GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

BULLETIN 153

LOWER AND MIDDLE DEVONIAN TRILOBITES OF THE CANADIAN ARCTIC ISLANDS

A. R. Ormiston

Price, $5.50

1967

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2,000—1966—5522

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Printed on No. 1 ANCASTER BOOK

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20th Century captions by
RYERSON PRESS

Artwork by CARTOGRAPHIC UNIT, GSC

Collotype by COTSWOLD

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OF CANADA

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By

A. R. Ormiston

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ENERGY, MINES AND RESOURCES
CANADA

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Price $5.50 Catalogue No. M42-153

Price subject to change without notice

ROGER DUHAMEL, F.R.S.C.
Queen's Printer and Controller of Stationery
Ottawa, Canada
1967

PREFACE

Precise age determinations and correlations of Lower and Middle Devonian rocks of the Canadian arctic islands have been hampered by a lack of readily available fossil information. The diverse trilobite faunas of the Arctic seemed to offer a key to many of the problems of correlation. The author has made a systematic study of these well-preserved fossils based on his own collecting in the field, and on collections made by officers of the Geological Survey of Canada. His report is an important contribution to Devonian palaeontology, and, in addition to being a major advance in Canadian stratigraphy, his conclusions have wider implications in the geochronology of the Devonian System, especially of the boreal regions.

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

OTTAWA, January 27, 1966

BULLETIN 153 — Trilobiten des unteren und mittleren Devons auf den Inseln der kanadischen Arktis.
Von A. R. Ormiston

БЮЛЛЕТЕНЬ 153 — Нижне- и среднедевонские трилобиты Канадских Арктических Островов.
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Abstract

Trilobite faunas of Lower Gedinnian, Emsian, Eifelian, and Givetian age are present in the Canadian arctic islands. Possibly but not demonstrably present are trilobites of Siegenian age. Trilobite assemblages show faunal affinity with Europe and with the Uralian province but also show a considerable degree of endemism, especially during the Givetian.

Thirty-four species are described and assigned to nineteen genera. New taxa comprise two genera, *Deltadechenella* and *Schizoproetoides*; one subgenus, *Pedinodechenella*; twenty-three species; and one subspecies.

The following age assignments are proposed on the basis of trilobites described in this report: strata exposed at Washington Point, Baillie Hamilton Island, Lower Gedinnian; strata exposed at Drake Bay, Prince of Wales Island, Eifelian in part; Stuart Bay Formation, Emsian in part; Eids Formation, Emsian; strata exposed on the largest of the Princess Royal Islands, Emsian and/or Eifelian; Blue Fiord Formation, Eifelian; and Bird Fiord Formation, Givetian, locally Eifelian in the basal part.

During Eifelian time the Canadian Arctic was apparently part of a "Uralian" province distinguished by the absence of representatives of the Phacopina, the presence of *Weberopeltis,* and possibly also by a proliferation of *Dechenella* (*Dechenella*).

Longiproetus is suggested as possibly ancestral to the Dechenellinae and the phylogeny of the subfamily is considered in detail.

Résumé

On retrouve dans les îles de l'Arctique canadien des trilobites du Gédinnien inférieur, de l'Emsien, de l'Eifélien et du Givétien. Bien qu'il puisse y exister aussi des trilobites du Siégénien, on n'en a pas décelé. Les variétés de trilobites révèlent des affinités fauniques avec l'Europe et la province Uralienne, mais également un degré considérable d'endémisme surtout durant le Givétien.

L'auteur décrit 34 espèces et les assigne à 19 genres. Les nouvelles classifications comprennent deux genres, *Deltadechenella* et *Schizoproetoides;* un sous-genre, *Pedinodechenella*; 23 espèces; et une sous-espèce.

Les âges suivants sont proposés en se fondant sur les trilobites mentionnés dans le présent rapport: pour les strates exposées à Washington Point, sur l'île Baillie Hamilton, le Gédinnien inférieur; les strates exposées à la baie Drake, sur l'île Prince-de-Galles, l'Eifélien en partie; la formation de la baie Stuart, l'Esmien en partie; la formation Eids, l'Emsien; les strates exposées sur la plus grande des îles Princesse-Royale, l'Emsien et l'Eifélien; la formation Blue Fiord, l'Eifélien; la formation Bird Fiord, le Givétien et, par endroits, l'Eifélien dans la partie fondamentale.

Durant l'âge eifélien, l'Arctique canadien faisait partie apparemment d'une province «Uralienne» qui se distinguait par l'absence de représentants des phacopidés, la présence de *Weberopeltis* et peut-être aussi par une prolifération de *Dechenella* (*Dechenella*).

L'auteur considère le *Longiproetus* comme l'ancêtre possible des déchenellidés et étudie en détail la phylogenèse de la sous-famille.

INTRODUCTION

Lack of fossil evidence has prevented precise age determinations of Lower and Middle Devonian rock stratigraphic units in the Canadian arctic islands. Tentative correlations by McLaren (*in* Fortier, *et al.*, 1963, pp. 57-63) were based on preliminary faunal studies, primarily of brachiopods and corals (Table 3).

This report is an attempt to determine the ages of those units through a systematic study of their diverse trilobite faunas. Except for the work of Tolmachoff (1926), which is revised in this report, there has been no previous systematic study of these trilobite faunas.

The trilobite faunas on which this report is based come in part from collections made by officers of the Geological Survey of Canada and in part from collections made by the writer during four summers (1959-62). Under the guidance of Professor A. H. McNair of Dartmouth College, the summers of 1959 and 1960 were spent measuring stratigraphic sections and collecting fossils. During that time Devonian rocks were studied on Bathurst, Prince of Wales, Cornwallis, and Baillie Hamilton Islands (Fig. 1). A brief period in the summer of 1961 was spent studying the Devonian of the Douro Range, Devon Island (Fig. 1, loc. 5) under the auspices of the Arctic Institute of North America. The summer of 1962 was devoted to intensive collecting in the Stuart Bay area of Bathurst Island and provided by far the most comprehensive of the collections described here.

Transportation within the arctic islands was primarily by light aircraft equipped with oversized, low pressure tires which permit landings on unprepared upland surfaces. Backpacking was an important secondary means of travel.

Devonian trilobites are described from Melville, Victoria, Princess Royal, Prince of Wales, Bathurst, Baillie Hamilton, Devon, Little Cornwallis, and Ellesmere Islands, an area measuring 500 miles from east to west and 350 miles from north to south. The bulk of the specimens come from horizons whose positions are accurately known within a sequence of Devonian formations that are widely distributed in the arctic islands. The stratigraphy of these formations is reasonably well understood (Fortier, *et al.*, 1963; and see below). Such collections permit not only useful biostratigraphic inferences but also permit inferences about possible phylogenies of the fossil species.

Other specimens have been collected from isolated exposures that are stratigraphically unstudied. These specimens are at present of limited usefulness. They are described in the interest of completeness and in the hope that future faunal studies will elucidate their stratigraphic significance.

FIGURE 1. Devonian trilobite localities, arctic islands.

Previous Work

The only Devonian trilobites previously described from the Canadian arctic islands are specimens collected by Per Schei, geologist of the Second Norwegian Arctic Expedition, in and around Goose Fiord, Ellesmere Island. These specimens come from the part of Per Schei's Series D now known to correspond to the Blue Fiord and Bird Fiord Formations. Following Schei's death shortly after returning from the Arctic, his collections were distributed among various palaeontologists for study. In a report published in 1926 Tolmachoff described, as part of a paper concerning several fossil groups, ten species of trilobites. The material described by Tolmachoff has been loaned to me through the courtesy of Dr. G. Henningsmoen of the Paleontologisk Museum, Oslo, and has been restudied.

Acknowledgments

The faunas described in this report were prepared and studied at the Museum of Comparative Zoology, Harvard University, under the guidance of Professor H. B. Whittington, and for part of the time during the tenure of a National Science Foundation Fellowship. Professor B. Kummel also provided many helpful suggestions in the course of the research. Financial and logistic support for field work came from the Society of Sigma Xi, the Arctic Institute of North America, and the Geology Department of Harvard University. Assistance in the field in 1962 was ably given by Mr. Jeffery Warner of Harvard University. To all who assisted in any way, the author is greatly indebted.

STRATIGRAPHY

The Devonian System of the Canadian Arctic was first systematically studied on Ellesmere Island by Per Schei, geologist of the Second Norwegian Arctic Expedition (1898-1902). Further detailed study was not made until 1955 when an intensive geological program was carried out by officers of the Geological Survey of Canada. The results of that program (Operation Franklin) are reported in Fortier, *et al.* (1963).

Devonian rocks are widespread in the arctic islands, occurring from Banks Island (Thorsteinsson and Tozer, 1962) in the west to Ellesmere Island (Fortier, *et al.*, 1963) in the east, and from Ellesmere Island in the north at least as far south as northern Prince of Wales Island. Because of their partly unfossiliferous nature and rapid lateral changes in facies (McLaren *in* Fortier, *et al.*, 1963, p. 50), rocks of the Lower Devonian Series are not well understood stratigraphically but are apparently widely distributed. The Middle Devonian Series is represented by predominantly marine rocks including several remarkably persistent formations. One of these, the Blue Fiord Formation, has been recognized on Victoria (Thorsteinsson and Tozer, 1962), eastern Melville (Thorsteinsson and Tozer, 1959), Bathurst, Devon, and Ellesmere Islands (*see* Fig. 1), and another, the Bird Fiord Formation, is present on Bathurst, Devon, and Ellesmere Islands (*see* Fig. 5). Marine Middle Devonian rocks attain a maximum thickness of 4,400 feet on Bathurst Island (Ormiston, 1960) and of 7,700 feet on Ellesmere Island (*see* McLaren *in* Fortier, *et al.*, 1963, p. 316). Upper Devonian rocks of the arctic islands are predominantly non-marine but include marine strata on Banks (Thorsteinsson and Tozer, 1962, p. 56) and Cameron Islands (Greiner *in* Fortier, *et al.*, 1963, p. 635).

The writer's experience is primarily with the Devonian System of Bathurst Island, but includes study of Devonian rocks on Prince of Wales, Devon, Baillie Hamilton, and Cornwallis Islands (Fig. 1). The following discussion is intended to amplify and extend knowledge of certain Devonian units that are defined and discussed in Fortier, *et al.* (1963). Formations are considered in chronological order from oldest to youngest, but their age and correlation are not discussed in detail.

Devonian Strata Exposed on Baillie Hamilton Island

Unnamed limestones of Lower Gedinnian age are exposed in a north-south-trending anticline 3 miles inland from Washington Point, Baillie Hamilton Island (Fig. 1, loc. 6). Fossils collected by the writer during a one-day visit in June 1959 include the trilobite *Warburgella rugulosa*, which is widespread in Europe in rocks of Lower Gedinnian age (Alberti, 1963b, p. 148). Because of the briefness of the visit to Baillie Hamilton, little is known of the stratigraphy of these beds. They consist of thinly bedded, slightly argillaceous limestones carrying a shelly fauna dominated by brachiopods and including pelecypods, gastropods and trilobites. No attempt was made to determine the thickness or lithological variations. These limestones contrast with those of the Cape Phillips Formation of nearby Cornwallis Island in lacking *Atrypella.*

Stuart Bay Formation

This name was proposed by McLaren (*in* Fortier, *et al.*, 1963, p. 606) for exposures in Twilight Creek, Stuart Bay, Bathurst Island. The writer has studied the formation at its type section and at other widely separated localities on Bathurst Island.

The Stuart Bay Formation overlies the Silurian Bathurst Island Formation and is overlain conformably by the Eids Formation. Its basal contact is gradational. Conglomeratic chert-pebble beds containing eroded fossils occur near the base in Stuart Bay, Young Inlet, and Caledonian River, and can be used to determine its basal contact in the field. These thin pebble beds are succeeded by strata similar to those of the underlying Bathurst Island Formation (predominantly flaggy siltstones and sandstones with minor amounts of limestone), but it is not possible to distinguish between these two formations on aerial photographs. Thin beds of laterally discontinuous limestones that contain poorly preserved fossils occur at irregular intervals in the Stuart Bay Formation.

The calcareous siltstones and sandstones of the Stuart Bay Formation are overlain by dark, calcareous shales and argillaceous limestones of the Eids Formation, a contact that is readily distinguished on aerial photographs.

The Stuart Bay Formation is peculiar to Bathurst Island where it is restricted to the area of the Parry Islands folds. The Sherard Osborn Formation (*see* Thorsteinsson *in* Fortier, *et al.*, 1963, p. 591), which occurs in the eastern part of Bathurst Island, is possibly partly equivalent to the Stuart Bay Formation to the west.

The writer has measured sections of this formation at three localities on Bathurst Island as follows: 1,190 feet at Stuart Bay; 1,046 feet at Crooked Creek; and 1,415 feet on Caledonian River. Because the interval containing the Stuart Bay and Bathurst Island Formations does not appear on aerial photographs to show significant changes in thickness in areas beyond the measured sections, it is concluded that the Stuart Bay Formation is of a fairly constant thickness on Bathurst Island.

The lithology of the Stuart Bay Formation differs from that of the Bathurst Island Formation only in including a minor amount of limestone. With rare exceptions fossils in the Stuart Bay are restricted to these thin, discontinuous limestone beds. Calcareous siltstones and fine-grained sandstones which weather flaggy are the predominant rock types.

The most pronounced areal change in the lithology of the Stuart Bay Formation is an increase in dolomite and dolomitic clastics from virtually none in the Crooked Creek area to an amount comprising nearly half the formation at Caledonian River 30 miles to the south.

Devonian Strata Exposed at Drake Bay, Prince of Wales Island

Devonian limestones and shales exposed at the head of Drake Bay, Prince of Wales Island (Fig. 1, loc. 10) and at another locality 20 miles to the northeast are probably partly correlative with the Blue Fiord Formation but differ from it lithologically and faunally. The presence of *Basidechenella, Cyrtodechenella,* and a large unidentified lichid distinguishes the Drake Bay fauna.

The strata outcropping at Drake Bay are flat lying to gently dipping, and nowhere is a continuous section thicker than 200 feet exposed. Neither the top nor the base of these strata is exposed so that their aggregate thickness is not known. The minimum thickness is not less than 200 feet. Despite the problems posed by a lack of information about their relations to rock stratigraphic units recognizable elsewhere in the arctic islands, the Drake Bay trilobites allow these beds to be dated.

Thin-bedded, tan weathering limestones, argillaceous limestones, and shales are the predominant rock types. Reef development was not observed, but large stromatoporoids occur abundantly at several horizons. At the head of Drake Bay argillaceous rocks account for a greater proportion of the section than they do 20 miles to the northeast. More detailed lithological information is presented in a section measured by the writer in 1960; this is included in the appendix.

Fossils collected from calcareous sandstones 10 miles south of Cape Dundas are considered by McLaren (*in* Fortier, *et al.*, 1963, p. 126) to be Upper Silurian or Lower Devonian. It is not certain whether the beds from that locality, which is 30 miles north of the head of Drake Bay, should be considered correlative with the strata at Drake Bay. The low dip of the beds along the coast suggests they should, but the age suggested by McLaren does not accord with the Lower and/or Middle Devonian age proposed for the Drake Bay strata. Northwestern Prince of Wales Island has not been studied enough to exclude the possibility of large-scale normal faulting, and it would be premature to attempt any synthesis of the scattered bits of stratigraphic information now available.

Eids Formation

McLaren (*in* Fortier, *et al.*, 1963, p. 317) proposed this formation for dark calcareous shales and argillaceous limestones underlying the Blue Fiord Formation at Eids Fiord, Ellesmere Island, and equated these beds (*op. cit.*, p. 608) with similar rocks in the Stuart Bay area of Bathurst Island (Fig. 1, loc. 8) that overlie the Stuart Bay Formation. In the type area the base of the formation is not exposed. The upper contact of the Eids Formation is transitional with the overlying Blue Fiord. The transition beds do not represent a constant stratigraphic horizon on Bathurst Island. Indeed, at some localities (e.g., Shale Creek, *see* Fig. 2) separation of the Blue Fiord and Eids Formations is entirely arbitrary. Together with the Blue Fiord Formation, the outcrop belt of the Eids Formation presents a remarkable example of edaphic control of vegetation. The mantle that develops on those calcareous units supports practically no vegetation and consequently shows up as a conspicuous light coloured zone on aerial photographs. The Eids is less resistant than the Blue Fiord Formation and in the field can usually be separated from it on that basis.

