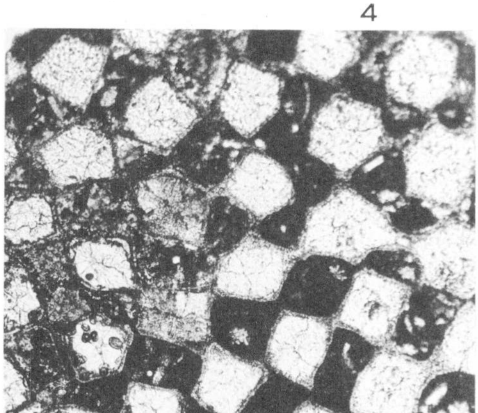

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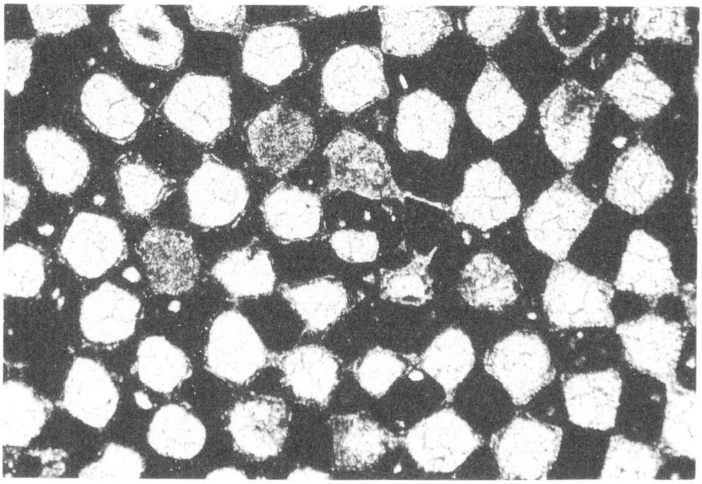
PLATE VII

Figure 1. *Labyrinthites (Labyrinthites) chidlensis* Lambe. Transverse section; x28; Middle Ordovician, east shore of large bay, southwestern Lake Manicouagan, Quebec. Hypotype, GSC No. 18734. (Page 18)

Figures 2, 3, 5. *Moyerolites angularis* (Stumm). 2, 5 — transverse sections exhibiting wide variation in shape of corallites from pronounced angularity and loosely chained (fig. 2) to rounded, isolated (fig. 5); 3 — longitudinal section showing syringoporoid-type connecting tubes as in *Troedssonites* (Pl. IX, fig. 1), short spines (Pl. X, fig. 4), budding, but no intercorallite vesicular tissue as in *M. sibiricus* Sokolov; x10; Hardwood Mountain Formation, Middle-Upper Silurian, southeast ninth of Chain Lakes quadrangle on shore of Jim Pond, Franklin county, Maine, U.S.A. Holotype, USNM No. 139449. (Page 23)

Figure 4. *Labyrinthites (Labyrinthites)* sp. Longitudinal section showing widely spaced tabulae and short connecting tubes; x10; Middle Ordovician, west side Mint River, 4.6 miles N81°W (True) of highest point of Brooks Mountain, Alaska. Figured specimen, USNM No. 144877. (Page 21)

Figure 6. *L. (L.) chidlensis* Lambe. Longitudinal section; x28; Middle Ordovician, same locality as figure 1. Hypotype, GSC No. 18733. (Page 18)



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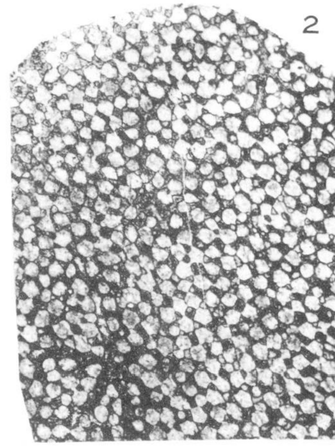

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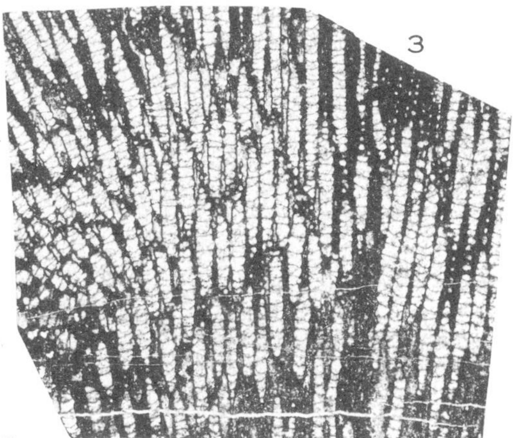

