

GEOLOGICAL  
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OF  
CANADA

DEPARTMENT OF MINES  
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**BULLETIN 91**

**CANADIAN FOSSIL  
OSTRACODA, CONCHOSTRACA, EURYPTERIDA,  
AND PHYLLOCARIDA**

**M. J. Copeland**

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## PREFACE

The six papers contained in this bulletin describe several diverse Palæozoic arthropods from widely scattered parts of Eastern and Arctic Canada. These include Ostracoda from the Middle Ordovician and Middle Silurian of southern Ontario, Lower Devonian of northern New Brunswick, and Middle Devonian of the Arctic and Yukon; Devonian Conchostraca from Melville Island in the Canadian Arctic; and additional Silurian Eurypterida and Phyllocarida from Cornwallis and surrounding islands in the central Arctic. These reports describe the further study of certain Canadian fossil arthropods begun with publication of Bulletin 60 of this series.

J. M. HARRISON,  
*Director, Geological Survey of Canada*

OTTAWA, August 14, 1961



# CONTENTS

PAGE

## *Some Leperditiid Ostracods from Northern Canada*

Introduction .....	1
Collections .....	1
Stratigraphic position .....	1
Systematic palæontology .....	2
References .....	8

## *Ostracoda from the Rochester Formation (Middle Silurian) of Southern Ontario*

Introduction .....	9
Localities .....	9
Occurrence of Rochester Ostracoda .....	10
References .....	11

## *Devonian Conchostraca from Melville Island, Canadian Arctic*

Discussion .....	12
Systematic palæontology .....	13
References .....	17

## *Ostracoda from the Lower Devonian Dalhousie Beds, Northern New Brunswick*

Geology .....	18
Discussion and correlation .....	19
Systematic palæontology .....	23
References .....	49

## *Additional Silurian Arthropoda from the Canadian Arctic*

Introduction .....	52
Systematic palæontology .....	52
References .....	54

## *Two new Ordovician Ostracoda from Southern Ontario*

Description .....	55
References .....	57

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Table I. Suggested evolution of Leperditiinae genera .....	2
II. Stratigraphic distribution of Ostracoda in the Dalhousie beds .....	20, 21
III. Other occurrences of Ostracoda species found in the Dalhousie beds .....	22

## Illustrations

Plates I-XII. Illustrations of fossils .....	<i>Following p.</i> 57
Figures 1, 2. Drawings of <i>Mölleritia canadensis</i> n. sp. ....	5



# CANADIAN FOSSIL OSTRACODA, CONCHOSTRACA, EURYPTERIDA, AND PHYLLOCARIDA

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## *Abstract*

Continued research on certain Palæozoic arthropod faunas of Eastern and Arctic Canada has revealed the presence of several well-preserved and diversified Ordovician, Silurian, and Devonian faunas. These include numerous new and previously recorded species of Ostracoda, Conchostraca, Eurypterida, and Phyllocarida.

## *Résumé*

Les recherches qui se poursuivent dans l'Est et l'Arctique canadiens sur certaines faunes à arthropodes paléozoïques ont révélé la présence de plusieurs faunes bien conservées et diversifiées de l'Ordovicien, du Silurien et du Dévonien. Ces spécimens comprennent plusieurs espèces nouvelles et antérieurement reconnues d'ostracodes, de conchostraces, d'euryptéridés et de phyllocaridés.



# SOME LEPERDITIID OSTRACODS FROM NORTHERN CANADA

## Introduction

Recent investigations have disclosed the presence of well-preserved leperditiid ostracods at several localities in Yukon and the Northwest Territories. These are similar to specimens described from the U.S.S.R. and western Europe but are types previously unrecorded from North America. Dorsal structures, hingement, and muscle scar impressions are those of the subfamily Leperditiinae.

Identification of megafossils was made by D. J. McLaren and A. W. Norris.

## Collections

1. Hart River, Yukon Territory, 65°11'N, 137°07'W, in light brown to dark grey, lithographic limestone, from talus (GSC locality 37058, collected by L. H. Green).

*Mölleritia canadensis* n. sp.

2. Hart River, Yukon Territory, 65°17'N, 137°03'W, in light brown, fine-grained lithographic limestone beneath a petroliferous crinoidal limestone with brachiopods and corals (GSC locality 37076, collected by L. H. Green).

*Mölleritia canadensis* n. sp., *Favosites* cf. *Favosites* sp. D.,

*Disphyllum* sp. G, *Keriophyllum* sp., *Gypidula* sp., pentamerid brachiopod.

3. East Porcupine River, Yukon Territory, 65°47'30"N, 139°14'30"W, in dark grey to black, dense, thin-bedded limestone (courtesy of Shell Oil Company of Canada, Limited, collection 3105).

*Mölleritia canadensis* n. sp., *Mölleritia canadensis insignis* n. subsp.

4. Victoria Island, District of Franklin, Prince Albert Peninsula, northern shore of Deans Dundas Bay, 72°21'N, 118°25'W, in thin- to thick-bedded grey limestone (GSC locality 40800, collected by E. T. Tozer).

*Mölleritia canadensis* n. sp., *Herrmannina* cf. *H. consobrina* (Jones),

*Alveolites* sp., *Keriophyllum* sp., "*Gypidula pseudogaleata* (Hall)" of Meyer 1913, *Productella* sp. C, *Atrypa* 2 spp., rhynchonellid? brachiopod n. gen.,

*Paracyclas robusta* Tolmachoff.

## Stratigraphic Position

The genus *Mölleritia* has previously been recorded from Middle Devonian strata of the U.S.S.R. *Herrmannina consobrina* (Jones) occurs in the Middle Devonian *Stringocephalus* beds (Givetian) of Belgium and Germany. McLaren considers *Keriophyllum* to be confined to the Middle Devonian and that the species reported here are strongly suggestive of an early (Eifelian) rather than a late (Givetian) Middle Devonian age. He also indicates that species of *Productella*, *Gypidula*, and *Paracyclas* in collection 40800 are common in the lower part of the Blue Fiord Formation on southwestern Ellesmere Island and elsewhere in the

Canadian Arctic and strongly suggest a lower Middle Devonian (Eifelian) age. Norris considers the brachiopods from locality 37076 probably indicate the same age.

## Systematic Palaeontology

### Order OSTRACODA

#### Family LEPERDITIIDAE

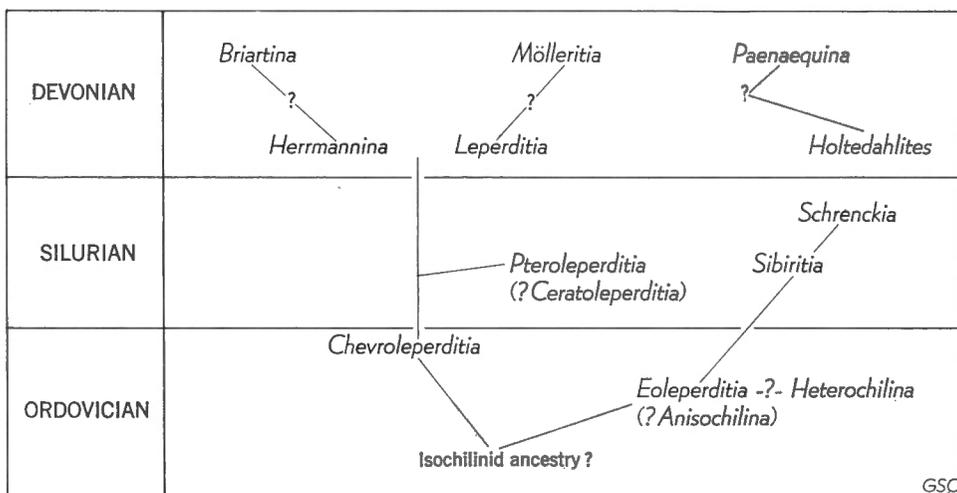
Evidence indicates that the subfamilies Leperditiinae and Isochilininae are very similar. This is shown by the presence of chevron-shaped muscle scars and right marginal interior ventral denticles in certain representatives of both subfamilies. These marginal prongs, as seen in the *Eoleperditia-Schrenckia* branch of the Leperditiinae, are like those in the type species of *Isochilina* (*I. ottawa*) of the Isochilininae. Whether these similar structures are completely analogous is not known.

Morphological dissimilarities, apart from the valve size and contact relationships, also occur. Fine, taxodont dentition within the Leperditiinae is developed in post-Ordovician genera and is not known in the Isochilininae. Valve ornamentation is more pronounced in the Isochilininae where sulcation and complete marginal borders are commonly present. These features probably served to strengthen the carapace in much the same fashion as did the denticulate hinge and overlap features of representatives of the Leperditiinae. A full discussion of these and other features of the Leperditiidae has been published by Swartz (1949, pp. 306-311).

#### Subfamily LEPERDITIINAE

Possible evolutionary relationships of genera of the Leperditiinae are shown in Table I. Some of these genera may prove to be identical (i.e., *Eoleperditia* and

**Table I**  
*Evolution of Leperditiinae genera*



*Anisochilina* as suggested by Swartz 1949, p. 318, or *Leperditia*, *Herrmannina*, and *Briartina*, three genera that are not well known). *Paenaequina* Solle 1935 and *Holtedahllites* Solle 1936 (= *Holtedahlina* Solle 1935 not Foerste 1924) may be similar but cannot be studied because the type specimens and all available comparative material have been destroyed (letter from Dr. A. Heintz to Dr. H. Frebald, March 16, 1960).

*Key to genera of the subfamily Leperditiinae Swartz 1949*

Leperditiidae with unequal valves, right valve generally overlapping left.

1. Part of interior margin of right valve with prongs or denticles.
  - A. No chevron-shaped muscle scar present
    - a. Overlap pronounced ..... *Eoleperditia* Swartz 1949  
(? *Anisochilina* Teichert 1937)
    - b. Overlap weak ..... *Heterochilina* Poulson 1937
  - B. Chevron-shaped muscle scar present, but weak
    - a. Marginal border absent or weakly developed ..... *Sibiritia* Abushik 1958
    - b. Marginal border well developed ..... *Schrenckia* Glebovskaya 1949
2. Right valve with no interior marginal prongs or denticles.
  - A. Posterodorsal swelling weak or absent
    - a. Longitudinal axis of valve oblique
      - I. Hinge not denticulate ..... *Chevroleperditia* Swartz 1949
      - II. Hinge denticulate
        - i. Lateral surface with alate projection ..... *Pteroleperditia* Hamada 1959  
(? *Ceratoleperditia* Harris 1960)
        - ii. Lateral surface smooth or nearly so ..... *Herrmannina* Kegel 1933
    - b. Longitudinal axis of valve horizontal ..... *Briartina* Kegel 1932
  - B. Posterodorsal swelling pronounced
    - a. Swelling in left valve only ..... *Leperditia* Rouault 1851
    - b. Swelling in both valves ..... *Mölleritia* Abushik 1958

Genus *Mölleritia* Abushik 1958, p. 237

*Type species.* By original designation of Abushik, 1958, p. 237, *Leperditia mölleri* Schmidt 1883.

*Description.* Abushik, 1958, pp. 237-238 (in translation):

Genus *Mölleritia* Abushik, gen. n.

*Description.* The largest representatives of the Leperditidae (1.5-8 cm), having a large eye tubercle, behind which there develop on each valve distinctly outlined humps often rising above the dorsal margin. Marginal border well defined, broad, long, and commonly extending onto the ventral margin leaving only its middle portion free. Overlap slight. Inclined longitudinal axis. Chevron large, more than half as large as the adductor and consisting of more than 200 tubercles grouped in the form of a triangle. Ventral margin of the chevron distinct and defined by elongate, mainly triangular large tubercles closely adjacent to one another and arranged in a row. Muscle scars within this row considerably finer, rounded, triangular, tetragonal, and polygonal. Chevron commonly extending as far as the eye tubercle via a group of very small triangular tubercles (fig. 3).

Exterior of the valves smooth or covered with tubercles of large size.

*Remarks.* The development of dorsal humps and the characteristic chevron in representatives of this genus is highly distinctive and differs markedly from the development in other genera.

*Distribution.* Ural and Novaya Zemlya. Middle Devonian.

This definition restricts the genus to species having a posterior hump on each valve and distinct anterior and posterior marginal borders. These criteria serve to distinguish between *Mölleritia* and *Leperditia*. Although during the present study only dissociated valves have been obtained, one new species and one new subspecies can be identified.

*Mölleritia canadensis* n. sp.

Plate I, figures 3-17; Figures 1 and 2

*Description.* Valves ovate, large, commonly exceeding 20 mm long and 15 mm high. Longitudinal axis oblique to hinge. Right valve larger than left, slightly overlapping the flange of the left valve on the terminal margins and more strongly overlapping on the ventral margin. Hinge line straight, finely taxodont (unfigured paratype GSC No. 15183), about two thirds as long as the valve; posterior half of the hinge obscured in lateral view by the posterior dorsal valve hump. Posterior margin broadly rounded, anterior margin more narrowly rounded, ventral margin oblique to hinge, obscured to some extent along the mid-venter by the greatest convexity of the valve. Marginal border wide, strongly produced along the anterior and posterior margins, meeting the dorsal margin at its extremities and also extending part way along the ventral margin, diminishing in width towards the mid-venter, absent on the mid-venter of the right (left plenate) valve, but continuous along the mid-venter of the left (right plenate) valve where it forms a ridge that defines the inner edge of the overlapped flange. Cardinal angles prominent, obtuse, anterior angle approximately 120 to 125 degrees, posterior angle somewhat greater, slightly concave on its posterior edge.

Valve smooth, very convex in its posterior half, more moderately convex toward the anterior, descending evenly to the marginal borders. Eye tubercle prominent, located about one tenth of the maximum height below the dorsal margin and one quarter the greatest length from the anterior margin, with two

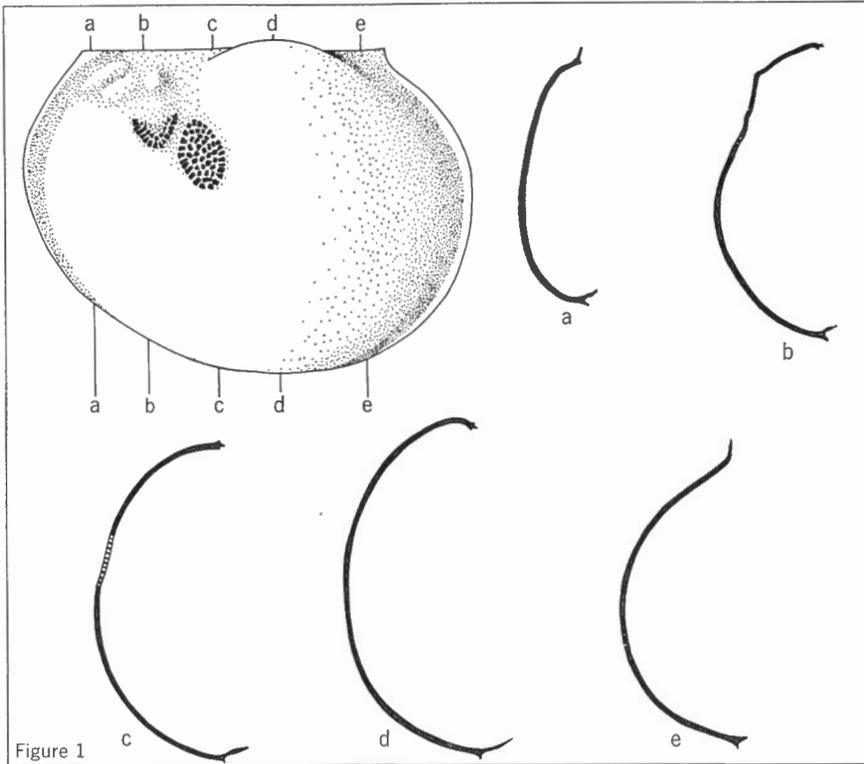


Figure 1

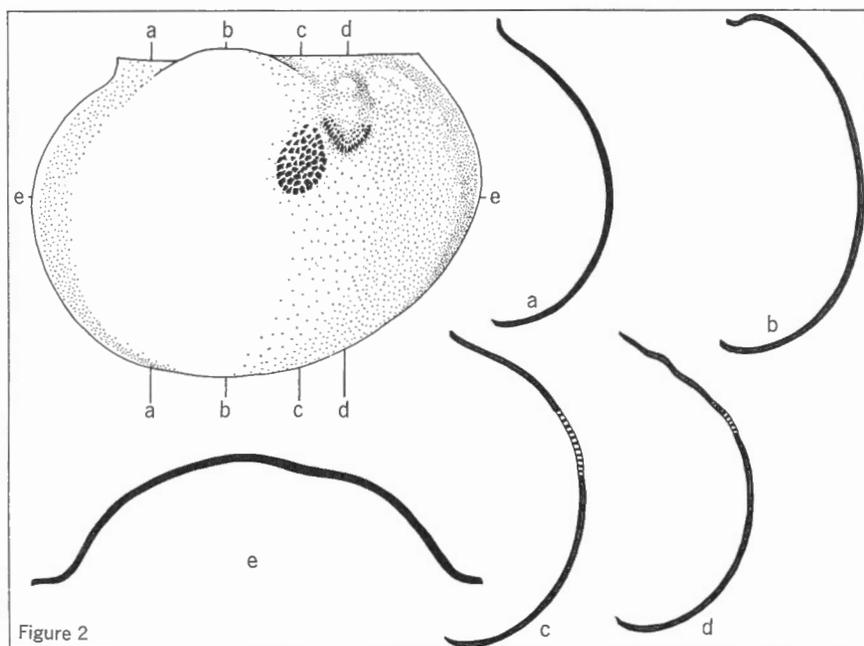


Figure 2

M. J. C.

**Figures 1, 2.** *Mölleritia canadensis* n. sp. Diagrammatic lateral views of left and right adult valves. The small letters mark planes along which polished surfaces 1a-e and 2a-e were located. All views are composite from numerous camera lucida sketches.

low, elongate-oblique nodes anterior to it and separated from it by the general anterior dorsal slope of the valve. Posterior dorsal hump prominent, extending above the hinge line and obscuring it in lateral view, continuous with the general posterior convexity of the valve but delimited anteriorly from the eye tubercle by an oblique undulation (not a shallow sulcus as in *Hogmochilina* Solle 1935) which is lost in the general adductor-chevron muscular area near mid-valve.

Adductor and chevron muscle scars readily observable on all specimens (Pl. I, figs. 15, 17). Chevron scar ventral to the eye tubercle, apex directed ventrally, with ventral edge defined by a row of elongate, triangular spots, reflected externally as a chevronate depression (Pl. I, fig. 13), remaining spots variously shaped, lying within this row. Well-developed, oval, adductor scar posterior ventral to and twice as large as the chevron scar, composed of numerous, closely spaced, more or less regular angular spots. On the valve interior a series of venose irregularly forking, depressed, flexuose lines radiate from the adductor scar. These lines appear as anastomosing ridges on the steinkern (Pl. I, fig. 16). Three small groups of accessory muscle scars situated near the hinge line dorsal to the eye tubercle present on one specimen, observable only in dorsal view.

Dimensions (in mm) of three complete valves:

GSC No.	Length	Height	Width	H/L	W/L
15177 (left)	17.0	11.9	5.5	0.70	0.32
15178 (right)	19.6	14.0	6.7	0.71	0.34
15179 (right)	23.1	16.0	7.7	0.69	0.33

*Remarks.* This species is larger than *M. mölleri* (Schmidt), and *M. mölleri laevigata* (Schmidt) and has a smooth surface with a less prominent eye tubercle. Possibly the unfigured subspecies *M. mölleri laevigata* (Schmidt), which is reported to be less tuberculate than *M. mölleri*, may be more similar to the present specimens than is the type species.

*Occurrence.* Localities 1 to 4 listed above.

*Types.* Holotype, GSC No. 15179; paratypes, GSC Nos. 15176-15178, 15180-15183.

*Mölleritia canadensis insignis* n. subsp.

Plate I, figures 1, 2

*Description.* Subspecies represented by only one slightly incomplete broken left valve. Valve ovate, large, 16 mm in greatest length, 11.5 mm in height. Longitudinal axis oblique to hinge. Overlap unknown. Hinge line straight, about two thirds as long as the valve, median part obscured in lateral view by the posterior dorsal hump. Posterior margin apparently broadly rounded, anterior margin more narrowly rounded, ventral margin oblique to hinge, obscured at mid-venter by greatest convexity of valve. Marginal border widest posteriorly,

diminishing ventrally to a ridge forming the inner edge of the overlapped flange of the left valve and widening anteriorly. Cardinal angles unknown due to poor preservation.

Lateral valve surface smooth, evenly convex in dorsal view (Pl. I, fig. 2). Eye tubercle prominent, located about one tenth the distance below the dorsal margin and one quarter the distance from the anterior margin, with indistinct nodes anterior to it. Posterior dorsal hump elongate, prominent, extending dorsal to the hinge and obscuring it in lateral view, continuous with the convexity of the valve but extending as a fairly narrow dorsal bulge along the mid-posterior part of the valve and descending abruptly to the hinge margin.

Adductor and chevron scars similar in size and shape to those of *M. canadensis* but the chevron scar of *M. canadensis insignis* lies proportionately closer to the eye tubercle and forms a prominent furrow on the lateral surface of the valve.

*Remarks.* This subspecies is like *M. canadensis* but is slightly less convex laterally and has a thin, more elongate posterior dorsal hump descending abruptly to the hinge margin. The eye tubercle lies on the anterior slope of the posterior dorsal hump rather than being separated from the hump by a shallow undulation as on *M. canadensis*.

*Occurrence.* East Porcupine River, Yukon Territory, 65°47'30"N, 139°14'30"W.

*Type.* Holotype, GSC No. 15175.

### Genus *Herrmannina* Kegel

*Herrmannella* Paeckelmann 1922, p. 16, *not* Canu, 1891, p. 479.

*Herrmannina* Kegel 1933b, p. 251; 1934, p. 409.

### *Herrmannina* cf. *H. consobrina* (Jones)

*Leperditia consobrina* Jones 1896, p. 147, pl. 1, figs. 6a-c; Maillieux, E., 1919, p. 108.

*Leperditia (Herrmannella) consobrina* (Jones) Kegel 1933a, p. 915, pl. 46, figs. 8, 15, text-fig. 6.

*Leperditia (Herrmannina) consobrina* (Jones) Kegel 1933b, p. 251.

*Remarks.* Specimens, identical with those described by Kegel (1933a), have been obtained from Victoria Island (locality 4). Measurements (in mm) of three valves (hypotypes, GSC Nos. 15184, a, b):

GSC No.	Length	Height	Width	Hinge Length	Height/L	Hinge/L
15184 (right)	6.81	4.32	1.70	4.50	0.63	0.66
15184a (right)	5.65	3.60	1.20	3.60	0.64	0.64
15184b (left)	5.75	3.40	1.12	3.60	0.58	0.63

The specimens have obtuse anterior and posterior cardinal angles measuring approximately 120 to 125 degrees and 135 to 145 degrees respectively. The chevron scar, located immediately ventral and extending nearly to the eye tubercle,

## Canadian Fossil Arthropoda

makes a well-defined depression on the external surface of the valve. The adductor scar is slightly inclined posterior dorsally. Marginal borders are apparently very poorly developed or absent on the extremities.

*Occurrence.* Victoria Island, District of Franklin, Prince Albert Peninsula, northern shore of Deans Dundas Bay.

*Types.* Hypotypes, GSC Nos. 15184, a, b.

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# OSTRACODA FROM THE ROCHESTER FORMATION (MIDDLE SILURIAN) OF SOUTHERN ONTARIO

## Introduction

Nine species of ostracods have been obtained from the Rochester Formation of the Middle Silurian Clinton Group in southern Ontario. They also occur in New York, Pennsylvania, and Maryland but only two have been previously recorded from Canada.