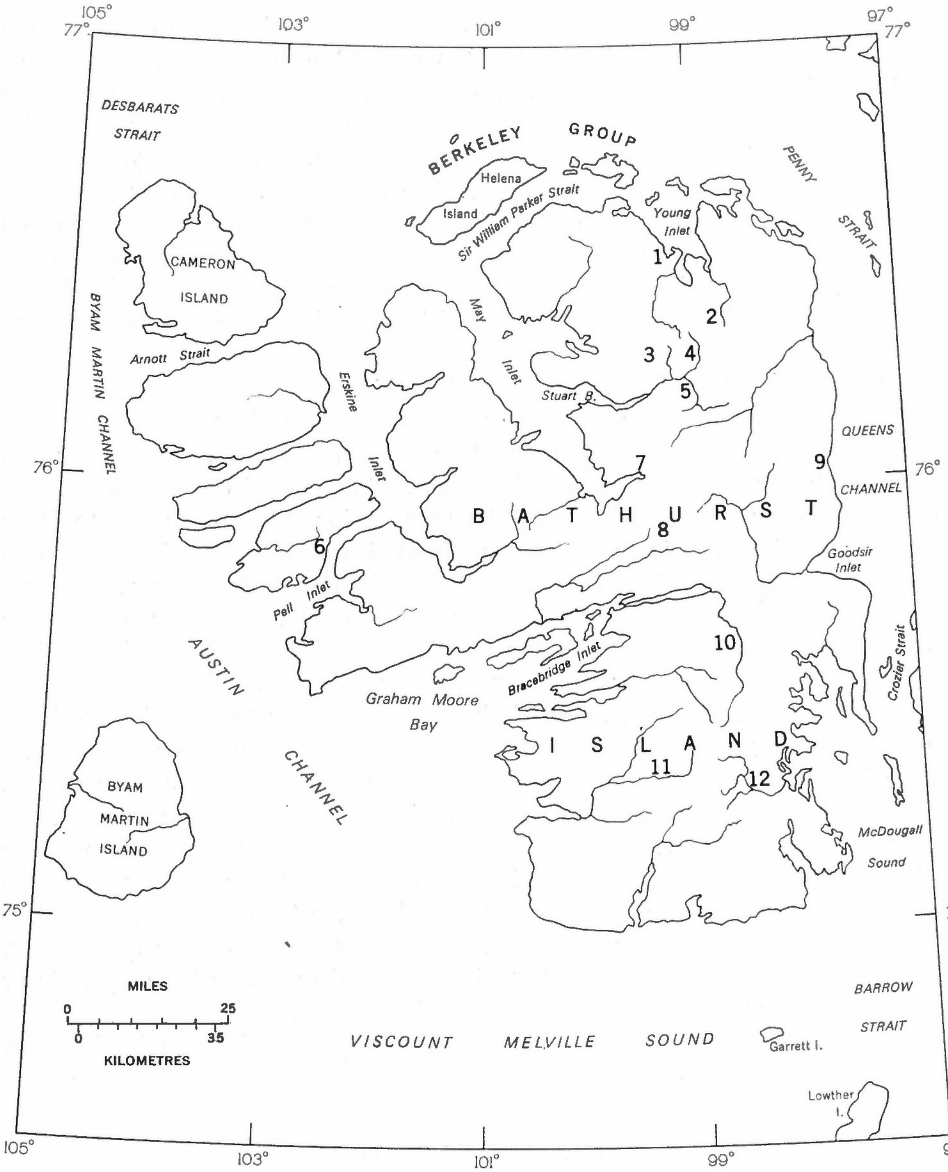
On Ellesmere Island the Eids Formation has been recognized only at the type locality; at Goose Fiord 50 miles to the south it does not occur. The formation occurs over most of Bathurst Island, except for the eastern part north of Goodsir Inlet where it is apparently absent. Outcrops of the Eids have been examined by the writer from Young Inlet (Fig. 2, loc. 1) in the north to Dyke Creek (Fig. 2, loc. 12) in the south, and from Bracebridge Inlet in the west to Dyke Creek in the east. Measured sections are 900 feet thick in Stuart Bay, and 885 feet at Great Day Creek. At certain localities on Bathurst Island where the contact between the dark limestone and the bioclastic limestone is high in the Blue Fiord–Eids interval the thickness may considerably exceed these figures.

Everywhere on Bathurst Island dark argillaceous limestone, dark pure limestone, calcareous shales, and mudstones in varying proportions make up this unit. Many of the Eids limestones on being dissolved in acetic acid yield a large amount of gummy organic residue. On southern Bathurst the formation contains large limestone concretions, whose surface is covered with tentaculitids. The proportion of shaly beds to limestones shows rapid lateral variations. Considerably more limestone is present, for example, on the south flank of the Stuart Bay anticline than occurs on the north flank, 8 miles away. Although a few benthonic types occur, the bulk of the Eids fauna (which is an impoverished one) consists of pelagic or nektonic invertebrates such as tentaculitids and goniatites.

Thin sandstone beds have been found in the Eids Formation at a few localities but are volumetrically unimportant.

Blue Fiord Formation

Originally studied and defined by McLaren (*in* Fortier, *et al.*, 1963, pp. 318, 610) at Blue Fiord, Ellesmere Island, and at Stuart Bay, Bathurst Island, this formation has come to be widely recognized in the arctic islands. The transitional basal contact has been discussed in the foregoing. The upper contact is sharp in most areas and coincides with a distinct lithological and faunal change (McLaren, 1959, p. 740). On Grinnell Peninsula, Devon Island, the upper contact is not sharply defined lithologically and is recognized on a faunal basis (McLaren, 1959, p. 742).



LOCALITIES REFERRED TO IN TEXT

1. West side of Young Inlet
2. Great Day Creek
3. Twilight Creek
4. Warner River
5. Cut Through Creek
6. Pell Creek
7. Shale Creek
8. Crooked Creek
9. Driftwood Bay
10. Caledonian River
11. Three Degree Creek
12. Dyke Creek

GSC

FIGURE 2. Devonian trilobite localities, Bathurst Island.

The writer has studied the formation at many localities on Bathurst Island and at Prince Alfred Bay on Devon Island. A section measured at Twilight Creek, Bathurst Island (Fig. 2, loc. 3), which is a reference section for the formation, is included in the appendix.

The Blue Fiord Formation has been identified on Victoria, eastern Melville, Bathurst, Devon, and Ellesmere Islands. From beds on the south side of Weatherall Bay, Melville Island, which were originally considered Silurian, McLaren (*in* Fortier, *et al.,* 1963, p. 648) has identified Blue Fiord corals and the writer has identified *Dechenella maclareni,* which occurs abundantly in the Blue Fiord of Bathurst. The Blue Fiord Formation is apparently absent from western Melville Island.

At its type locality, Blue Fiord, Ellesmere Island, the formation attains a thickness of 3,800 feet (McLaren *in* Fortier, *et al.,* 1963, p. 316), which is more than four times the thickness on northern Bathurst Island.

On Devon Island the Blue Fiord Formation is restricted to the northwestern part including Grinnell Peninsula where McLaren estimates its thickness at 1,500 feet. On Bathurst Island the formation averages 650 feet thick in the northern part and 1,000 feet in the southern part. Large areas of southern Bathurst Island are underlain by low-dipping Blue Fiord beds, and, from the air, appear very barren of vegetation. Low dips and discontinuous exposures prevent a determination of the thickness of the Blue Fiord Formation on Victoria Island, except that its minimum thickness is several hundred feet (Thorsteinsson and Tozer, 1962, p. 50).

At the type section (McLaren *in* Fortier, *et al.,* 1963, p. 318) the Blue Fiord Formation is divisible into two members, the lower of which is shaly at the base and contains highly fossiliferous bioherms. One of these bioherms is described by McLaren (p. 320) as being three quarters of a mile long. The upper member consists largely of variably bioclastic, brown limestones. At Goose Fiord, where the trilobites described by Tolmachoff were collected, the formation is only half as thick as at the type section and much less fossiliferous (McLaren *in* Fortier, *et al.,* 1963, p. 323). The lower and upper parts of the section consist of dolomite; only the middle part is fossiliferous. On Sutherland River, Devon Island (Fig. 1, loc. 5), the basal 300 feet of the Blue Fiord Formation consists of bioclastic and finely crystalline limestones with a zone near the base containing silicified fossils. Several blocks of this limestone etched by the writer yielded *Atrypa, Nucleospira, Douvillina, Gypidula, Warrenella,* scolecodonts, sponge spicules, pelecypods, and corals. Overlying the limestones is 100 feet of brown and yellow-brown dolomites, which are barren of fossils. The upper beds of the formation are not exposed at Sutherland River but outcrop nearby at the south end of Arthur Fiord where they are highly fossiliferous limestones. Trilobites are uncommon in the Blue Fiord Formation in this area; the writer found only three specimens.

On northern Bathurst Island, the Blue Fiord Formation consists of light to dark brown, finely crystalline, medium-bedded, fossiliferous limestone interbedded with brown, medium to coarsely crystalline, bioclastic limestone and grey calcareous shale. At several horizons trilobites are abundant enough to constitute 50 per cent of the rock. The amount of shale is highly variable. At Cut Through Creek there is practically no shale, whereas 25 miles to the south at Shale Creek almost the entire formation consists of shale. It is characteristic of the Blue Fiord in this area that the proportion of shale shows very rapid lateral variation. Bioherms are not a common feature of the Bathurst occurrences of the Blue Fiord but are present. Small bioherms occur for half a mile along strike at one horizon on Great Day Creek. The largest bioherm observed by the writer occurs on Three Degree Creek, southern Bathurst Island (Fig. 2) and has dimensions of 50 by 100 feet.

The proportion of dolomite increases from virtually none on northern Bathurst to 100 per cent on Dyke Creek, southern Bathurst Island. Associated with this change is one of texture, from medium crystalline in the north to aphanitic in the south. This southward increase in dolomite content is reminiscent of a similar change in the Stuart Bay Formation.

Bird Fiord Formation

This formation was named for exposures in the vicinity of Bird Fiord, Ellesmere Island (McLaren *in* Fortier, *et al.,* 1963, p. 325). The basal contact is drawn at the first appearance of large amounts of quartzose clastics above the limestones of the Blue Fiord Formation. The upper contact is transitional with the non-marine sandstones of the Frasnian Okse Bay Formation, and is arbitrarily drawn at the last occurrence of calcareous sandstones. The Bird Fiord Formation is much softer weathering than the resistant Blue Fiord Formation. On aerial photographs its outcrop belt has a conspicuously banded appearance caused by the denser growth of vegetation on the shaly bands producing darker bands than those of the sandy limestones.

The formation has been recognized on Ellesmere, Devon, and Bathurst Islands, but is absent from Melville Island where equivalent aged rocks are of different facies. As with the Blue Fiord Formation, the thickest known section of the Bird Fiord Formation is in the type area where it is about 3,000 feet thick. On nearby Goose Fiord the formation totals 1,750 feet. It is apparently very thin on Grinnell Peninsula, Devon Island; McLaren (*in* Fortier, *et al.,* 1963, p. 248) estimates the thickness there at 650 feet. A traverse by the writer through the formation at southeastern Arthur Fiord, Devon Island, confirms a thickness of that order of magnitude. In the Stuart Bay area of Bathurst Island it is about 1,600 feet thick. The formation uniformly thickens and becomes more sandy in a northwesterly direction on Bathurst Island. Eighteen miles northwest of Stuart Bay it is 2,200 feet thick, whereas in Driftwood Bay 30 miles southeast of Stuart Bay it is only 800 feet thick (Thorsteinsson *in* Fortier, *et al.,* 1963, p. 594). Sections measured elsewhere on Bathurst Island confirm this systematic regional variation.

The dominant rock types in the Bird Fiord Formation are quartzose, bioclastic limestones, calcareous sandstones, calcareous shales and mudstones, and minor dolomite. The sandy bioclastic limestones are coarsely crystalline and weather yellow-brown. Some limestone horizons are so fossiliferous that brachiopod shells constitute more than half of the rocks. Trilobites are also remarkably abundant at some horizons. Most sections of the Bird Fiord Formation show an upward increase in sand content and calcareous sandstones predominate in the upper few hundred feet. Shales tend to be more common in the basal part of the formation.

An exceptional section is exposed at Goose Fiord, Ellesmere Island. The exposures there contrast with those of the type section and Bathurst Island in containing beds of gypsum as much as 6 feet thick and limestone pebble-conglomerates (McLaren *in* Fortier, *et al.,* 1963, p. 326).

On Bathurst Island the northwestward thickening of the formation is accompanied by a marked increase in sand content. These observations suggest that the Bird Fiord clastics of the Bathurst Island area had a northwestern provenance.

DEVONIAN STAGES

There is little faunal similarity between the Devonian trilobites of the Canadian Arctic and those of the classical New York State Devonian section as the two regions were apparently the sites of separate faunal provinces (see later discussion) during much of Devonian time. It is therefore not possible to employ the standard North American Devonian stages (Cooper, *et al.,* 1942) in correlations discussed in this report. Instead, because the Devonian trilobite faunas of the Canadian Arctic most closely resemble those of Europe, European Devonian stages must be used. Ideally, one should also be able to make tentative correlations between the Canadian Arctic and New York State on the basis of the correlations of New York State stages with European stages proposed by Cooper, *et al.* (1942, chart 4). Recently, however, the position of the Emsian-Eifelian (Lower-Middle Devonian) boundary in the New York State section advocated by Cooper, *et al.* (1942) has been challenged (Oliver, 1960, p. 174; House, 1962, p. 253). These authors assert that at least part of the Onondaga limestone assigned by Cooper, *et al.* to the Lower Devonian Onesquethawan Stage actually belongs to the Eifelian (basal Middle Devonian) Stage of the European chronology on the basis of corals and goniatites. If this is true, important revisions must be made in the correlations proposed by Cooper, *et al.* (1942) between the New York State and European Devonian stages. For the purposes of this report use of New York State stage names is avoided and reference to the age of North American rock-stratigraphic units is made in terms of the European stages to which they seem from available evidence to best correspond.

Considerable confusion has accompanied the application of several equivalent or partly equivalent European Devonian stage names because of uncertainty in determining their exact boundaries in successions away from the type area. Thus two sets of partly equivalent stage names (e.g. Emsian-Coblenzian, Couvinian-Eifelian) continue to be used for different areas of Europe. Interchangeable use of these stage names has become common practice but as Richter has pointed out (1950b, p. 273) this is a mistake for the Couvinian and Eifelian Stages as they are not entirely equivalent. Definitions of the limits of the stages used in this paper are given below.

Givetian

Until recently most European stratigraphers have placed the base of the Givetian at the base of the "Fleringer schichten" (Table 1), but the writer adheres to Struve's (1961b, p. 323, Table 1) slightly higher placement of that boundary.

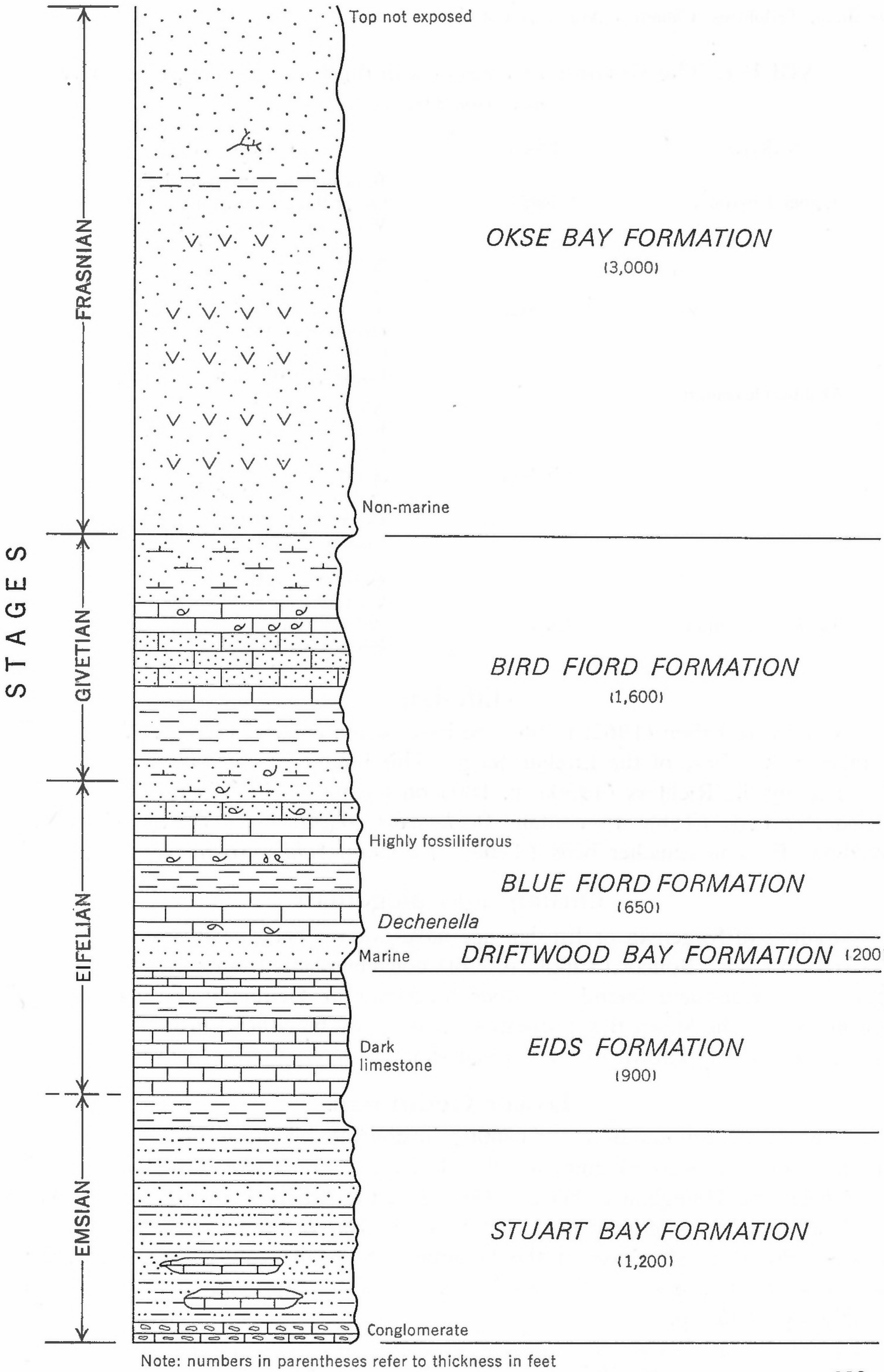


FIGURE 3. Generalized stratigraphic column for Devonian System, Bathurst Island.

TABLE 1. The Devonian succession in the Eifel district, Germany
(*modified from Struve, 1961b*)

SERIES	STAGE	FORMATION
Upper Devonian	Frasnian	Büdesheimer goniatite shales Ooser flaggy limestones Wallersheimer dolomite
Middle Devonian	Givetian	Bolsdorfer beds Kerpener beds Rodert beds Dreimühlen beds Cürten beds } "Fleringer beds" Loogher beds } "Fleringer beds"
	Eifelian	Ahbach beds } "Fleringer beds" Freilinger beds Rommersheimer beds Ahrdorfer beds Upper Nohner beds Lower Nohner beds Laucher beds
Lower Devonian	Emsian	Heisdorfer beds Wetteldorfer beds Wiltzer beds Berleer beds

Eifelian

Following Erben (1962, p. 66) the base of the zone of *Gyroceratites gracilis* is taken as the base of the Eifelian Stage. This boundary corresponds to the one favoured by the Richters (1950a, p. 180) on the basis of trilobites. The Emsian Heisdorfer beds (Table 1) contain *Dechenella (Basidechenella) kayseri* and the overlying Eifelian Laucher beds (Table 1) contain *Schizoproetus onyx.*

Emsian[1] and Siegenian

Faunas of Siegenian or Emsian age have not yet been positively identified in the arctic islands. Boucot (1960b, p. 290) considers beds from west of Irene Bay, Bay Fiord, Ellesmere Island as either Siegenian or Gedinnian on the basis of brachiopods. The Stuart Bay Formation faunas may be either Emsian or Siegenian but are too poorly known to merit discussion.