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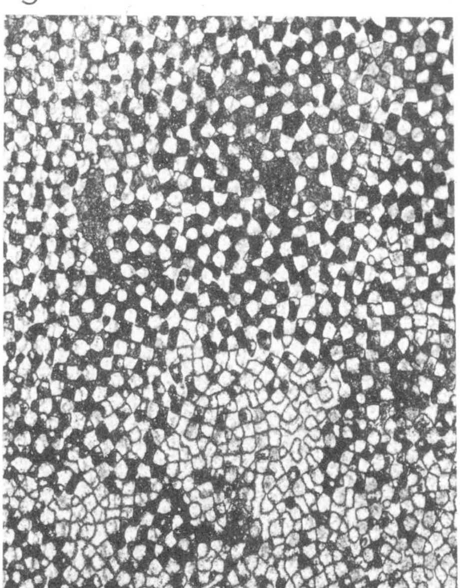

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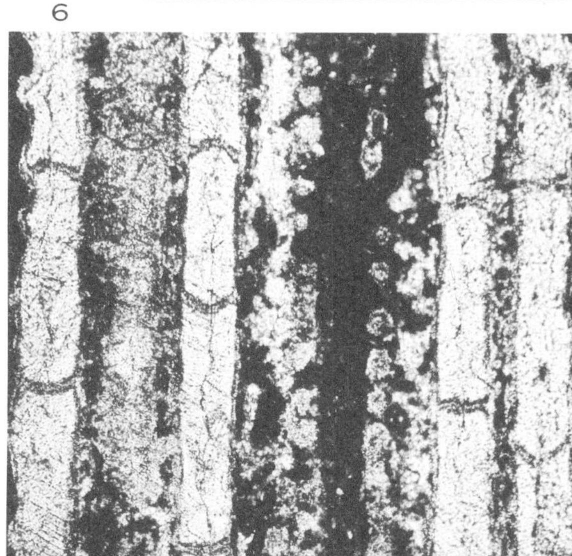

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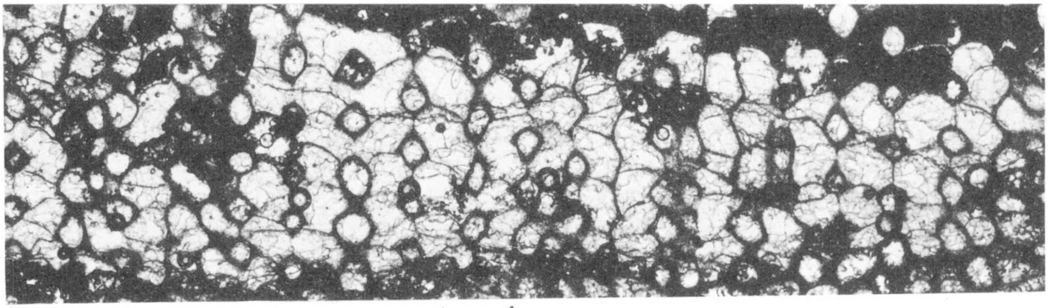
PLATE VIII

Figures 1-3. *Multisolenia tortuosa* Fritz. 1 (inverted), 2 — longitudinal section; x10 and x4; 3 — transverse section; x4; Thornloe Formation, Middle Silurian (Niagaran), Mann Island, Lake Timiskaming, Ontario-Quebec. Hypotype, GSC No. 18739. (Page 26)

Figure 4. *M. tortuosa* Fritz. Transverse section; x10; Thornloe Formation, Middle Silurian (Niagaran), north end of Lake Timiskaming, Ontario. Hypotype, GSC No. 18741. (Page 26)