The Rochester ostracods described by Ulrich and Bassler (1923), and Swartz (1933-1935, 1942) were placed by them in the *Drepanellina clarki* zone. Some of these species are widespread (i.e., *Paraechmina spinosa*, *P. abnormis*, *P. postica*, and *Dizygopleura symmetrica*) but *Drepanellina clarki* itself has not been found in northwestern New York (Gillette, 1947) or Ontario. Gillette (ibid., p. 24), therefore, prefers to refer to the *Paraechmina spinosa* zone.

The author is grateful to Dr. Jean M. Berdan of the United States Geological Survey for critical reading of the manuscript and for information concerning ostracods from the Rochester Formation of northwestern New York State, and to the Hydro-Electric Power Commission of Ontario for permission to examine sections at the DeCew Falls and Sir Adam Beck generating stations.

## Localities

Shale and limestone samples of the Rochester Formation were collected from highway and quarry exposures along the crest of the Niagara escarpment (section numbers from Bolton, 1957, are given in parentheses):

1. Old quarry, Nelson (24).
2. No. 5 highway, Waterdown (23).
3. East Waterdown quarry (22).
4. No. 6 highway, Clappison Corners (21).
5. Sydenham Road, Dundas (20).
6. No. 2 highway, Ancaster (18).
7. Jolly Cut, Hamilton.
8. No. 20 highway, Stoney Creek (14).
9. DeCew Falls generating station, St. Catharines (1).
10. Access road, Sir Adam Beck-Niagara generating station, Niagara Falls.

The formation varies in thickness from less than 2 feet (localities 1 and 2) at the northern limit of outcrops to approximately 60 feet (localities 9 and 10) near Niagara River. For a detailed discussion of the surface stratigraphy, lithology, and palæontology of the Rochester Formation in southern Ontario, the reader is referred to Bolton (1957).

Ostracods previously reported from the Rochester Formation of this area (Williams, 1919, p. 56; Caley, 1940, p. 53; Bolton, 1957, Table VIII) are *Paraechmina spinosa*, *P. postica*, and an undetermined species of *Leperditia?*. The present study indicates the occurrence of seven additional species (Pl. II) from four of the sections investigated (localities 4, 8, 9, and 10). The number and variety of ostracods increase greatly as the formation thickens and becomes more shaly, east of Grimsby, Ontario.

## Occurrence of Rochester Ostracoda

Ostracoda	Southern Ontario	Western New York (General)	Lockport and vicinity, New York (J. M. Berdan)	Maryland	Pennsylvania
<i>Paraechmina spinosa</i> (Hall)	X	X	X	X	X
<i>P. abnormis</i> (Ulrich)	X	X	X	X	X
<i>P. postica</i> Ulrich and Bassler	X	X		X	X
" <i>Octonaria</i> " <i>curta</i> Ulrich	X	X	X		
" <i>O.</i> <i>cranei</i> Ulrich	X	X			X
" <i>Ctenobolbina</i> " <i>punctata</i> Ulrich	X	X	X		
<i>Aechmina</i> sp.	X		X		
<i>Dizygopleura symmetrica</i> (Hall)	X	X	X	X	X
<i>Bythocypris</i> spp.*	X	X	X		

\*This undoubtedly includes the imperfectly known subspecies *Bythocypris punctulata niagarensis* Ulrich, 1891.

Specimens were found in quantity only at localities 9 and 10. An indeterminate pyritized ostracod was obtained, however, in the lower foot of strata at locality 4 and *Bythocypris* sp. was collected from the basal 6 feet at locality 8. Bolton obtained *P. spinosa* (Hall) and *Leperditia?* sp. near Grimsby at localities intermediate between 8 and 9.

Most of the species obtained at localities 9 and 10 near Niagara River range throughout the formation, however, "*Ctenobolbina*" *punctata* Ulrich (Pl. II, figs. 11-13) only occurs in the lower 40 feet and *Dizygopleura symmetrica* (Hall) (Pl. II, figs. 14-18) in the upper 30 feet (30 to 60-foot interval) of beds. Berdan (personal communication) collected "*C.* *punctata* and *D. symmetrica* from a road-cut a mile east of Gasport, New York, and Swartz (1933, p. 248) obtained *D. symmetrica* from the upper part of the Rochester Formation on the eastern side of Niagara River and in Pennsylvania. *D. symmetrica* is apparently long ranging as it is also recorded from the younger McKenzie Formation of Pennsylvania and the Eramosa Member of the Lockport Formation in Ontario.

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# DEVONIAN CONCHOSTRACA FROM MELVILLE ISLAND, CANADIAN ARCTIC

## Discussion

Only one previous occurrence of fossil Conchostraca has been reported from the Canadian Arctic, that of *Estheria canadensis* Lambe 1910 from Dundas Peninsula, Melville Island. Strata from which this species was obtained were thought to be of Carboniferous age but are now known to be either late Middle and/or early Upper Devonian. Three more conchostracan species have been found by E. T. Tozer in beds of the same age and are described below.

### Localities:

1. Melville Island, south coast, Dundas Peninsula, in a ravine 4 miles northeast of Cape Providence; GSC type specimens 10000; *Asmussia canadensis* (Lambe).
2. Melville Island, west coast, Kelly Point south of Purchase Bay, in talus; GSC locality 24863; *Asmussia* sp. cf. *A. pogrebovi*? (Lutkevich), *Asmussia* sp. cf. *A. membranacea* Pacht.
3. Melville Island, west coast, 5 miles southwest of Kelly Point at 510 feet elevation; GSC locality 24866; *Pteroleaia canadensis* n. sp.

Within this stratigraphic succession *Lingula melvillensis* Lambe, *Lingula* sp., and an indeterminate kloedenid ostracod are also present. Also *Schizophoria* sp. and probable Upper Devonian placoderm fragments were obtained from strata between localities 2 and 3 (Tozer, 1956, pp. 15, 17) and König (1824) indicated the presence of *Avicula melvilliana* (without description) in strata of similar lithology from Liddon Gulf, Melville Island.

The conchostracans occur in the Melville Island Formation (Tozer, 1956; Thorsteinsson and Tozer, 1959). This formation is more than 12,000 feet thick and is composed of sandstone, shale, and siltstone with thin coal seams in the upper part (McGregor, 1960). Marine fossils of Givetian and Frasnian age, identified by D. J. McLaren (*in* Tozer, 1956, p. 15), occur in thin beds in parts of the sequence, but most of the formation is unfossiliferous. The conchostracans are present in sections where diagnostic marine fossils are unknown. Thorsteinsson and Tozer (personal communication) believe that these strata lie between marine beds of Givetian and Frasnian age.

Similar conchostracans have been described by Lutkevich (1929, 1941) from the Leningrad basin. They occur in the Middle Devonian Narova beds at the base of the Devonian section, near the junction of Ruya (Ruia) and Plussa (Pliusa) Rivers and also in the basal Upper Devonian Stchigry and Snetnaya beds of the Volga and Leningrad regions.

## Systematic Palaeontology

Family ASMUSSIIDAE Tasch

*Asmussia* Pacht

*Asmussia canadensis* (Lambe)

Plate III, figures 1, 2

*Estheria canadensis* Lambe 1910, in Bernier, J. E., Appendix A, pp. 482, 483.

? *Estheria vulgaris* Lutkevich 1941, p. 281, pl. 1, figs. 12-16.

*Description:* The original description is as follows:

The valves of the Melville Island *Estheria* are rather high in proportion to their length, and have a straight dorsal margin shorter than the total length of the valve. The beak is about one-third the length of the dorsal margin from its anterior end. The surface is covered with strong, rounded, concentric ridges, about twelve in number, at rather regular intervals apart. Finer ridges occur between the larger ones, in the ventral half of the valve where the former frequently replace the latter as the ventral margin is approached. The maximum depth is at about the mid-length of the valve. The ventral margin is broadly rounded. The anterior and posterior ends are evenly curved and inclined inward above to meet the straight dorsal margin at an obtuse angle. The dimensions of an average sized valve are: length, 6 mm., height, 5 mm. In a large valve the measurements are: length, 7 mm., height, 5.7 mm.

Between the concentric ridges, on the dorsal part, the valves appear to be smooth and without the polygonal ornamentation of *A. membranacea* Pacht as reported by some authors. The initial growth lines are indistinct, and separated by wide, smooth interspaces, eight to ten growth lines surround the beak and occupy the anterior median dorsal half of the valve. Finer ridges occur between subsequent growth lines; distally these increase greatly in number. Along the ventral edge of the valve these concentric ridges become extremely numerous. From fifteen to thirty-five ridges have been counted, larger valves having more than the smaller. Most valves have length/height ratios of 1.22 to 1.29.

*Remarks.* *A. membranacea* Pacht is similar to the present species in shape and relative measurements, but has nearly equispaced concentric growth lines not becoming more numerous distally as in *A. canadensis*. Several figured specimens of *Estheria vulgaris* Lutkevich from the basal Upper Devonian Stchigry and Snetnaya beds of the Volga and Leningrad regions have a length/height ratio of approximately 1.24. They also bear growth lines that become increasingly numerous toward the ventral margin and may belong to *A. canadensis*.

*Occurrence.* Melville Island, south coast, Dundas Peninsula, in a ravine 4 miles northeast of Cape Providence.

*Types.* Lectotype, GSC No. 10000 (here selected); paratypes, numerous specimens, GSC No. 10000a. (All specimens on the same piece of rock.)

*Asmussia* sp. cf. *A. membranacea* Pacht

*Synonymy*: See Lutkevich, 1929, p. 128; Raymond, 1946, pp. 235, 236.  
*Estheria* sp. McLaren, D. J. in Tozer, E., 1956, p. 17 (part).

This name has long been accepted in a broad sense for specimens of *Asmussia* having straight dorsal margins, subcentral beaks and variable numbers of relatively equispaced concentric growth lines. Raymond (1946) separated such specimens into three species based on their geographic and geologic distributions and the numbers and form of their growth lines; *A. membranacea* Pacht, *A. murchisoniana* (Jones), and *A. clarkei* Raymond.

On Melville Island a few very poorly preserved specimens of *Asmussia* have been found that appear generally to conform to the writer's concept of *A. membranacea* Pacht. The growth lines appear to be consistently fewer than those of *A. murchisoniana* and *A. clarkei*, as stated in Raymond (1946, p. 235), and consequently most nearly conform in number with those of *A. membranacea*.

*Occurrence*. Melville Island, west coast, Kelly Point, south of Purchase Bay, from talus.

*Type*. Hypotype, GSC No. 15185.

*Asmussia* sp. cf. *A. pogrebovi*? (Lutkevich)

*Estheria pogrebovi* Lutkevich 1929, pp. 129, 138, pl. 36, figs. 5-8; 1941, p. 280, pl. 1, figs. 4, 5.  
*Asmussia pogrebovi* (Lutkevich) Raymond 1946, p. 236, not *Asmussia sinuata* (Lutkevich) Raymond, *ibid.*  
*Asmussia pogrebovi* (Lutkevich) Kobayashi 1954, p. 87.  
*Estheria* sp. McLaren, D. J. in Tozer, E.T., 1956, p. 17 (part).

This species differs from *A. membranacea* Pacht only by its greater length/height ratio. The poorly preserved specimens obtained during the present study are only impressions but they appear to agree with the published description of *A. pogrebovi*. The growth lines extend to the umbo and are equidistant except where they are crowded along the lateral margins. No indication of ornamentation on the interspaces between the concentric growth lines can be seen. Measurements of several slightly crushed specimens indicate variation in length/height ratios from 1.55 to 1.7.

*Occurrence*. Melville Island, west coast, Kelly Point, south of Purchase Bay, in talus.

*Type*. Hypotype, GSC No. 15185a.

Family LEAIADIDAE Raymond

*Pteroleaia* n. gen.

*Type species*. *Pteroleaia canadensis* n. sp.

*Description*. Multiribbed, rostrate leaiadidae with dorsal marginal ribs or keels around which the growth lines are recurved sinuously.

*Discussion.* That this genus is a leaiid is shown by the presence of radial ribs that cross the umbo. This major criterion has been stressed by Kobayashi (1954, p. 139) and more recently by Tasch (1956, pp. 1254, 1255), and effectively serves to separate the Leaiadidae from the Estheriellidae.

Within the Leaiadidae the separation of *Pteroleaia* from other genera is equally distinctive. Tasch (personal communication) believes that the anterior and posterior dorsal ribs or keels around which the growth lines are recurved to form an anterior rostrum and to a lesser extent a posterior marginal flexure are unique characteristics unknown in other genera of the family. *Leaia* Jones 1863 and *Trileaia* Kobayashi 1954 (the latter included in *Praeleaia* by Tasch, 1956, p. 1250) and several other leaiid genera bear a posterior dorsal rib but none is anteriorly rostrate.

Superficially *Praeleaia* Lutkevich 1929\* resembles this genus in certain aspects. According to Lutkevich (1929, 1941, and in a personal communication), *Praeleaia* is characterized by species bearing on each valve four or five radial ribs but with no keel or ridge along the dorsum. Novojilov (1956, p. 84) described *Praeleaia* as having a "straight and insignificantly thickened" dorsal margin and further stated "The anterior and posterior keels are the extreme of the keels". This is not readily apparent from his figures (69 and 70, p. 85) of *P. quadricarinata* and *P. quinquecarinata*, in which he shows each of these species with what appears to be a dorsal marginal keel. Tasch (1958, p. 1102) has pointed out this discrepancy, but, judging from the text, the dorsal structures on Novojilov's drawings may be meant to represent their alleged "insignificantly thickened" dorsal margins. Casts of the type specimens of *Praeleaia* were kindly provided by Dr. Lutkevich and the Leningrad Central Geological Museum and no indication of a dorsal ridge or keel has been observed.

Morphologically and chronologically *Pteroleaia* appears to be intermediate between the multiribbed, Middle Devonian genus *Praeleaia* and a dorsally keeled Carboniferous or Permian genus such as *Leaia* or *Trileaia*. The systematic position of *Trileaia* as a possible subjective synonym of *Praeleaia* is not clear.

*Distribution.* Middle or Upper Devonian of Melville Island, District of Franklin.

*Pteroleaia canadensis* n. sp.

Plate IV, figures 1-6, Plate V, figure 25

*Description.* Valves semicircular, anteriorly rostrate, slightly longer than high. Beak subcentral, about one third the distance from the anterior end. Growth lines prominent, numbering ten to twenty. Median lateral surface marked by three to

\*No type species was originally designated, however Lutkevich (*in Batalina, et al.*, 1941, p. 282) chose *P. quinquecarinata* Lutkevich as the type of *Praeleaia*. Raymond (1946, p. 294) subsequently designated *P. quadricarinata* Lutkevich as the type species, this being accepted by all subsequent authors (Kobayashi, 1954; Novojilov, 1956, 1960, 1961; Tasch, 1958).

five straight to slightly curved radial ribs originating near the beak and extending to the ventral margin. Ribs strong near the middle of the valve, slightly weaker near the beak and tapering distally, almost disappearing at the ventral margin. Dorsal margin straight (Pl. V, fig. 25) to slightly angular with anterior and posterior keels. Posterior keel rib-like, somewhat spinose where crossed by the slightly recurved growth lines. Anterior dorsal keel more broadly folded (Pl. IV, fig. 3) or rib-like (Pl. IV, figs. 1, 5) forming a prominent anterior dorsal rostrum around which the growth lines are broadly recurved.

## Measurements of several valves:

GSC No.	No. of Ribs	Angle between posterior dorsal keel and					Height (mm)	Length at Hinge (mm)	
		Anterior dorsal keel	Rib 1	Rib 2	Rib 3	Rib 4			Rib 5
15189	4	167	103	90	69	43	5.3	6.5	
15189b	4	160	102	86	56	36	5.4	8.1	
15189c	4	164	96	88	65	39	4.0	5.6	
15189a	4	157	91	77	57	37	4.7	7.0	
15188	5	166	104	90	68	56	36	6.0	6.4
15190	3	170	88	67	42		4.0	5.2	
15186	4	170	107	83	52	34	5.5	7.2	
15186	4	?	90	82	60	38	?	?	
15186	4	163	92	77	61	32	4.0	5.5	
15186	4	160	98	74	58	42	3.7	5.0	
15186	4	162	94	78	56	36	3.5	4.6	
15186	4	160	98	86	65	40	3.3	4.0	

*Discussion.* The specimens are preserved on three small pieces of rock. One (GSC paratype 15186; Pl. IV, fig. 6) bears on its surface several dozen specimens in various states of preservation — all with four median ribs. A second bears impressions of several four-ribbed specimens (paratype 15186a). Only on the third sample (Pl. IV, figs. 1-5, Pl. V, fig. 25), which bears six complete and well-preserved valves, is there a three- and a five-ribbed specimen. It appears that this species typically bears four median ribs, only rare specimens with three or five. Whether this divergence from the normal number of ribs is a sexually dimorphic feature or is the result of polymorphism is unknown. Kobayashi (1954, p. 22) states "It is sometimes difficult to grasp the specific concept of fossil Estherians because of a high degree of polymorphism due to endemism, mutation and sexual dimorphism, in addition to secondary deformation." It is considered advisable, therefore, to place all of these specimens within the same species.

*Occurrence.* Melville Island, west coast, 5 miles southwest of Kelly Point, at 510 feet elevation.

*Types.* Holotype, GSC No. 15189b; paratypes, GSC Nos. 15186, a, 15188, 15189, a, c, 15190.

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# OSTRACODA FROM THE LOWER DEVONIAN DALHOUSIE BEDS, NORTHERN NEW BRUNSWICK

## Geology

The typical section of the Dalhousie beds is on the southern shore of Chaleur Bay at Stewart's Cove. This section, at the southern limit of the town of Dalhousie, New Brunswick, is well exposed and consists of three sequences of sedimentary rocks separated from one another and bounded above by volcanic rocks. The sedimentary rocks consist primarily of fossiliferous calcareous shale and arenaceous to argillaceous limestone with some tuffaceous beds, dipping in a northerly direction at 60 to 75 degrees. The thickness of the two lower sedimentary sequences (lower Dalhousie beds) is estimated to be more than 275 feet. Only about 160 feet of the upper sequence (upper Dalhousie beds) was exposed when the present collections were made, the previously observed uppermost 25 feet of limestone was covered with beach sand. No attempts were made to ascertain the thickness of the associated volcanic rocks. Collections were also made from a 12-foot-thick bed of arenaceous limestone (zone number 6 of Clarke) that is intercalated with the volcanic flow at the base of the upper Dalhousie beds.

The earliest geological account of these strata was that by Hind (1865, pp. 127-129) who presented a generalized section of the Cape Bon Ami beds near Dalhousie; Ells (1881), Dawson (1891), and Ami (1900, 1902) also reported on this section. Clarke (1909, 1913) described these Dalhousie beds and their fossils in detail, and measured a continuous section consisting of sixteen sedimentary zones numbered in ascending order. Clarke's monograph (1909) containing the description of this section and its fossils is the standard reference for these beds. Alcock (1935) mapped the area for the Geological Survey of Canada and condensed much of this information. A shortened version of his detailed description of these strata (pp. 56-62) follows with Clarke's zonal classification in parentheses:

	Thickness (feet)	
Lavas in several flows, one intrusion .....	215+	
Gap in section .....	250	
<i>Upper Dalhousie beds:</i>		
Shale and limestone, some volcanic ash beds .....	207	(7-16)
Agglomerate and andesite, with one 12' bed of arenaceous limestone	280	(6)
<i>Lower Dalhousie beds:</i>		
Shale and limestone, some volcanic ash beds .....	217	(1-5)
Volcanic flows .....	225	
Calcareous shales .....	90	0

During the present study, fossils were obtained from the sedimentary sequences (Alcock's zone O, Clarke's zones 1-5, 6, and 7-16) enumerated above, but Clarke's zones 15 and 16 were inaccessible.

## Discussion and Correlation

Ostracoda are common in the sampled section but are not present in the lowest sedimentary sequence (Alcock's zone O). Some were described by Jones (1889), and by Ulrich and Bassler (1908). Specimens described in these two publications were examined during the present investigation — the former in the type collection of the Geological Survey of Canada, the latter in the United States National Museum. They were also recorded by Clarke (who indicated the presence of three additional ostracod species) and Alcock. In all, thirteen species (several of which are considered to be synonymous) have been previously recorded. During the present investigation twenty-seven genera of ostracods were studied, represented by forty-three species: eighteen species are new, nineteen were previously described, and six are only identifiable to genera. These are listed on Table II with the stratigraphic position in which they were found. In addition, specimens previously described by Jones (1889) as *Primitia mundula* Jones and *Primitia aequalis* Jones and Holl were examined but were considered to be immature individuals or too poorly preserved for identification.

Table II shows that only five ostracod species (10 per cent of the total ostracod fauna) are restricted to the lower Dalhousie beds whereas twenty-eight species (65 per cent) are present only in the upper Dalhousie strata. This is shown even more strongly in the composite faunal list of Clarke (1909) in which fourteen of eighty species are recorded from the lower Dalhousie beds, only one of which is restricted to this interval. It cannot be demonstrated that this faunal break has major stratigraphic implications (i.e., transitional between the Helderbergian and Deerparkian Stages) as a small percentage of the ostracods from both the upper and lower beds are in association elsewhere in the Appalachian region. Ecological and environmental conditions are, therefore, the major contributing factors. It may be assumed that a slow initial establishment of such a distinctive Lower Devonian fauna would result after a period of intense volcanic activity such as that represented by the lower extrusions within the Dalhousie section. The absence of ostracods in the basal beds (Alcock's zone O) indicates a lack of parent stock in this section from which a flourishing ostracod assemblage could quickly emerge. This, together with the slightly arenaceous aspect of the lower Dalhousie sedimentary sequence, may account for the relatively few ostracod species (fifteen) present in these beds. Vulcanism at the base of the upper Dalhousie does not seem to have had any great effect on the numbers of upper Dalhousie ostracod species as compared to those in the lower Dalhousie. This is shown by the loss of only five lower Dalhousie species from the assemblage, with four new species being added to the fauna within a stratigraphic interval of at least 50 feet above the basal extrusions of the upper Dalhousie sequence. It was only with the introduction of the calcareous shales of zone 9 that environmental factors permitted the rapid development and flourishing of the upper Dalhousie ostracod fauna. This was abruptly terminated by the ash beds of zone 13 with resultant impoverishment of the ostracod fauna in the overlying beds.