Lower Gedinnian

The writer follows Boucot (1960b) in considering the following rock-stratigraphic units Lower Gedinnian: the Lochkov Limestone of Bohemia; the Bredeneck and Huinghauser beds of Germany; the Manlius, Coeymans, and New Scotland Formations of New York State; and the Borszczow and Czortkow Formations of Podolia. The base of the Gedinnian Stage has long been accepted as equivalent to the base of the marine Devonian section (but *see* Boucot and Pankiwskyj, 1962, p. 4).

[1]Trilobites from the Eids Formation of eastern Bathurst Island are now considered to indicate an Emsian age (*see* p. 18). Emsian beds are possibly also present on the largest of the Princess Royal Islands (*see* p. 18).

CORRELATION AND AGE

Beds Exposed at Washington Point, Baillie Hamilton Island

It is not now possible to determine what rock-stratigraphic units elsewhere in the arctic islands may be correlative with the Baillie Hamilton beds. The Stuart Bay Formation of Bathurst Island which could conceivably include strata of Gedinnian age does not resemble the Baillie Hamilton beds either lithologically or faunally.

Rock-stratigraphic units datable only as Silurian and/or Devonian are widespread in the arctic islands (*see* McLaren *in* Fortier, *et al.*, 1963, p. 50) but are difficult to correlate because of pronounced differences in facies from place to place. Perhaps the Baillie Hamilton beds represent one such unit of local extent that is unique in containing a good marine fauna.

Limestone beds exposed at Washington Point, Baillie Hamilton Island (Fig. 1) contain the trilobite *Warburgella rugulosa canadensis*. Subspecies of *Warburgella rugulosa* are widespread in Europe in strata of Lower Gedinnian age (Alberti, 1963a, p. 152). The species is known from the Huinghauser beds of Germany; the Bostov Series of the Holy Cross Mountains, Poland; the Lochkov Limestone of Bohemia; and the Borszczow and Czortkow Formations (Boucot and Pankiwskyj, 1962) of Podolia, all of which are Lower Gedinnian. The strata at Washington Point are therefore considered Lower Gedinnian. This age assignment is consistent with what is known about the relation of the beds on Baillie Hamilton to older strata from nearby Cornwallis Island. Washington Point is 12 miles north of Cape Phillips, Cornwallis Island, where east-northeast-dipping middle Ludlovian (Whittington, 1961, p. 438) limestones of the Cape Phillips Formation are exposed. The thickness of the strata intervening between the middle Ludlovian exposures at Cape Phillips and the Gedinnian beds on Baillie Hamilton Island cannot be determined as these strata are hidden by the waters of Maury Channel.

Although the remainder of the fauna of the Baillie Hamilton beds (brachiopods, pelecypods) has not been studied in detail, no forms were noticed that obviously contradict the age assignment given here. The brachiopod fauna definitely differs from that of the Cape Phillips Formation in lacking *Atrypella*.

Stuart Bay Formation

Trilobites are not common in this unit and where found are usually poorly preserved. The writer has been able to identify only: Proetid gen. and sp. indet., *Leonaspis* sp., and ?*Ceratarges* sp. The lichid is represented by a single hypostome, an internal mould that closely resembles that of *Ceratarges* sp. from the Blue Fiord

Formation on Svendsen Peninsula. The hypostomes of several Devonian lichid genera are basically similar, however (Tripp, 1957, text-fig. 4) and the possibility of homeomorphy cannot be dismissed. The writer does not therefore consider the hypostome assigned to ?*Ceratarges* sp. necessarily an indicator of Middle Devonian age. *Leonaspis* is a long-ranging genus which does not help to date the formation. In short, the trilobites add nothing to what is already known about the age of the Stuart Bay faunas.

TABLE 2. Correlation of Lower and Middle Devonian formations of the Canadian arctic islands, Germany, Bohemia, and New York State

STAGES		CANADIAN ARCTIC ISLANDS	EIFEL DISTRICT, GERMANY Solle, 1951; Struve, 1961B	BOHEMIA Chlupáč, 1957; Erben, 1962	NEW YORK STATE Cooper et al, 1942; Boucot, 1960
GIVETIAN			Bolsdorfer beds		Hamilton Group
		?	Kerpener beds		
		Bird Fiord Formation	Rodert beds	Roblín beds	
			Dreimuhlen beds		
			Cürten beds		
			Loogher beds	Kačák beds	
EIFELIAN			Ahbach beds	Choteč limestone	
		Blue Fiord Formation	Freilinger beds		? Onondaga limestone
			Rommersheimer beds		
			Ahrdorfer beds		
			Nohner beds	Třebotov limestone	
			Laucher beds	Daleje shale	
EMSIAN	UPPER		Heisdorfer beds	Chýnice limestone	? Schoharie Formation
		? Eids Formation	Wetteldorfer beds		
			Wiltzer beds	Zlíchov limestone	
			Ems quartzite		
	LOWER	Stuart Bay Formation	Klerfer beds	Dvorce-Prokop Ls.; Loděnic-Řeporyjer Ls.; Slivenec limestone; Upper Koněprus Ls.	
			Stadtfelder beds		Esopus shale
SIEGENIAN			Wustenbach beds		Oriskany sandstone
			Rhurberger beds		Becraft limestone
		? Strata at Bay Fiord, Ellesmere Island	Monschauer beds		
GEDINNIAN	UPPER		Weismes beds		New Scotland
	LOWER	Strata on Baillie-Hamilton Island	Bredeneck beds	Lochkov limestone	Coeymans; Manlius
			Hüinghäuser beds		

GSC

Fossils collected by D. J. McLaren in the type area of the Stuart Bay Formation consist mostly of brachiopods and are considered Lower Devonian by Cumming (*in* Fortier, *et al.*, 1963, p. 607). On the other hand, a fish fragment from the Stuart Bay Formation was considered by R. H. Denison to most likely indicate a pre-Givetian Middle Devonian age (*in* Fortier, *et al.*, 1963, p. 607). Because the trilobite evidence suggests an Emsian age for the Eids Formation on Bathurst Island, the writer favours a Lower Devonian age for the underlying Stuart Bay Formation. The exact time span of the Stuart Bay Formation is unknown and that shown on Table 2 is only conjectural.

Beds Exposed at Drake Bay, Prince of Wales Island

Only the trilobites among fossils from the strata at Drake Bay (Fig. 1, loc. 10) have yet been studied. These do not indicate a single age for the entire thickness of these beds, but indicate that at least part of the section is Middle Devonian. The presence of *Schizoproetoides ellesmerensis* n. sp. in beds at the head of Drake Bay suggests that they are correlative with the Blue Fiord Formation of Ellesmere Island (Fig. 5). The same correlation might be suggested for beds 9 miles northwest of the head of the bay which contain *Schizoproetoides ellesmerensis* n. sp. and *Cyrtodechenella macnairi* n. sp., but in the Eifel district of Germany *Cyrtodechenella* occurs in beds of early Givetian age (R. and E. Richter, 1950).

The gentle, westward regional dip on northwestern Prince of Wales Island indicates that, if the section is unfaulted, beds in the vicinity of Drake Bay are younger than beds 20 miles to the northeast which contain *Dechenella (Basidechenella) laticaudata* n. sp. This species closely resembles *D.* (*B.*) *dombroviensis* from beds near the Lower-Middle Devonian boundary in Poland. The presence of *D. (B.) laticaudata* could be interpreted as evidence for either a Lower or Middle Devonian age (Emsian or Eifelian). It is thus possible that the beds 20 miles northeast of Drake Bay are partly of Lower Devonian age.

Eids Formation

The dark limestones, shales and mudstones which conformably underlie the Blue Fiord Formation at Blue Fiord, Ellesmere Island and over most of Bathurst Island (except south of Driftwood Bay where the Driftwood Bay sandstone appears between the Blue Fiord and Eids Formations) contain few diagnostic fossils and are difficult to date. Goniatites occur rarely in the Eids of Bathurst and one from the Stuart Bay region was considered possibly referable to *Mimagoniatites* by McLaren (*in* Fortier, *et al.*, 1963, p. 609) on the basis of which identification a Lower Devonian age was suggested. *Mimagoniatites* has both Lower and Middle Devonian species, however, and the genus alone is not satisfactory evidence of Lower Devonian age. Cumming (*in* Fortier, *et al.*, 1963, p. 59) considers brachiopods from near the base of the formation as indicative of a Lower Devonian age.

Trilobites, though rare, do occur in the Eids Formation and have an important bearing on its age. The writer has seen but does not have available for study a *Harpes* close to *H. macrocephalus* from the Eids Formation in the vicinity of Stuart Bay. From 80 feet below the top of the Eids Formation, southeastern Bathurst Island comes *Platyscutellum brevicephalus.* This species occurs elsewhere 400 miles west-southwest of Bathurst on the largest of the Princess Royal Islands in rocks of Eids-like lithology where it is associated with a diverse trilobite fauna: *Cornuproetus tozeri, Leonaspis eremia, Harpes* cf. *macrocephalus, Otarion balanops, Astycoryphe* aff. *cimelia,* and *Dechenella* sp. indet. Its presence in this assemblage suggests a correlation of the beds on Princess Royal Island with at least part of the Eids Formation. In Europe *Platyscutellum* is restricted to the Lower Devonian (Šnajdr, 1960, p. 254). The species to which *P. brevicephalus* is most similar are of Emsian age.

Collections from 90 feet above the base of Eids Formation on Twilight Creek contain *Aulacopleura (Paraaulacopleura)* cf. *beyrichi* (Novak, 1890) which is most similar to a Lower Devonian form from the east side of the Urals figured by Tschernyschew (1893, Pl. 1, fig. 4).

The trilobite evidence thus distinctly favours an Emsian age for the Eids Formation of eastern Bathurst Island. Because of its facies relations to other formations (*see* p. 7), it is probably of different ages in different places.

Beds on the Largest of the Princess Royal Islands

On the largest of the Princess Royal Islands (Fig. 1, loc. 13) occur limestones that Thorsteinsson and Tozer (1962, p. 51) refer to the Blue Fiord Formation. These beds are Eids-like in lithology but carry an abundant trilobite fauna (*see above*) which includes both Emsian and Eifelian elements. *Platyscutellum brevicephalus* and *Cornuproetus tozeri* of this fauna suggest an Emsian age, whereas *Otarion balanops, Astycoryphe* aff. *A. cimelia,* and *Leonaspis elliptica* seem to indicate an Eifelian age. This apparent mixture of Emsian and Eifelian elements probably means that these beds are close to the Emsian-Eifelian boundary. Since all the fossils mentioned above are found together on the same rock slabs, the answer cannot be that both Emsian and Eifelian beds are present.

Blue Fiord Formation

In the type area near Blue and Eids Fiords on Ellesmere Island (McLaren *in* Fortier, *et al.,* 1963, p. 59) the Blue Fiord Formation attains a thickness of 3,800 feet. On Bathurst Island it is considerably thinner, attaining a maximum thickness of 1,000 feet in the southern half of the island and averaging about 650 feet in the northern half (Ormiston, 1960). The question naturally arises whether the fourfold difference in thickness between Bathurst and Ellesmere Islands represents westward thinning of an essentially contemporaneous unit or whether much younger or much older beds are present in the thicker Ellesmere Island occurrence of the formation. The trilobite distribution suggests that the oldest Blue Fiord beds on Bathurst Island may be slightly younger than the oldest Blue Fiord beds on Ellesmere and Devon Islands. *Proetus (L.) sverdrupi,* which occurs near the base of the formation on both Devon and Ellesmere Islands, is not known from Bathurst Island. Moreover, the species which are most characteristic of the formation at Twilight Creek (e.g., *D. maclareni, D. paragranulata,* and *L. elliptica*) first appear well above the base of the formation on Devon and Ellesmere (*see* Fig. 5). None of the trilobite species that occur near the base of the Ellesmere Blue Fiord Formation are known from Bathurst Island. These observations seem to suggest that older (Emsian?) beds are present in the formation east of Bathurst Island.

The trilobite fauna of the Blue Fiord Formation is a diverse one, which includes some endemic species and some identical with or closely comparable to European forms. The Bathurst Island collections include the following trilobite species that are identical with Eifelian species from Europe: *Harpes macrocephalus* Goldfuss, 1839; *Astycoryphe cimelia* n. sp.; *Leonaspis elliptica* (Burmeister, 1843); and *Otarion balanops* Erben, 1953. The Blue Fiord genus *Schizoproetoides* in resembling *Schizoproetus* also suggests relationship to the European Middle Devonian. The genera *Ceratarges, Ancyropyge,* and the species *Scutellum depressum* all indicate a Middle Devonian age.

Were this the entire Blue Fiord trilobite assemblage one would not hesitate to correlate it with the European Eifelian, but there is a complication. Fully half of the Blue Fiord trilobite species are dechenellinids: *Dechenella (D.) maclareni* n. sp.; *D. (D.) paramaclareni* n. sp.; *D. (D.) paragranulata* n. sp.; *D. (D.) tesca* n. sp.; *D. (D.) franklini* n. sp.; *D. (D.) retusa* n. sp.; *D. (D.)* aff. *planimarginata* (Meek, 1873); *D. (D.) spaekkassensis* (Tolmachoff, 1926); and *Deltadechenella bathurstensis* n. gen., n. sp. Several of the Blue Fiord *Dechenellas* closely resemble European Givetian species: *D. maclareni* n. sp. (*D. verneuili* (Barrande, 1852)); *D. paragranulata* n. sp. (*D. granulata* R. Richter, 1912); and *D. spaekkassensis* (Tolmachoff, 1926) (*D. arschensis* Maximova, 1955).

It has long been accepted (Richter, R. & E., 1921) that no Dechenellinae except *Schizoproetus* occurs in the Eifelian of Europe (*see* R. and E. Richter, 1950, p. 180, unnumbered text-fig.). Recently, however, *Dechenella (Dechenella)* has been discovered in the late Eifelian Freilinger beds of the Eifel district (Ochs and Wolfart, 1961, p. 38). These reports are based on only a few specimens and it is still true that in the Eifel district the epibole of *Dechenella (Dechenella)* does not begin until the Givetian and that *Dechenella* is absent from beds of early or middle Eifelian age.

The non-dechenellinid trilobites of the Blue Fiord Formation representing four families and six subfamilies indicate a correlation with the Eifelian (see below) of Germany, but the presence of *Dechenella (Dechenella)* in an apparently early Eifelian fauna is at variance with the situation in Europe. In this instance the age suggested by the representatives of five different families (Scutelluidae, Lichidae, Odontopleuridae, Harpidae, and Otarionidae) must be given more weight than the divergent age suggested by representatives of one subgenus, *Dechenella.* This implies that *Dechenella (Dechenella)* appears earlier in the Canadian Arctic than in Europe. It is possible that the Canadian Arctic was at or near the site of origin of *Dechenella (Dechenella)* from which it was dispersed towards Europe appearing there the better part of a stage later. Examples of apparent time transgressive migration of fossil invertebrates from one faunal province to another are numerous (e.g., Kindle and Whittington, 1958, p. 338; Spjeldnaes, 1961, p. 52; Whittington, 1963, p. 22) and the possibility must always be considered when correlations are being made.

Coral Evidence

Further evidence concerning the age of the Blue Fiord Formation is available in the form of an abundant tetracoral fauna. From Cut Through Creek, Bathurst Island, the writer has sectioned and tentatively identified: *Lekanophyllum* cf. *kayseri* Wedekind, 1924; *Digonophyllum (D.)* cf. *schulzi* Wedekind, 1923; *Digonophyllum (Zonodigonophyllum)* sp.; *Dialytophyllum* cf. *complicatum* Amanhauser, 1925; and *Zonophyllum* aff. *solidum* Wedekind, 1924. This assemblage consists entirely of genera present in the Eifelian of the Eifel district, Germany, and provides striking corroborative evidence not only of the Eifelian age but also of the strong German faunal affinities of the Blue Fiord Formation. The writer suspects that the Blue Fiord forms represent species rather close to certain German Eifelian ones (here indicated by cf.).

The Age of Scutellum depressum *and* Ancyropyge

The two Blue Fiord Formation trilobites which show North American rather than European faunal affinities would also seem to suggest a Givetian rather than Eifelian age. *Scutellum depressum* originally described from Givetian rocks of Calhoun County, Illinois, occurs in the Blue Fiord Formation at several localities on Bathurst Island. This species belongs to a plexus of very closely related, long-ranging, and presumably slowly evolving European and North American species which includes: *S. flabelliferum* (Eifelian); *S. costatum* (Givetian-Frasnian); *S. tullium* (Givetian-?Frasnian), and *S. alutaceum* (Eifelian). Because the morphological differences between known Eifelian and known Frasnian members of this species group are so subtle and because some of them are long ranging, it is advisable to avoid relying on members of this plexus for precise interregional correlation. *S. depressum* is consequently not considered a Givetian age indicator.

Prior to its discovery in the arctic islands the genus *Ancyropyge* was known from only two specimens from the Traverse Group of Michigan. The first of these was collected about 100 years ago and the second found only after an intensive search by G. A. Cooper. It is safe to say, then, that in continental North America the genus is very rare. In contrast, specimens of this genus are abundant in the Blue Fiord, more than 60 specimens having been collected by the writer. This wide difference in relative abundance, certainly not a reflection of differences of man hours devoted to collecting, suggests that the Michigan occurrences of *Ancyropyge* represent southern stragglers of a genus which arose and proliferated far to the north. The Michigan *Ancyropyge romingeri* (Hall and Clarke) is of Givetian age whereas *Ancyropyge arcticus* n. sp. is Eifelian. This age difference can be explained by the interpretation of *Ancyropyge* as a northern genus which gradually migrated southward, reaching the Michigan area an age after its initial appearance in the arctic islands. The Michigan area may represent the approximate southern limit of the genus, as it is unknown in equivalent aged rocks of New York State and the mid-continent.