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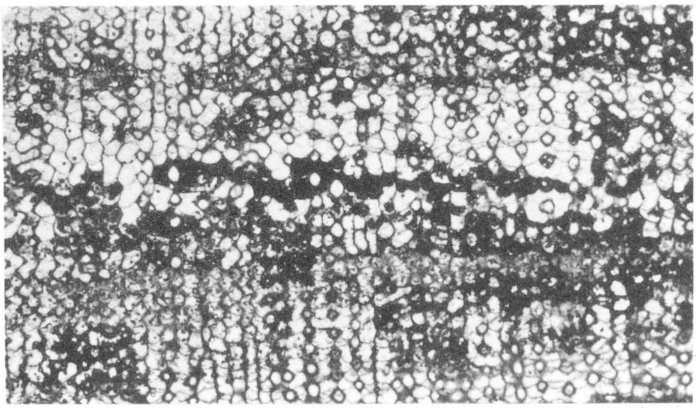

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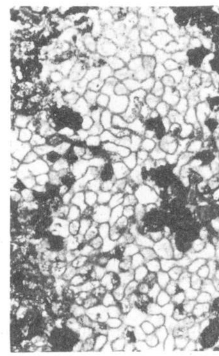

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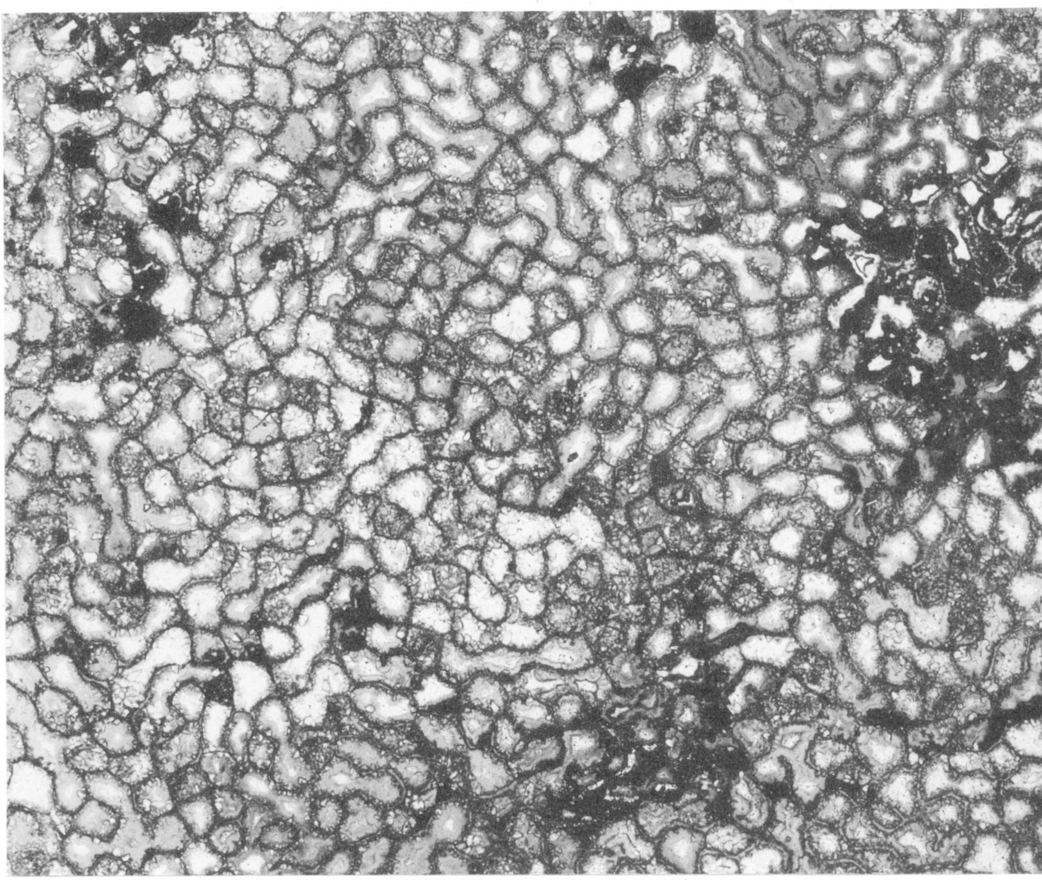
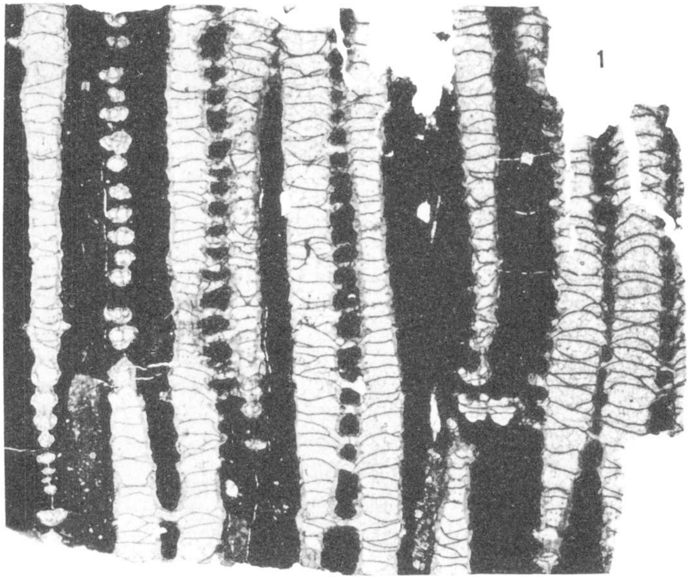