Table II

		Ostracoda			<i>Strepulites dalhousiensis</i>	<i>Octonaria foordi</i>	"Amphissites (?)" concentricus (U. and B.)	<i>Bythocypris swartzi</i>	<i>Tubul Bairdia chaleurensis</i>	<i>Thipsurella curvistrata</i> (Roth)	<i>Bythocypris</i> cf. <i>B. phaseolina</i> U. and B.	<i>Eukloedenella alcocki</i>	<i>Pachydomella? clarkei</i>	<i>Libumella reticulata</i>	<i>Dizygopleura chaleurensis</i>	<i>Camdenidea canadensis</i>	<i>Bollia sagittiformis</i> Swartz			
		Locality numbers	Thickness (feet)	Zones (Clarke, 1909; Alcock, 1935)																
DALHOUSIE BEDS	UPPER	41877	3	} 14																
		41876	8																	
		41875	3	} 12-13																
		41874	4																	
		41873	5	} 11																
		41872	5																	
		41871	5																	
		41870	5																	
		41869	5																	
		41866-68	15	} 10		X	X	X	X	X	X	X	X	X	X	X	X	X	X	
		41865	10			X	X	X	X	X	X	X	X	X	X	X	X	X	X	
		41864	8			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		41863	8	} 9		X	X	X	X	X	X	X	X	X	X	X	X	X	X	
		41862	6			X	X	X	X	X	X	X	X	X	X	X	X	X	X	
		41861	6			X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	41860	6			X	X	X	X	X	X	X	X	X	X	X	X	X	X		
	41859	8	} 8		X	X	X	X	X	X	X	X	X	X	X	X	X	X		
	41858	10			X	X	X	X	X	X	X	X	X	X	X	X	X	X		
	41857	20			X	X	X	X	X	X	X	X	X	X	X	X	X	X		
	41856	4	} 8																	
	41855	4																		
	41853-54	3			X	X	X	X	X	X	X	X	X	X	X	X	X	X		
	41851-52	5			X	X	X	X	X	X	X	X	X	X	X	X	X	X		
	41850	7	} 7																	
	Volcanic rocks																			
	45072	12	} 6						X	X	X		X							
	Volcanic rocks																			
	LOWER		41887	20+	} 4-5															
			41886	20+																
			41885	5	} 3		X			X	X	X	X	X	X			X		
		41884	100+						X	X	X	X	X	X	X			X		
		41883	15	} 2	X				X	X	X	X	X	X			X			
		41882	13						X	X	X	X	X	X	X			X		
		41881	4	} 1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
		41880	4			X	X	X	X	X	X	X	X	X	X	X	X	X		
		41879	4			X	X	X	X	X	X	X	X	X	X	X	X	X		
		41878	10			X	X	X	X	X	X	X	X	X	X	X	X	X		
	Volcanic rocks		} 0	X																
	41887A	80+																		
	Covered																			

## Stratigraphic Distribution of Ostracoda

<i>Eucraterellina oblonga</i> (U. and B.)						X								
<i>Thlipsura whiteavesti</i>						X								
<i>Kloedenia?</i> <i>newbrunswickensis</i>		X		X	X	X	X	X	X	X				
<i>Cytherellina?</i> sp.						X								
<i>Thlipsurella</i> cf. <i>T. v-scripta</i> (J. and H.)					X	X								
<i>Bythocypris alcocki</i>					X	X	X	X	X				X	
<i>Microparapararchites?</i> sp.						X	X	X	X					
<i>Bythocypris</i> sp. 1						X								
<i>Pyxiprimitia ventriclesta</i> Swartz						X	X	X	X					
<i>Bollia americana zygocornis</i> Swartz						X								
<i>Bairdia</i> sp.						X								
<i>Bythocypris?</i> cf. <i>B. perarcuata</i> Swartz and Swain						X	X	X						
<i>Arcyzona foordi</i>						X	X	X						
<i>Pyxiprimitia</i> cf. <i>P. germana</i> (Ulrich)						X								
<i>Parabolbina granosa</i> (Ulrich)						X	X	X	X					
<i>Bythocypris?</i> sp. 2						X								
<i>Phlyctiscapha keslingi</i>						X	X	X						
<i>Mesomphalus magnificus</i>						X	X							
<i>Kloedenia retifera</i> U. and B.						X	X	X						
<i>Daleiella?</i> <i>canadensis</i>						X								
<i>Kloedenia?</i> sp.						X	X	X	X					
<i>Octonaria</i> cf. <i>O. typicus</i> (Bassler)						X								
<i>Zygobeyrichia dalhousiensis</i>						X	X							
<i>Eucraterellina crateriformis</i> (Swartz)						X	X	X						
<i>Eukloedenella dalhousiensis</i>						X	X	X	X					
<i>Aechmina equilateralis?</i> Bassler						X								
<i>Kloedenia punctilosa</i> U. and B.						X						X		
<i>Kloedenia</i> sp. aff. <i>K. sussexensis</i> (Weller)						X						X		
<i>Kloedenia acadica</i> (Jones)						X						X		
<i>Saccarchites labrosus</i> (Jones)						X						X		

Clarke (1909, p. 17) indicated the "essentially Helderbergian" nature of the Dalhousie beds on the basis of their contained megafauna. He did, however, suggest that there "are some definite relationships to the calcareous Oriskany of the Appalachian province". Swartz (*in* Willard, Swartz, and Cleaves, 1939, p. 65), on the basis of the contained '*Spirifer concinnus* and '*S. perlamellosus* fauna, considered the Dalhousie beds as "probably equivalent to the Becraft, at least in part". Table III shows the North American distribution of some of the species of Ostracoda that occur in the Dalhousie beds.

Most of the ostracods listed in Table III are referable to species obtained by Swartz (1932, 1936) and others from the middle Lower Devonian (Deerpark Stage) Shriver Chert of Pennsylvania. Fewer species are representative of collections from the Helderbergian Birdsong Shale of Tennessee and Haragan Shale of Oklahoma, and the Camden Chert (Onesquehaw) of Tennessee. Caution must be used, however, if correlation with the Shriver Chert is attempted as the ostracods of that formation constitute the best known and most cosmopolitan Lower Devonian fauna of this type in the Appalachian region. Relatively much less reliable information is available on the ostracods of most other Lower Devonian strata in the Appalachian area. In this respect detailed studies of Helderbergian

Table III

*Other Occurrences of Ostracoda Species Found in the Dalhousie Beds\**

	[Appalachian Region]			Oklahoma
	Helderberg	Deerpark	Onesque- thaw	Helderberg
	Birdsong Shale	Shriver Chert	Camden Chert	Haragan Shale
<i>Aechmina equilateralis?</i> Bassler			X	
" <i>Amphissites?</i> " <i>concentricus</i> Ulrich and Bassler	X	X		X
<i>Bollia americana</i> <i>zygocornis</i> Swartz		X		
<i>Bollia sagittaformis</i> Swartz		X	X	
<i>Eucraterellina crateriformis</i> (Swartz)		X		
<i>Eucraterellina oblonga</i> (Ulrich and Bassler)		X		
<i>Octonaria</i> cf. <i>O. typicus</i> (Bassler)			X	
<i>Parabolbina granosa</i> (Ulrich)	X			X
<i>Pyxiprimitia ventriclefta</i> Swartz		X		
<i>Thlipsurella curvistriata</i> (Roth)	X			X

\*Five other species of questionable identification are not included in this table.

ostracods from New York and Pennsylvania (i.e., Kalkberg Limestone, Berdan, 1960, p. 468; Port Ewen Shale, Swartz, 1941, pp. 1162, 1181; Swartz, 1942, p. 187) would be valuable. Ten Kalkberg ostracod genera reported by Berdan (ibid.) are present in the Dalhousie beds but only one species, *P. granosa* (Ulrich), is known to be common to both formations. In a collection from the Port Ewen Shale, Berdan (personal communication) obtained *Eucraterellina oblonga* (Ulrich and Bassler), a species also present in the Dalhousie strata.

Until the stratigraphic occurrences of Appalachian Lower Devonian ostracods are definitely established, age determination of the Dalhousie beds must be based on their megafauna. Recent work by Boucot (personal communication; Boucot, *et al.*, ms. in press) indicates that the Dalhousie megafauna is similar to that of the New Scotland Shale of New York and Pennsylvania. In this he is fundamentally in agreement with Cooper, *et al.* (1942). On this basis the Helderbergian equivalence of the Dalhousie beds as suggested by Clarke (1909) appears probable.

## Systematic Palaeontology

### Family THLIPSURIDAE Ulrich

Genus *Thlipsura* Jones and Holl 1869, emended Swartz 1932

*Type species.* *Thlipsura corpulenta* Jones and Holl 1869.

*Thlipsura whiteavesi* n. sp.

Plate V, figures 3-5

*Description.* Carapace robust, subovate in dorsal view, greatest width anterior; subovate to subreniform in lateral view, dorsal margin strongly arcuate, ventral margin straight to slightly convex, posterior margin more broadly curved than the anterior; greatest height slightly posterior to middle; greatest length ventral. Left valve slightly larger than right, overlapping it along the free margins.

Surface of valve regularly convex, interrupted posteriorly by a depressed arcuate shelf area bordering the posterior margin and extending forward in part to the middle of the valve. This area is nearly circular in outline with an anterior rim interrupted only in its ventral part by a highly arched, inverted 'V'-shaped ridge extending obliquely upwards about two thirds the diameter of the depressed area before turning abruptly downwards. It dissects the posterior depressed area into a broad spiral. Surfaces of all specimens corroded giving them a granular aspect. Length 1.1 mm, height 0.7 mm.

*Remarks.* This species is somewhat similar to *T. furcoides* Bassler and to *T. confluens* Swartz but differs from these species in the shape of the ridge extending into the posterior depressed area of the valve. In *T. furcoides* this is a knob-like extension of the general valve surface whereas in *T. confluens* it is 'U'-shaped.

*Occurrence.* Lower Dalhousie beds, localities 41881, 41883, 41885.

*Types.* Holotype, GSC No. 14519; paratypes, GSC Nos. 14519a-c.

Genus *Thlipsurella* Swartz 1932

Type species. *Thlipsurella ellipsoclefta* Swartz 1932.

*Thlipsurella curvistriata* (Roth)

Plate V, figures 9-12

*Thlipsura curvistriata* Roth 1929, p. 354, pl. 36, figs. 15a, b.

*Thlipsurella curvistriata* Swartz 1932, p. 44; Wilson, 1935, p. 642; Warthin, 1945, Thlipsuridae 55.

*Remarks.* The posterior furrow of the Dalhousie specimens is more posteriorly enlarged and comma-shaped than slit-like as in the type specimens. In dorsal view the specimens are more evenly tapered anteriorly without the relatively abrupt lateral angulation shown by the type specimens. Some individuals are dorsally subangulate but most have an evenly convex dorsal margin. The left valve overlaps the right prominently on the ventral and less noticeably on the posterior margin.

*Occurrence.* Lower Dalhousie beds, localities 41878-41880, 41885; upper Dalhousie beds, localities 45072, 41859-41861, 41864, 41865.

*Types.* Hypotypes, GSC Nos. 14521, a-d.

*Thlipsurella* cf. *T. v-scripta* (Jones and Holl)

Plate V, figures 1, 2

*Thlipsura v-scripta* Jones and Holl 1869, p. 214, pl. 15, figs. 3a-c.

*Thlipsurella v-scripta* Swartz 1932, p. 44, pl. 10, fig. 7.

*Remarks.* This species may be included in a lineage from *T. discreta* (Jones) with two discrete oblique posterior grooves, *T. secoclefta* Swartz having four associated posterior pits and *T. ellipsoclefta* Swartz with two adjacent, lunate posterior grooves to the present species in which the posterior grooves are merged to form a 'C' similar to that of *Eucraterellina oblonga* (Ulrich and Bassler). The presence of a vertical anterior groove, however, serves to distinguish *T. v-scripta* from *E. oblonga*.

The similarity between these specimens and the English Wenlockian *T. v-scripta* is very evident, the ovate Dalhousie specimens being closer to the original figures of *T. v-scripta*, however, than to the more elongate figure shown by Ulrich and Bassler (1923) and reproduced by Swartz (1932, pl. 10, fig. 7). The posterior 'C'-shaped groove is elongate postero-ventrally but is not noticeably angular ('V'-shaped) or sometimes divided as indicated by Jones and Holl. The present specimens show marked overlap of the left valve along the entire margin of the right valve. The surfaces of the valves are etched and consequently have a granulose or papillose texture.

*Occurrence.* Upper Dalhousie beds, localities 41858, 41859.

*Types.* Hypotypes, GSC Nos. 14518, a, b.

Genus *Strepulites* Coryell and Malkin 1936

*Type species.* *Strepulites mooki* Coryell and Malkin 1936.

The genera *Strepulites* Coryell and Malkin and *Octonaria* Jones are very alike. They are similar in lateral outline and have the same general ornamentation, except that *Octonaria* bears distinct pits between the curved longitudinal ridges whereas *Strepulites* has a ridge and intermediate groove ornamentation. It is this, possibly incorrect, interpretation that is followed in this report, otherwise *Strepulites* should be considered to be synonymous with *Octonaria*.

*Strepulites dalhousiensis* n. sp.

Plate V, figures 15, 16

*Description.* Carapace elongate, subrectangular in lateral view; dorsal margin straight, truncated anteriorly and passing smoothly into the rounded posterior and anterior margins; anterior margin extended slightly ventrally; ventral margin gently concave. Hingement unknown; left valve overlapping the right along entire margin, most noticeably dorsally and ventrally.

Surface of valve elevated within a nearly complete narrow ridge which is breached dorsally but roughly parallels the margins and is shaped somewhat like a recumbent figure 8. Somewhat less distinct horizontal ridges are present at the line of greatest length of the valve. This arrangement of ridges divides the elevated part of the valve into four larger depressed areas (the antero-dorsal area is generally subdivided by a lesser ridge) with a slightly more deeply depressed centrally situated pit (point of muscular attachment?). This ornamentation is enlarged on the larger left valve, the ridge being closer to the margins. The greatest height is located anteriorly; the greatest length centrally, parallel with the dorsal margin. Length 1.0 mm, height 0.56 mm.

*Remarks.* The numbers and arrangement of ridges on this species agree in part with those of some species of *Euglyphella*, however, other obvious differences exist between these genera. *S. mooki* Coryell and Malkin 1936 from the Middle Devonian of Ontario also has a ridged ornamentation of but slightly different arrangement.

*Occurrence.* Lower Dalhousie beds, localities 41878-41880, 41883; upper Dalhousie beds, localities 41853, 41854, 41858-41868.

*Types.* Holotype, GSC No. 14523; paratype, GSC No. 14523a.

Genus *Octonaria* Jones 1887

*Type species.* *Octonaria octoformis* Jones 1887.

*Octonaria foordi* n. sp.

Plate V, figures 18-24

*Description.* Carapace subovate-rectangular; greatest height anterior to middle; greatest length median; ends smoothly rounded, nearly equal; dorsal

border nearly straight to slightly convex; ventral margin slightly concave; left valve overlapping right around the entire margin. Lateral surface of valve elevated, bearing seven (?) pits separated by a sigmoidal ridge that parallels the anterior and posterior borders and crosses the valve diagonally in a slight curve from antero-ventral to postero-dorsal. The pits are further separated from each other by transverse ridges joining the main 'S'-shaped ridge. Two elongate pits present in the narrow anterior saddle of the sigmoidal ridge, separated from each other by a fine lateral ridge, the dorsal pit confluent with the dorsal margin of the right valve but restricted dorsally to form a long horizontal groove parallel with the dorsal edge of the left valve; ventral pit deep, slightly curved, convex anteriorly and extending obliquely across the central anterior part of the valve. The five (?) posterior pits aligned on the ventral side of the broader, dorsally convex posterior part of the sigmoidal ridge, separated into two rows by a strong transverse ridge and from each other by generally weaker vertical ridges. The three (?) smaller pits of the dorsal row are nearly confluent whereas the ventral row of two larger pits may be confluent to a greater or lesser degree at the elevated surface of the valve but they retain their identity at depth or the pits may become widely separated giving the valve a thlipsurellid aspect (Pl. V, figs. 22, 24). Length 0.9 mm; height 0.55 mm.

*Remarks.* This species agrees somewhat with *Octonaria* cf. *O. typicus* in having a pitted surface and a sigmoidal ridge. It differs, however, in lateral outline, number and depth of the pits and strength of the supporting ridges. *T. multipunctatus* (Ulrich and Bassler) has a somewhat similar distribution of pits but differs in lateral outline. Right valves of specimens of *O. foordi* agree very well with those of *Thlipsuropsis diploglyptulis* Swartz and Whitmore and *T. longisulcata* Swartz and Whitmore but the left valves of *O. foordi* do not show the thlipsurid ornamentation shown by Swartz and Whitmore's species. A similar relationship is present between *O. foordi* and *O. laevilatata* Kesling and Kilgore, in which the right and left valve ornamentation is radically different.

*Occurrence.* Lower Dalhousie beds, localities 41878, 41885; upper Dalhousie beds, localities 41853-41855, 41858-41870.

*Types.* Holotype, GSC No. 14525; paratypes, GSC Nos. 14525a-j.

*Octonaria* cf. *O. typicus* (Bassler)

Plate V, figure 17

*Octonariella typica* Bassler 1941, p. 27, figs. 36, 37.

*Strepulites typicus* Warthin 1945, Thlipsuridae 43; Swain 1953, p. 273, pl. 38, figs. 6a-d.

*Remarks.* A single carapace referable to this species was recovered from the upper Dalhousie beds. This specimen agrees in most aspects to *O. typicus* but has an additional row of two pits near the ventral margin. The two small spines on

the posterior arcuate crest of *O. typicus* are not present on the Dalhousie specimen. The left valve overlaps the right around the entire margin.

*Occurrence.* Upper Dalhousie beds, locality 41864.

*Type.* Hypotype, GSC No. 14524.

Genus *Eucraterellina* Wilson 1935

*Type species.* *Eucraterellina randolphi* Wilson 1935.

*Eucraterellina crateriformis* (Swartz)

Plate V, figures 6-8

*Thlipsurella crateriformis* Swartz 1932, p. 50, pl. 11, figs. 2a, b.

*Eucraterellina crateriformis* Wilson 1935, p. 641; Warthin 1945, Thlipsuridae 1.

*Remarks.* The Dalhousie specimens agree in most respects with the original description but they have more posterior height and a slightly larger, more crescent-shaped posterior crater. The left valve strongly overlaps the right along the anterior dorsal and posterior ventral margins.

*Occurrence.* Upper Dalhousie beds, localities 41866-41870.

*Types.* Hypotypes, GSC Nos. 14520, a, b.

*Eucraterellina oblonga* (Ulrich and Bassler)

Plate V, figures 13, 14

*Craterellina oblonga* Ulrich and Bassler 1913, p. 540, pl. 98, fig. 20.

*Thlipsurella oblonga* Swartz 1932, p. 45.

*Eucraterellina oblonga* Wilson 1935, p. 641; Warthin 1945, Thlipsuridae 3.

*Remarks.* The Dalhousie specimens of *E. oblonga* are mostly preserved in eroded condition. They appear very similar to *E. moorei* (Roth) from the Haragan marl of Oklahoma. Chief differences appear to be the more posterior position of the line of greatest height and possibly the slightly smaller, more medially located 'C'-shaped posterior groove of *E. oblonga*. In both species the elevated median part within the posterior groove connects anteriorly with the general surface of the valve via a narrow isthmus. This connection is obscured on the type specimen of *E. oblonga* (Swartz, 1932, p. 49) but additional specimens from the Shriver Chert (ibid., pl. 11) indicate that it is present. Examination of the type specimens of both *E. oblonga* and *E. moorei* may prove them to be conspecific as "the Shriver and Haragan material is subject to so much variation as to make the distinction of doubtful value". (Swartz, 1932, p. 50).

*Occurrence.* Lower Dalhousie beds, localities 41880, 41883, 41885; upper Dalhousie beds, localities 41856, 41858, 41861.

*Types.* Hypotypes, GSC Nos. 14522, a.

Family PRIMITIIDAE Ulrich and Bassler

Genus *Pyxiprimitia* Swartz 1936

*Type species.* *Pyxiprimitia ventriclefta* Swartz 1936.

*Pyxiprimitia ventriclefta* Swartz 1936

Plate VI, figures 1-4, 6

*Pyxiprimitia ventriclefta* Swartz 1936, p. 569, pl. 87, figs. 2a-d; Warthin, 1937, *Beyrichiacea* 91; etc.  
*Pyxiprimitia ventripunctata* Swartz 1936, p. 570, pl. 87, figs. 3a-h; Warthin, 1937, *Beyrichiacea* 91.

*Remarks.* Some Dalhousie specimens appear to have fewer lateral pits, a less confluent row of ventral marginal pits and a small presulcal elevation (Pl. VI, figs. 1, 2). These were included in *P. ventripunctata* Swartz. Variation exists, however, between these specimens and *P. ventriclefta* Swartz which bears more numerous pits and a ventral-marginal cleft formed by confluent pits (Pl. VI, fig. 3). Some specimens exhibit characteristics of *P. ventripunctata* but bear very numerous pits (Pl. VI, fig. 6) and have a suggested presulcal elevation. Such variation suggests possible relationship between the two species (whether due to dimorphism as suggested by Warthin or simply variation in form is not known) and they are consequently grouped here as *P. ventriclefta*.

*Occurrence.* Upper Dalhousie beds, localities 41860-41863.

*Types.* Hypotypes, GSC Nos. 14526, a-d.

*Pyxiprimitia* cf. *P. germana* (Ulrich)

Plate VI, figure 5

*Kirkbya germana* Ulrich 1900, p. 185, pl. 8, figs. 19-22.  
*Pyxiprimitia germana* Warthin 1937, *Beyrichiacea* 90.

*Remarks.* This specimen agrees fundamentally with the Middle Devonian species described by Ulrich but has a prominent, smoothly rounded posterior marginal ridge and a well-developed median lateral ridge ventral to which are two or three ridges paralleling the free margin and separated from each other by linearly arranged pits. Dorsal to the median ridge, the pits are generally arranged randomly but may be interpreted as linear in some areas.

*Occurrence.* Upper Dalhousie beds, locality 41860.

*Type.* Hypotype, GSC No. 14527.

Family BOLLIIDAE Bouček 1936

Genus *Bollia* Jones and Holl 1886

*Type species.* *Bollia bicollina* Jones and Holl 1886.

*Bollia americana zygocornis* Swartz 1936

Plate VI, figures 32, 33

*Bollia americana zygocornis* Swartz 1936, p. 575, pl. 88, figs. 3a-g.

*Remarks.* The distinctive features of this species are the thickened, nearly nodelike swelling on the postero-ventral part of the yoke connecting the two dorsal nodes and the presence of a marginal ridge extending from "near the antero-dorsal angle to about half way up the posterior margin, where it is generally somewhat thickened". (Swartz, 1936, p. 575.)

*Occurrence.* Upper Dalhousie beds, localities 41860, 41864.

*Types.* Hypotypes, GSC Nos. 14534, a.

*Bollia sagittaformis* Swartz 1936

Plate VI, figures 30, 31

*Bollia sagittaformis* Swartz 1936, p. 574, pl. 88, figs. 1a-f; Bassler, 1941, p. 23, fig. 11.

*Remarks.* The straight, unenlarged posterior limb of the inner ridge of this species has been used to distinguish it from *B. burgeneri* Swartz. *B. haraganensis* Roth is less posteriorly plicate and has more robust inner and outer ridges. The Dalhousie specimens are greatly obscured by foreign material encrusting between the lateral ridges.

*Occurrence.* Lower Dalhousie beds, localities 41880, 41883-41885.

*Types.* Hypotypes, GSC Nos. 14533, a, b.

Family AECHMINIDAE Swartz

Genus *Aechmina* Jones and Holl 1869

*Type species.* *Aechmina cuspidata* Jones and Holl 1869.

*Aechmina equilateralis?* Bassler 1941

Plate VI, figure 34

*Aechmina equilateralis* Bassler 1941, p. 24, fig. 14.

*Remarks.* This species agrees reasonably well with specimens of *A. cuspidata?* Jones and Holl reported by Ulrich and Bassler from the Lower Devonian of Tennessee, West Virginia and New York. Both species possess minute marginal spines and a robust dorsal spine; *A. equilateralis* has, however, the dorsal spine directed slightly posteriorly and the valve is nearly equilateral. The Dalhousie

Canadian Fossil Arthropoda

specimen is somewhat crushed and broken, the marginal spines being broken off except at the anterior.

*Occurrence.* Upper Dalhousie beds, localities 41866-41868.

*Type.* Hypotype, GSC No. 14535.

Family HOLLINIDAE Swartz

Genus *Parabolbina* Swartz 1936

*Type species.* *Ctenobolbina granosa* Ulrich 1900.

*Parabolbina granosa* (Ulrich) 1900

Plate IX, figures 15-19

*Ctenobolbina granosa* Ulrich 1900, p. 183, pl. 8, fig. 12; Coryell and Cuskley, 1934, p. 7, fig. 9; Wilson 1935, p. 638.