Bird Fiord Formation

Relation to the Blue Fiord Formation

The contact between the Blue Fiord and Bird Fiord Formations is lithologically and faunally sharp throughout the Parry Islands fold belt with a single important exception. In Tucker River valley, Grinnell Peninsula, Devon Island, the lowest beds of the Bird Fiord Formation examined by McLaren (1963, p. 248) consist not of sandy or shaly beds but of a medium-grained limestone which contains typical Bird Fiord brachiopods, e.g., *Nervostrophia latior; Schizophoria* sp.; *Adolfia* sp. A; *Fimbrispirifer scheii* (Meyer); and *Atrypa* sp. The trilobites occurring at this horizon are, however, unlike those found anywhere else in the Bird Fiord Formation on Bathurst Island. This unusual Bird Fiord trilobite assemblage includes: *Leonaspis* sp.; *Cyrtodechenella* sp.; *Dechenella* cf. *paragranulata; Dechenella (D.) franklini*?; and *Dechenella (D.)* aff. *franklini* and is the only record in the Bird Fiord Formation of *Leonaspis* and *Cyrtodechenella,* elsewhere known only in the Blue Fiord and its equivalents. Without the brachiopod evidence one would certainly include this horizon in the Blue Fiord Formation.

The persistence of a Blue Fiord trilobite assemblage into the Bird Fiord Formation in an area in which the basal part of the Bird Fiord Formation is not marked by the appearance of considerable clastic material suggests that the single most important factor in the abrupt change in trilobite assemblage between the Blue Fiord and Bird Fiord Formations that is typical throughout the Parry Islands is the advent of large amounts of clastics at the base of the Bird Fiord Formation. The trilobites further indicate that at least in the Tucker River area and possibly elsewhere as well there is not a great time break between the Blue Fiord and Bird Fiord Formations. That this is probably so on Bathurst Island is suggested by the persistence of *Dechenella maclareni* across the Blue Fiord–Bird Fiord boundary (*see* Fig. 4). It is probable that part of the Bird Fiord Formation belongs to the Eifelian Stage.

Transgressive Base of the Bird Fiord Formation

McLaren (1963, p. 63) reports the occurrence at 185 feet above the base of the Bird Fiord Formation in Twilight Creek of four species of brachiopods known elsewhere only from the middle of the Blue Fiord Formation, Ellesmere Island.

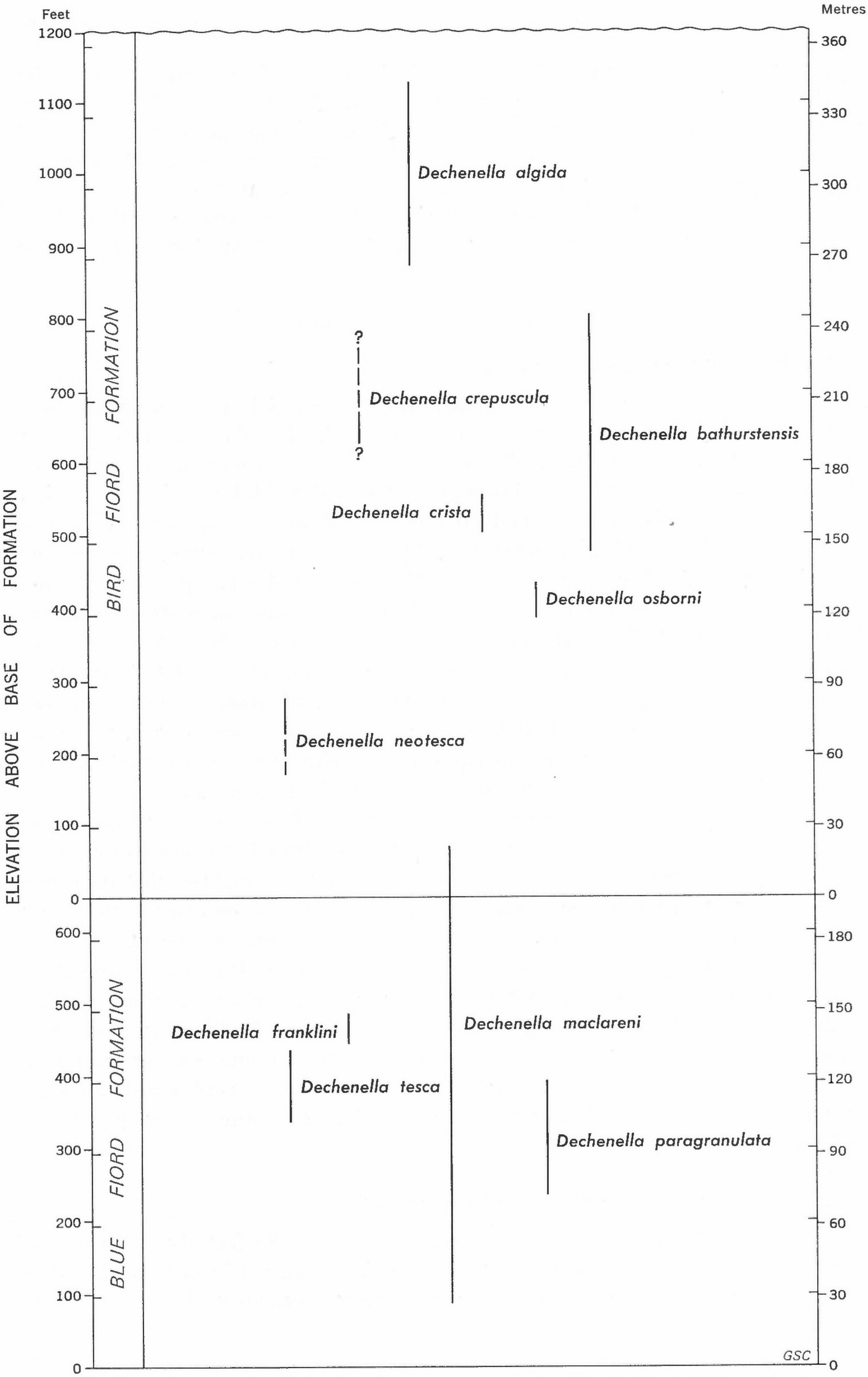


FIGURE 4. Stratigraphic distribution of species of *Dechenella* at Twilight Creek, Bathurst Island.

This suggests an Eifelian age for the basal 200 or so feet of the Bird Fiord Formation in the area of Twilight Creek. It is probable that the Blue Fiord-Bird Fiord contact (limestone-quartzose limestone contact) becomes progressively older towards the west or northwest in the arctic islands. Sections of the Bird Fiord Formation measured by the writer at many places on Bathurst Island (1960) reveal that the formation thickens and coarsens towards the northwest suggesting a northwestern provenance for the Bird Fiord clastics. This northwestern provenance is not restricted to Bathurst Island but is a general phenomenon throughout the Parry Islands fold belt. On western Melville Island, for example, the entire Middle Devonian section consists of clastic rocks and no Blue Fiord type of lithology is present. The Bird Fiord Formation is apparently time transgressive, Bird Fiord clastics having appeared earliest in the northwest and only later reaching the southeastern part of the Parry Islands fold belt. It would be an oversimplification to regard the Bird Fiord Formation as corresponding to the Givetian Stage, a possibility entertained by McLaren (1959, p. 742). The position of the Eifelian-Givetian Stage boundary in the arctic islands will be difficult to establish and may nowhere exactly coincide with the Blue Fiord–Bird Fiord contact. In the area of Twilight Creek it is probably situated within the basal 200 feet of the Bird Fiord Formation. There is as yet insufficient faunal evidence to locate this boundary on Ellesmere and Devon Islands.

Interregional Correlation

The Bird Fiord trilobite fauna is very restricted, comprising only five genera of which four are rare. One genus, *Dechenella,* is represented by ten species some of which can be relied on for correlations. In Europe *Dechenella (Dechenella)* although making its first appearance in the late Eifelian (Ochs and Wolfart, 1961, p. 38), first becomes abundant in the Givetian, and the base of its epibole can be used to distinguish the Givetian from the Eifelian Stages. As discussed earlier there is good evidence that in the Canadian Arctic *Dechenella (Dechenella)* appears in great abundance very early in the Eifelian and cannot be used as a Givetian age indicator as in Europe. This being so, more sophisticated faunal information must be sought to establish the age of the Bird Fiord Formation.

The two most abundant and long-ranging trilobite species in the Bird Fiord Formation of Bathurst Island closely resemble Givetian species from Europe and England; *Dechenella algida* n. sp. is close to *Dechenella burmeisteri* R. Richter, 1909 from the Givetian of Westphalia and *Dechenella bathurstensis* n. sp. to *Dechenella setosa* Whidborne, 1888 from the Givetian of England. The remaining species of *Dechenella* in the Bird Fiord Formation show much more similarity among themselves than they do to any extra-Arctic species and are not useful for interregional correlation. Of the remaining four genera present in the Bird Fiord Formation three are represented by unidentified species. The fourth, *Ancyropyge manitobensis* (Whiteaves, 1892), is the best trilobite evidence of a Givetian age for the greater part of the Bird Fiord Formation. In Manitoba this species occurs in the Winnipegosis Formation and is associated with *Stringocephalus*. A Givetian age is therefore strongly indicated for *Ancyropyge manitobensis*.

The Givetian age indicated by the Bird Fiord trilobites accords with that suggested by its brachiopod fauna (McLaren *in* Fortier, *et al.*, 1963, p. 63).

TABLE 3. Age assignments of this paper contrasted with previous assignments

Unit	Tentative age assignments of McLaren *in* Fortier, *et al.*, 1963	Ormiston, this paper
Bird Fiord Fm.	GIVETIAN	GIVETIAN and EIFELIAN
Blue Fiord Fm.	EIFELIAN	EIFELIAN
Eids Fm.	Lower Devonian	EMSIAN
strata exposed at Drake Bay	none	EIFELIAN in part
Stuart Bay Fm.	Lower Devonian	Lower Devonian
strata exposed on Baillie Hamilton Island	none	LOWER GEDINNIAN

FAUNAL PROVINCES

Lower Devonian[1]

The only trilobite species identified from known Lower Devonian rocks in the arctic islands suggests affinity with western Europe and especially with Germany, Poland, and Podolia. In Lower Gedinnian rocks of Europe *Warburgella rugulosa* is represented by two subspecies, one restricted to Bohemia and the other found in Germany, Poland, and Podolia. It is the latter subspecies with which the Canadian Arctic *Warburgella rugulosa canadensis* shows the greater similarity. A study of the remainder of the fauna (especially the brachiopods) with which *W. rugulosa canadensis* is associated is needed for further documentation of its affinities. The genus *Warburgella* is not known in continental North America.

Eifelian

Mackenzie River Basin

Trilobite faunas from Devonian rocks of the Mackenzie River Basin, the region nearest the arctic islands in which marine Devonian is present, remain to date largely undescribed. What little is known of these faunas is contained in faunal lists whose reliability is difficult to judge. The Hume Formation of this region is considered Eifelian by McLaren (1962, p. 12) on the basis of its tetracoral fauna (*Digonophyllum* and *Zonophyllum* among others), which also suggests a correlation with the Blue Fiord Formation of the arctic islands. According to Basset (1961, p. 488), the Hume Formation has yielded *Dechenella* sp., *Odontocephalus* sp., and *"Proetus"* sp. The presence of *Odontocephalus* in this Blue Fiord correlative demonstrates the near ubiquity of Phacopina in rocks of this age and calls attention to the uniqueness of the Middle Devonian of the nearby Canadian Arctic in which no Phacopina occur.

Corgan (1963) has discussed and figured trilobites from the Peel River district which he considers of Lower Devonian (Onesquethawan) age. As discussed elsewhere, the Onesquethawan Stage of Cooper, *et al.* (1942) now seems to correspond largely to the lower Middle and not the upper Lower Devonian. Corgan is probably correct in considering the fauna of Onesquethawan (equals Eifelian) age, but in attempting to prove the Lower Devonian age of this fauna he ascribes incorrect geological ranges to several trilobites *(Leonaspis, Odontocephalus, Prerataspis)*. The trilobites figured by Corgan are in the writer's judgment almost certainly Middle Devonian (Eifelian). For example, the *Odontocephalus* sp. of Corgan (p. 155, fig. 6) is probably a species of *Coronura* close to *C. aspectans*

[1]Trilobites from the Eids Formation of eastern Bathurst Island are now considered to indicate an Emsian age (*see* p. 18). Emsian beds are possibly also present on the largest of the Princess Royal Islands (*see* p. 18).

(Conrad, 1841) (Stumm, 1954, p. 204, pl. 1, fig. 1; pl. 2, figs. 1-2), which is widespread in Eifelian rocks of North America (Dundee Ls.; Columbus Ls.). The trilobite fauna listed by Corgan—*?Basidechenella, Terataspis, Leonaspis, Dechenella, Crassiproetus, Odontocephalus* (=*Coronura*)—suggest that the Eifelian trilobite faunas of the Mackenzie River Basin are probably like those of the Blue Fiord Formation with the important exception that no Phacopina occur in the arctic islands.

Greenland

Marine Devonian rocks are not definitely known from Greenland. Devonian rocks which have been studied are all of continental facies and yield only plant and vertebrate fossils (Butler, 1961).

North America—New York State, Michigan, Ohio, and Illinois

Middle Devonian trilobite faunas of New York State and Michigan are quite unlike those of the Canadian Arctic. In the Eifelian of Michigan, for example, the species of Phacopina recognized by Stumm (1954) outnumber the species of proetids (1953a). Proetids are more numerous in the Givetian of Michigan, but there are still eight species of Phacopina. The gross composition of the New York State trilobite faunas of the Middle Devonian is comparable to that of the Michigan faunas.

These trilobite assemblages contrast sharply with the Middle Devonian Arctic faunas in which proetids are dominant; harpids, which are absent from New York and Michigan, are important but the Phacopina, important in New York and Michigan, are absent.

The only species common to the Middle Devonian of the Arctic and Michigan is *Scutellum depressum*. This species belongs to a plexus of closely similar, slowly evolving species of world-wide distribution. *Dechenella planimarginata* (Meek, 1871) of the Eifelian Dundee limestone of Ohio and Michigan has a close relative in the Blue Fiord Formation of Ellesmere Island. *Ancyropyge*, previously known only from Michigan, has been found in abundance in the Blue Fiord Formation. The Arctic species is older and distinct from that found in Michigan and it is argued elsewhere in this report that the Michigan species is a southern straggler of what is basically an Arctic genus. The many points of difference between the North American and Arctic faunas overshadow their slight degree of similarity.

Western Europe

By far the strongest affinities of the Arctic Eifelian trilobites are with those of western Europe, particularly the Eifel district of Germany and Belgium. The faunal similarity between the Arctic and western Europe has been documented in the discussion of the age of the Blue Fiord Formation and need not be repeated. The tetracoral fauna of the Blue Fiord suggests the same affinities. Tetracorals of Eifelian age tend, however, to have a rather cosmopolitan distribution and undue emphasis should not be given them as indicators of faunal affinity. As in North America and unlike the Arctic, representatives of the Phacopina are present in the European Eifelian but account for only a small percentage of the total assemblage. In the Geeser horizon and Rommersheimer beds of the Eifel district (Richter, 1921, p. 164) species of the Phacopina constitute only 15 per cent (four species) of the trilobite fauna, whereas in the Eifelian of Michigan (*see* Stumm, 1953a and b) they account for nearly 50 per cent (sixteen species). The absence of *Dechenella* (*Dechenella*) from rocks of pre-late Eifelian age is another way in which European faunas differ from Canadian Arctic and North American ones.

Considering the Eifelian trilobite fauna of the Canadian Arctic as a whole, one must conclude that it belongs in the same faunal province as western Europe, but that it may be set off as a separate subprovince, for which the absence of the Phacopina is considered a diagnostic feature.

Soviet Union

The Eifelian trilobite faunas of the Urals and the Altai (*see* Maximova, 1955; 1960) contain many species which are related to Eifelian species from western Europe and are only slightly more removed in degree of resemblance from Arctic Eifelian trilobites. Both the Arctic and Russian Eifelian contain species in common with western Europe, but no species are common to all three areas.

The discovery in the Blue Fiord Formation of a *Weberopeltis* closely related to *Weberopeltis arcticum* (Weber, 1945) from the Eifelian of the Urals is important as the first reported occurrence of the genus outside of the Soviet Union. The degree of affinity between the Canadian Arctic and Russian Eifelian trilobites, though less than that between the Arctic and western Europe, is still considerably greater than that between the Arctic and New York State or Michigan.

Information on Palaeozoic faunas of the Soviet Arctic is meagre. The writer has relied primarily on Markova and Nalivkin (1957, *The Geology of the Soviet Arctic*) in which faunal lists are given for the Devonian of Novaya Zemlya, the Taimyr Peninsula, and the central Siberian Plateau. The few Eifelian and Givetian trilobites mentioned in these lists are too incompletely identified to permit discussion of faunal affinity. It is noteworthy, however, that no Phacopina are reported from the Eifelian of the Soviet Arctic. This is admittedly negative evidence, but it is at least suggestive that the Soviet Arctic may belong to the Arctic subprovince of Eifelian time.

Givetian

Manitoba

The only Bird Fiord trilobite species also known to occur outside of the arctic islands is *Ancyropyge manitobensis* (Whiteaves, 1892) which occurs in the Winnipegosis Formation at Lake Winnipegosis and Lake Manitoba. This single common species does not, however, necessarily reflect a high degree of faunal affinity. A notable difference between the two regions is that *Stringocephalus* with which *A. manitobensis* occurs in the Winnipegosis Formation has yet to be found in the arctic islands. Neither do the numerous species of *Dechenella* in the Bird Fiord Formation appear to have counterparts in the Winnipegosis Formation. There appears, therefore, to have been little basic faunal similarity between the arctic islands and Manitoba during Givetian time.

The Givetian trilobite assemblage of the Canadian Arctic is largely composed of endemic species. The few dechenellinids that show affinity with other areas (e.g., *D.* aff. *struvei, D. bathurstensis, D. algida*) suggest affinity with western Europe, but the restriction of the Arctic Givetian trilobite assemblage to a few genera of which only one is common makes determination of affinities difficult.

Several major trilobite groups present in the Blue Fiord Formation disappeared from the Canadian Arctic region at the beginning of Bird Fiord time. The ecological niches formerly occupied by those species then became available to the Dechenellinae, the only major trilobite group that persisted undiminished from Blue Fiord to Bird Fiord time. This situation apparently favoured a radiation in the genus *Dechenella* resulting in the appearance of several endemic species.