Plate IX

Figures 1, 4. *Troedssonites conspiratus* (Troedsson). Longitudinal and transverse sections; x4; Upper Ordovician, western side Kane Basin, eastern Darling Peninsula, east-central Ellesmere Island. Hypotype, GSC No. 18737. (Page 24)

Figures 2, 3. "*Tollina feildeni* (Etheridge)". Transverse and longitudinal sections; x2 and x4; Upper Ordovician, 5 miles northeast of sharp bend in southern part of Canyon Fiord, 1 mile from north shore, west-central Ellesmere Island (GSC locality 47664; collected by J. W. Kerr, 1961). Hypotype, GSC No. 18738. (Page 25)



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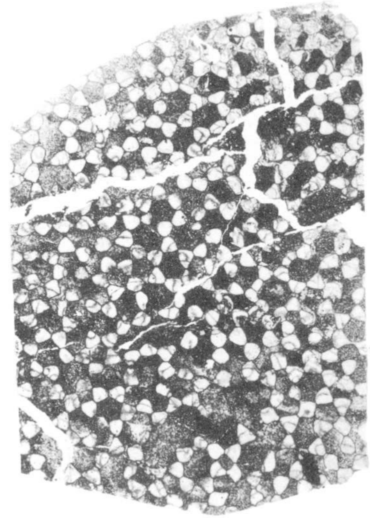

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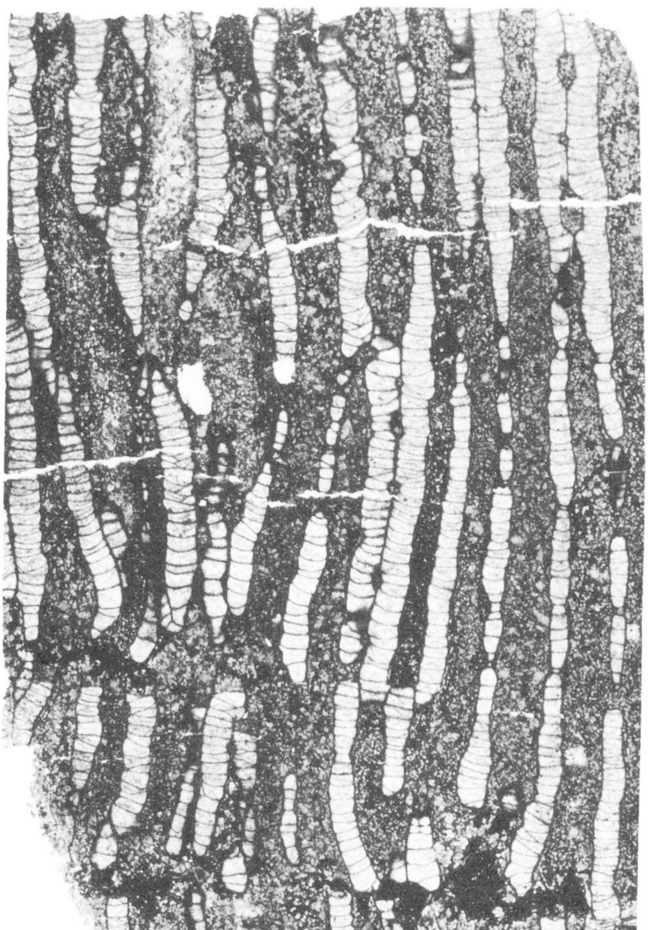