*Parabolbina granosa* Swartz 1936, p. 570, pl. 80, fig. 2.

*Remarks.* The Dalhousie specimens agree in most respects with the type description but do not have as broadly undulating a frill as that shown by Ulrich. One specimen (Pl. IX, fig. 19) does not show a frill (possibly due to breakage?) and is more elongate than other specimens; this may be a male individual and thus *P. granosa* may have characteristics somewhat similar to the possible dimorphism suggested by Warthin (1937) between *P. limbata* Swartz and *P. ventrispinosa* Swartz. The distinctive features of this species are the granulose surface and the slightly posteriorly oblique and inverse 'T'-shaped sulcus.

*Occurrence.* Upper Dalhousie beds, localities 41862, 41865-41869.

*Types.* Hypotypes, GSC Nos. 14543, a-f.

Family BEECHERELLIDAE? Ulrich

Genus *Daleiella* Bouček 1937, emend. Morris and Hill 1952

*Type species.* *Cythere corbuloides* Jones and Holl 1869.

This genus seems to be closely related to *Janusella* Roth in general outline. Both are triangular in cross-section with a broad, flat venter, and are strongly inequivalved — the left valve being larger and overlapping the right at least along the highly arched dorsal and relatively straight ventral margins. Species of *Janusella* have a strong hollow spine (Berdan, 1960, p. 473) projecting from the mid-dorsum of the larger left valve whereas the similar valve of *Daleiella* bears a dorsal swelling and is highly arched, either smoothly curved as in the type species or more angular. In all known species of *Janusella* the right valve has a horizontally projecting postero-ventral spine — this is also true of *D. americana* Morris and Hill and the present species but is not prominent in either the type species or

in *D. triangularis* Bouček, both of which are referred to *Pachydomella* by Krömmelbein (1955, p. 299). Similarly, the anterior lip on the smaller valve of *Janusella* may also be present in *D. americana* (J. M. Berdan, personal communication). It appears possible that the North American species presently referred to *Daleiella* could represent a separate genus intermediate between the true European Middle Silurian *Daleiella* and the North American *Janusella*. It is likewise possible that at least the North American species of both genera could be accommodated within a slightly revised definition of the genus *Janusella*.

*Daleiella? canadensis* n. sp.

Plate VI, figures 27-29

*Description.* Species known from three incomplete specimens. Carapace robust, triangular in lateral outline and in cross-section, venter broad and flat. Hinge line unknown; dorsal margin convex, angular; anterior sharply rounded, antero-dorsal slope long and straight; posterior acuminate; greatest height in anterior half; greatest length ventral; greatest width about median. Left valve triangular in outline, larger than right and overlapping it along the dorsum and mid-venter. Dorsal margin of left valve angular, highly arched, partly broken off in all specimens. Posterior of both valves acuminate, the right valve prolonged posteriorly in the form of a cylindrical blunt spine slightly curved laterally and ventrally. Length 1.5 mm; height 0.83 mm; width 0.7 mm.

*Remarks.* These specimens are allied to *D. americana* Morris and Hill in outline and valve shape but have more angular anterior and dorsal margins and smaller ventral overlap. Since they are preserved as carapaces the presence of an anterior lip in the smaller valve, similar to that mentioned above as possibly occurring in *D. americana*, cannot be ascertained. The broken or abraded dorsal margin of the left valve apparently does not show any indication of being hollow as would be expected if this was a species of *Janusella* from which the dorsal spine was removed. This latter criterion, however, may not be significant.

*Occurrence.* Upper Dalhousie beds, locality 41864.

*Types.* Holotype, GSC No. 14532; paratypes, GSC Nos. 14532a, b.

Family BEYRICHIIDAE Matthew 1886

Genus *Zygobeyrichia* Ulrich 1916

*Type species.* *Zygobeyrichia apicalis* Ulrich 1916.

*Zygobeyrichia dalhousiensis* n. sp.

Plate VI, figure 35

*Description.* Species known mainly from one male (?) carapace. Subelliptical in outline; hinge line long, five sixths of greatest length. Cardinal angles nearly equal, obtuse, abrupt, slightly extended. Left valve larger and pronouncedly overlapping

the right on the ventral margin. Free margins of left valve smoothly rounded, more broadly curved than the right which has a slightly recessive posterior ventral margin. A broad, rounded submarginal border extends from the cardinal angles along the free margins of both valves, broader ventrally on the left and narrower ventrally on the right valve, finely tuberculate with six to eight tubercles on the anterior ventral margins of both valves.

Surface moderately convex, divided by two sulci into three lobes. Posterior and median lobes joined ventrally, 'U'-shaped, separated dorsally by a deep vertical sulcus situated posterior of median and extending from the dorsal margin to slightly ventral of mid-height of the valve. Posterior lobe broad, constricted ventrally; median lobe vertical, narrower than posterior, with a marked dorsal swelling, not extending to the dorsal margin. Anterior lobe somewhat crescent-shaped, completely separated from the median lobe by a curved sulcus extending from the dorsal margin to slightly above mid-height as a moderately deep, narrow groove and becoming shallower near mid-height and deeper once more at its ventral end where it joins the groove delineating the interior edge of the marginal border. Surface finely punctate. Length 1.5 mm; height 1.0 mm.

*Remarks.* This species agrees with several other members of the genus (i.e., *Z. apicalis*, *Z. tonolowayensis*) in many respects, however, the smoothly convex lateral outline of the valves, the presence of a smooth, complete third lobe, the complete separation of the anterior from the median lobe and the finely tuberculate anterior ventral marginal rims of both valves serve to distinguish *Z. dalhousiensis*. The small size of the specimen may indicate it to be immature, however, this is unknown as only one complete carapace has been obtained.

*Occurrence.* Upper Dalhousie beds, localities 41866-41868, 41870.

*Type.* Holotype, GSC No. 14536.

Genus *Kloedenia* Jones and Holl 1886, emend.

Ulrich and Bassler 1908

*Type species.* *Beyrichia wilckensiana* Jones 1855.

*Kloedenia?* sp. indet.

Plate VII, figures 11-13

*Description.* Species known from several incomplete valves. Valves sub-elliptical in outline; hinge line long, five sixths as long as greatest length. Cardinal angles nearly equal, obtuse. Overlap unknown. Free margins apparently smoothly rounded, convex, with a complete broad, rounded submarginal border. Surface divided into three ventrally confluent dorsal lobes by two short sulci. Posterior lobe broad, limited anteriorly by a relatively deep vertical sulcus extending from the dorsal margin to mid-height of valve. Median lobe prominent, marked by a

pronounced, slightly posteriorly oriented, pointed, dorsal node. Anterior sulcus shallow, one third as long as greatest height of the valve. Anterior lobe parallel with anterior margin. Surface smooth. Measurements unknown.

*Remarks.* These specimens apparently represent a smooth surfaced species somewhat similar in lobation to the highly pitted *K. centricornis* Ulrich and Bassler. No female individuals have been obtained so it is not certain that the generic designation is valid.

*Occurrence.* Upper Dalhousie beds, localities 41864-41868, 41870.

*Types.* Hypotypes, GSC Nos. 14539, a-e.

*Kloedenia punctillosa* Ulrich and Bassler 1908

Plate VII, figures 9, 10

*Kloedenia punctillosa* Ulrich and Bassler 1908, p. 301, pl. 38, fig. 17; Clarke, 1909, p. 21; Warthin, 1937, *Beyrichiacea* 28.

*Remarks.* The redescription of this species by Warthin is much more exact than that given in the original publication. The specimens shown here are only partly preserved but sufficient is present for identification. The valves are more coarsely reticulate in their median parts, becoming more finely so near the marginal border. There may be the suggestion of a faint ventral depression aligned with but not confluent with the anterior dorsal sulcus—this could indicate possible zygobeyrichiid characteristics similar to that shown for *Z. nearpassi* (Weller) by Swartz and Whitmore, 1956, p. 1073. No female specimens of this species have been found.

*Occurrence.* Upper Dalhousie beds, locality 41875.

*Types.* Holotype, USNM No. 53938; hypotypes, GSC Nos. 14538, a.

*Kloedenia retifera* Ulrich and Bassler 1908

Plate VII, figures 14-21

*Kloedenia retifera* Ulrich and Bassler 1908, p. 302, pl. 38, fig. 18; Clarke, 1909, p. 20; Warthin, 1937, *Beyrichiacea* 29.

*Description.* Carapace suboblong; greatest height in anterior third, greatest length in dorsal half; hinge line straight to slightly sinuous, produced into small horns at the cardinal corners; cardinal angles obtuse, anterior one more so than the nearly right angled posterior angle. Free margins smoothly convex, slightly flattened in mid-venter. Left valve larger than right, overlapping it along the ventral margin; overlap more pronounced along anterior ventral and posterior ventral margins. Marginal border narrow, broader along the ventral margin of the left valve, nearly absent along the mid-ventral margin of the right valve where it fits into the left valve during closure.

Valve divided dorsally by two very short sulci into three lobes, broadly confluent ventrally. Anterior sulcus very short, less than one fourth as long as the greatest height; posterior sulcus slightly variable, from one third to nearly one half as long as the greatest height. Median lobe indistinct, broad, globular, not reaching the dorsal margin. Remainder of lateral surface smoothly elevated, confluent. Surface marked by a coarse, flat-bottomed, subrounded to polygonal reticulation except on the posterior part of the median node, in the posterior sulcus and on the marginal border.

Immature specimens have more poorly developed sulci, the anterior one nearly absent, disappearing in the general reticulation of the lateral surface. Average measurements of the four immature right valves shown (Pl. VII, figs. 14-16, 18) are: length 1.9-2.0 mm; height 1.06-1.2 mm.

Adult male specimens (Pl. VII, figs. 17, 19) have better developed sulci, the anterior one being a noticeable depression, the posterior one becoming deeper and curving slightly anteriorly in its ventral part. Measurements of these specimens are: length 2.6 mm; height 1.5 mm (height of a complete carapace — fig. 19 — is 1.6 mm).

Adult female individuals (Pl. VII, figs. 20, 21) with more pronounced sulci than the previously described specimens; the posterior sulcus extending nearly to the middle of the valve. Brood pouch present in the anterior ventral part of the valve, occupying most of the anterior half of the valve and broadly overhanging the free margin. Measurements are: length 2.9-3.1 mm; height 1.9 mm.

*Remarks.* The right valve figured by Ulrich and Bassler (1908), and Warthin (1937) may be immature although it is only slightly smaller than the adult males listed above; this would account for the very faint sulcation on the type specimen. No previous description has been published of female individuals.

This species does not appear to be closely related to any previously described species of the genus. *K. crassipunctata* Swartz and Whitmore bears a somewhat similar ornamentation but has a more prominent marginal border and is more elongate.

*Occurrence.* Upper Dalhousie beds, localities 41864-41868.

*Types.* Holotype, USNM No. 53939; hypotypes, GSC Nos. 14540, a-g.

*Kloedenia* sp. aff. *K. sussexensis* (Weller)

Plate VIII, figure 13

*Kloedenia sussexensis* Ulrich and Bassler 1908, p. 302, pl. 38, figs. 19, 20.

*Beyrichia arcuata* Jones 1889, p. 381, pl. 17, figs. 7a-c.

*Remarks.* The figures shown by Ulrich and Bassler are of an immature individual and a male right valve, the latter heavily pustulose, with a continuous, relatively wide, thick marginal border. They appear to agree somewhat with figures of the syntypes of *K. sussexensis* (Weller) published by Swartz and Whitmore, 1956, p. 1064, pl. 106, but the adult male is broken, much larger and more pustulose than is usual for the species. The specimen figured by Jones and

reproduced here is also a very large male but lacks most of the shell. It is possible that the specimens do not represent *K. sussexensis* but the meagre material available does not permit more exact identification. No additional specimens were obtained during the present study.

*Occurrence.* Zone number 12 of Clarke (upper Dalhousie beds, locality 41875(?) of this report).

*Types.* Hypotype, GSC No. 4197; plesiotypes, USNM No. 53940.

*Kloedenia? newbrunswickensis* n. sp.

Plate VIII, figures 1-8

*Description.* Carapace oval-rectangular in lateral view. Hinge line straight, slightly depressed, hidden by the very slight dorsal elevation of the anterior lobe and the more pronounced dorsal extension of the posterior lobe; ventral margin straight, joining smoothly with the broadly rounded posterior margin and more acutely rounded anterior margin. Cardinal angles obtuse, abrupt. Greatest length median; greatest height and width posterior. Left valve overlapping right ventrally, overlap not observable laterally. Lobation consisting of three ventrally confluent lobes separated dorsally by two short sulci which extend to near mid-valve. Anterior sulcus narrow, slit-like, not extending to dorsal margin due to the faint horizontal posterior dorsal extension of the anterior lobe, curving slightly posteriorly at its ventral end and partly restricting the ventral extension of the median lobe. Posterior sulcus deep, with steeply elevated sides, extending to dorsal margin. Anterior lobe separated by a very obscure oblique ventral depression from the otherwise ventrally confluent part of the valve, generally with a thin posteriorly extending dorsal crest which dies out dorsally of the median lobe. Median lobe ovate, elongate vertically, slightly inclined posteriorly at its ventral end, not extending to the dorsal margin, restricted ventrally but connected to the posterior lobe by an obscure shell thickening ventral to the second sulcus. Posterior lobe broad, with a slight dorsal crest extending above the hinge.

Valves with a continuous very narrow border (bend?) extending along the lateral margins. Marginal surface smooth, slightly channeled. Right valve with a thin contact ridge against which the contact margin of the left valve abuts. Contact margin of left valve finely denticulate anteriorly and anterior ventrally corresponding to faint crenulations in the right contact ridge. Posterior and posterior ventral parts of the right contact ridge denticulate, corresponding structures of the left valve unknown but presumed to be denticulate or crenulate. Surface of valves with fine punctae, widely spaced and generally of random orientation. Punctae in the vicinity of the ventral part of the posterior sulcus delineate numerous smooth radiating venose ridges which cross the poorly defined elevation yoking the median and posterior lobes and also extend onto the ventral lobe.

Measurements of the holotype: length 4.1 mm; height 2.5 mm; width of carapace 2.05 mm.

*Remarks.* No recognizable female specimens of this species are known. It has kloedenid lobation, lophokloedenid dorsal extension of the anterior lobe without, however, a posterior node in the dorsal part of the median sulcus, and wellerioid outlines with a narrow border along the lateral margin.

The species appears to agree most nearly with *Kloedenia notata* (Hall) and *Kloedenia oculina* (Hall) but differs from these species in being much larger and having a different length/height relationship.

*Occurrence.* Upper Dalhousie beds, localities 41851-41852, 41858-41871, 41873(?).

*Types.* Holotype, GSC No. 14541; paratypes, GSC Nos. 14541a-g.

*Kloedenia acadica* (Jones) 1889

Plate VIII, figures 14-16

*Beyrichia kloedeni* M'Coy var. *acadica* Jones 1889, p. 379, pl. 17, figs. 3(?), 4a-c, 5, 6a-c, 8, 9a-c.

*Beyrichia kloedeni acadica* Jones, Clarke, 1908, p. 244.

*Beyrichia kloedeni* McCoy cf. var. *acadica* Jones, Clarke, 1909, p. 19.

*Kloedenia marginalis* Ulrich and Bassler 1908, p. 301, pl. 38, fig. 16; Clarke, 1909, p. 20; Warthin, 1937, Beyrichiacea 23.

? *Kloedenia manliusensis* (Weller) Ulrich and Bassler 1908, p. 301, pl. 38, fig. 21.

? *Kloedenia manliusensis* (Weller) Clarke 1909, p. 20.

*Remarks.* The redescription of *K. marginalis* by Warthin is essentially correct but the orientation is reversed in this paper. The female left valve figured by Jones (and shown here on Pl. VIII, fig. 16) has an anterior ventral pouch that effectively hides the ventral margin. All of Jones' specimens are preserved in rock matrix and thus do not show additional marginal structures. No additional specimens were obtained during the present study.

*Occurrence.* Zone number 12 of Clarke (upper Dalhousie beds, locality 41875(?) of this report).

*Types.* Lectotype, GSC No. 4188a; paratypes, GSC Nos. 4186, 4188, b, c; hypotypes USNM Nos. 53937, 53941.

Genus *Phlyctiscapha* Kesling 1953

*Type species.* *Phlyctiscapha rockportensis* Kesling 1953, p. 222, fig. 1; Pl. 1, figs. 1-20; Pl. 2, figs. 1-19.

*Phlyctiscapha keslingi* n. sp.

Plate IX, figures 20-24

*Description.* Female carapace tumid, subovate, tapering anteriorly in dorsal view and dorsally in end view; male carapace lanceolate; greatest length in dorsal third; greatest height median; greatest width in posterior half. Left valve overlapping right in both dimorphs especially along the ventral margins and along the

posterior margin of male specimens. Dorsal margin nearly straight to slightly convex, not noticeably humped, about two thirds of total length of valves; dorsal corners rounded, posterior corner more acute, nearly right angled; free margins smoothly subrounded, anterior margin more broadly curved than posterior. Valves of each dimorph with a distinct anterior swing.

Anterior and posterior corners separated from the lateral surface of the valve by a distinct groove present, in the female, only at the dorsal part of the anterior and posterior borders, the posterior groove meeting the posterior lateral margin at an angle and joining the submarginal groove; and in the male from the dorsal corners nearly to the mid-venter, delineating the proximal edge of the marginal ridge. Marginal ridge small, separated from the ridge along the contact margin by a narrow furrow. Contact ridge small in right valve, much larger in the left where it forms the valve overlap.

Brood pouch in the female occupying the posterior ventral half of the valve, smoothly confluent with the valve surface, most extended at mid-ventral part of the valve; internal structures of pouch unknown. Surface smooth, pores faint, large muscle spot slightly anterior of middle of valve in some specimens.

Measurements: female valve — length 1.6 mm, height 1.3 mm; male valve — length 1.7 mm, height 1.3 mm.

*Remarks.* This species agrees with *P. subovata* Smith 1956 in straightness of the dorsal margin but *P. keslingi* is larger, slightly more anteriorly plenate, the posterior corner is more abrupt and the greatest width of the male carapace is posterior. It differs from female specimens of *P. rockportensis* and *P. apleta* Kesling in having the brood pouch confluent with the lateral surface of the valve, not separated from it by a depression or groove, also the male carapace of *P. keslingi* is not as acuminate anteriorly in dorsal view. Whether the specimen figured as *Phlyctiscapha* sp. by Swartz and Whitmore, 1956 is a valid member of this genus is unknown.

*Occurrence.* Upper Dalhousie beds, localities 41863-41865.

*Types.* Holotype, GSC No. 14544; paratypes, GSC Nos. 14544a-d.

#### Genus *Saccarchites* Swartz and Whitmore 1956

*Type species.* *Saccarchites saccularis* Swartz and Whitmore 1956, p. 1080, pl. 103, figs. 18-19.

#### *Saccarchites labrosus* (Jones) 1889

##### Plate IX, figure 25

*Isochilina labrosa* Jones 1889, p. 383, pl. 17, fig. 11, text-figs. 3, 4.

*Description.* Species known from a female left valve preserved in rock so that the marginal and closing structures are mostly hidden. Valve tumid, subovate, tapering posteriorly in dorsal view and dorsally in end view; greatest length in

dorsal half; greatest height median. Overlap unknown. Dorsal margin slightly concave, two thirds total length of the valve; dorsal corners sharp, anterior angle less acute than posterior; free margins smoothly rounded, anterior more broadly than posterior. Valve with distinct anterior swing.

Anterior and posterior corners separated from the lateral surface of the valve by distinct grooves that mark the proximal edge of the marginal ridge and extend a short distance down the anterior and farther down the posterior margin before being covered in lateral view by the overhanging brood pouch. Marginal ridge complete, apparently separated from the contact margin by a shallow groove. Brood pouch large, occupying the anterior ventral half of the valve, smoothly confluent with the valve surface, broadly overlapping the ventral and anterior ventral margins. Valve finely granulose. Length 4.0 mm; height 2.6 mm.

*Remarks.* This is somewhat similar to the type species in that it possesses a long, straight to slightly concave dorsal margin and a broad anterior ventral brood pouch in the adult female. In both of these respects the genus differs from *Phlyctiscapha* Kesling. *S. labrosus* is much larger than the type species and has a broader, ventrally situated brood pouch. There is no groove or depression delineating the brood pouch from the lateral surface of the valve and no depressions are observed along the dorsal surface indicating the presence of rudimentary sulci or lobes.

*Occurrence.* Cape Bon Ami, "in greenish-grey calcareous shale" (Jones, 1889, p. 384), collected by A. H. Foord. A note by T. R. Jones on the reverse side of the slide containing the specimen states, "Sent with specimens from Bon Ami etc. from Canad. Geol. Survey — no locality or note of any kind on the pill-box in which it came: only marked 'Leperditia'. 3. Isochilina — Cap. Bon Ami."

*Type.* Holotype, GSC No. 3841.

#### Genus *Mesomphalus* Ulrich and Bassler 1913

*Type species.* *Mesomphalus hartleyi* Ulrich and Bassler 1913, p. 523, Pl. 95, figs. 22-24; Pl. 96, figs. 1-3.

#### *Mesomphalus magnificus* n. sp.

Plate VII, figures 1-8; Plate VIII, figures 9-12

*Description.* Carapace subovate to subquadrate in lateral view; hinge line straight, seven eighths the greatest length. Cardinal angles well defined, subround to angular, anterior angle about 105 degrees, posterior angle about 90 degrees. Dorsal margin sinuous, anterior and posterior lobes and intervening dorsal edge projecting above hinge line, posterior lobe the highest; anterior margin smoothly rounded; ventral margin straight to slightly convex, sometimes with a slight posterior

angulation; posterior margin oblique-convex, meeting the posterior dorsal corner nearly at a right angle in mature valves or slightly more acutely in immature instars. Greatest length in dorsal half; greatest height generally anterior but may be variable due to posterior dorsal hump.

Valve surface convex, trilobate; with a prominent, rounded, complete marginal border, separated from the lateral surface by a pronounced groove paralleling the free margins; border extending across the marginal surface to the contact edge as a broad, smooth flat flange. Lateral surface with three indistinct lobes separated by two equally indistinct sulci; confluent ventrally in the male. Anterior lobe slightly crescent-shaped, extending slightly above the hinge line and separated posterior ventrally by a weak depression from the low median node situated slightly above mid-valve not reaching the dorsal margin; posterior lobe broad, equal to half of the valve, limited anteriorly by the second sulcus which is prominent and narrow only immediately posterior to the median node; posterior lobe extending well above the hinge line and yoked dorsally to the anterior lobe across the weak dorsal depression representing the joined sulcal grooves.

Posterior lobe of male valves dissected by an obliquely curved longitudinal groove or furrow extending from near the mid-point of the posterior marginal groove to near the posterior ventral edge of the median node. A similar, though more feeble, groove present on female valves, largely obscured by the ventral brood pouch.

Female brood pouch sausage-shaped, elongate, only faintly overlapping the ventral marginal border, extending along the central half of the ventral margin and nearly two thirds the distance from the ventral border to the median node. Marginal border continuous but constricted medially by the overhanging pouch.

Surface of valves granular to finely papillose, sparsely punctate.

Valve measurements: adult female — length 2.4 mm, height 1.6 mm; adult male — length 2.55 mm, height 1.52 mm.