PHYLOGENETIC TRENDS

Examples of direct descent of one fossil species from another are not common. The numerous and closely spaced collections made at Twilight Creek, Bathurst Island, have yielded two such examples of evolutionary lineages. If correctly interpreted, these lineages illustrate two different patterns of speciation.

Dechenella tesca–Dechenella neotesca Lineage

The Blue Fiord *Dechenella tesca* is separated by 440 feet of beds from the Bird Fiord *Dechenella neotesca* to which it is considered ancestral (*see* Fig. 4). No entirely satisfactory explanation can be given for the absence of a transitional population from that 440 feet of strata, but there is the possibility that such a population was small and not likely to leave a fossil record. The structural changes involved in deriving *D. neotesca* from *D. tesca* are: (1) a pronounced deepening of the barely perceptible sagittal indentation in the pygidium of *D. tesca*; (2) an increase in convexity of cranidial and pygidial borders; (3) a steepening of the pygidial pleural field; (4) an increase in the transverse convexity of the glabella; and (5) a steepening of the slope of the palpebral lobes. Figure 6 illustrates these changes.

The origin of the sagittal pygidial notch in *D. tesca* and its subsequent accentuation in *D. neotesca* may be the result of neoteny. Osmolska (1962, p. 57) reports that a sagittal pygidial notch (a larval notch) is a general phenomenon in the meraspid pygidium of the Cyrtosymbolinae. During ontogeny this notch disappears. (cf. Osmolska, 1962, pl. 9, figs. 1-6). Considering the close relation between the Cyrtosymbolinae and the Dechenellinae (*see* p. 68), the writer considered it likely that the dechenellinid meraspid also might show a larval notch. Unfortunately, only one well-preserved meraspid pygidium was recovered from the Stuart Bay collections. This meraspid which belongs to *D. crepuscula* shows a conspicuous larval notch. The adult pygidium of *D. crepuscula* has no notch. In all likelihood the situation in the Dechenellinae is comparable to that in the Cyrtosymbolinae in which all meraspid pygidia observed by Osmolska (1962, p. 57) show a larval notch. On the basis of this evidence it is suggested that the slight indentation in the posterior margin of the adult pygidium of *D. tesca* appeared through the retention of the larval notch into the adult pygidium. The increased depth of this notch in *D. neotesca* is an example of the rapid development of a newly acquired character.

The adaptive value of a deep notch in the pygidium of *D. neotesca* is not known. One possibility is that it was an anal notch which provided a channel for currents moving waste products away from the living organism.

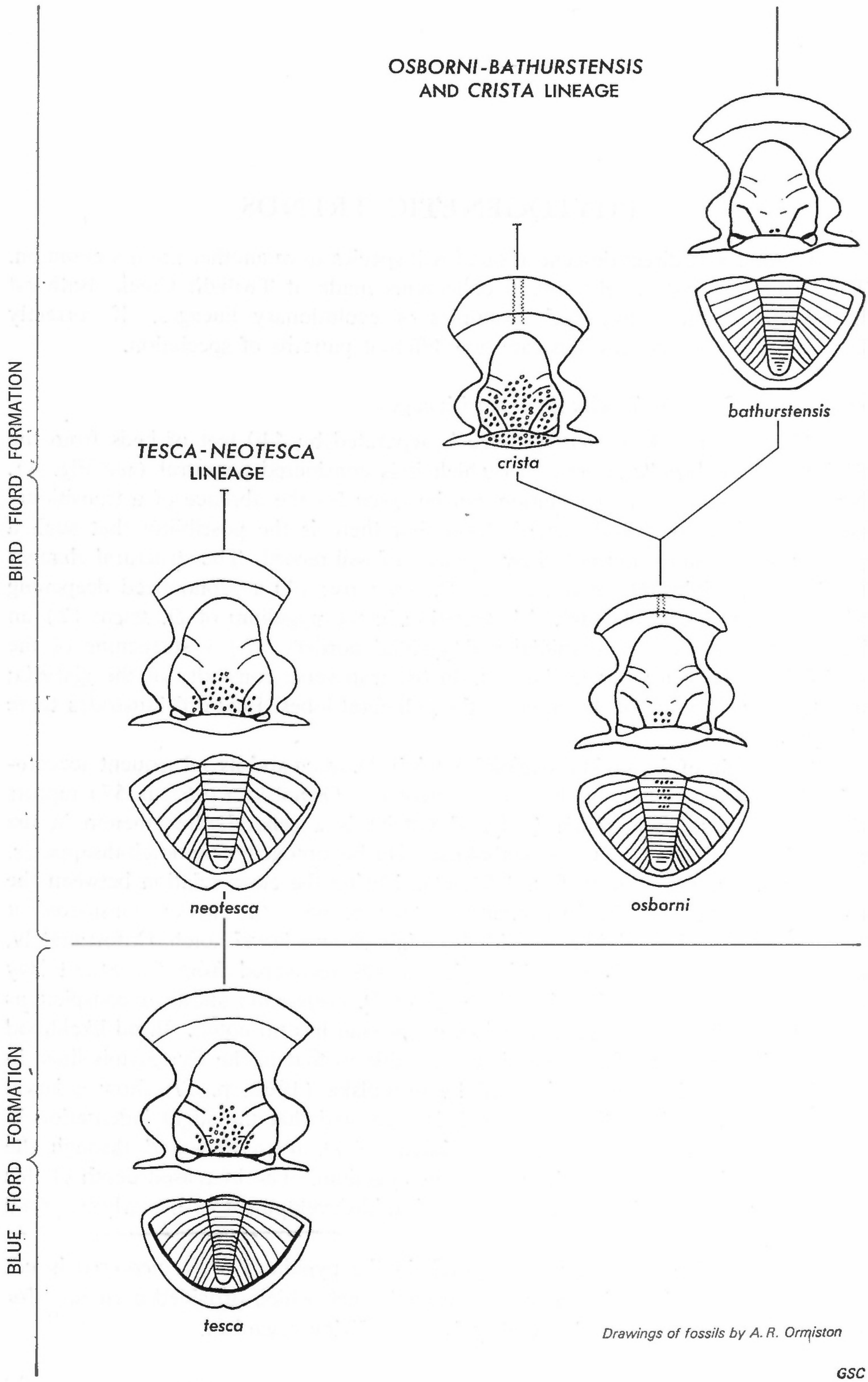


FIGURE 6. Two lineages in *Dechenella*, Twilight Creek, Bathurst Island.

Dechenella osborni–Dechenella crista and *Dechenella bathurstensis* Lineage

Dechenella osborni, the ancestral species of this lineage, first appears at 375 feet above the base of the Bird Fiord Formation (*see* Fig. 4). This horizon is 125 feet stratigraphically below the lowest known occurrence of *D. crista* and 100 feet below that of *D. bathurstensis*. That *Dechenella osborni* is ancestral to both *D. crista* and *D. bathurstensis* is suggested by morphological features that all three share and by their stratigraphic positions. The major morphological changes involved in deriving *D. bathurstensis* from *D. osborni* are: the disappearance of the faint sagittal, preglabellar ridge; the shallowing and shortening of the 2p and 3p furrows; broadening of the palpebral lobes; virtual disappearance of the cranidial prosopon; and a change in pygidial outline. Those involved in deriving *D. crista* are a strengthening and lengthening of the preglabellar ridge; a lengthening of the anterior border; a shortening of the glabella; and an increase in density of tuberculation on glabella and occipital ring. It is interesting to see that the characters that become more pronounced in one descendant species (preglabellar ridge, tuberculation, length of border) become weaker in the other.

Of the two species produced by splitting from *D. osborni* one was relatively successful and the other was not. *D. crista* is a rare species with a stratigraphic range of only 30 feet on Twilight Creek (*see* Fig. 4), and it is restricted to highly sandy beds. Its disappearance coincides with a change to finer grained rocks. In contrast, *Dechenella bathurstensis* is the most abundant Bird Fiord trilobite and ranges through 300 feet of strata (Fig. 4) in the Twilight Creek area.

SYSTEMATIC PALAEONTOLOGY

All type and figured specimens are in the collections of the Geological Survey of Canada (GSC) with the exception of the types of Tolmachoff (1926) which are in those of the Paleontologisk Museum, Oslo (PMO). Topotype material of several of the more common species has been deposited in the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts (MCZ). Dimensions included in the descriptions of the species are given in millimetres.

Faunal Composition

Middle Devonian trilobites of the Canadian arctic islands belong to seven families (Proetidae, Otarionidae, Aulacopleuridae, Harpidae, Scutelluidae, Lichidae, and Odontopleuridae). Thirty-four species are distributed among nineteen genera of which only two are new. Twenty-three species are new and fifteen of these belong to *Dechenella.*

A remarkable feature of these faunas is the apparent absence of any Phacopina, a group which is almost always present in Devonian faunas elsewhere in the world (Europe, Soviet Union, North America, South America, and Africa). All trilobites from Ellesmere Island assigned by Tolmachoff (1926) to *Dalmanites* have been restudied and are considered proetids.

The recognition of *Weberopeltis* in the Canadian Arctic is the first report of that genus outside of the Soviet Union.

Characters of the newly discovered cephalon and hypostome of *Ancyropyge* indicate that this unusual genus belongs in the Scutelluidae rather than in the Odontopleuridae where it had been previously placed.

Terminology

The terminology employed in this paper is that used by Whittington (1950, p. 2, text-fig. 1; 1956, pp. 160-162; 1957, fig. 1; 1960, p. 406, text-fig. 1; and 1961, p. 434) except that the term "glabella" is used to exclude the occipital ring. For terms not covered in the papers cited above the reader is referred to Harrington, *et al.* (1959, pp. 0117-0126) and to the glossary which follows.

Glossary

ANTERIOR NODE—A node occurring in the axial furrow at the position occupied by the anterior pit in many trilobites. This structure is present in *D. (Pedinodechenella) melvillensis* n. sp.

BETA—The Richters proposed a scheme (1949, p. 69) of Greek letters to designate certain positions (angles) in the course of the facial suture. Some of these seem to be of limited usefulness, but the writer finds frequent occasion to refer to 'the angle of the facial suture where it crosses the anterior border furrow' and finds it useful to employ the Richters' designation of that angle (beta).

EYE SOCLE—A translation of the Richters' (1950a, p. 164) augensockel. The part of the free cheek directly beneath the visual surface of the eye and separated from the genal field by a break in slope an/or a furrow. Typically it is also separated from the visual surface by a furrow and has the form of a curb-like ridge (*see* Shaw and Ormiston, 1963, in press).

GLABELLA—Used to exclude the occipital ring. It can be argued that the fusion of the occipital ring with the glabella in some trilobite groups (especially Illaenids) makes such a usage undesirable. However, in most trilobites that have the occipital ring fused to the glabella, the glabella is not circumscribed anteriorly by furrows and can only be arbitrarily defined.

GLABELLAR IMPRESSION—Used in descriptions of the Scutelluidae and other groups in which impressions on the glabella do not have the form of a furrow.

PREANNULUS—(*See* R. and E. Richter, 1956c, p. 346). In certain proetids the thoracic axial ring subdivided by a furrow (intra-annular furrow of R. and E. Richter, 1956) into an anterior part, the preannulus, and a posterior part, the postannulus.

PROSOPON—Used in place of "ornament" as recommended by Gill (1949, p. 572).

SIGMA—In the scheme of R. and E. Richter (1949, p. 68) the most distal point on the palpebral lobe.

TROPIDIUM—Originally proposed by R. Richter (1919, p. 3) for a ridge which traverses the preglabellar field parallel to the anterior border and continues on to the free cheek. It was recently used in this sense by Whittington (1960, p. 419). The true tropidium corresponds in position with the inner edge of the doublure and is therefore a totally different structure from the ridge on the genal field and fixed cheek of many proetids that has been called a tropidium by some authors (e.g., Hessler, 1963, p. 552.).

Taxonomic Criteria

At present there is considerable difference in the criteria used by different trilobite specialists (especially between students of Cambrian and students of post-Cambrian trilobites) to discriminate among species. Palmer (1960, p. 58) relies heavily on surface ornamentation (exoskeletal prosopon) as a specific character and has, for example, distinguished three species of *Litocephalus* on the basis of the prosopon of the cranidial border. Such procedure is at variance with the work of Best (1961, p. 1029) on a large sample (900 pygidia) which he regards as a local population of the single species *Encrinurus ornatus.* Best records as much variation in the exoskeletal prosopon of *Encrinurus ornatus* as exists in Palmer's three species of *Litocephalus.*

The writer prefers to regard taxa that vary only in exoskeletal prosopon as of subspecific rank in contemporaneous geographic variants (cf. *Warburgella rugulosa canadensis*) or as intraspecific variants in others. Characters used in this paper to discriminate among species (*see* Tables 4, 5) are comparable to those used by Whittington (1963, p. 26, pl. 28, figs. 1–15). Such characters most nearly correspond to Palmer's (1960, p. 58) generic criteria.

TABLE 4. Characters by which Bird Fiord species of *Dechenella* (*Dechenella*) can be readily distinguished

	D. bathurstensis	*D. algida*	*D. osborni*	*D. crista*	*D. neotesca*	*D. crepuscula*
anterior border	broad and flat	moderately broad, semi-cylindrical	bears a faint sagittal ridge	very broad, sagittal ridge	broad and gently convex	moderately broad, semi-cylindrical
glabellar outline and transverse convexity	conical gentle	somewhat clover-leaf shaped moderate	conical gentle	conical gentle	subconical moderate	somewhat clover-leaf shaped moderate
outline of lp furrow	strongly angulate	arcuate	subarcuate deeper than in *bathurstensis*	sub-arcuate	angulate	arcuate
angle of divergence of anterior branch of suture from midline	36 degrees	40 degrees	27 degrees	37 degrees	28 degrees	31 degrees
number of glabellar furrows	3	4	3	3	3	4
number and shape of axial rings	16-17 transverse	14 last five are fused	16 transverse	—	14 transverse	14 last five are fused
pygidial outline	truncate posteriorly	truncate posteriorly	nearly semioval	—	W shaped	evenly rounded posteriorly

Examples of characters considered generic are (1) glabellar construction (including outline, number and position of furrows, and convexity); (2) position of the eye; (3) position and number of major cephalic spines; (4) pygidial outline; and (5) hypostomal configuration. *Deltadechenella* n. gen. will serve as an illustration of the degree of difference considered generic. The cranidium resembles that of *Dechenella* except for the anterior branch of the facial suture not being angulated at beta. The pygidium, however, has a triangular outline and only five pleural furrows unlike any known species of *Dechenella.*

TABLE 5. Characters by which Blue Fiord species of *Dechenella* (*Dechenella*) can be readily distinguished

	D. maclareni	*D. paramaclareni*	*D. paragranulata*	*D. tesca*	*D. franklini*	*D. spaekkassensis*
anterior border	broad and low	shorter than in *maclareni*	bipartite in cross section	broad and low	absent	broad and convex
glabellar outline and transverse convexity	conical gentle	subconical gentle	blunt anteriorly strong	sub-conical gentle	clover-leaf shaped moderate	conical gentle
outline of lp furrow	arcuate	arcuate	sigmoidal	angulate	arcuate	subarcuate
angle of divergence of anterior branch of suture from midline	38 degrees	28 degrees	26 degrees	43 degrees	33 degrees	29 degrees
number of glabellar furrows	4	4	4	3	3	3
number and shape of axial rings	18 fused posterior to 5	—	14 bowed posteriorly	16-17 flattened apically	—	13-15 bowed posteriorly
pygidial outline	semioval	—	semioval	indented medially	—	nearly semicircular

Family Scutelluidae R. and E. Richter, 1955

Discussion. The number of genera in the Scutelluidae has increased rapidly in recent years largely as a result of works by the Richters (1956a, 1956b) and Šnajdr (1958, 1960). Several of the genera were originally considered subgenera (*Paralejurus, Planiscutellum, Scabriscutellum, Thysanopeltis, Kolihapeltis*) by the Richters (1956a) and later promoted to generic rank by Šnajdr (1958, 1960), who proposed a total of twelve new genera. Although some palaeontologists might regard the introduction of so many new genera in such a short time as evidence of excessive "splitting", the writer considers this large number the result of a sensible overhaul of a group in which revision was long overdue. Šnajdr's two papers have done a great deal to bring the family up to date.

The genus *Scutellum* (*see* diagnosis) is used in this paper in the restricted sense of the Richters and Šnajdr. The present work requires augmenting the Scutelluidae by yet another genus as *Ancyropyge* has proved to have the characters of that family rather than of the Odontopleuridae in which it was formerly placed. An Arctic representative of *Platyscutellum* Šnajdr, 1958 apparently requires extending the geological range of that genus to include the Middle Devonian.[1]

Genus *Scutellum* Pusch, 1833

Type species: *Scutellum costatum* Pusch, 1833

Diagnosis. Cephalon low lying to moderately convex; glabella moderately expanded forward. Preglabellar depression very narrow or absent. Three pairs of lateral glabellar impressions, 1p imperfectly horseshoe shaped (convex inward) with a small medium elevation, 2p (the supplementary pit between 2p and 3p of R. and E. Richter, 1956a, p. 101) a gentle transversely oval depression separate from axial furrow, 3p deeper and longer (trans.) than 2p typically reaching axial furrow. An additional area of muscle insertion is the semicircular depression in the fixed cheek adjacent to axial furrow and posterior to lp impression. Anterior part of fixed cheek narrow, broad (trans.) in vicinity of palpebral lobes. An eye ridge is typically present.

Thorax of ten segments, axis wide but narrower than pleurae. Pygidium semi-elliptical to slightly pentagonal. Raised central platform of pygidium fairly small, surrounding pygidial area concave in profile. Seven paired pleural ribs are broad and moderately convex, median rib wide and not bifurcated. Length of pygidial doublure (sag.) about half of post-axial pygidial length.

Geological range. Silurian to Upper Devonian (Frasnian).

Scutellum depressum Cooper and Cloud, 1938

Plate I, figures 1-6

1938. *Scutellum tullium depressum* Cooper and Cloud, pp. 458-459, Pl. 55, figs. 36, 37, 39-45.