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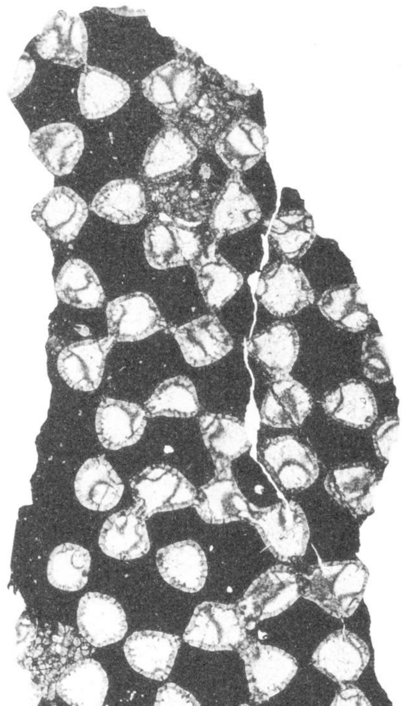

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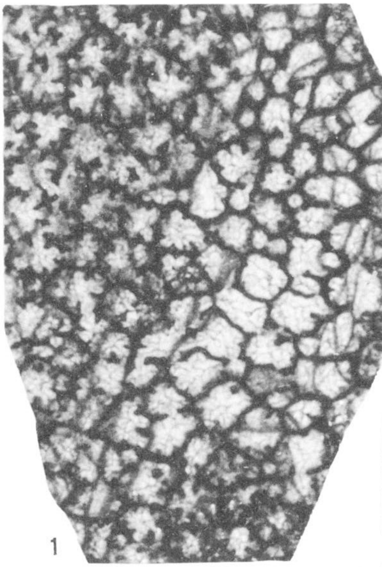
Plate X

Figures 1, 5. *Fossopora lowi* (Lambe). Transverse and longitudinal sections; x10; Upper Silurian, Beechey Island, Lancaster Sound, Arctic. Syntype, GSC No. 7849. (Page 29)

Figure 2. *Encrinurus (Frammia) arcticus* (Haughton). Thorax and pygidium; x1; 'Series B', lower part, Upper Silurian, north side Rendalen Valley, southeast Goose Fiord, southwestern Ellesmere Island. Syntype of *Frammia dissimilis* Holtedahl, Paleontologisk Museum Oslo No. A10863. (Page 4)

Figure 3. '*Proetus*' *leptorhachis* Holtedahl. Pygidium; x4; 'Series B', upper part, Devonian (?), valley south of Borgen, southeast Goose Fiord, southwestern Ellesmere Island. Holotype, Paleontologisk Museum Oslo No. A13320. (Page 3)

Figure 4. *Moyerolites angularis* (Stumm). Longitudinal section, part of figure 3, Plate VII enlarged to show short spines; x30; Middle-Upper Silurian, Franklin county, Maine, U.S.A. Holotype, USNM No. 139449. (Page 23)



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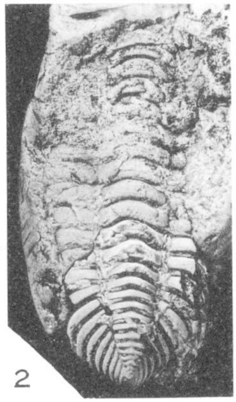

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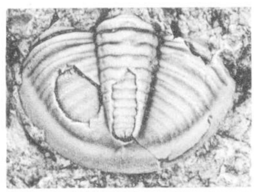

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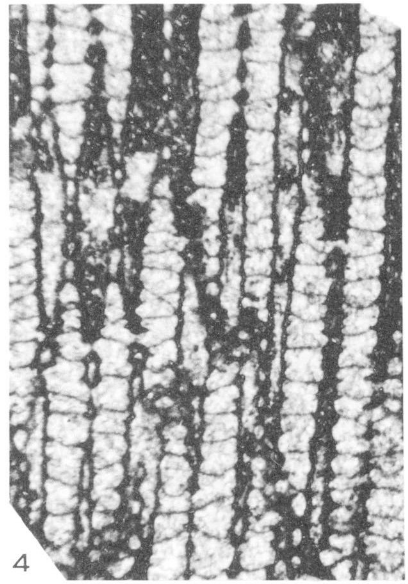