*Remarks.* This species differs from other described species of the genus by its much larger size and by having a broad, flat marginal surface continuous from the marginal ridge to the point of closure. In *M. hartleyi* the marginal ridge is thick laterally but not broad and flat on the marginal surface (Kesling and Rogers, 1957, pl. 130, fig. 15). The anterior swing of the present species is similar to that of *M. rhomboidalis* Swartz and Whitmore and *M. striatellus* Swartz and Whitmore but neither of these species shows the pronounced dorsal humps of the anterior and posterior lobes which overhang the hinge line of *M. magnificus*. In *M. rhomboidalis* both dimorphs are semi-reticulate and the female pouch markedly overhangs the ventral edge of the valves. *M. striatellus* possesses a long longitudinal groove which crosses the third lobe and extends anterior to the base of the median lobe.

*Occurrence.* Upper Dalhousie beds, localities 41864, 41865.

*Types.* Holotype, GSC No. 14537; paratypes, GSC Nos. 14537a-n.

Family KLOEDENELLIDAE Ulrich and Bassler

Genus *Dizygopleura* Ulrich and Bassler 1923

*Type species.* *Dizygopleura swartzi* Ulrich and Bassler 1923, p. 693, pl. 62, figs. 1-8.

*Dizygopleura chaleurensis* n. sp.

Plate VI, figures 22-26

*Description.* Carapace subovate in lateral view; hinge line straight; hinge tooth of left valve strong, situated above anterior sulcus; left valve slightly overlapping right ventrally. Dorsal margin sinuous, humped posteriorly by the overhanging posterior lobe; anterior margin broadly curved; ventral margin straight, inclined posteriorly; posterior margin narrowly rounded. Greatest length in dorsal half; greatest height anterior; greatest width posterior in female dimorph, median in male dimorph.

Median sulcus deep, inclined obliquely toward the anterior at its ventral end, extending from hinge line to mid-height of valve. Anterior sulcus narrow, deep, extending from dorsal margin parallel to the anterior margin, curving parallel first to the ventral margin and then the posterior margin and ending blindly near the middle of the posterior half of the valve. Lobes broad, ridgelike, joined in a sigmoidal curve; median lobe (L2) inflated dorsally, extending ventrally with diminished width and, becoming broader, extending abruptly posterior dorsally in an inclined 'U'-shaped curve to meet the posterior third of the dorsal margin where it forms the hump overlying the posterior third of the hinge and comprising the confluent third and fourth lobes. Posterior lobe (L3, 4) joined to anterior lobe (L1) in male dimorph by a narrow ridge (thinner along its ventral extent) passing anteriorly parallel with the free margin, and in the female dimorph by a similarly shaped ridge broadly inflated posteriorly where it is perpendicular to the dorsal margin, thread-like parallel with the ventral margin and, increasing in thickness, parallel with the anterior margin. Male valves with this ridge separated from the marginal ridge by a continuous groove, broader anteriorly and posteriorly; female valves with a flange curving smoothly from the posterior edge of the thickened posterior lobe, extending anteriorly as in the male dimorph with a groove separating the marginal ridge and the curved ridge joining the anterior and posterior lobes. Valves very finely granulose or papillose.

Measurements: adult female — length 1.02 mm, height 0.6 mm; adult male — length 0.95 mm, height 0.54 mm.

*Remarks.* This species agrees most nearly with the Silurian species *D. conjugata* Swartz 1933 in lateral valve ornamentation. Both species have the lobes joined in a similarly sinuous fashion. *D. conjugata* is wider in dorsal view,

the median sulcus is vertically square instead of oblique, comma-shaped and the posterior lobe is more remote from the posterior margin than in *D. chaleurensis*.

*Occurrence.* Lower Dalhousie beds, locality 41879; upper Dalhousie beds, localities 41860-41864.

*Types.* Holotype, GSC No. 14531; paratypes, GSC Nos. 14531a-f.

Genus *Eukloedenella* Ulrich and Bassler 1923

*Type species.* *Eukloedenella umbilicata* Ulrich and Bassler 1923, p. 669, pl. 57, figs. 8-12.

*Eukloedenella alcocki* n. sp.

Plate X, figures 7-15

? *Kloedenella pennsylvanica* Clarke, 1909, p. 21.

? *Kloedenella halli* Clarke, 1909, p. 21.

*Description.* Carapace ovate, elongate; dorsal margin straight, ventral margin slightly concave medially, anterior and posterior margins smoothly rounded. Greatest length slightly dorsal of median; greatest height variable; greatest width posterior. Median sulcus distinct, comma-shaped, slightly anterior of mid-valve and in dorsal third. Hinge straight posteriorly, slight projection of right valve onto left immediately above median sulcus, tooth of left valve well developed, projecting over dorsal edge of right anterior to sulcus. Essentially equivalved.

Male carapace with pronounced lateral posterior ventral shoulder rising abruptly from a broad (*ca.* 0.1 mm) posterior marginal flange which diminishes in width anteriorly and disappears near mid-venter. Posterior surface of female carapaces inflated, rising less abruptly from posterior margin.

Measurements: female carapace — length 1.25 mm, height 0.67 mm, width 0.52 mm; male carapace — length 1.1 mm, height 0.62 mm, width 0.4 mm.

*Remarks.* This species agrees in general shape with *Eukloedenella sulcifrons* Ulrich and Bassler 1923 (*see* Swartz, 1933, p. 258), which possesses a posterior flange on male specimens but is more concave ventrally and has a less distinct sulcus.

No specimens of *Kloedenella* have been obtained from the Dalhousie beds during the present investigation. It appears therefore, that the identifications by Clarke of *K. pennsylvanica* (Jones) and *K. halli* (Jones) from these beds are highly doubtful.

*Occurrence.* Lower Dalhousie beds, localities 41878, 41880, 41885; upper Dalhousie beds, localities 45072, 41851-41870.

*Types.* Holotype, GSC No. 14546; paratypes, GSC Nos. 14546a-h.

*Eukloedenella dalhousiensis* n. sp.

Plate X, figures 1-6

? *Kloedenella pennsylvanica* Clarke, 1909, p. 21.

? *Kloedenella halli* Clarke, 1909, p. 21.

*Description.* Carapace ovate, elongate; dorsal margin straight posteriorly; ventral margin straight to slightly concave; posterior margin broadly rounded in male specimens, slightly obliquely convex posterior ventrally in female dimorphs; anterior margin more narrowly rounded, with relatively straight oblique dorsal shoulder. Greatest length dorsal of median; greatest height posterior; greatest width posterior. Median sulcus distinct, straight, slit-like, situated in dorsal half of valves and slightly anterior of median; possible slight indication of anterior sulcus. Hinge straight posteriorly, slight angulation of right valve hinge onto left immediately above median sulcus, tooth of left valve well developed, projecting over dorsal edge of right anterior to sulcus. Essentially equivalved.

Male carapaces elongate, broadly rounded posteriorly, evenly convex in dorsal view, obliquity of anterior dorsal shoulder barely noticeable. Female carapaces shorter, obliquely truncate posterior ventrally; lateral surface rising more abruptly from posterior margin than in the male. Anterior dorsal shoulder very noticeable, oblique, straight.

Measurements: female carapace — length 1.0 mm, height 0.6 mm, width 0.42 mm; male carapace — length 1.1 mm, height 0.56 mm, width 0.4 mm.

*Remarks.* This species agrees in lateral view with *Eukloedenella manliensis* Swartz and Whitmore 1956. One dimorph of both species (the male of *E. dalhousiensis* and the female (?) of *E. manliensis*) is elongate whereas the other dimorph (female of *E. dalhousiensis* and male (?) of *E. manliensis*) is shorter and higher. Only a faint suggestion of the anterior sulcus is evident in either species but *E. dalhousiensis* has a well-developed hinge tooth whereas in *E. manliensis* this is almost obsolete.

*Occurrence.* Upper Dalhousie beds, localities 41866-41870, 41872, 41873, 41875, 41877.

*Types.* Holotype, GSC No. 14545; paratypes, GSC Nos. 14545a-e.

Family ARCYZONIDAE Kesling 1961

Genus *Arcyzona* Kesling 1952

*Type species.* *Amphissites diadematus* Van Pelt 1933, p. 329, pl. 39, figs. 8-15.

*Arcyzona foordi* n. sp.

Plate VI, figures 7, 8

*Description.* Carapace subquadrate in lateral view. Dorsal border nearly straight, three fourths of length; lateral borders gently rounded, anterior slightly

more so than posterior. Dorsal corners nearly equal, subrounded, obtuse. Lateral surface flat to gently convex with irregularly distributed polygonal reticulations and a deep, near median, kirkbyid pit.

Marginal ridge extending from corner to corner, at or parallel with the free border except at the anterior and posterior dorsal margins. Indistinct submarginal ridge separated from the marginal ridge by the smooth to slightly granulose marginal surface. Length 0.7 mm; height 0.43 mm.

*Remarks.* This species agrees in general outline with those described by Kesling (1952) but is not as coarsely reticulate, has a smaller, more shallow median pit and the marginal surface is not grooved.

*Occurrence.* Upper Dalhousie beds, localities 41860, 41861.

*Types.* Holotype, GSC No. 14528; paratypes, GSC Nos. 14528a, b.

#### Family Uncertain

#### Genus *Amphissites* Girty 1910

*Type species.* *Amphissites rugosus* Girty 1910.

*"Amphissites(?)" concentricus* (Ulrich and Bassler) 1913

Plate VI, figures 17-21

*Primitia? concentrica* Ulrich and Bassler 1913, p. 517, pl. 95, figs. 6-8.

*Amphissites retiferus* Roth 1929, p. 348, pl. 36, fig. 11; Wilson, 1935, p. 638.

*Amphissites primaevus* Roth 1929, p. 348, pl. 38, fig. 11; Wilson, 1935, p. 638.

*Amphissites concentricus* Warthin 1937, Beyrichiacea 98.

*Remarks.* This species is represented in the collections by several well-preserved specimens. They bear very faint marginal and submarginal ridges not previously reported for this species. The exact generic position of this and other Lower Devonian species presently referred to *Amphissites* (i.e., *A. planus* Wilson) is unknown.

*Occurrence.* Lower Dalhousie beds, localities 41878-41881, 41883.

*Types.* Hypotypes, GSC Nos. 14530, a-f.

#### Family APARCHITIDAE Jones 1901

#### Genus *Libumella* Rozhdestvenskaya 1959

*Type species.* *Libumella discoides* Rozhdestvenskaya 1959, p. 134, pl. 4, figs. 1a-c.

*Synonymy.* *Macronotella* Ulrich 1894, (part).

*Ehlersia* Kesling, Crafts, Darby, Shubak, and Smith 1960.

The original description of this genus is as follows (in translation):

**Diagnosis.** The shell is large, convex, round or truncated-oval in outline. Dorsal margin is either straight or is slightly convex in the middle. Hinge margin lies in a deep hinge groove. Left valve slightly overlaps the right. Three rounded ridge-shaped ribs adjacent to one another, run along the contact margin of the valves. The valve exterior is ornamented with large randomly distributed punctae; the ribs and the median scar are free of ornamentation.

**Comparison.** Representatives of the genus *Libumella* closely resemble *Macronotella* Ulrich, a genus described from the Ordovician deposits of Minnesota (genotype *M. scofieldi* Ulrich, 1894, pages 683-84, table 43, figs. 30-34) in outlines and in the character of the valve exterior, but differ from the latter in having a convex shell and ridge-shaped ribs along the contact margin. These features have not been observed in representatives of the genus *Macronotella* and served as a basis for the establishment of the new genus. Genus *Libumella* has been established on the basis of two species from the Biya beds of Bashkiria. *Macronotella hypercala* Kesling and Kilgore (1952, page 2, table 1, figs. 25-36) from the Genshaw formation (Traverse Group) of the Givetian stage in Michigan, USA, has also been classified with this genus.

Age: Middle Devonian.

*Libumella reticulata* n. sp.

Plate VI, figures 9-16

**Description.** Carapace semiovate, slightly plenate posteriorly (?); hinge sunken; hinge line and dorsal border straight or very slightly convex; free border rounded. Lateral and marginal surfaces meet along a slightly ridged rim-like bend at or closely parallel with the lateral margin of the valve. Bend separated from the marginal ridge by a smooth, shallow, channel. Marginal ridge strongly developed on overlapping left (?) valve, weaker on right (?). Cardinal angles smooth, obtuse, anterior(?) nearly at right angle.

Lateral surface coarsely and randomly punctate except for the peripheral rim and centrally located round to tear-shaped bare spot. Holotype, length 1.2 mm; height 0.9 mm.

**Remarks.** The orientation adopted for the above description is similar to that used by Rozhdestvenskaya and Kesling, Crafts, Darby, Shubak, and Smith. It is thought preferable to retain the orientation used by these authors for the present until further evidence is forthcoming to indicate whether this is correct.

*L. reticulata* is very similar to but is less coarsely pitted than *L. hypercala* (Kesling and Kilgore) and bears a more indistinct, sometimes tear-shaped central smooth spot. From *L. dubia* (Tolmachoff) of nearly the same age it differs in having a more pronounced ridge-like marginal bend and is less prominently reticulate.

**Occurrence.** Lower Dalhousie beds, localities 41879, 41880; upper Dalhousie beds, localities 41851-41868.

**Types.** Holotype, GSC No. 14529; paratypes, GSC Nos. 14529a-g.

Family CYPRIDIDAE Baird 1845

Genus *Camdenidea* Swain 1953

*Type species. Camdenidea camdenensis* Swain 1953, p. 280, pl. 39, figs. 10a-g.

*Camdenidea canadensis* n. sp.

Plate X, figures 28-31

*Description.* Carapace elongate, subtriangular in lateral view; dorsal margin strongly arched; anterior margin narrowly rounded; ventral margin straight to slightly concave; posterior margin bluntly pointed. Greatest length ventral; greatest height anterior; greatest width median. Left valve overlapping right ventrally.

Lateral surface convex, flat in ventral view, rising abruptly from the ventral margin to greatest width of the valve, less abruptly from other margins. Posterior end compressed. Hinge straight, about two fifths as long as greatest length of valves, situated immediately posterior to the highest part of the dorsal margin. Hingement and muscular attachment unknown. Surface smooth.

Measurements of largest carapace: length 1.4 mm; height 0.6 mm; width 0.7 mm.

*Remarks.* This species is only distinguished with difficulty from *C. camdenensis* Swain. *C. canadensis* is consistently smaller, straight-sided in ventral (or dorsal) view, less highly arched dorsally and has the line of greatest length situated more dorsally than the type species. *Camdenidea geisi* (Wilson) 1935 (= *Bythocypris geisi* Wilson) is very similar to *C. camdenensis* and the present species but differs in having its greatest height in the posterior half and a less pointed posterior margin.

*Occurrence.* Lower Dalhousie beds, localities 41879-41882.

*Types.* Holotype, GSC No. 14550; paratypes, GSC Nos. 14550a-c.

Family BAIRDIIDAE Sars 1888

Genus *Bythocypris* Brady 1880

*Type species. Bairdia bosquetiana* Brady 1866 (= *Bythocypris reniformis* Brady 1880).

*Bythocypris* sp. 1

*Remarks.* Three very elongate, cylindrical specimens averaging between 2.8 and 3.0 in length/height ratios were obtained from the Dalhousie shales. These differ from the type of *B. pergracilis* Ulrich and Bassler 1923 (which has a length/height ratio of 2.4) in being smaller, but both species appear similar in lateral outline.

*Occurrence.* Upper Dalhousie beds, localities 41859, 41862.

*Types.* Hypotypes, GSC Nos. 14554, a, b.

*Bythocypris?* cf. *B. perarcuata* Swartz and Swain 1941

Plate X, figures 25-27

*Bythocypris* (?) *perarcuata* Swartz and Swain 1941, p. 446, pl. 6, figs. 7a,b.

*Remarks.* These specimens are generally similar in lateral view to that described by Swartz and Swain but show obvious overlap by the left valve along the straight to slightly concave ventral margin and the anterior and posterior dorsal slopes of the right. The valves of the Dalhousie specimens are highly arched but are slightly flattened mid-dorsally on most specimens unlike the mould of the type specimen figured by Swartz and Swain. The lateral extremities of the present specimens are not situated in as ventral a position as those of the type specimen.

*Occurrence.* Upper Dalhousie beds, localities 41860, 41861, 41864.

*Types.* Hypotypes, GSC Nos. 14549, a, b.

*Bythocypris* cf. *B. phaseolina* Ulrich and Bassler 1923

Plate X, figures 21-24

*Bythocypris phaseolina* Ulrich and Bassler 1923, p. 703, pl. 63, fig. 7.

*Remarks.* Highly generalized, cylindrical, relatively equal-valved bythocyprids of this type are common throughout the Dalhousie beds. They vary in length/height ratios from 2.0 to 2.2 (type specimen 2.2) and are similar in size to that described by Ulrich and Bassler.

*Occurrence.* Lower Dalhousie beds, localities 41878, 41880, 41881, 41883, 41885; upper Dalhousie beds, localities 41857, 41860-41865.

*Types.* Hypotypes, GSC Nos. 14548, a-c.

*Bythocypris alcocki* n. sp.

Plate X, figures 16-20

*Description.* Valves bean-shaped, broadly ovate posteriorly; left valve overlapping right along all margins, greatest ventrally; hinge straight, in anterior half. Greatest length median; greatest height posterior; greatest width posterior. Muscle scar circular, median in position. Surface smooth. Measurements: length 1.1 mm; height 0.6 mm.

*Remarks.* This species is posteriorly elevated similar to *Bythocypris nearpassi* Weller 1903 but is not as anteriorly acuminate as that species.

*Occurrence.* Upper Dalhousie beds, localities 41857-41862, 41870, 41873, 41875.

*Types.* Holotype, GSC No. 14547; paratypes, GSC Nos. 14547a-d.

*Bythocypris swartzi* n. sp.

Plate X, figures 37-40

*Description.* Carapace bean-shaped, ovate, elongate in lateral view, regularly convex in dorsal view. Left valve overlapping right mid-ventrally and on both shoulders. Dorsal margin regularly convex to slightly arcuate, highest posteriorly; ventral margin concave medially; posterior margin narrowly rounded, prolonged ventrally, with a fairly straight, oblique dorsal shoulder; anterior margin more regularly rounded, also prolonged ventrally. Greatest length ventral; greatest height posterior; greatest width posterior. Measurements of a carapace: length 2.3 mm; height 1.2 mm; width 0.9 mm.

*Remarks.* This species somewhat resembles *B.*? cf. *B. perarcuata* Swartz and Swain but is much larger, less arcuate dorsally and has a higher posterior end.

*Occurrence.* Lower Dalhousie beds, localities 41878-41881; upper Dalhousie beds, localities 45072, 41851-41869.

*Types.* Holotype, GSC No. 14552; paratypes, GSC Nos. 14552a-f.

Genus *Bairdia* M'Coy 1844

*Type species.* *Bairdia curta* M'Coy 1844, p. 164, pl. 23, fig. 6.

*Bairdia* sp.

*Remarks.* One poorly preserved specimen has been found, mis-shapen anteriorly, but showing the left valve overlapping the ventral and posterior dorsal margins of the right valve. The acuminate posterior extremity is near mid-height of the valve, concave dorsally and smoothly curved ventrally very similar to *Bairdia summacuminata* Coryell and Malkin 1936, p. 9, fig. 23 (= *B. leguminoides* Ulrich 1891).

*Occurrence.* Upper Dalhousie beds, locality 41860.

*Type.* Hypotype, GSC No. 14553.

Family PACHYDOMELLIDAE Berdan and Sohn 1961

Genus *Tubulibairdia* Swartz 1936

*Type species.* *Tubulibairdia tubulifera* Swartz 1936, p. 581, pl. 89, figs. 2a-r.

*Tubulibairdia chaleurensis* n. sp.

Plate X, figures 32-36

? *Pachydomella* sp. nov. Clarke, 1909, p. 20.

*Description.* Carapace ovate, elongate; hinge straight, half length of valve, sunken; all margins convex, posterior margin more acute, posterior dorsal slope

nearly straight. Left valve overlapping right except anteriorly, most pronounced ventrally, umbonate dorsally projecting well above hinge. Greatest length median; greatest height slightly posterior of median; greatest width posterior.

Carapace smooth externally; numerous coarse circular pores present in shell, not occurring on large round medially situated muscle scar, on marginal edges of the valves, or on dorsal lateral surface at anterior end of the hinge line. Measurements of one carapace; length 1.7 mm; height 1.1 mm; width 1.1 mm.

*Remarks.* It is not known whether the interior valve pores of this species open internally as in the type species but they are assumed to do so. This species, as stated by Clarke (1909), is apparently closely allied to *Pachydomella* (= ? *Tubulibairdia*) *longula* Ulrich and Bassler 1913, but differs in size and lateral outline.

*Occurrence.* Lower Dalhousie beds, localities 41878-41882, 41885; upper Dalhousie beds, localities 45072, 41851-41870; also indicated by Clarke (1909, p. 20) as occurring in horizon 13 — locality 41875 of the present report.

*Types.* Holotype, GSC No. 14551; paratypes, GSC Nos. 14551a-e.

Genus *Pachydomella* Ulrich 1891

*Type species.* *Pachydomella tumida* Ulrich 1891, p. 198, pl. 13, figs. 5a-c.

*Pachydomella? clarkei* n. sp.

Plate IX, figures 1-14

*Description.* Carapace small, tumid, ovate in lateral view; left valve larger than right, overlapping it on all sides except dorsally, greatest overlap ventral. Hinge line straight, deeply sunken between dorsal humps of both valves, dorsal margin of left valve generally higher than right; free margins rounded, posterior narrowly convex, anterior generally more broadly rounded, ventral margin slightly convex. Greatest length median or ventral of median; greatest height median; greatest width in posterior half. Posterior end of left valve bluntly pointed, with a small smooth boss. Humped dorsal margins of both valves marked with a smooth crest, most pronounced medially, fading out anteriorly and posteriorly. Broad, smooth to slightly pitted interarea on both valves between the hump crest and the short straight medially situated depressed hinge, steeply sloping toward hinge, either straight or slightly convex. Surface of valves coarsely reticulate posteriorly with randomly oriented, deep, polygonal, flat-bottomed pits in posterior half and at anterior edge of the muscle scar; immature specimens with smaller pits; best preserved on right valves. Anterior part of both valves nearly smooth to granular, similar in texture to the unornamented margins of both valves and the round, centrally situated muscle scar.

Measurements (in mm) of four carapaces are:

Length	Height	Width
0.80	0.53	0.54
0.90	0.58	0.60
0.82	0.57	0.55
0.80	0.54	0.51

*Remarks.* *P.?* *clarkei* is similar in lateral view to most other species of the genus. Posterior ornamentation has been noted on several European species of this genus (Krömmelbein, 1955) as well as on the type species *P. tumida* Ulrich. On these species the ornamentation consists of faint rugulose to anastomosing horizontal ridges whereas *P.?* *clarkei* is posteriorly reticulate. The deeply sunken hinge of the present species is not usual in this genus, however, *Newsomites pertumidus* Morris and Hill 1952 — a species that should possibly be contained within the genus *Pachydomella* — has a similarly depressed hinge and is comparable to *P.?* *clarkei* in lateral and end views.

*Occurrence.* Lower Dalhousie beds, localities 41878-41882, 41885.

*Types.* Holotype, GSC No. 14542; paratypes, GSC Nos. 14542a-d.

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# ADDITIONAL SILURIAN ARTHROPODA FROM THE CANADIAN ARCTIC

## Introduction

Since the commencement of extensive geological exploration in the Canadian Arctic Archipelago numerous Silurian arthropods have been discovered. Some of these were described by Copeland and Bolton (1960) but other phyllocarid and eurypterid remains have been obtained from Cornwallis, Baillie-Hamilton, and Devon Islands along Wellington Channel. The author is grateful to J. C. Sproule and Associates Limited, whose geologists collected the material described herein, for making the specimens available.