Material. GSC No. 18089, nearly complete specimen lacking free cheeks; GSC No. 18090 and GSC No. 18091, two cranidia; GSC No. 18092, pygidium; Blue Fiord Formation, 350 feet above the base, Warner River, Bathurst Island, lat. 76°20′, long. 98°50′; coll. Ormiston, 1962.

Description. Cranidium—Outline of anterior margin nearly straight medially, laterally curving more strongly backward. Preglabellar depression shallow and narrow, disappearing medially where the glabella impinges on the anterior border, and merging with the axial furrow at the anterolateral corner. In longitudinal

[1] Platyscutellum brevicephalus is now considered Emsian (*see* p. 18).

profile the glabella is steeply convex anteriorly, and moderately convex posteriorly. In transverse profile gently convex and low lying. Glabella expands evenly and rapidly anteriorly. The maximum glabellar width occurs at one fifth the total glabellar length from the anterior margin and is more than twice that at the occipital furrow. Glabellar width equals length of glabella (sag.) plus occipital ring. Glabellar outline sub-triangular. Three pairs of glabellar furrows are smooth, shallow depressions. 1p imperfectly horseshoe-shaped, surrounding a median tubercle. The posterior part of the 1p furrow more deeply incised than the anterior part, both reach the axial furrow. 1p is situated just anterior to a point opposite the anterior edge of the palpebral lobe and extends transversely for one third the width of glabella. 2p is a short, transversely elongate, oval depression isolated from the axial furrow by a distance about its own length. 3p runs from the anterior pit on the axial furrow parallel to the anterior margin for a distance equal to one third the maximum glabellar width. Distance (exs.) between 1p and 2p equal to that between 2p and 3p. An additional area of muscle insertion is the smooth field developed on the fixed cheek adjacent to the axial furrow and extending from the base of the glabella to the midpoint of the 1p furrow. Anterior glabellar lobe rectangular and of length (exsagittal) equal to one third that of whole glabella. In longitudinal profile the anteriorly sloping occipital ring rises above the level of the glabella. Occipital furrow broad and moderately deep, accentuated by the steep decline of the posterior edge of glabella. Occipital ring broad and strongly convex transversely. A distinct, but shallow transverse furrow crosses the ring at a point just posterior to the midpoint of the palpebral lobes and merges laterally with the paired, roughly circular, smooth depressions present on the lateral edge of the ring just above the axial furrow. These areas are occipital muscle impressions. Axial furrow deep, deepest opposite the basal glabellar lobe. A deep, circular, anterior pit occurs on the axial furrow at the distal end of the 3p glabellar furrow. From the anterior pit a broad, posterolaterally directed furrow crosses the fixed cheek. Axial furrow shallows anteriorly. Fixed cheeks narrow in front of eyes, broadest at eye line. Fixed cheek gently concave anterior to anterior pit and strongly convex posterior to it, but nearly horizontal opposite the palpebral lobe. Posterior to the palpebral lobe the fixed cheek declines abruptly. A shallow but distinct palpebral furrow parallels the outer margin of the palpebral lobe at a distance of about 1 mm. Palpebral lobes of less than glabellar height, horizontally directed, longer than broad, possessing a projecting tubercle at the posterolateral corner. Anterior branch of the facial suture runs in a very gently outwardly convex curve to a point opposite the anterior branch of the 1p furrow, thereafter is a straight line which is weakly divergent anteriorly. Posterior branch of suture curves backward and outward to run nearly at right angles to the midline before curving around in a semicircle to cut the posterior margin. Exoskeletal surface of glabella, occipital ring and fixed cheek posterior to the anterior pit bears tubercles that have a steep posterior slope and a gentle anterior slope and appear to be inclined backward.

Thorax—Thorax of ten segments. Convex axial rings forwardly sloping in longitudinal profile. Inner half of pleurae horizontal, outer half sloping evenly downward and curving gently backward. Width of axis equal to three fourths that of pleural field. Axis and inner part of pleurae tuberculate. Pygidium—Ratio of length to width about 2:3. Outline semi-elliptical. Triangular axis strongly convex, about twice as wide as long, length equal to one fifth the total length of the pygidium. Axis not longitudinally subdivided. Axial furrows shallow, nearly obsolete at posterior end of axis. Pleural regions bear seven pair of furrows which set off seven paired ribs and an unpaired median rib. Furrows do not reach the pygidial margin. Ribs moderately convex in cross section, tapering anteriorly so that width adjacent to axis equals one third their maximum width, except for median rib which, though initially tapering, expands slightly just posterior to the axis. Average rib width equals four times the width of a furrow. Inner half of pleural regions platform-like, nearly horizontally directed. At about the mid-length of the pygidium there is an abrupt change in slope of pleural regions along a boundary roughly parallel to the pygidial margin so that they slope downward and outward. Doublure broad, equal to two thirds the width of pleural regions. Exoskeletal surface of ribs and axis tuberculate.

Dimensions.

	GSC No. 18091	GSC No. 18090	GSC No. 18092
cranidial length	11.5	10.1	
glabellar length	8.9	8.1	
maximum glabellar width	11.3	10.0	
occipital glabellar width	5.0	4.3	
sag. glabellar height	3.0	2.9	
pygidial length			24.2
pygidial width			(35.2)
axial length			5.1
axial width			9.0

Discussion. The species *S. tullium* (Hall, 1888) from the Middle Devonian of New York State, *S. depressum* Cooper and Cloud, 1938 from the Middle Devonian of Illinois, *S. flabelliferum* (Goldfuss, 1843) from the Middle Devonian of Germany, and *S. costatum* (Pusch, 1833) from the Middle and Upper Devonian of Europe are all very similar to one another. The cranidia of these species can be distinguished only with difficulty, the pygidia somewhat more easily.

Less closely allied but similar to these species is *S. alutaceum* (Goldfuss, 1843) from the Eifelian of Germany. The structure of the pygidial axis in *S. alutaceum* distinguishes it fairly readily from the others.

All the above-mentioned species with the exception of *S. depressum* are represented in the MCZ collections (*S. flabelliferum* MCZ 4067-4080; *S. tullium* MCZ 4101; *S. costatum* MCZ 4090; and *S. alutaceum* MCZ 4092) and have been compared directly with the Arctic material.

The material described here may be distinguished from *S. tullium* Hall by its lower, less convex glabella, a circular rather than oval anterior pit, and a gentler slope to the posterior part of the pygidial field. The glabellar dimensions are essentially identical with those of the paratype USNM 95201e of *S. depressum* (Cooper and Cloud, 1938, pl. 55, figs. 30 and 44). The sagittal glabellar height (2.9 mm) and occipital glabellar width (4.2 mm) of that specimen compare very closely with the same dimensions of GSC No. 18090 (*see* measurements). In contrast, a similar size specimen of *S. tullium,* hypotype USNM 89742 (Cooper and Cloud, 1938, pl. 55, fig. 35; Cooper and Williams, 1935, pl. 60, fig. 12) has a sagittal glabellar height of 4.0 mm and an occipital glabellar width of 3.9 mm.

Although the cranidium is very like those of *S. flabelliferum* (Richter, R. and E., 1956, p. 96, p. 7, figs. 40–42) and *S. costatum* (Richter, R. and E., 1926, pp. 117–123, pl. 7, figs. 18–23), *S. depressum* may be distinguished from both species by pygidial features. From the former it differs in having much narrower pygidial furrows and in lacking the sigmoidal longitudinal profile which pygidia of *S. flabelliferum* exhibit. From the latter it differs mainly in the nature of the median rib which tapers continuously in *S. costatum* but expands slightly just posterior to the axis in *S. depressum.* From *S. alutaceum* (Goldfuss, 1843) (R. and E. Richter, 1956a, p. 95, pl. 6, figs. 38-39; pl. 7, figs. 44-46), *S. depressum* may be distinguished by lacking the fine line surrounding the central part of the pygidial axis that is characteristic of *S. alutaceum* (*see* R. and E. Richter, 1956a, p. 95).

Considering the very minor differences that distinguish, for example, *S. costatum* from *S. tullium,* it seems that the differences in glabellar convexity and pygidial profile between *S. tullium* and *S. tullium depressum* (Cooper and Cloud) merit elevating the latter form to specific rank, as Whittington (1960, p. 417) has already suggested by usage.

The type material of *S. depressum* comes from Calhoun County, Illinois, from strata considered by Cooper, *et al.* (1942) to belong to the upper Middle Devonian Taghanic Stage.

Genus *Platyscutellum* Šnajdr, 1958

Type species: *Bronteus formosus* Barrande, 1846

Diagnosis. See Šnajdr (1960, p. 254)

Platyscutellum brevicephalus n. sp.
Plate I, figures 7-11

Holotype GSC No. 18095. Incomplete cranidium lacking the occipital region but with the left sutural margin preserved. Eids Formation, about 75 feet below the top, Dyke Creek, southeastern Bathurst Island, lat. 75°15′, long. 98°27′; coll. Ormiston, 1959.

Paratypes GSC No. 18099. Fragmentary pygidium, same horizon and locality. GSC Nos. 18096 to 18098. Two pygidia, one crushed cranidium; Middle Devonian limestone, largest of Princess Royal Islands, lat. 72°48′, long. 117°46′; coll. E. T. Tozer, 1959.

Description. Cranidium–Anterior margin nearly transverse opposite the width of the median glabellar lobe, curving gently backward distally. Preglabellar depression broad (sagittal), gently concave, becoming broader distally. Glabella not distinctly separated from the depression medially, distally a change in slope delimits the anterior glabellar margin. In longitudinal profile glabella is weakly convex, depressed, with a broad transverse depression opposite the base of the median lateral lobe. (According to Šnajdr, 1960, p. 231 this circular lobe represents the fused median and anterior lateral lobes.) In transverse profile glabella is low lying and gently convex. Glabella expands rapidly anteriorly, maximum width at anterior end is more than two and one half times that opposite the compound 1p-2p glabellar impression. Glabellar outline subpentagonal. Three pairs of lateral glabellar impressions, 1p and 2p are fused and lack the median elevation between them present in other species of the genus. These fused impressions form a gentle circular depression opposite the anterior edge of the palpebral lobe at a distance of one third the glabellar width from the axial furrow. Posteriorly this depression is joined to the axial furrow by a broad, smooth depression. An anterior prolongation of the 1p-2p impression runs parallel to the midline to join the proximal end of the 3p impression. The 1p-2p impression is united opposite the anterior edge of the palpebral lobe by a distinct transverse depression of length equal to one third the width of the glabella. This transverse furrow also forms the posterior boundary of an anterior median glabellar lobe. The transversely elongate oval 3p impression is joined to the axial furrow by a smooth, shallow depression. Thus a rounded lateral lobe is isolated between the anterior and lateral parts of the 1p-2p impression and the 3p impression. This is termed the median lateral lobe. An anterior, median glabellar lobe of subrectangular outline is also delimited. In front of the 3p impression is the anterior lateral lobe which is roughly rectangular in outline and of slightly greater length (exs.) than the median lateral lobe. All of these glabellar lobes are slightly inflated. The occipital area is not preserved. Axial furrows distinct, deepest opposite the midpoint of the palpebral lobe. Fixed cheeks in front of eye narrow, becoming twice as broad (trans.) in vicinity of palpebral lobe, moderately convex. Palpebral lobe of glabellar height, as broad (trans.) as long (exs.). Distinct palpebral furrow at proximal edge of lobe runs subparallel to palpebral margin. Anterior branch of the facial suture strongly divergent, running parallel to the axial furrow, curves gently inward before cutting the anterior margin. At the anterior edge of the palpebral lobe suture runs outward perpendicular to the midline and runs inward perpendicular to the midline at its posterior edge. Posterior branch of suture runs backward and slightly outward for a short distance, then bends around sharply to run outward and slightly forward before again turning slightly backward. Posterior margin of cranidium is not preserved.

The suface of cranidium excepting the glabellar furrows bears scattered tubercles of varying size. Tubercles in the preglabellar depressions are smaller than those elsewhere.

Pygidium—Description based on hypotype GSC No. 18098. Outline semi-elliptical to faintly pentagonal; ratio of length to width as 7:8. Subtriangular trilobate axis twice as wide as long; axial furrows distinct. Pleural regions with seven pairs of furrows setting off seven paired ribs and median rib. Ribs broadly convex in cross section about three times as wide as rib furrows. Median rib bifurcate for nearly entire length. Doublure near to dorsal exoskeleton, occupying about one third of post-axial pygidial length. Exoskeletal surface tuberculate, axis with sagittal row of tubercles.

Discussion. The glabellar outline, nature of the preglabellar furrow, glabellar lobation, course of the facial suture, and form of the fixed cheeks are characters of this species that suggest assignment to *Platyscutellum*. It differs, however, from all known species of the genus in its depressed and shorter glabella, the absence of a median elevation in the compound 1p-2p glabellar impression, the presence of a transverse depression uniting the 1p-2p impression, the less arcuate outline of the anterior cranidial margin, and from all but *P. lochkovense* Šnajdr, 1960 (Šnajdr, 1960, pl. 15, figs. 3-4) in having tubercles. The absence of a median elevation in the 1p-2p impression may represent the end point in a reduction of this lobe in which *P. spiniferum* (Barrande, 1852) (Šnajdr, 1960, pl. 16, fig. 8), with this elevation reduced to an isolated tubercle, could be considered an intermediate form.

P. brevicephalus resembles most closely *P. viator* (Barrande, 1852) from the Lower Devonian of Bohemia (op. cit., pl. 17, figs. 2-8), being especially similar in glabellar outline, glabellar lobation, and form of fixed cheeks. The most conspicuous difference between the two species is the less inflated and proportionately shorter glabella of *P. brevicephalus*. The ratio of the maximum glabellar width to the dimension measured from the anterior edge of the glabella to a sagittal point opposite the midpoint of the palpebral lobe averages 1.38:1 for three specimens of *P. viator* in the MCZ collections (MCZ 3958) and 1.64:1 for *P. brevicephalus* (GSC No. 18095). Other differences include the larger palpebral lobe and narrower (trans.) anterior part of the fixed cheek of *P. viator*. The width (trans.) of the anterior part of the fixed cheek of *P. brevicephalus* is more comparable to that of *P. formosum* (Barrande, 1846) (Šnajdr, 1960, pl. 16, fig. 4).

The new species resembles *P. lochkovense* Šnajdr, 1960 (1960, p. 255, pl. 15, figs. 3-4) in having scattered tubercles on the exoskeleton rather than the sculpturing which all other species exhibit.

Genus *Ancyropyge* Clarke, 1891

Type species: *Acidaspis romingeri* Hall and Clarke, 1888

Diagnosis. Cephalon twice as broad (trans.) as long (sag.), outline exclusive of cephalic spines transversely elliptical, bearing a long librigenal spine, a second spine arising proximal to the base of the eye lobe, and a single occipital spine. All five major cephalic spines of approximately equal length, which is three times glabellar length (sag.). Glabellar outline tear-drop shaped. Glabella forwardly expanding, three pair of lateral impressions. Occipital area weakly differentiated from glabella, produced in a long spine. Fixigenae rapidly rising posterior to 3p glabellar lobe. Palpebral lobe slopes downward and outward. Eye situated far posteriorly, overhangs posterior cephalic margin. Anterior branch of facial suture forwardly convergent; posterior branch runs nearly vertically on sharply down-turned posterior part of fixed cheek, beneath overhanging eye. Pygidial axis inflated, with one ring and trilobite terminus. There are six paired marginal spines, the lateral ones backwardly recurved so as to eventually parallel the midline. An additional pair of spines situated just axially from the fourth marginal pair emerges at an angle of 30 degrees from the pleural field near the margin. Length of spines about 4.5 times pygidial length (exs.).

Ancyropyge arcticus n. sp.

Plate I, figure 12; Plate II, figures 1-11; Plate III, figures 1-5

Holotype GSC No. 18101. Cranidium; Blue Fiord Formation 315 feet above the base, Middle Devonian, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′; coll. Ormiston, 1962.

Other material. Paratypes: GSC No. 18108, pygidium lacking axis; GSC No. 18102, hypostome; GSC No. 18110, cranidium with fixigenal spines; GSC No. 18104, cranidium; GSC No. 18107, cranidium; GSC Nos. 18100, 18109 and 18111, three pygidia; GSC Nos. 18103 and 18105, two free cheeks; GSC No. 18106, pygidial doublure; same horizon and locality.

Description. Cranidium—Anterior border narrow (sag.), semicylindrical in profile. Preglabellar depression narrow, widening slightly distally. In longitudinal profile the glabella declines anteriorly in a steep gently convex slope and ascends posteriorly in a shallower less convex slope, in transverse profile least convex across the midlength of the 3p glabellar lobes, very steep sided and strongly convex posterior to that position. Glabella expands forward rapidly from occipital furrow to midpoint of 3p glabellar lobe, but expands only slightly anterior to 3p lobe. Maximum glabellar width is just anterior to anterior pit at one fourth the glabellar length (sag.) from the anterior margin and is 1.6 times that opposite occipital furrow. Maximum glabellar width approximately equals glabellar length.