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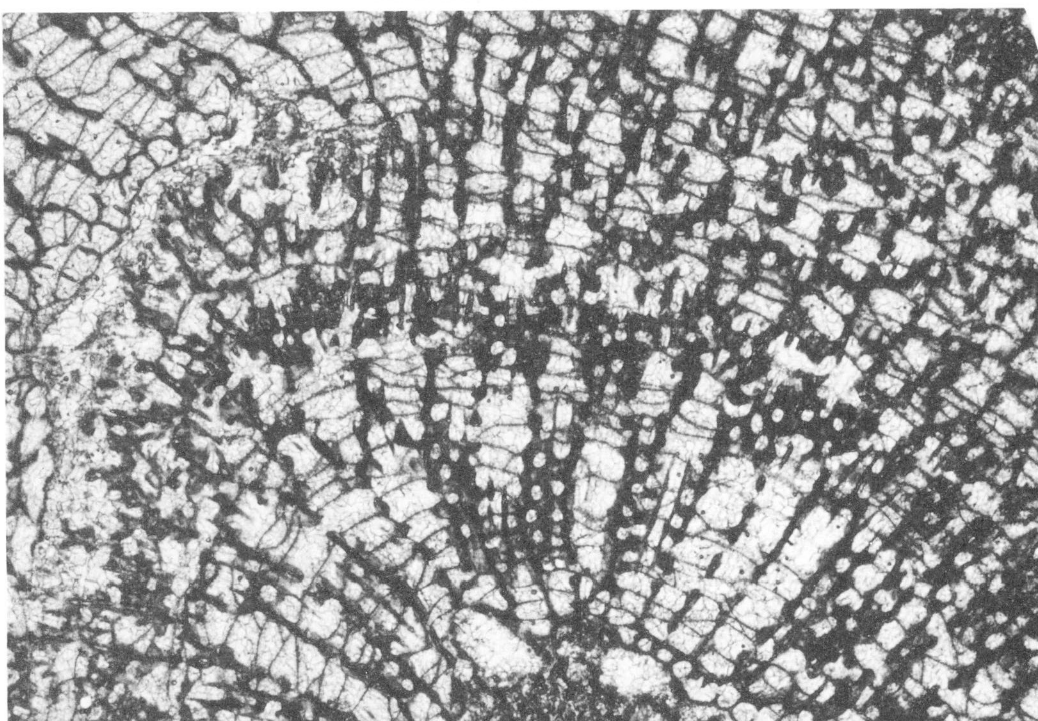

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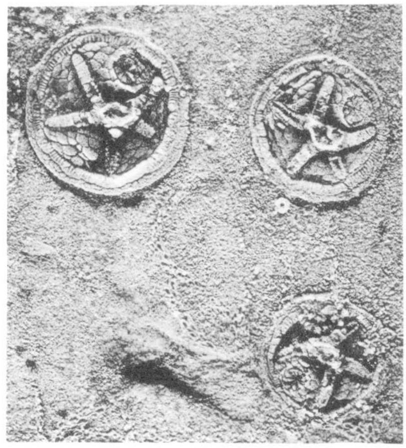
Plate XI

Figures 1-6.	*Hemicystites pleiadae* n. sp. Vauréal Formation, Upper Ordovician, Anticosti Island, Quebec. (Page 37)
1.	The holotype, x9. The radial ridging of the submarginal ring of plates is well shown, as is the clavate shape of the lower part of the cover plates, seen on the lower side of the arm at the left.
2.	Another view of holotype looking obliquely into a theca, to show the shape of the cover plates when the food grooves are removed; x9.
3.	Group of three on upper left corner of figure 6. The holotype is the specimen at the upper left; x3.
4.	The small specimen located at the extreme right in figure 6, to show the true width of the marginal zone of plates, exposed by the slumping of the rest of the theca down and to the right (in the view given here); x9.
5.	View of six of the group, holotype at the upper left; x3.
6.	Holotype (top left) and six paratypes, GSC No. 14680; x1.

1



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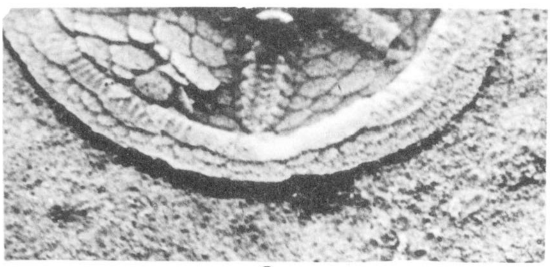

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