The area has been defined by Thorsteinsson (1958, p. 116, Fig. 5) as lying within the Cornwallis Fold Belt. This is an area of late Silurian or early Devonian deformation that extends from the Cornwallis Islands to Grinnell Peninsula. The stratigraphic position of the various Silurian formations within part of this region has been shown by Thorsteinsson (*ibid.*, Table VI; Fig. 3) and previous occurrences of Silurian Eurypterida and Phyllocarida have been indicated by Copeland and Bolton (1960, Table IV; pp. 24-26, 49-51). The present paper gives additional information on the occurrence of the phyllocarid genus *Ceratiocaris* (*C. cornwallisensis*, *Ceratiocaris* sp.) and records for the first time from the Canadian Arctic the eurypterid genus *Carcinosoma*?

## Systematic Palaeontology

*Ceratiocaris cornwallisensis* Copeland

Plate XI, figures 1, 2

*Ceratiocaris cornwallisensis* Copeland 1960, p. 49, Pl. VIII, Nos. 1, 2; Pl. IX, No. 5.

*Remarks.* This species was originally described from four specimens showing only the telson and posterior abdominal segments. A similar telson (Pl. XI, fig. 2) has been obtained during the present investigation from Prince Alfred Bay, Devon Island. In addition, part of a carapace with three abdominal segments has been collected from the type section of the Cape Phillips Formation on Cornwallis Island near beds from which the type specimen of *C. cornwallisensis* was found. This carapace is 10.4 cm long (as preserved) and 6.5 cm in greatest height. The upper, left valve is apparently crushed upon the right giving the specimen a double-margined lateral outline. Only small patches of the left valve are preserved near the mid-posterior and ventral margins. The valve appears to consist of two parts — a thin outer brownish layer bearing faintly impressed and irregularly spaced longitudinal striae and a thicker inner blue-grey nacreous layer showing numerous pore canals. Only the smooth nacreous layer is exposed in the dorsal half of the right valve. The carapace margin is broadly curved ventrally with a nearly right angled posterior ventral corner and a smooth, shallowly concave posterior notch.

The dorsal margin appears to be slightly curved and has a small, ovate-rhomboid posterior hinge node bearing a central hole or tubercle<sup>1</sup>. The disarticulated abdominal segments (three) are composed of the same material as the carapace but show no external ornamentation.

*Occurrence.* The telson (hypotype, 14555) was obtained from Devon Island, 6½ miles northeast of Point Hogarth, Prince Alfred Bay, in calcareous siltstone and shale of the Devon Island Formation in a river valley wall. Collected by A. MacKenzie. The carapace (hypotype, 14556) was collected by G. A. Wilson from Cornwallis Island, in talus of the Cape Phillips Formation, 3½ miles southeast of the mouth of the river flowing into Stuart ('Disappointment') Bay.

*Types.* Hypotypes, GSC Nos. 14555, 14556.

*Ceratiocaris* sp.

Plate XI, figure 3

*Remarks.* A small specimen referable to this genus was obtained from south-eastern Baillie-Hamilton Island. The incomplete right valve is brown, more coarsely striate than *C. cornwallisensis* and slightly wrinkled longitudinally. The ventral margin is broadly curved with a smoothly curved posterior ventral angle and a shallow posterior notch. The dorsal margin is convex.

*Occurrence.* Baillie-Hamilton Island, Washington Point, Member C of the Read Bay Formation. Collected by G. A. Wilson.

*Type.* Hypotype, GSC No. 14557.

*Carcinosoma?* sp.

Plate XII, figure 1

*Description.* The only specimen is fragmentary and poorly preserved. It consists of impressions of parts of three limbs assumed to be limbs III-V (second to fourth walking legs) with most of their segmentation obscured. Each limb is provided with numerous strong, curved to nearly straight, striated spines, some of which are 4 cm long. The anterior limb (III) is very large, about 12 cm long, and bears fourteen strong spines, ten of which are directed anteriorly. The second limb (IV) is slightly more than half as long (7 cm) as the preceding one and bears the same number of similarly distributed spines. The posterior limb (V) is known only from its distal spines (?).

The preserved integument is black to amber in colour when mounted in Canada balsam. No ornamentation other than scattered minute granules is visible on integument from the limbs proper but the spines are marked by fine, alternating and interrupted striae.

<sup>1</sup>First noted by W. D. Ian Rolfe (personal communication). Rolfe also interprets the length of the last abdominal segment of the holotype of *C. cornwallisensis* (Copeland, 1960, p. 49, Pl. VIII, No. 2) to be approximately 61 mm, not 35 mm as originally described.

*Remarks.* This specimen may be referred to the genus *Carcinosoma* on the basis of the distinctive walking limbs which increase in size anteriorly from V to III and bear numerous, very strong, anteriorly directed spines (i.e., *C. newlini* (Claypole) as drawn by Kjellesvig-Waering, 1958).

*Occurrence.* Cape Majendie, Grinnell Peninsula, Devon Island, 3.2 miles west-northwest along the coast from Cape Majendie Point, from interbedded argillaceous limestone and black limy shale of the Allen Bay Formation. Collected by J. Stuart-Smith. The specimen occurs with *Cyrtograptus* n. sp. of Thorsteinsson and *Monograptus* sp. cf. *M. priodon* (Bronn).

*Type.* Hypotype, GSC No. 14558.

Eurypterid? remains

Plate XI, figures 4, 5

*Description.* An impression of two segments of a presumed eurypterid with imbricating scale-like ornamentation was obtained from the same locality as *Carcinosoma?* sp. above. The segments are approximately 6 cm wide and one of them is 4 cm long.

*Occurrence.* Same as *Carcinosoma?* sp.

*Type.* Hypotype, GSC No. 14559.

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## TWO NEW ORDOVICIAN OSTRACODA FROM SOUTHERN ONTARIO

### Description

The ostracods described here are from the lower part of the Middle Ordovician Trenton Group in southern Ontario. They belong to the genera *Eurychilina* and *Oepikium*, the latter previously unknown from North America. The specimens were obtained in brown, argillaceous, limestone from the upper beds of Gretna Quarry on the north side of Ontario highway 41, 4½ miles south-southwest of Napanee, Ontario (see Kay, 1942, p. 602), which also contained *Ceraurus* sp., *Sowerbyella* sp., *Leperditella?* sp., *Aparchites* cf. *A. fimbriatus* (Ulrich), and bryozoans.

Family EURYCHILINIDAE Ulrich and Bassler 1923

Genus *Eurychilina* Ulrich 1889

*Type species. Eurychilina reticulata* Ulrich 1889.

*Eurychilina tutu* n. sp.

Plate XII, figures 2-10

*Description. Female:* Valves moderately large, about 1.6-1.8 mm long (with frill), semicircular, ends nearly equal. Greatest length in ventral half of domicilium, greatest height median, greatest width in posterior half of domicilium. Dorsal margin straight, lateral and ventral margins broadly rounded.

Domicilium truncated-elliptical, dorsal margin straight with a continuous dorsal crest curving ventrally at both ends and disappearing in the dorsal quarter of the domicilium. The junction of the frill and domicilium forming a sharp angle ventrally, less pronounced near the dorsal margin. Pit-like sulcus (S2) slightly dorsal and anterior to mid-point of the valve, extending dorsally as a shallow depression. Low, relatively indistinct preadductor node anterior and dorsal of the pit, merging smoothly with the lateral surface of the valve. Surface of the domicilium ornamented with distinct, irregularly spaced tubercles and finer, sometimes reticularly arranged papillae in the interspaces. Both sizes of ornamentation present on the dorsal three quarters of the domicilium and near the junction of the frill (where the larger pustules form an interrupted row), these areas separated by a narrow curved band of fine papillae near and paralleling the proximal edge of the frill.

Female velate frill divided ventrally into a proximal, convex, sausage-shaped pouch ('dolon' of Jaanusson's terminology, 1957) extending from mid-anterior to ventral posterior margins, and a peripheral concave flaring frill extending in diminished width to the dorsal corners. Entire frill 0.4-0.5 mm in greatest width,

evenly divided ventrally into dolonal and peripheral parts. Both parts radially striate, the dolon occasionally bearing remote pustules, the peripheral frill with fine longitudinal striae paralleling the margin giving it a reticulate pattern.

One specimen (Pl. XII, fig. 10) shows the internal structures of a right valve, the domicilium with numerous irregularly spaced pits corresponding to the larger external tubercles, the dolonal part of the frill limited by the eurychilid subdistal ridge (Kesling's terminology, 1960).

*Male:* Domicilium similar to female in size, shape and ornamentation. Frill undivided, concave, flaring, with reticular ornamentation, equal in width to that of the female and diminishing slightly toward the dorsal corners. One immature? specimen (Pl. XII, fig. 3) smaller but otherwise similar to the adult male.

Average measurements (in mm):

	Domicilium		Entire valve*	
	Length	Height	Length	Height
Immature instar	1.2	0.65	1.5	1.0
Male	1.5	0.85	1.9	1.1
Female	1.3-1.4	0.70-0.85	1.6-1.8	0.90-1.3

\*Dependent on frill preservation.

*Remarks.* The domicilium of this species closely approximates that of *Laccochilina* (*Laccochilina*) Hessland 1949 in the size of the preadductor node and the somewhat pit-like sulcus. The nature of the velate frill, however, clearly indicates its relationship to the genus *Eurychilina* as described by Jaanusson (1957, p. 232) and Kesling (1960, p. 354). The species displays several domicilial features not common to the genus: a very weak, apparently unyoked preadductor node, a pit-like adductor sulcus with an only faintly discernible dorsal extension and a banded distribution of pustulose ornamentation. These domicilial features are somewhat similar to those reported by Hessland (1949) for species of *Eurychilina* (*Laccochilina* of Henningsmoen, 1953, p. 228; Jaanusson, 1957, p. 241) from Sweden.

*Types.* Holotype, GSC No. 15199; paratypes, GSC Nos. 15198, a-h; 15199a.

#### Family PIRETELLIDAE Öpik 1937

#### Genus *Oepikium* Agnew 1942

*Type species.* *Biflabellum tenerum* Öpik 1935.

#### *Oepikium planum* n. sp.

Plate XII, figure 11

*Description.* Species known from one imperfect male left valve. Valve elongate, twice as long as high, apparently prolonged posteriorly. Greatest length

dorsal, greatest height near mid-length. Dorsal margin straight to slightly concave, anterior cardinal angle abrupt, obtuse, slightly thickened; posterior cardinal angle unknown.

Domicilium lowly elevated, flatly rounded to slightly undulating, surface smooth. Sulcus in anterior half, poorly developed, extending nearly vertically from the dorsal margin to the ventral frill, more pronounced in dorsal half, ventrally with a slight anterior curvature. Low, rounded node anterior to sulcus, slightly dorsal of mid-height, merging smoothly with the valve surface.

Only proximal part of the frill preserved, merging evenly with the ventral edge of the domicilium and composed of distinct, connected tubules. Frill extending from slightly above mid-height of the anterior margin to half(?) the distance up the posterior ventral marginal slope. Anterior quarter of frill slightly convex, posterior three quarters concave and flaring. Posterior end of frill thickened, possibly representing a spine-like process similar to that present on certain other species of the genus.

*Remarks.* The species differs from most other members of the genus in the distinct separation of the frill tubercles and the very poorly developed sulcus. Unfortunately the frill is broken distally on the type specimen so as to preclude further comparison with the very broadly frilled European species described from the Baltoscandian region. The convex nature of part of the frill has been reported by Jaanusson (1957, p. 408, Pl. XIV, fig. 5) for technomorphs (his term) of several European species but, unlike the frill of *O. planum*, is restricted ventrally. The significance of this feature is presently unknown.

*Type.* Holotype, GSC No. 15200.

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**PLATES I to XII**

PLATE I

- Figures 1, 2. *Mölleritia canadensis insignis* n. subsp. (Page 6)  
Lateral and dorsal views of an incomplete left valve; East Porcupine River, Yukon Territory; X2. Holotype, GSC No. 15175.
- Figures 3-17. *Mölleritia canadensis* n. sp. (Page 4)
3. Right lateral view of a crushed specimen; Hart River, Yukon Territory, X2. Paratype, GSC No. 15176.
- 4-8. Left lateral, posterior, dorsal, anterior, and ventral views of a complete valve; Victoria Island, Northwest Territories; X2. Paratype, GSC No. 15177.
- 9-11. Right lateral, ventral, and posterior views of a complete specimen; Victoria Island, Northwest Territories; X2. Paratype, GSC No. 15178.
- 12-14. Dorsal, right lateral, and posterior views of a complete specimen; Victoria Island, Northwest Territories; X2. Holotype, GSC No. 15179.
15. Adductor and chevron-shaped muscle scars of an incomplete right valve; Victoria Island, Northwest Territories; X4. Paratype, GSC No. 15180.
16. Venose lines radiating from the adductor scar of a partly exfoliated right valve; East Porcupine River, Yukon Territory; X3. Paratype, GSC No. 15181.
17. Adductor and chevron-shaped muscle scars of an incomplete right valve; Hart River, Yukon Territory; X4. Paratype, GSC No. 15182.

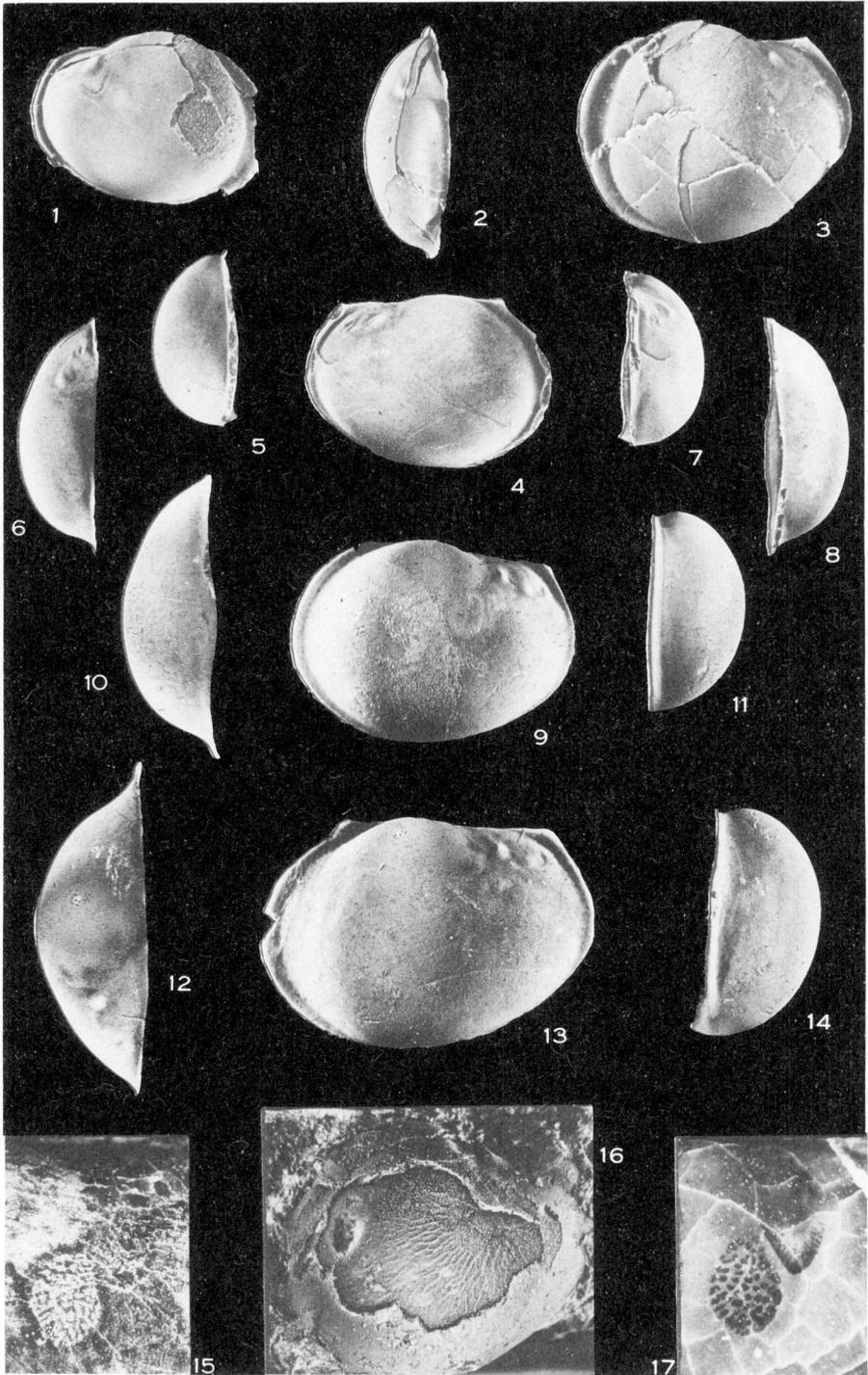


PLATE II

(All figures X15 except 19 and 20)

- Figure 1. *Paraechmina postica* Ulrich and Bassler (Page 10)  
Lateral view of a left valve; locality 9, DeCew Falls, 20-25 feet above base.  
Hypotype, GSC No. 15191.
- Figures 2-5. *Paraechmina spinosa* (Hall) (Page 10)  
2, 3. Lateral views of right and left valves; locality 9, DeCew Falls, 30-35 feet  
above base. Hypotypes, GSC Nos. 15192, a.  
4, 5. Lateral views of right and left valves; locality 10, Niagara River, 28-30  
feet above base. Hypotypes, GSC Nos. 15192b, c.
- Figures 6-9. *Paraechmina abnormis* (Ulrich) (Page 10)  
A right and three left valves; locality 9, DeCew Falls, 15-30 feet above base.  
Hypotypes, GSC Nos. 15193, a, b, c.
- Figure 10. *Aechmina* sp. (Page 10)  
Lateral view of a left valve; locality 10, Niagara River, 0-5 feet above base.  
Hypotype, GSC No. 15194.
- Figures 11-13. "*Ctenobolbina*" *punctata* Ulrich (Page 10)  
11. Lateral view of right valve; locality 9, DeCew Falls, 10-15 feet above base.  
Hypotype, GSC No. 15195.  
12, 13. Lateral views of left and right valves; locality 10, Niagara River, 10-13  
feet above base. Hypotypes, GSC Nos. 15195a, b.
- Figures 14-18. *Dizygopleura symmetrica* (Hall) (Page 10)  
14, 15. Left lateral and dorsal views of two female carapaces; locality 9,  
DeCew Falls, 40-45 feet above base. Hypotypes, GSC Nos. 15196, a.  
16, 17. Left lateral and dorsal views of two male carapaces; locality 9,  
DeCew Falls, 40-45 feet above base. Hypotypes, GSC Nos. 15196b, c.  
18. Lateral view of male left valve; locality 10, Niagara River, 28-30 feet  
above base. Hypotype, GSC No. 15196d.
- Figures 19, 20. "*Octonaria*" *curta* Ulrich (Page 10)  
Lateral views of two valves; locality 9, DeCew Falls, 20-25 feet above base.  
Hypotypes, GSC Nos. 15197, a.

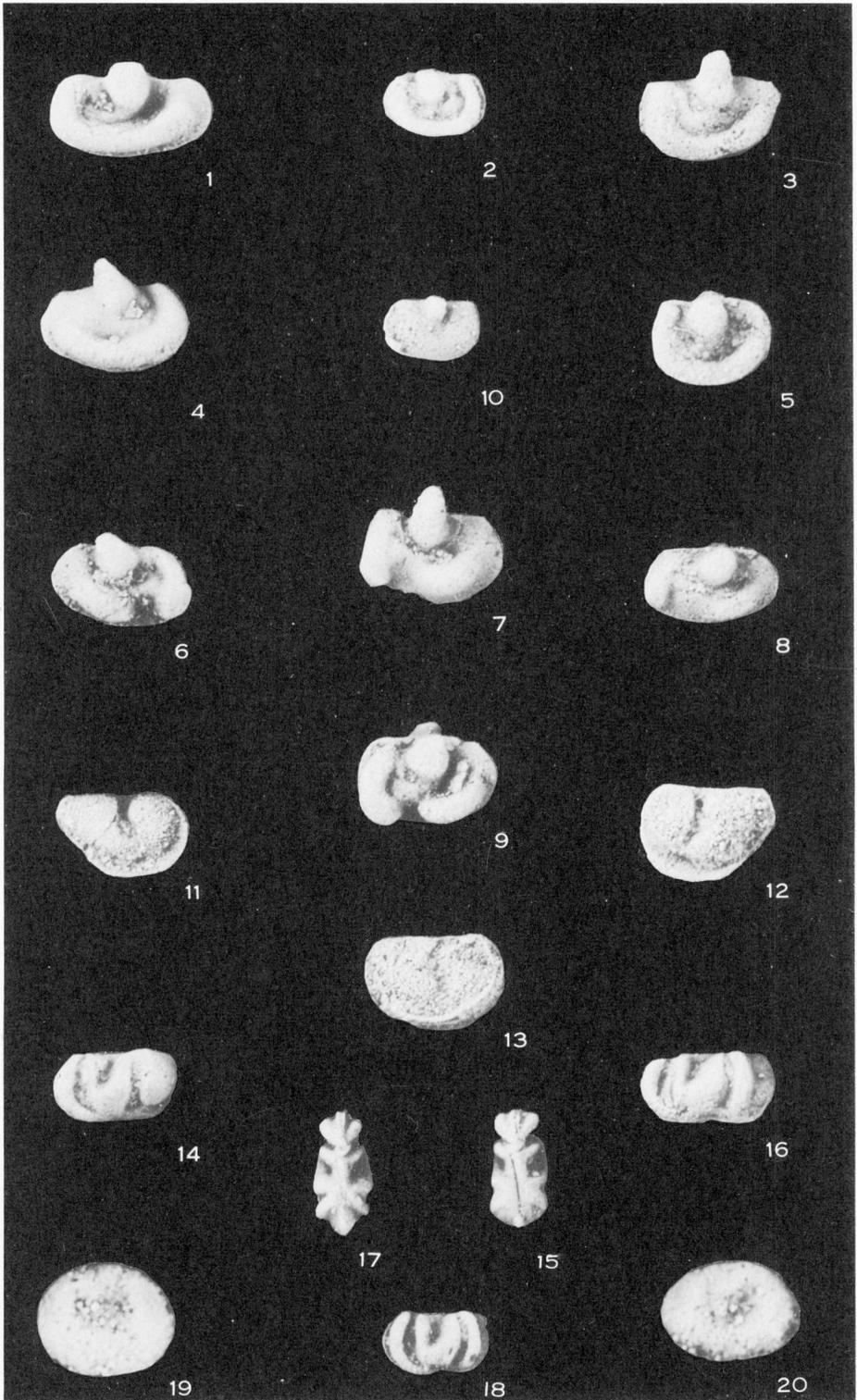
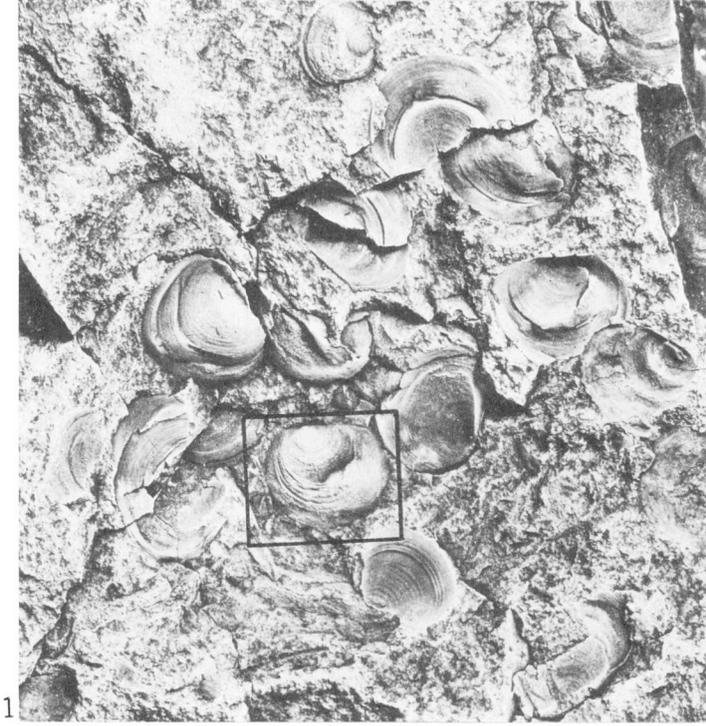


PLATE III

- Figures 1, 2. *Asmusia canadensis* (Lambe) (Page 13)  
Two views of numerous crushed specimens on the same piece of rock; X3.  
Lectotype, GSC No. 10000 (enclosed); paratypes, GSC No. 10000a.