Glabellar outline tear-drop shaped, slightly constricted opposite 1p glabellar impression. Three pair of glabellar impressions are smooth, fairly shallow depressed areas. 1p is a short, slightly backwardly directed furrow located opposite the anterior edge of the palpebral lobe, runs from the axial furrow up the nearly vertically sloping side of the glabella to a position nearly level with the outer margin of the palpebral lobe. The distal end of the ovoid 2p impression is only slightly anterior to the distal end of 1p but is separated from the axial furrow, beginning well up on the steep glabellar slope. 2p is deeper than 1p and runs forward and slightly inward for a short distance, shallowing anteriorly. 3p is an oval depression directed inward and slightly backward, beginning just proximal to the anterior pit with which it is connected by a shallow saddle. Distance (exs.) between 2p and 3p furrows equals about twice the length of 3p furrow. An additional area of muscle insertion is a crescentic impression on the fixed cheek adjacent to the axial furrow opposite the 1p lobe. Basal glabellar lobe ovoid in outline with long axis parallel to 1p furrow, slightly inflated. 2p glabellar lobe not developed. 3p glabellar lobe nearly isolated, subtriangular in outline, inflated. Length of 3p lobe (exs.) equals one third total glabellar length. Anterior glabellar lobe short (sag.), not inflated, outline rectangular. Occipital furrow broad and shallow, indistinct except adjacent to axial furrow where lateral part of occipital ring is distinctly set off and occipital furrow merges with the axial furrow. Occipital area is weakly differentiated from glabella. Occipital ring produced in a long medial spine of circular cross section. In profile occipital spine initially rises at 20 degrees to the horizontal, progressively more downturned posteriorly. Axial furrow deep, deepest opposite 1p lobe, climbing and becoming shallowest opposite the midlength of the 3p glabellar lobe then declining again anteriorly. A large, sub-circular anterior pit present on axial furrow opposite the distal end of the 3p lateral glabellar impression. Fixed cheek broad (trans.), width opposite 2p impression equals one third glabellar length, narrowing anteriorly. Fixed cheek rises posteriorly from anterior pit in a steep even slope making an angle of 40 degrees to the horizontal. Posterior to the 3p glabellar lobe the inner part of the fixed cheek slopes steeply downward and inward to the axial furrow. Anterior part of fixed cheek concave, bounded anteriorly by nearly vertical anterior border. A distinct eye ridge traverses the fixed cheek from near the 3p lobe to the anterior end of eye. The posterolateral corner of the fixed cheek is produced in a fixigenal spine similar in size and curvature to the occipital spine. Beneath the fixigenal spine the cheek descends steeply to the posterior margin. Narrow (trans.) palpebral lobe rarely preserved situated opposite to the basal glabellar lobe, slopes downward and outward (Pl. III, fig. 1). Palpebral lobe of slightly less than glabellar height. Anterior branch of facial suture runs in a very gentle outwardly convex curve to a point opposite the base of 3p glabellar lobe from which it continues as an anteriorly convergent straight line curving inward before cutting the anterior margin. The angle of sutural convergence towards the midline is 10 degrees. Posterior branch of suture runs nearly vertically on sharply downturned cheek initially inward and downward curving to run at right angles to midline before cutting inward and downward across the posterior margin. Exoskeletal surface of glabella anterior to 2p furrows bears terrace lines subparallel to anterior margin. Whole glabella and fixed cheeks bear numerous tubercles. The exoskeleton of the occipital and fixigenal spines bears a backwardly directed fish scale-like prosopon.

Free cheek– Eye holochroal, with about 2,500 lenses arranged in diagonal rows, large, length equals about two thirds maximum width of cheek, semicircular. Eye set so far posteriorly on cheek that one eighth its length overhangs posterior margin. Outline of cheek exclusive of genal spine a right triangle. Genal field slopes steeply and evenly down from eye and turns up laterally to merge with border of semicylindrical cross section. Degree of marginal flexure increases anteriorly. Border bears strong diagonally directed terrace lines. Posterior edge of cheek turns down sharply and slopes nearly vertically to posterior margin. No posterior border. Posterior margin trends at 60 degrees to cephalic midline. Posterolateral corner of cheek is produced in a broad, long genal spine of oval cross section which curves outward and progressively more strongly backward. Length of genal spine at least twice that of genal field and presumably equal to that of fixigenal and occipital spines. Exoskeletal surface of genal field bears scattered tubercles. Prosopon of genal spine like that of fixigenal and occipital spines. Hypostome–wider than long. Greatest width across anterior edge of anterior wings (trans.) equals 1.3 times greatest length (sag.). Outline of anterior margin forwardly convex but straightened medially. Triangular anterior wing small, ascending very steeply. Outline of middle body subcircular, part of middle body posterior to maculae faintly elongated longitudinally. Middle body equally convex longitudinally and transversely, strongly inflated. No middle furrow. Lateral border broad, flat to inwardly sloping, steepening posteriorly, with prominent lateral shoulder. Border furrow broad and shallow. On the middle body posterior to the shoulder and adjacent to border furrow is a macula of oval outline bearing scattered granules on its posteroventral face. Outline of posterior hypostomal margin smoothly rounded. At posterior midline doublure descends at about 90 degrees to border, elsewhere doublure makes an angle with border of about 130 degrees. Exoskeletal surface of middle body bears subconcentric, irregular terrace lines.

Thorax unknown.

Pygidium– Outline exclusive of pleural spines subrectangular. Pygidium wider than long. Axis inflated, maximum width (trans.) is more than one half pygidial width. The axis consists of a trilobate terminal piece in front of which there is a ring which is broken on all specimens. On several specimens the lateral part of the anterior margin is, however, preserved and is located so far forward of the broken ring that I consider that the ring cannot represent an articulating half ring but must be an axial ring. Presumably there is only one strongly inflated ring. The ring furrow is broad and deep. Terminal axial piece twice as wide as long, tapering rapidly posteriorly. Axial furrow broad and deep anteriorly, shallow posteriorly (Pl. III, fig. 3). In transverse profile pleural field slopes axially, gently convex in longitudinal profile. There are six paired marginal spines, the lateral ones strongly recurved eventually paralleling the midline, the posterior spines nearly straight. The third through sixth pair of spines are clearly continuations of pleural ribs which are set off by broad, shallow rib furrows that die out axially. An additional pair of spines situated slightly axially from the fourth pair of marginal spines emerges at an angle of 30 degrees from the pleural field near the margin. Length of pygidial spines is at least 4.5 times pygidial length (exs.) (GSC No. 18108). Doublure convex downward of width (sag. and exs.) equal to three fourths post axial pygidial length (sag.). Terminal piece of axis bears tubercles.

Dimensions.

	GSC No. 18101	GSC No. 18107	GSC No. 18104
maximum glabellar width	60	14.0	14.6
glabellar length (to occ. furrow)	60	14.8	14.8
glabellar width at occ. furrow	3.9	10.0	9.2
minimum length occ. spine	8.0	22.0	17.0
	GSC No. 18111	GSC No. 18100	GSC No. 18108
pygidial width	15.6	15.0	14.0
pygidial length	——	10.0	cca. 9.0
width terminal axial piece	10.0	8.6	——
length terminal axial piece	5.0	4.3	——
minimum length of spines	20.0	——	44.0

Discussion. The genus *Ancyropyge* Clarke, 1891 has been hitherto known from only two pygidia, the holotype, described as *Acidaspis romingeri* by Hall and Clarke (1888, p. 71, pl. 16b, figs. 15-18) and a hypotype described by Stumm (1953b, p. 126, pl. 6, fig. 2). Both specimens were collected from the Middle Devonian Traverse Group in the area of Little Traverse Bay, Michigan. Prantl and Přibyl (1949, p. 133) considered the systematic position of *Ancyropyge* "very doubtful" but placed it in the Superfamily Odontopleuracea. Stumm (1953b, p. 126) assigned the genus to the Odontopleuridae. Whittington initially (1956a, p. 282) indicated reservations about the systematic position of *Ancyropyge* by listing it among taxa "sometimes referred to Odontopleuridae", but later (*in* Harrington, *et al.,* 1959, p. 509) placed it in the family Odontopleuridae.

The material described here clearly demonstrates that *Ancyropyge* is a scutelluid, although an unusual one. The trilobate pygidial axis, hypostome, glabellar outline, and glabellar impressions are all scutelluid in nature. The strong, overall structural similarity of *Ancyropyge* to the Odontopleuridae suggests it is an odontopleurid mimic. The cephalic and pygidial spines are especially odontopleurid-like, and it is understandable that when only the tail was known, *Ancyropyge* was mistaken for an odontopleurid.

Ancyropyge most closely resembles the scutelluid *Weberopeltis* Z. Maximova (Richter *in* Harrington, *et al.*, 1959, p. 372, fig. 281) (Maximova, 1960, p. 147, fig. 347). The two genera have in common an anteriorly convergent facial suture, fixigenae produced backward into spines, a strong occipital spine, and strongly developed marginal pygidial spines. *Ancyropyge* differs from *Weberopeltis* chiefly in the nature of the glabellar outline which is subtriangular and forwardly expanding in the former genus, but posteriorly rectangular and not forwardly expanding in the latter; in that the cephalon is not so short (sag.); and in having only seven paired pygidial spines and no additional unpaired median spine as in *Weberopeltis aculeata* (Weber) (Richter, *in* Harrington, *et al.*, 1959, fig. 281). Other differences include the position of the eye which is at the posterior margin of the cheek in *Ancyropyge* but far anterior to that position in *Weberopeltis*; the distribution of pygidial spines all in one plane in *Weberopeltis* contrasted with several planes in *Ancyropyge.*

A forwardly convergent facial suture is uncommon among scutelluids, but the two genera are distinct. Presumably they have a common ancestry.

Ancyropyge arcticus closely resembles the type species *Ancyropyge romingeri* (Hall and Clarke). It differs in having a less inflated, and less distinctly trilobate axial terminus, and in that the non-marginal pair of pygidial spines which in *A. romingeri* rise directly above the fourth marginal pair, in *A. arcticus* are situated slightly axially from the fourth pair and do not overlie them. In all other respects the two species are practically identical.

Ancyropyge manitobensis (Whiteaves, 1892)
Plate III, figures 6-8

1892. *Bronteus manitobensis* Whiteaves, p. 347, Pl. 46, figs. 5, 6 (*not* 7).

Material. GSC No. 18112, nearly complete cranidium; GSC No. 18113, partial cranidium; Middle Devonian Bird Fiord Formation, 390 feet above base, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′; coll. Ormiston, 1962.

Description. Cranidium– differs from that of *Ancyropyge arcticus* only in the following features: (1) A prominent sagittal glabellar node is situated opposite the midpoint of the 2p lateral glabellar lobe. The node is transversely elongate and has concentrically arranged terrace lines around it. (2) In longitudinal profile the anterior slope of the glabella merges with that of the median node and is steeper and less convex than that of *A. arcticus.* Specimen 18112 retains both fixigenal spines which are similar in size and length to the occipital spine.

Hypostome– indistinguishable from that of *A. arcticus.*

Discussion. Whiteaves (1892, p. 347) described under the name *Bronteus manitobensis* five specimens from strata now known to belong to the Winnipegosis Formation of Manitoba. He expressed some reservation that all five specimens should be assigned to the same species. A re-examination of Whiteaves' syntypes confirms that three of the specimens are conspecific. Two others (GSC No. 4110 and GSC No. 4111), although identifiable as belonging to *Ancyropyge*, are too poorly preserved for specific assignment. These two specimens are probably best excluded from the type series of *B. manitobensis.* The three remaining syntypes (GSC Nos. 4109, 4109a, and 4108) are conspecific with the specimens described here from the Bird Fiord Formation.

The Manitoba occurrences of *A. manitobensis* are in the *Stringocephalus*-bearing upper beds of the Winnipegosis Formation. These strata represent the earliest appearance of *Stringocephalus* in Manitoba (Warren and Stelck, 1962, p. 283, fig. 4) and are presumably of early Givetian age. Alleged pre-Givetian occurrences of *Stringocephalus* in Germany are apparently based on the work of Kayser (1871, p. 340). Struve (1961a, p. 328) has been unable to find any Eifelian occurrences of this important brachiopod, and implies (p. 330) that reports of such occurrences result from misidentifications.

Of twenty cranidia of *A. arcticus* examined none showed a longitudinal profile approaching that of *A. manitobensis.* The nature of their stratigraphic occurrence is additional reason for regarding *A. arcticus* and *A. manitobensis* as discrete species.

Genus *Weberopeltis* Z. A. Maximova, 1959

Type species: *Bronteus aculeatus* Weber, 1945

Diagnosis. (Maximova, *in* Tchernysheva, 1960, p. 147.) "Cephalon structurally nearer to *Scabriscutellum* than to *Scutellum,* sometimes carrying spine-shaped outgrowths. Pygidium of *Scutellum* type but typically with strong development of pleural spines, always appearing as continuations of the pleural ribs. Median rib sometimes bifurcated. Surface usually granulose. Many species. Silurian to Middle Devonian (Eifelian Stage) of the Urals, Kuznetz Basin, Rudnig Altai, and Central Asia." (freely translated)

Discussion. Elsewhere she added (Maximova, 1960, p. 35), "From *Scabriscutellum,* which it resembles in the cephalon, and from Western European species of *Thysanopeltis* it differs in the broad pleural ribs of the pygidium and in the possession of pleural spines (in *Scabriscutellum* the pygidial margin is entire, in *Thysanopeltis* the marginal spines are unconnected with the pleurae)." (freely translated)

Geological range. Upper Silurian to Middle Devonian (Eifelian).

Weberopeltis aff. *arcticum* (Weber, 1945)

Plate IV, figures 1-3

Material. GSC No. 18115, one nearly complete pygidium; upper 200 feet, Middle Devonian Blue Fiord Formation, S.E. Svendsen Peninsula, Ellesmere Island. GSC No. 18114, external mould of pygidium; 600 feet above base of Blue

Fiord Formation, Blue Fiord, Ellesmere Island, lat. 77°12′, long. 86°55′. Coll. D. J. McLaren, 1955.

Description. Pygidium– Length equals about three fourths width (inclusive or exclusive of spines). Axis incompletely preserved, about one and one half times length, length equals one fourth total pygidial length, weakly convex in longitudinal profile. Axial furrows distinct anteriorly, becoming faint posteriorly and uniting with seventh pair of rib furrows. Posterior margin of axis faintly defined, merging with median rib. Pleural regions subdivided by seven pair of furrows which set off seven paired ribs and an unpaired median rib. Course of furrows typically a sigmoidal curve, but variable. For example, the third rib furrow on the left side intersects the second furrow posterior to the axial furrow, whereas the corresponding furrow on the right side joins the axial furrow. Ribs plano-convex in cross section except for first pair which is strongly convex. Average width of rib four times that of furrow. The median rib tapers anteriorly to two thirds its width at posterior margin, bifurcated by shallow median depression for posterior half of its length. Width of median rib at posterior margin is nearly twice that of adjoining ribs. Distally each rib is continued as a pleural spine the length of which is slightly greater than that of corresponding rib. The median rib is produced as two pleural spines equal in size to the others. Thus there are eight pair of equal-sized pleural spines on the pygidium, the anterior ones of which curve posteriorly. The pygidium GSC No. 18115 shows signs of flattening (Pl. IV, fig. 3) and the blade-like outline and median "furrows" of the pleural spines are interpreted to be a result of flattening. The pleural spines were probably originally circular or elliptical in cross section and not so broad as they now appear. In longitudinal profile the pygidium is gently convex as far posteriorly as the unbifurcated part of the median rib, posterior to that it is broadly concave. The exoskeletal surface of the pygidium is smooth.

Dimensions.

	GSC No. 18115	Kuznetz Basin specimen
axial length	4.0	3.0
axial width	6.4	5.8
pygidial length (minus spines)	10.2	8.0
pygidial width (minus spines)	14.5	13.0
pygidial length (plus spines)	15.0	14.0
pygidial width (plus spines)	21.8	19.0

Discussion. Authorship of the genus *Weberopeltis* is ascribed in Harrington, *et al.* (Richter *in* Harrington, *et al.,* 1959, p. 372) to Maximova, 1957. The correct date of authorship is, however, 1959 (*see* Maximova, 1960, p. 35) and the diagnosis and illustration in Harrington, *et al.* (p. 372, fig. 281) apparently constitute the original publication of *Weberopeltis* Maximova.

Weber's 1945 paper in which the type material of *W. arcticum* is described is not available to the writer, but the specimen described here is very close to if not conspecific with a specimen of *W. arcticum* (Weber) from the Lower Middle Devonian of the Artishti District, Kuznetz Basin described and figured by N. E. Tchernysheva (1951, p. 12, Pl. I, fig. 4, text-fig. 2). There are only minor differences between the Canadian and Russian specimens. The median rib of the Ellesmere Island specimen appears to taper more strongly anteriorly than that of the Kuznetz Basin specimen. The variability in the course of corresponding rib furrows on either side of the pygidium from Ellesmere Island suggests, however, that the outline of any particular rib may vary a great deal from one specimen to another and should not be too strongly relied on. The interpretation of the pleural spines of GSC No. 18115 as having been flattened explains why they appear much broader than those of the Kuznetz Basin specimen. Because the axial part of the specimen figured by Tchernysheva (1951, Pl. I, fig. 4, text-fig. 2) is incompletely preserved, it is not possible to be positive that the Ellesmere specimens are conspecific with *W. arcticum* (Weber, 1945). The writer therefore prefers to refer the Ellesmere material to *W.* aff. *arcticum* (Weber, 1945).

The type species, *W. aculeata* (Weber) (Richter *in* Harrington, *et al.*, 1959, fig. 281) from the Upper Silurian of the North Urals differs from *W. arcticum* by its unpaired medial pygidial spine. The pygidia of several Devonian species of *Weberopeltis, W. bublitchenkoi* Maximova, 1960 (Maximova, 1960, p. 36, Pl. VI, figs. 11-12) and *W. kurjensis* Maximova, 1960 (op. cit., p. 37, Pl. VI, figs. 6-8) from the Lower Middle Devonian of Rudnig Altai, and *W. eugeni* (N. Tchernysheva) (Tchernysheva, 1951, p. 13, Pl. I, fig. 5) from the Lower Middle Devonian near Baskuskan, U.S.S.R., are alike in having short pleural spines, a feature which readily distinguishes them from *W. arcticum.*

The genus *Weberopeltis,* though widely distributed within the U.S.S.R., had not previously been reported from other areas. The Ellesmere Island specimens are the first occurrence outside of Russia. An affinity between Couvinian trilobites of the Canadian Arctic and the U.S.S.R. is thus suggested.

The two known occurrences of *Weberopeltis* on Ellesmere Island suggest that the genus ranges through almost the entire thickness of the Blue Fiord Formation.