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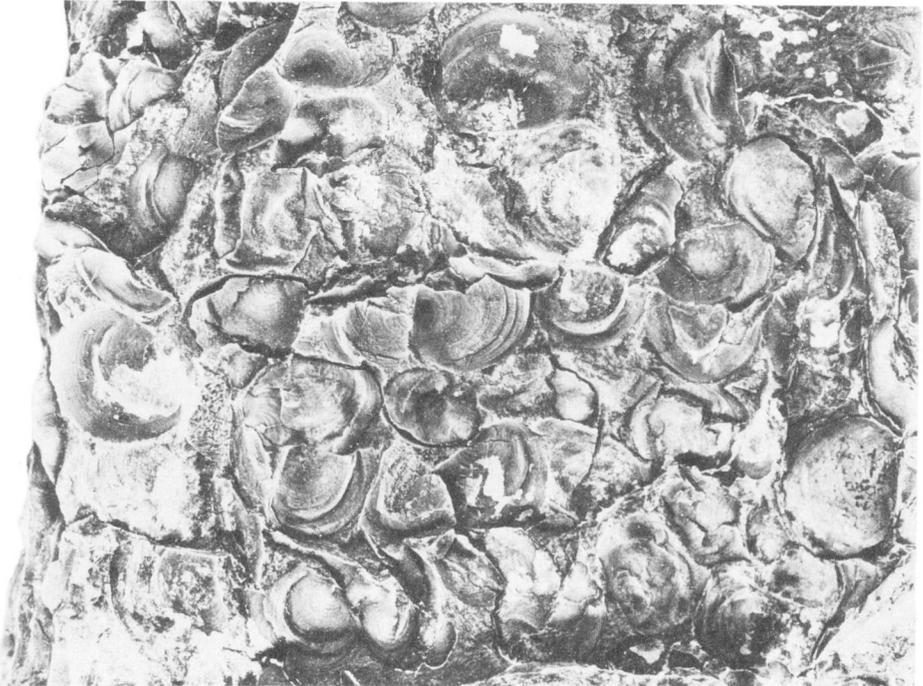
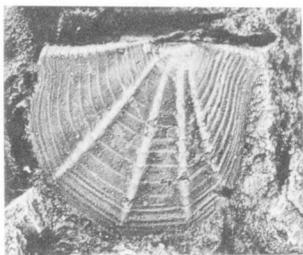
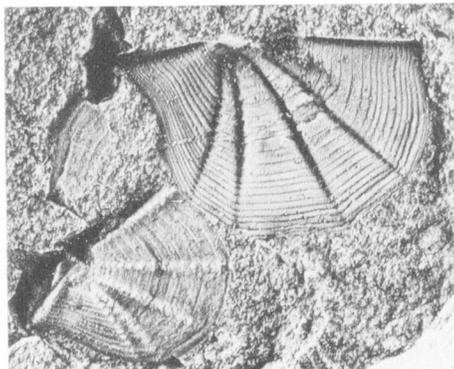


PLATE IV

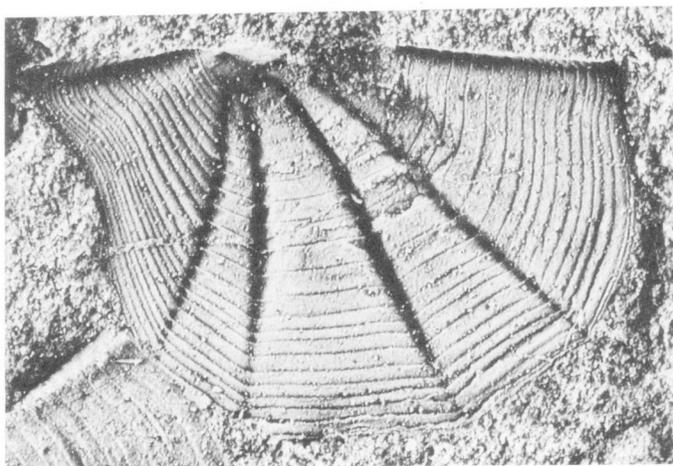
- Figures 1-6. *Pteroleia canadensis* n. sp. (Page 15)
1. Right lateral view of a four-ribbed specimen; X5. Paratype, GSC No. 15189.
  2. Right interior and left exterior views of four-ribbed specimens; X5. Holotype, GSC No. 15189b, and paratype, GSC No. 15189c.
  3. The same; X10. Holotype, GSC No. 15189b.
  4. Left lateral view of a four-ribbed specimen; X5. Paratype, GSC No. 15189a.
  5. Left lateral view of a five-ribbed specimen; X5. Paratype, GSC No. 15188.
  6. View of numerous crushed specimens; X2. Paratype, GSC No. 15186.



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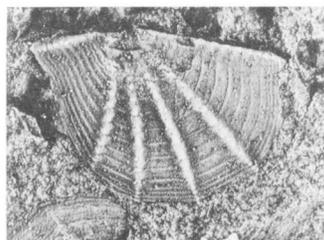
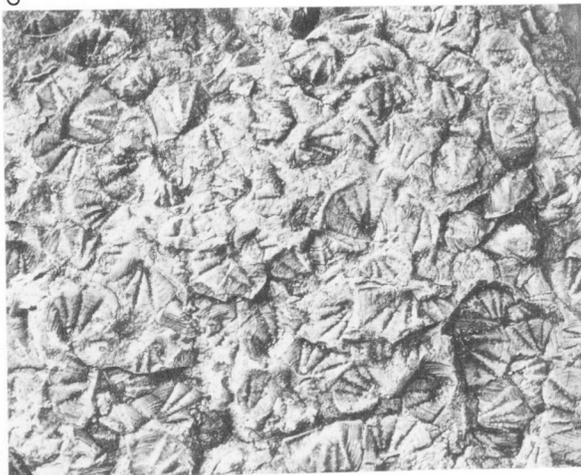


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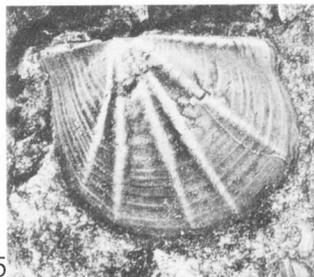


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PLATE V

- Figures 1, 2. *Thlipsurella* cf. *T. v-scripta* (Jones and Holl) (Page 24)  
Left and right lateral views of two carapaces; localities 41858, 41859; X30.  
Hypotypes, GSC Nos. 14518, a.
- Figures 3-5. *Thlipsura whiteavesi* n. sp. (Page 23)  
3. Right lateral views of a complete carapace; locality 41881; X15. Holotype,  
GSC No. 14519.  
4, 5. Right and left lateral views of two carapaces; localities 41881, 41883;  
X15. Paratypes, GSC Nos. 14519a, b.
- Figures 6-8. *Eucraterellina crateriformis* (Swartz) (Page 27)  
Right, left and dorsal views of three carapaces; locality 41869; X30. Hypotypes,  
GSC Nos. 14520, a, b.
- Figures 9-12. *Thlipsurella curvistriata* (Roth) (Page 24)  
9, 10. Left lateral views of two carapaces; locality 41859; X15. Hypotypes, GSC  
Nos. 14521, a.  
11, 12. Right lateral and dorsal views of two carapaces; locality 41860; X15.  
Hypotypes, GSC Nos. 14521b, c.
- Figures 13, 14. *Eucraterellina oblonga* (Ulrich and Bassler) (Page 27)  
Right lateral views of two carapaces; locality 41856; X30. Hypotypes, GSC  
Nos. 14522, a.
- Figures 15, 16. *Strepulites dalhousiensis* n. sp. (Page 25)  
Right and left lateral views of two carapaces; locality 41858; X30. Holotype,  
GSC No. 14523; paratype, GSC No. 14523a.
- Figure 17. *Octonaria* cf. *O. typicus* (Bassler) (Page 26)  
Right lateral view of a complete carapace; locality 41864; X30. Hypotype, GSC  
No. 14524.
- Figures 18-24. *Octonaria foordi* n. sp. (Page 25)  
18. Left lateral view of a complete carapace; locality 41858; X30. Paratype,  
GSC No. 14525a.  
19. Right lateral view of a complete carapace; locality 41858; X30. Holotype,  
GSC No. 14525.  
20, 21. Dorsal and ventral views of two carapaces; locality 41858; X30. Para-  
types, GSC Nos. 14525b, c.  
22-24. Right, left and dorsal views of three carapaces; locality 41862; X30.  
Paratypes, GSC Nos. 14525e-g.
- Figure 25. *Pteroleaia canadensis* n. sp. (Page 15)  
Left lateral view of an incomplete, three-ribbed valve; X11. Paratype, GSC  
No. 15190.

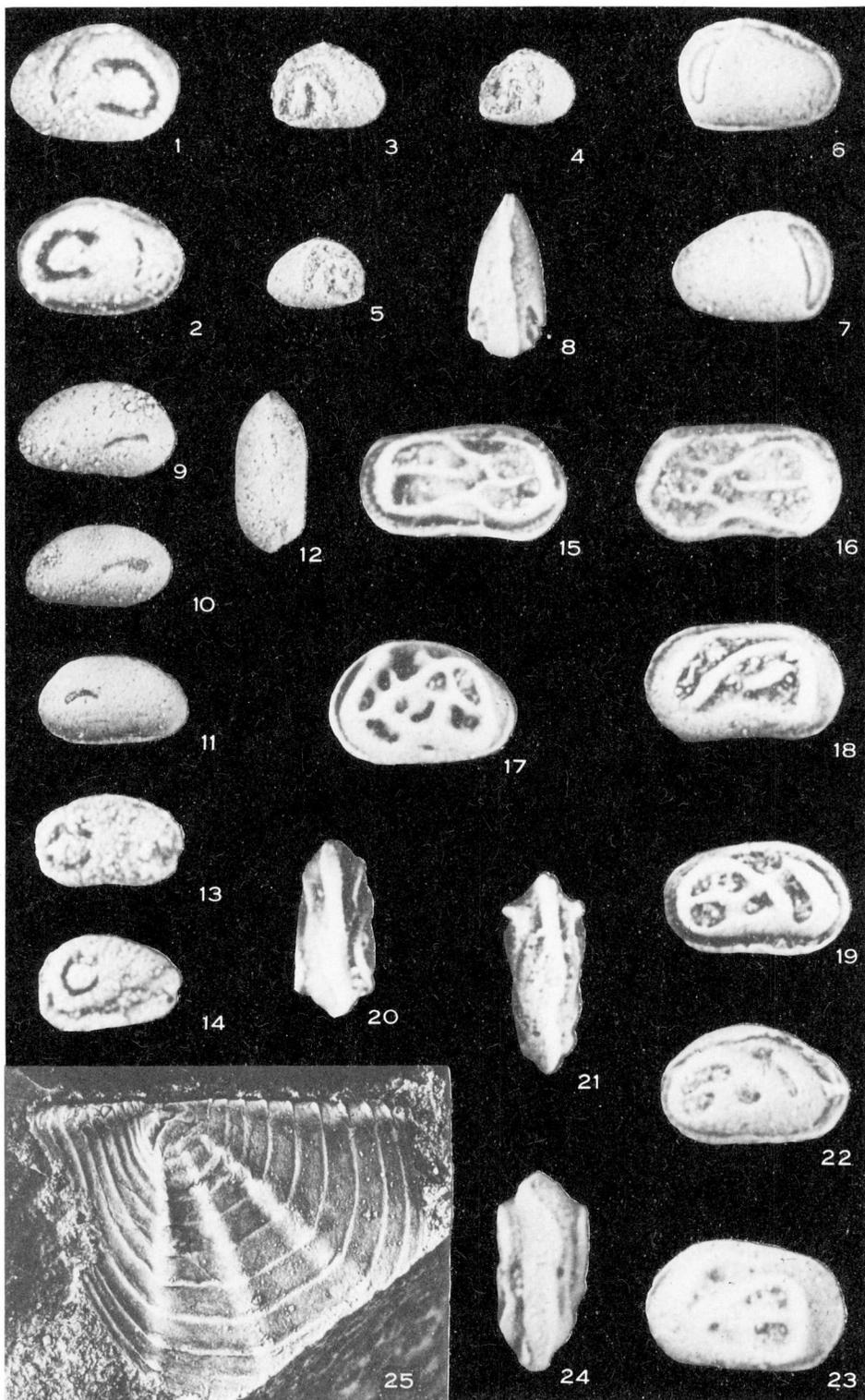


PLATE VI

- Figures 1-4, 6. *Pyxiprimitia ventriclefta* Swartz (Page 28)  
Lateral views of two right and three left valves; localities 41860, 41863; X30. Hypotypes, GSC Nos. 14526, a-d.
- Figure 5. *Pyxiprimitia* cf. *P. germana* (Ulrich) (Page 28)  
Right lateral view of a complete carapace; locality 41860; X30. Hypotype, GSC No. 14527.
- Figures 7, 8. *Arcyzona foordi* n. sp. (Page 42)  
Right lateral views of two valves; locality 41860; X30. Holotype, GSC No. 14528; paratype, GSC No. 14528a.
- Figures 9-16. *Libumella reticulata* n. sp. (Page 44)  
9-11. Three lateral views; locality 41851; X15. Paratypes, GSC Nos. 14529a-c.  
12. Right (?) lateral view of a complete carapace; locality 41860; X15. Holotype, GSC No. 14529.  
13, 15. Dorsal views of two specimens; locality 41860; X15. Paratypes, GSC Nos. 14529d, e.  
14, 16. Ventral views of two specimens; locality 41860; X15. Paratypes, GSC Nos. 14529f, g.
- Figures 17-21. "*Amphissites* (?) "*concentricus* (Ulrich and Bassler) (Page 43)  
Lateral and one ventral views of five specimens; locality 41879; X15. Hypotypes, GSC Nos. 14530, a-d.
- Figures 22-26. *Dizygopleura chaleurensis* n. sp. (Page 40)  
22-24. Right lateral, left lateral, and ventral views of three female carapaces; localities 41860, 41864; X15. Paratypes, GSC Nos. 14531b-d.  
25, 26. Right lateral and ventral views of two male carapaces; locality 41861; X15. Holotype, GSC No. 14531; paratype, GSC No. 14531a.
- Figures 27-29. *Daleiella?* *canadensis* n. sp. (Page 31)  
27, 29. Ventral and left lateral views of two incomplete specimens; locality 41864; X15. Paratypes, GSC Nos. 14532a, b.  
28. Right lateral view of a carapace; locality 41864; X15. Holotype, GSC No. 14532.
- Figures 30, 31. *Bollia sagittaformis* Swartz (Page 29)  
Views of two right valves; locality 41880; X15. Hypotypes, GSC Nos. 14533, a.
- Figures 32, 33. *Bollia americana zygocornis* Swartz (Page 29)  
Left and right lateral views of two valves; locality 41864; X15. Hypotypes, GSC Nos. 14534, a.
- Figure 34. *Aechmina equilateralis?* Bassler (Page 29)  
Lateral view of an incomplete left valve; localities 41866-41868; X30. Hypotype, GSC No. 14535.
- Figure 35. *Zygobeyrichia dalhousiensis* n. sp. (Page 31)  
Right lateral view of the type specimen; locality 41870; X15. Holotype, GSC No. 14536.

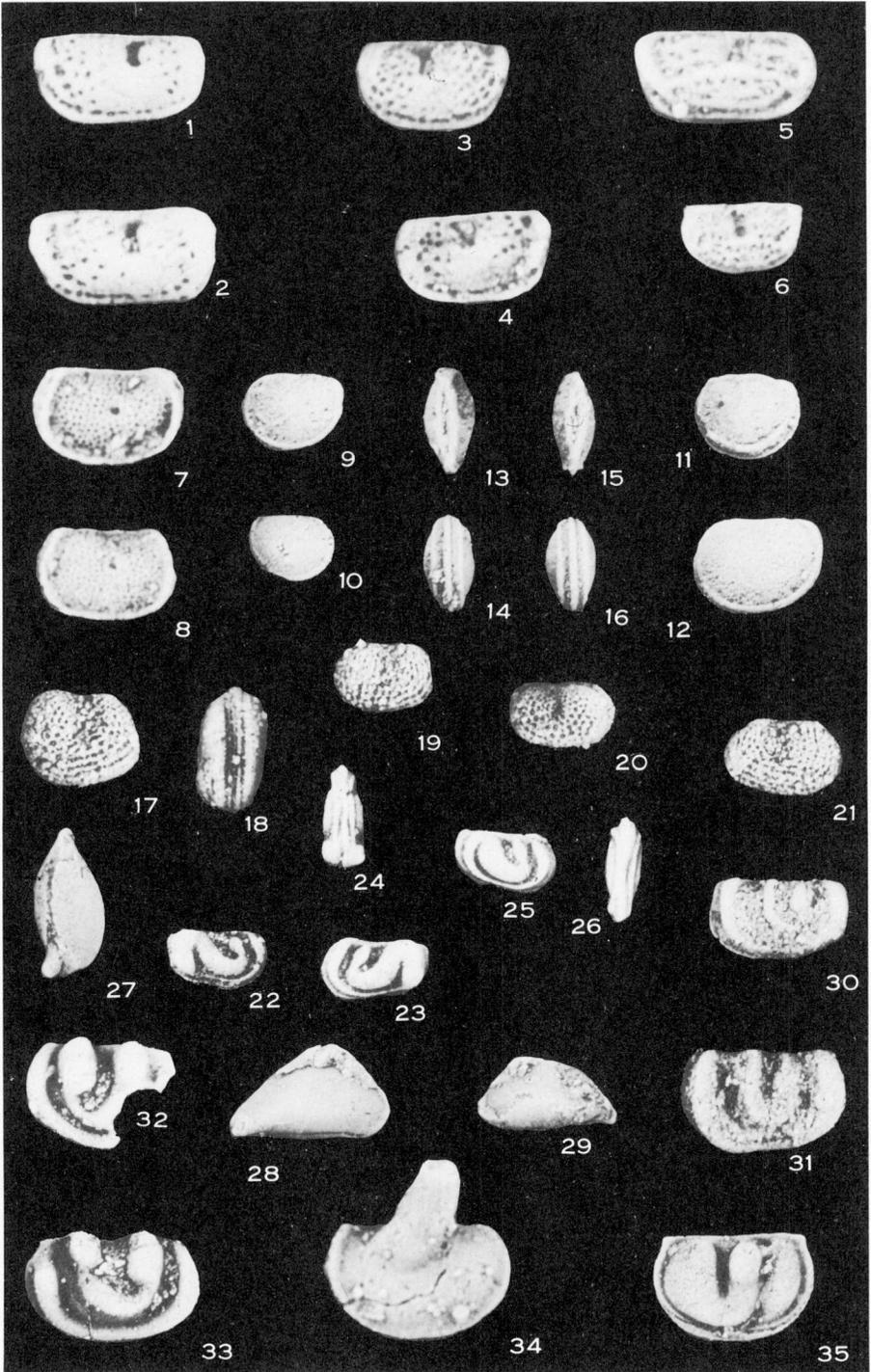


PLATE VII

- Figures 1-8. *Mesomphalus magnificus* n. sp. (Page 38)  
1-4. Three right and one left lateral views of four immature valves; locality 41864; X15. Paratypes, GSC Nos. 14537a, b, c, d.  
5. Left lateral view of an adult male specimen; locality 41864; X15. Paratype, GSC No. 14537e.  
6. Left lateral view of an immature specimen; locality 41864; X15. Paratype, GSC No. 14537f.  
7, 8. Right lateral views of two incomplete valves — female and male; locality 41864; X15. Paratypes, GSC Nos. 14537 g, h.
- Figures 9, 10. *Kloedenia punctillosa* Ulrich and Bassler (Page 33)  
Right and left lateral views of two incomplete valves; locality 41875; X15. Hypotypes, GSC Nos. 14538, a.
- Figures 11-13. *Kloedenia?* sp. indet. (Page 32)  
Two left and one right lateral views of three incomplete specimens; locality 41864; X15. Hypotypes, GSC Nos. 14539, a, b.
- Figures 14-21. *Kloedenia retifera* Ulrich and Bassler (Page 33)  
14-16, 18. Four immature right valves; locality 41864; X15. Hypotypes, GSC Nos. 14540, a-c.  
17, 19. Views of two adult male right valves, the latter a carapace; locality 41864; X15. Hypotypes, GSC Nos. 14540d, e.  
20, 21. Two female left valves; locality 41864; X15. Hypotypes, GSC Nos. 14540f, g.

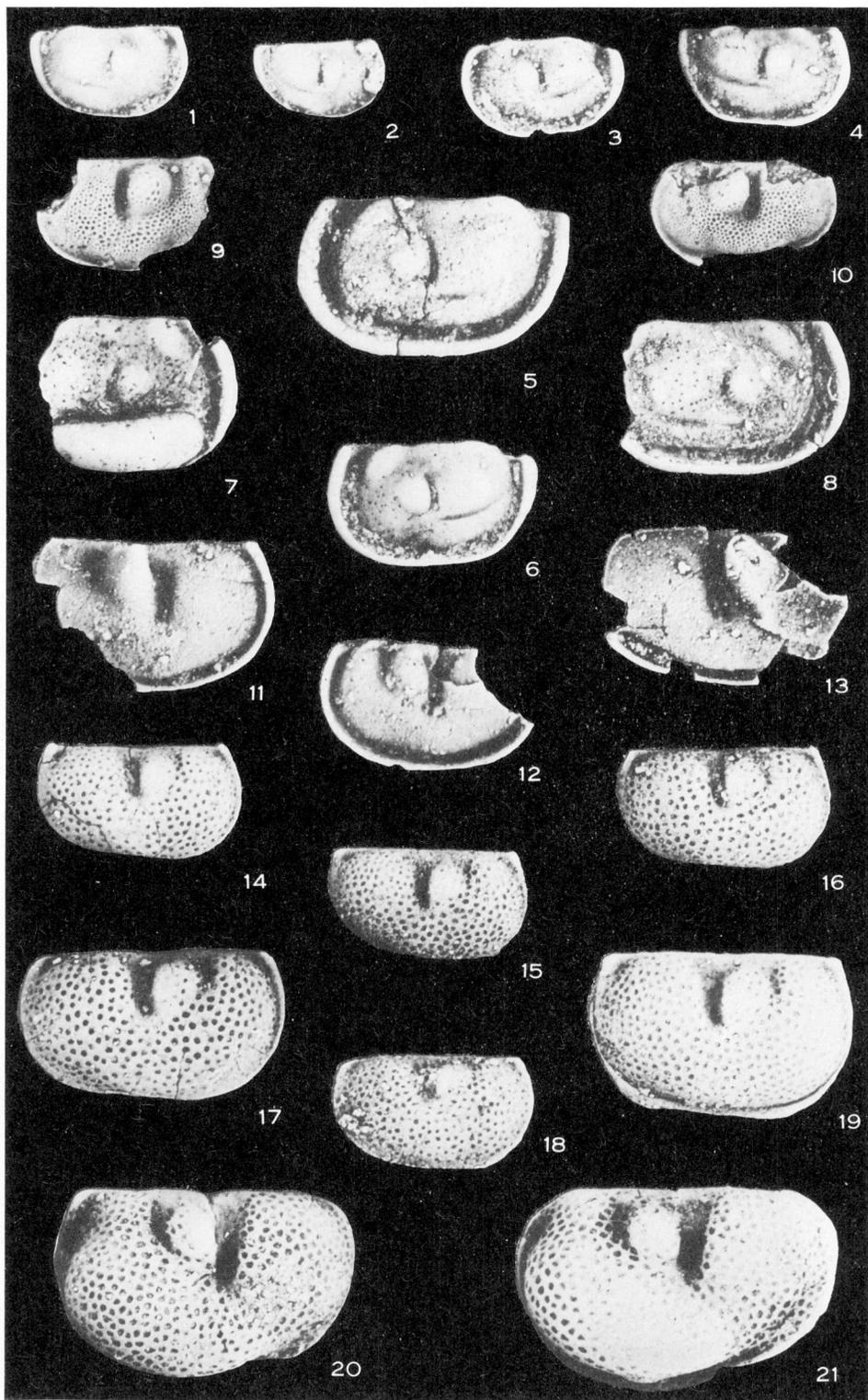


PLATE VIII

- Figures 1-8. *Kloedenia? newbrunswickensis* n. sp. (Page 35)  
1, 4. Right lateral views of two partly crushed specimens; locality 41858; X10. Paratypes, GSC Nos. 14541a, b.  
2. Left lateral view of an unusually short carapace; locality 41864; X10. Paratype, GSC No. 14541c.  
3. Left lateral view of an extremely elongate valve; locality 41864; X10. Paratype, GSC No. 14541d.  
5. Ventral view of an incomplete right valve; locality 41864; X10. Paratype, GSC No. 14541e.  
6. Right lateral view of a complete carapace; locality 41864; X10. Holotype, GSC No. 14541.  
7, 8. Left lateral views of two carapaces; locality 41864; X10. Paratypes, GSC Nos. 14541f, g.
- Figures 9-12. *Mesomphalus magnificus* n. sp. (Page 38)  
9. Right lateral view of a carapace; locality 41864; X15. Holotype, GSC No. 14537.  
10-12. Ventral, left lateral, and right lateral views of three female specimens; locality 41864; X15. Paratypes, GSC Nos. 14537i, j, k.
- Figure 13. *Kloedenia* sp. cf. *K. sussexensis* (Weller) (Page 34)  
Internal cast of a right valve; locality 41875(?); X15. Hypotype, GSC No. 4197.
- Figures 14-16. *Kloedenia acadica* (Jones) (Page 36)  
14. Internal cast of a left valve; locality 41875(?); X15. Lectotype, GSC No. 4188a.  
15. Internal cast of a left valve showing an internal zygobeyrichiid type anterior groove; locality 41875(?); X10. Paratype, GSC No. 4188c(1).  
16. Internal cast of a female left valve; locality 41875(?); X10. Paratype, GSC No. 4188c(2).

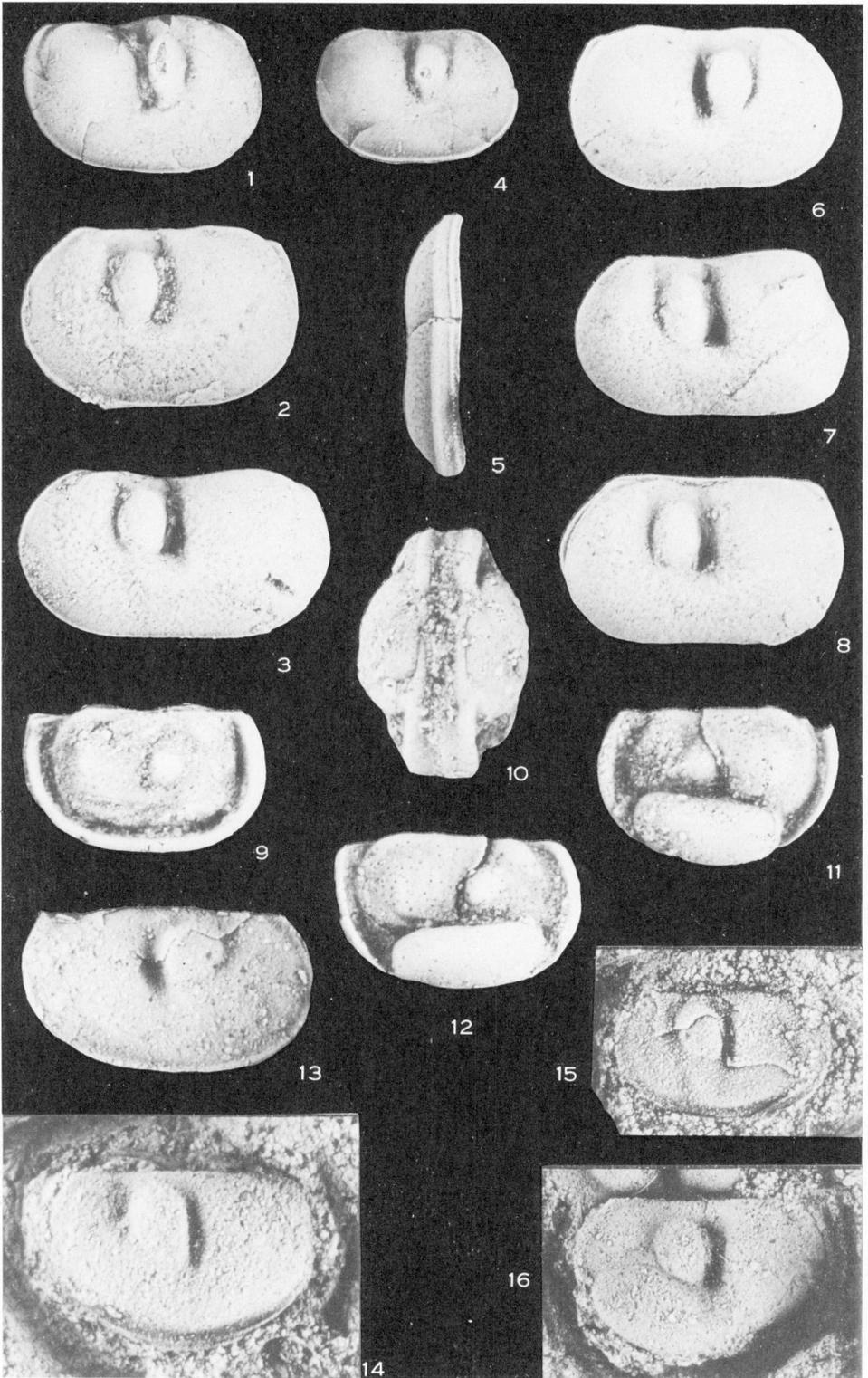


PLATE IX

- Figures 1-14. *Pachydomella? clarkei* n. sp. (Page 48)  
1-5. Right lateral, left lateral, anterior, dorsal, and ventral views of a complete carapace; locality 41880; X35. Paratype, GSC No. 14542a.  
6-10. Right lateral, left lateral, anterior, ventral, and dorsal views of a complete carapace; locality 41880; X35. Holotype, GSC No. 14542.  
11-13. Right lateral, dorsal and anterior views of a carapace; locality 41880; X35. Paratype, GSC No. 14542b.  
14. Right lateral view of a carapace; locality 41880; X35. Paratype, GSC No. 14542c.
- Figures 15-19. *Parabolbina granosa* (Ulrich) (Page 30)  
15, 16. Left and right lateral views of two valves; locality 41868; X30. Hypotypes, GSC Nos. 14543, a.  
17. Ventral view of a carapace; locality 41868; X30. Hypotype, GSC No. 14543b.  
18, 19. Right lateral views of two specimens; locality 41868; X30. Hypotypes, GSC Nos. 14543c, d.
- Figures 20-24. *Phlyctiscapha keslingi* n. sp. (Page 36)  
20. Ventral view of a female carapace; locality 41863; X15. Paratype, GSC No. 14544a.  
21. Right lateral view of a female carapace; locality 41864; X15. Holotype, GSC No. 14544.  
22-24. Ventral, left lateral, and right lateral views of three male carapaces; localities 41864, 41865; X15. Paratypes, GSC Nos. 14544b-d.
- Figure 25. *Saccarchites labrosus* (Jones) (Page 37)  
Lateral view of the female left valve; locality 41875(?); X10. Holotype, GSC No. 3841.

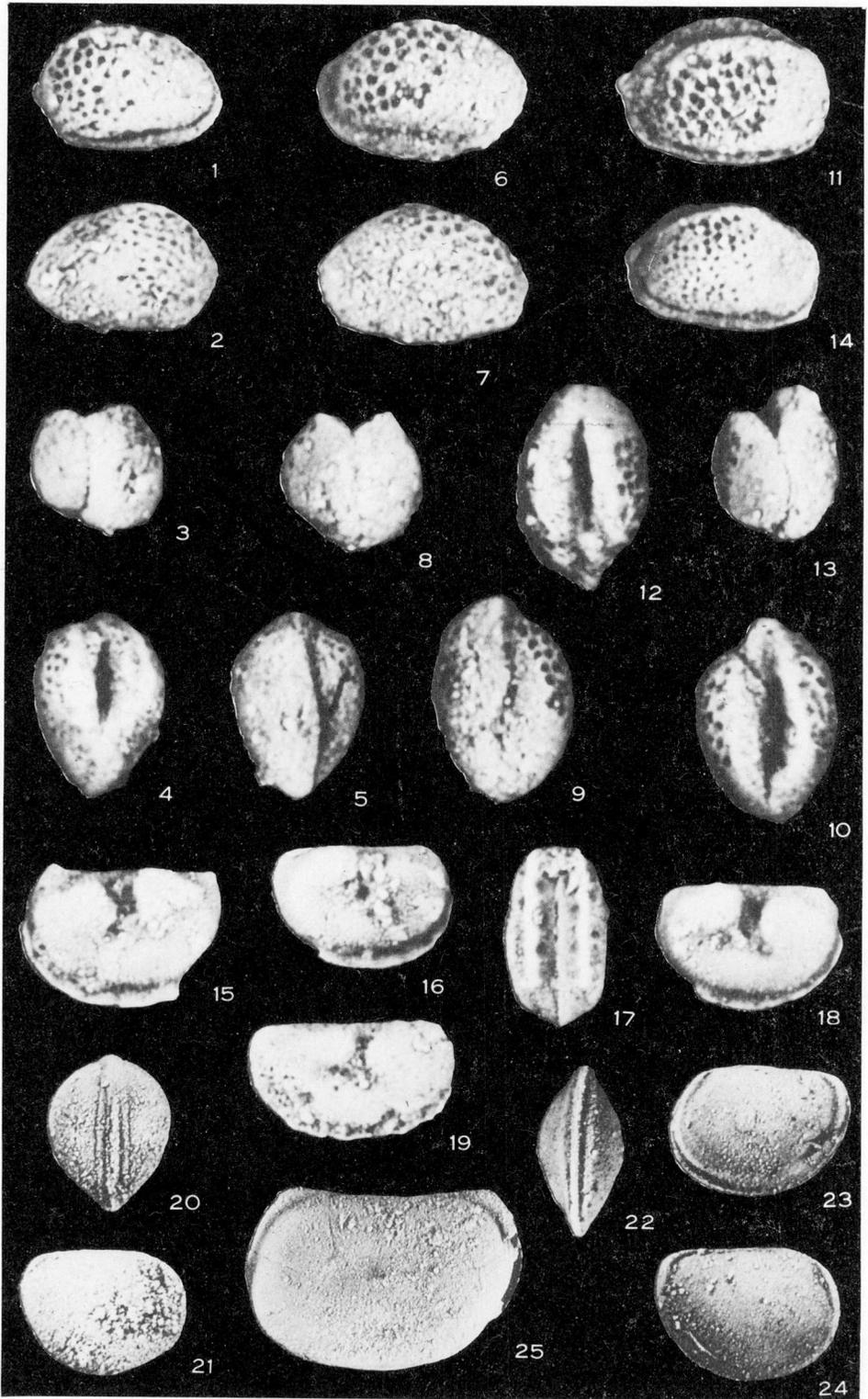


PLATE X

- Figures 1-6. *Eukloedenella dalhousiensis* n. sp. (Page 42)  
 1, 4, 6. Left lateral, dorsal, and ventral views of three female carapaces; locality 41875; X15. Paratypes, GSC Nos. 14545a, b, c.  
 2. Right lateral view of a male carapace; locality 41875; X15. Holotype, GSC No. 14545.  
 3, 5. Dorsal and ventral views of two male carapaces; locality 41875; X15. Paratypes, GSC Nos. 14545d, e.
- Figures 7-15. *Eukloedenella alcocki* n. sp. (Page 41)  
 7. Right lateral view of a male carapace; locality 41864; X15. Holotype, GSC No. 14546.  
 8-10. Left lateral, ventral, and dorsal views of three male carapaces; localities 41861-41863; X15. Paratypes, GSC Nos. 14546a-c.  
 11. Dorsal view of a female carapace; locality 41863; X15. Paratype, GSC No. 14546d.  
 12-15. Ventral, dorsal, left and right lateral views of four female carapaces; localities 41862-41864; X15. Paratypes, GSC Nos. 14546e-h.
- Figures 16-20. *Bythocypris alcocki* n. sp. (Page 46)  
 16, 18-20. Right lateral, left lateral, ventral, and dorsal views of four carapaces; locality 41875; X15. Paratypes, GSC Nos. 14547a-d.  
 17. Right lateral view of a carapace; locality 41875; X15. Holotype, GSC No. 14547.
- Figures 21-24. *Bythocypris* cf. *B. phaseolina* Ulrich and Bassler (Page 46)  
 Lateral views of four specimens; locality 41860; X15. Hypotypes, GSC Nos. 14548, a-c.
- Figures 25-27. *Bythocypris?* cf. *B. perarcuata* Swartz and Swain (Page 46)  
 Two right and one left lateral views of three specimens; localities 41860, 41861; X15. Hypotypes, GSC Nos. 14549, a, b.
- Figures 28-31. *Camdenidea canadensis* n. sp. (Page 45)  
 28. Left lateral view of a carapace; locality 41879; X15. Holotype, GSC No. 14550.  
 29-31. Right lateral, dorsal, and ventral views of three specimens; locality 41879; X15. Paratypes, GSC Nos. 14550a-c.
- Figures 32-36. *Tubulibairdia chaleurensis* n. sp. (Page 47)  
 32-34. Right lateral, ventral, and dorsal views of three carapaces; localities 41853-41855; X15. Paratypes, GSC Nos. 14551a-c.  
 35. Left lateral view of a carapace; locality 41855; X15. Holotype, GSC No. 14551.  
 36. Right lateral view of a carapace; locality 41856; X15. Paratype, GSC No. 14551d.
- Figures 37-40. *Bythocypris swartzi* n. sp. (Page 47)  
 37. Right lateral view of a carapace; locality 41853; X15. Paratype, GSC No. 14552a.  
 38, 40. Left and right lateral views of two carapaces; localities 41851, 41852; X15. Paratypes, GSC Nos. 14552b, c.  
 39. Right lateral view of a carapace; locality 41853; X15. Holotype, GSC No. 14552.

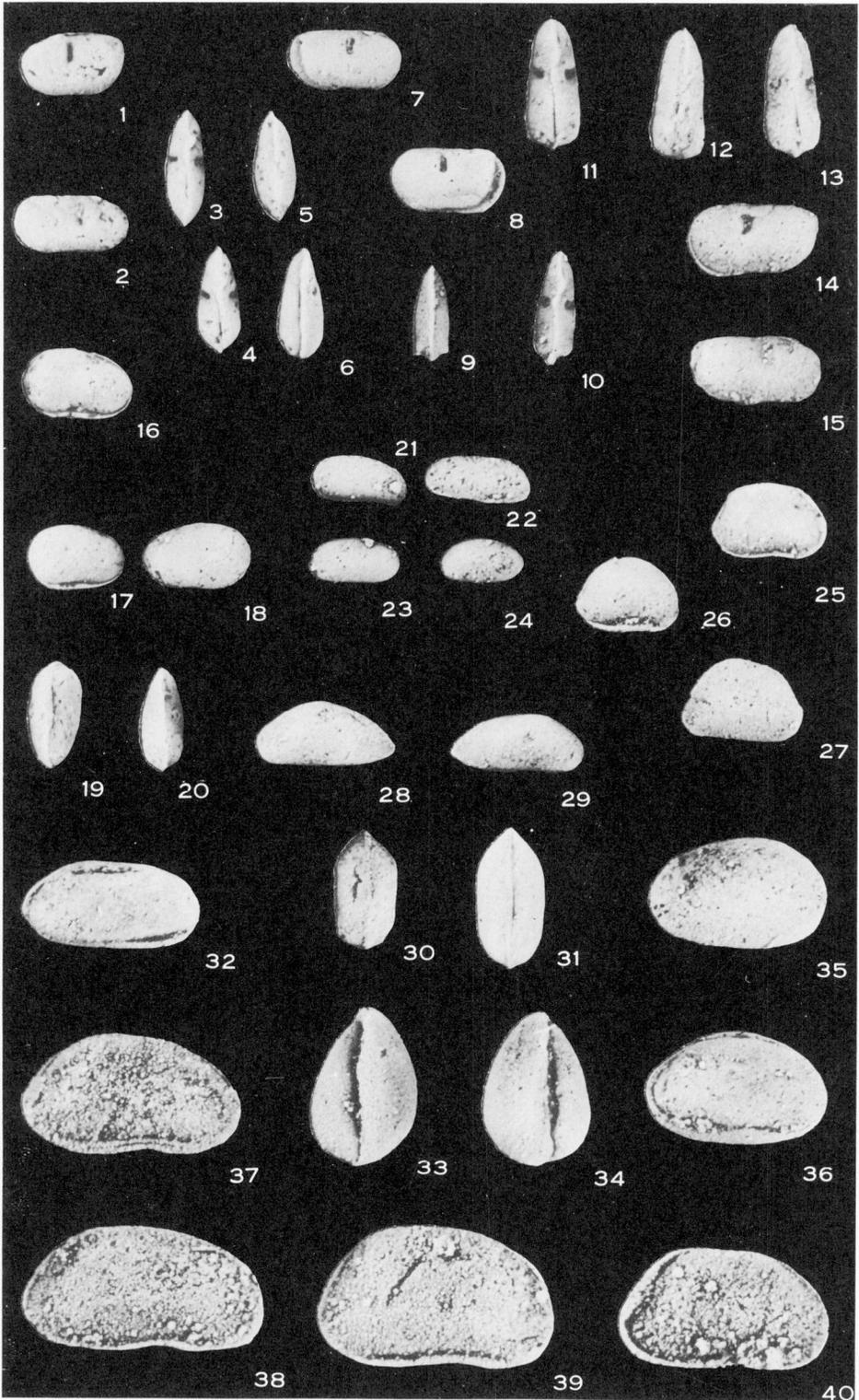


PLATE XI

- Figures 1, 2. *Ceratiocaris cornwallisensis* Copeland (Page 52)  
1. Lateral view of a partial carapace and three abdominal segments; Cape Phillips Formation, Cornwallis Island; X1. Hypotype, GSC No. 14556.  
2. Lateral view of a telson; Prince Alfred Bay, Devon Island; X1. Hypotype, GSC No. 14555.
- Figure 3. *Ceratiocaris* sp. (Page 53)  
Right lateral view of an incomplete carapace; Baillie-Hamilton Island; X1. Hypotype, GSC No. 14557.
- Figures 4, 5. Eurypterid? remains (Page 54)  
Surface texture of parts of two poorly preserved segments; Grinnell Peninsula, Devon Island; X2. Hypotype, GSC No. 14559.

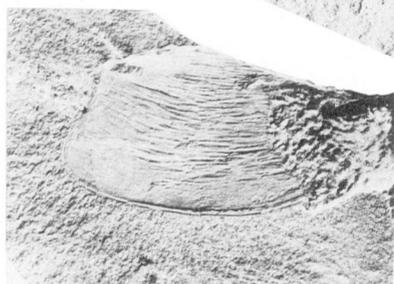
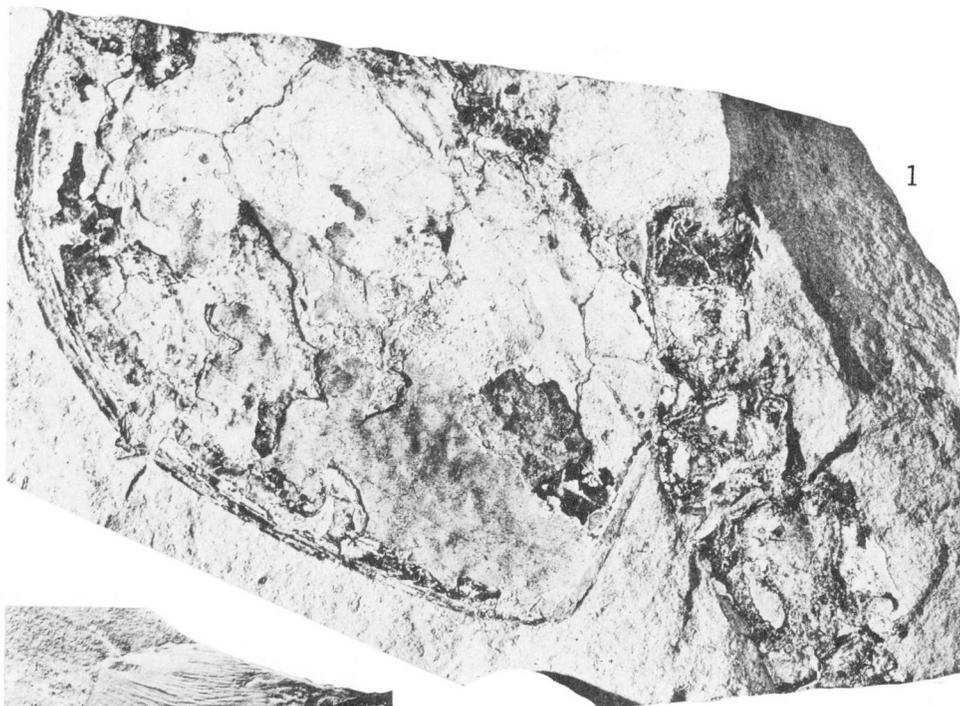


PLATE XII

- Figure 1. *Carcinosoma?* sp. (Page 53)  
View of the only partly preserved walking limbs ?III-V with associated graptolites  
a. *Monograptus* sp. cf. *M. priodon* (Bronn), b. *Cyrtograptus* n. sp. of Thorsteins-  
son; Cape Majendie, Grinnell Peninsula, Devon Island; X1. Hypotype, GSC  
No. 14558.
- Figures 2-10. *Eurychilina tutu* n. sp. (Page 55)  
(all figures ca. X15½)  
2. Lateral view of female right valve; Gretna Quarry, 4½ miles south-south-  
west of Napanee, Ontario. Paratype, GSC No. 15198.  
3. Lateral view of immature? right valve. Paratype, GSC No. 15198a.  
4. Lateral view of male left valve. Paratype, GSC No. 15199a.  
5. Lateral view of female left valve. Paratype, GSC No. 15198b.  
6. Lateral view of female left valve. Paratype, GSC No. 15198c.  
7. Lateral view of female left valve. Holotype, GSC No. 15199.  
8. Lateral view of female left valve. Paratype, GSC No. 15198d.  
9. Lateral view of female left valve. Paratype, GSC No. 15198e.  
10. View of interior of female right valve. Paratype, GSC No. 15198f.
- Figure 11. *Oepikium planum* n. sp. (Page 56)  
View of only known specimen, an incomplete male left valve; Gretna Quarry,  
4½ miles south-southwest of Napanee, Ontario; X ca. 15½. Holotype, GSC  
No. 15200.