Family HARPIDAE Hawle and Corda, 1847

Genus *Harpes* Goldfuss, 1839

Type species: *Harpes macrocephalus* Goldfuss, 1839

Diagnosis. See Whittington, 1950, p. 14

Harpes macrocephalus Goldfuss, 1839
Plate IV, figures 4-7

1839 *Harpes macrocephalus* Goldfuss, p. 358, Pl. 33, figs. 2a-d.
1840 *Harpes maerocephalus* (sic) Goldfuss; Münster, p. 43.
1841 (Non) *Harpes macrocephalus* Goldfuss; Phillips, pp. 127-8, Pl. 55, fig. 246.
1842 (Non) *Harpes macrocephalus* Goldfuss; Archiac and Verneuil, p. 337.
1843 (Non) *Harpes macrocephalus* Goldfuss; Goldfuss, p. 548.
1843 (In part) *Harpes ungula* Sternberg; Burmeister, p. 88, Pl. I, fig. 11.
1846 *Harpes macrocephalus* Goldfuss; Beyrich, p. 32, Pl. 4, fig. 3.
1846 *Harpes macrocephalus* Goldfuss; Burmeister, p. 75.
1846 *Harpes macrocephalus* Goldfuss; Barrande, p. 55.
1889 (Non) *Harpes macrocephalus* Goldfuss; Whidborne, pp. 30-32, Pl. 2, figs. 19-23.
1914 *Harpes macrocephalus* Goldfuss; Richter, p. 146, fig. 2.
1920 *Harpes macrocephalus* Goldfuss; Richter, Pl. 16, figs. 1-4, 6; Pl. 17, figs. 10, 12, 14, 16.

This partial synonomy omits all post-1920 references to *Harpes macrocephalus* and includes only the more important earlier ones.

Material. GSC No. 18119, incomplete cephalon, 315 feet above the base of the Blue Fiord Formation, Twilight Creek, Bathurst Island; GSC Nos. 18116 and 18117, one complete and one partial cephala, upper 200 feet of the Blue Fiord Formation, S.E. Svendsen Peninsula, Ellesmere Island, lat. 77°35′, long. 83°46′; coll. Kerr, 1961.

Description. The morphology of *Harpes macrocephalus* has been illustrated in detail by Richter (1920, Pl. 16, figs. 1-4, 6; Pl. 17, figs. 10, 12, 14, 16). More recently Whittington (1950, p. 14) based his diagnosis of *Harpes* s.s. on this species. Specimens of *Harpes macrocephalus* from the Eifel district in the MCZ collections (MCZ collections, MCZ 2067–2074) have been compared directly with the Arctic material, and the Bathurst and Ellesmere specimens are identical in all respects save one with *Harpes macrocephalus* from Germany. On satisfactorily preserved specimens from Bathurst and Ellesmere Islands there can be seen a narrow but distinct genal ridge (Pl. IV, fig. 4) which begins at the base of the eye lobe, curves slightly downward and strongly backward and runs subparallel to the inner margin of the cheek lobe dying out opposite the posteriormost part of the alar furrow. The width of this genal ridge (trans.) does not exceed the space between adjacent pits on the inner part of the cheek roll. Richter in his detailed discussion of *Harpes macrocephalus* (1920) does not mention the presence of such a feature, nor is a genal ridge visible on any of the cephala in the MCZ collections. The writer regards this difference between the Eifel and Arctic specimens as intraspecific variation. Whittington (1963, p. 32, Pl. 2, figs. 4–8; Pl. 3) has described *Selenoharpes vitilis* in which the genal ridge varies from pronounced to very faint among different specimens from a single locality. This evidence of the intraspecific variability of the genal ridge in another harpid is offered in support of the writer's interpretation. The Bathurst and Ellesmere specimens differ from one another only in the state of preservation, those from Ellesmere commonly being crushed, whereas the Bathurst material, though not crushed, is commonly exfoliated. The fine detail of exoskeletal structure which is necessary for the discrimination of *Harpes macrocephalus* is best seen on rubber casts of external cephalic moulds from Ellesmere.

Dimensions.

	Eifel District, Germany			Ellesmere Island	
	MCZ 2075	MCZ 2074	MCZ 2072	GSC No. 18116	GSC No.18117
glabellar width at anterior margin of alae.........	7.6	5.5	8.5	11.0	5.0
alar width	3.3	2.7	3.7	4.9	2.1
glabellar length	8.8	8.2	11.5	15.8	7.8

average ratio of glabellar width to alar width for three MCZ specimens=0.45
average ratio of glabellar width to alar width for three Ellesmere specimens=0.45

Discussion. Whittington (1950, p. 14) restricted the genus *Harpes* to forms similar to the type species, *Harpes macrocephalus,* and excluded *Harpes venulosus* Hawle and Corda, 1847 (Whittington, 1950, p. 12, figs. 9a, 9b) making it the type of a new genus *Lioharpes* (1950, figs. 9a, 9b). Whittington gave (p. 14) as characters distinguishing *Lioharpes* from *Harpes*: the smaller alae, the absence of rows of coarse pits flanking the girder and at the external margin, the narrower cheek roll, the presence of radiating ridges on cheek roll and brim, and the reticulate ornament on the cheek lobes. Prantl and Přibyl (1954, p. 125) regarded *Lioharpes* as a synonym of *Harpes* Goldfuss. These authors give (p. 127) as characters distinguishing *Lioharpes* from *Harpes* "in the conception of H. B. Whittington" several features (shorter spines, palpebral lobe shifted more forwards, narrower brim) which Whittington did not mention. From this unfortunate beginning they go on to attempt to discredit (p. 127) each of the differences mentioned by Whittington. From an examination of specimens of *Lioharpes venulosus* (130 cephala) and *Harpes macrocephalus* (19 cephala) in the MCZ collections the writer offers the following comments on the criticisms of Prantl and Přibyl (1954, p. 127). Their contention that the exoskeletal surface of the cheek lobes of *Lioharpes venulosus* is finely granulate is correct. The reticulate pattern seen by Whittington occurs only in the internal mould of the upper lamella. The alar surface of *L. venulosus* is smooth as claimed by Whittington and denied by Prantl and Přibyl. They claim the presence of coarser pits adjacent to the girder and the external margin of *L. venulosus* much as in *H. macrocephalus.* The actual situation is as figured by Whittington (1950, fig. 9a); the pits adjacent to the girder and margin in *L. venulosus* are no larger than those elsewhere on the brim. Although the spaces between the radiating ridges adjacent to the girder appear superficially to be large pits, on close inspection they are seen to be occupied by numerous small pits. Prantl and Přibyl imply (p. 127) that the conspicuous pattern of radiating ridges or genal cecae (Raymond, 1920, p. 82) on *L. venulosus* is present but less conspicuous on *H. macrocephalus.* However, the MCZ specimens of *H. macrocephalus* show no trace of such a pattern on the exoskeletal surface of the upper lamella. As genal cecae presumably reflect closely part of the internal anatomy of trilobites, their presence is of more than routine significance and is a very important difference between *Lioharpes* and *Harpes.*

Thus, with the exception of the prosopon on the cheek lobes, the differences between *Lioharpes venulosus* and *Harpes macrocephalus* recognized by Whittington still stand, and are sufficient in the writer's opinion to make *Lioharpes* a valid genus.

Harpes macrocephalus most closely resembles *Harpes whidbornei* Whittington (1950, p. 48, Pl. 7, figs. 5-10) from the Middle Devonian of England. The differences between these species were listed by Whittington (1950, p. 49).

As far as the writer is aware, the only previously confirmed occurrences of *Harpes macrocephalus* are from the Eifel District of Germany.

On Twilight Creek, Bathurst Island, *Harpes macrocephalus* occurs at 90 feet and 315 feet above the base of the Blue Fiord Formation.

Harpes sp. indet.

Plate IV, figures 8-9

Material. GSC No. 18121, poorly preserved cephalon, and GSC No. 18120, well-preserved thorax; unnamed Middle Devonian limestones, northwest side of the largest of the Princess Royal Islands, lat. 72°48′, long. 117°46′; coll. E. T. Tozer, 1959.

Description. Cephalic outline incomplete, brim prolongations not preserved. Rows of coarse pits flank the girder and another row is present adjacent to external margin. The alae are broad (trans.), subdivided into two crescentic parts. Basal glabellar lobes subtriangular in outline. Remainder of glabella crushed. Occipital ring not preserved.

Thorax– consisting of at least 23 segments. The anteriormost segment preserved exhibits a strong lateral facet indicating that it is the true first thoracic segment. Maximum thoracic width at the tenth or eleventh segment. There is a progressive decrease in the length (exs.) of segments posterior to the thirteenth. Maximum axial width equals about one fourth total width of segment. Axis gradually tapering posteriorly. Axial rings strongly convex in transverse profile. Articulating furrow moderately deep. Articulating half ring extends forward to next anterior articulating furrow. Pleurae extend horizontally from axial furrow to distal edge where they slope initially at 45 degrees then nearly vertically. The broad, shallow pleural furrow terminates distally against a diagonal ridge which is the posterior margin of the segmental facet. Pleural termination rounded. Exoskeletal surface of crest of axial rings bears irregular tubercles.

Discussion. The harpid thorax is a conservative structure (Whittington, 1950, p. 20), and the well-preserved thorax here described does not help in making a specific assignment. The poorly preserved cephalon shows certain features (rows of coarse pits, alar size and structure) which suggest *Harpes macrocephalus,* but the material does not permit specific identification.

Family ODONTOPLEURIDAE Burmeister, 1843
Subfamily ODONTOPLEURINAE Burmeister, 1843
Genus *Leonaspis* R. and E. Richter, 1917

Type species: *Odontopleura leonhardi* Barrande, 1846

Subgenus *Leonaspis* (*Kettneraspis*) Prantl and Přibyl, 1949

Type species: *Acidaspis pigra* Barrande, 1872

Diagnosis. Cephalic outline typically subtrapezoid. Lateral cephalic spines perpendicular to margin. First two thoracic segments truncated by faceting and having short posterior pleural spines.

Geological range. Middle Silurian to Middle Devonian.

Leonaspis (Kettneraspis) elliptica (Burmeister, 1843)
Plate V, figures 1-8

1839 *Arges armatus* (partim) Goldfuss; Goldfuss, 1839, p. 355, Pl. 33 fig. 1d-e (*not* 1a-c).
1843 *Odontopleura elliptica* Burmeister; Burmeister, 1843, p. 73, Pl. 1, fig. 4.
1845 *Odontopleura dentata* Goldfuss; Goldfuss, 1845, Pl. 4, fig. 2.
1846 *Odontopleura elliptica* Burmeister; Beyrich, 1845, p. 23.
1917 *Acidaspis* (*Leonaspis*) *elliptica* Burmeister; Richter, R. and E., 1917, p. 471.
1918 *Acidaspis* (*Leonaspis*) *elliptica* Burmeister; Richter, R. and E., 1918, p. 127, Pl. 2, figs. 10b, 11.
1926 *Ceratocephala* (*Leonaspis*) *elliptica* Burmeister; Richter, R. and E., 1926, p. 108.
1930 *Leonaspis elliptica* Burmeister; Richter, R. and E., 1930, p. 34, text-fig. 3.
1949 *Acanthaloma* (*Kettneraspis*) *elliptica* Burmeister; Prantl and Přibyl, 1949, p. 166.
1952 *Leonaspis* (*Kettneraspis*) *elliptica* Burmeister; Richter, R. and E., 1952, p. 113.
1956 *Leonaspis* (*Kettneraspis*) *elliptica* Burmeister; Richter, R. and E., 1956a, p. 372.

Material. GSC No. 18122, nearly complete specimen lacking right free cheek; GSC No. 18124, hypostome; GSC No. 18125, free cheek; GSC No. 18126, cranidium; GSC No. 18128, cranidium; Middle Devonian Blue Fiord Formation, 315 feet above base, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′; coll. D. J. McLaren, 1955. GSC No. 18127, pygidium, Middle Devonian limestones, Princess Royal Island, lat. 72°48′, long. 117°46′; coll. E. T. Tozer, 1959.

Description. Cranidium– Anterior margin transverse, border short (sag. and exs.), medially merging with frontal glabellar lobe. In longitudinal profile frontal glabellar lobe strongly convex and steep anteriorly, median glabellar lobe convex in transverse profile. Glabellar outline subcircular, as long as wide. Greatest glabellar width across anterior edge of basal glabellar lobe. Two pair of isolated lateral glabellar lobes of ovate outline (long axis longitudinal). Basal (1p) glabellar lobe convex, defined anteriorly by inwardly and slightly backwardly directed 1p glabellar furrow, which is deepest where it joins the pronounced longitudinal furrow which separates the median and lateral glabellar lobes. 2p glabellar lobe strongly convex, three fourths the length (exs.) of 1p lobe, defined anteriorly by short, deep 2p lateral glabellar furrow. Width of median glabellar lobe half that of glabella, outline subquadrate, slightly expanded (trans.) in line with midpoint of 2p lateral lobe, anteriorly expanding into short (sag.) frontal lobe. Occipital furrow broad. Occipital ring convex, long (sag. and exs.), prolonged medially in an upwardly and backwardly directed spine of length more than twice that of the ring. Axial furrow runs in outwardly convex course, shallowest opposite the 1p furrow, deepest at the anterolateral edge of 2p lobe. A prominent eye ridge starts at lateral edge of frontal lobe, runs outward and progressively more strongly backward till it parallels the sutural boundary. Posterior to 2p lateral lobe there is a narrow convex segment of fixed cheek between the eye ridge and axial furrow. Posteriorly fixed cheek declines steeply and bears an upwardly and backwardly directed spine between the posterior edge of palpebral lobe and the axial furrow. Anterolateral corner of fixed cheek bears a deep, circular anterior pit immediately in front of eye ridge. Palpebral lobe situated opposite end of occipital furrow, rises nearly vertically. Anterior branch of facial suture an outwardly convex curve, runs nearly parallel to axial furrow, crosses anterior margin at point in line (exs.) with median part of axial furrow. Posterior branch of suture runs backward and outward in outwardly concave curve, then parallel to posterior border (nearly transverse) for three fourths the width of cheek before cutting diagonally across posterior border. Coarse tubercles are present on surface of glabellar lobes, eye ridge, and fixed cheeks; a row of smaller tubercles along the anterior border.

Free cheek– Eye lobe markedly elevated, subhemispherical, lenses holochroal, arranged in diagonal rows. Outline of cheek triangular, genal field slopes steeply adjacent to eye, flattens out rapidly distally, weakly convex in cross section. Lateral border furrow shallow, border of two parts, inner slope flat and nearly horizontal, outer slope at angle of about 45 degrees. Whole border broadens (trans.) posteriorly and merges with base of curving genal spine. Genal spine twice as long as genal field (exs.). Lateral border bears a series of outwardly projecting spines (thirteen in specimens of about 8 mm length) which become progressively shorter anteriorly. Two spines emerge from inner edge of basal part of genal spine. Lateral border and genal field with coarse tubercles.

Hypostome– specimen described is a rubber cast of inner (ventral) exoskeletal surface. Hypostomal outline subtetragonal, anterior margin gently convex anteriorly. Maximum width across anterior wings is 3.8 mm, length (sag.) 3.2 mm. Middle body gently convex transversely and longitudinally, outline circular. Middle furrows short and shallow. Border furrows broad and shallow except opposite lateral shoulder where they are deep. Lateral border narrow (trans.) and convex. Lateral shoulders well defined. Posterior border long (sag. and exs.), inwardly sloping, posterior margin not preserved.

Thorax– of nine segments. Width of convex axis more than one third of total thoracic width (excluding spines). Ring furrows broad, articulating half ring as long (sag.) as ring. First two segments shorter (sag. and exs.) than succeeding segments. In transverse profile inner part of pleurae essentially horizontal, outer part sloping gently downward. Each pleura consists of a convex median ridge, transversely directed and distally extended into a pleural spine, a low-lying, weakly convex, narrow band anterior to the median ridge and separated from it by a furrow, and posterior to the median ridge an even narrower (exs.) depressed band. The pleural spines of the first two segments are short as those segments are strongly faceted, other pleural spines curve sharply backward and posterior ones nearly parallel the axis; the third pleural spine is longest, the others progressively shorter so that they all terminate at about the same distance from the end of the thorax. From the anterolateral corner of the anterior band of the third through ninth pleurae emerges a pair of short anterior pleural spines (Pl. V, fig. 2) fused at their bases and outwardly directed. Each of these spines may bifurcate distally. A pair of thorn-like vertically directed spines on the median ridge of posterior pleurae, one near the axis, the other at the fulcrum. These fragile spines are rarely preserved and have been seen only on the posterior pleurae, but probably occur on all pleurae because a pair of elevations with hollow centres apparently representing spine bases is present on each pleura.

One tubercle on either side of midline of each axial ring.

Pygidium– More than twice as wide as long. Axial width one third of total width. Axis of two rings, the first laterally continuous with a prominent ridge which curves outward and sharply backward across the pleural regions and continues posteriorly into the major (sixth) border spine. Axial furrow obsolete adjacent to first axial ring, deep adjacent to second ring and shallowing posteriorly. Triangular pleural area anterolateral to pleural ridge is gently convex. Seven pair of border spines, the sixth the major pair; first two border spines short, fused at their bases, outwardly directed from anterolateral edge of pygidium. These spines are analogous to the anterior pleural spines of the thorax. Third, fourth, and fifth border spines are progressively longer, the single pair of spines inside the major pair about equal in size to the fifth pair. Each axial ring bears a small tubercle on either side of midline, one pair of tubercles on pleural ridge opposite second axial ring, four aligned tubercles along posterior border, and two tubercles near anterolateral corner of pygidium.

Dimensions.

	GSC No. 18122	GSC No. 18126	GSC No. 18129	GSC No. 18128
glabellar length	7.6	7.0	10.0	7.7
maximum glabellar width	7.9	7.1	9.9	7.8
width of median lobe	4.2	3.7	5.0	4.2
length of occipital ring	——	4.0	——	——
length of occipital spine	——	1.6	2.0	1.8

Discussion. Because the faceting of the first two thoracic segments is of structural (Whittington, 1956b, p. 506) rather than evolutionary significance, the subgenus *Kettneraspis* is of doubtful value. Until the five species assigned to it by Prantl and Přibyl have been restudied, it seems advisable to use it provisionally.

Comparison of the Arctic material with topotype specimens of *L.* (*K.*) *elliptica* in the MCZ collections (MCZ 4224, 4225) reveals only minor differences which are considered to be intraspecific. The anterior pit of the Arctic specimens is subcircular, whereas that of the topotype specimens is more nearly slot-like. The MCZ specimens do not have the occipital ring preserved, but Richter (1918, p. 127) mentions the presence of an occipital spine in *L.* (*K.*) *elliptica.* The nature of the occipital spine in the Arctic material can be seen in Plate V, figure 7.

A species to which *L.* (*K.*) *elliptica* is similar is *L.* (*K.*) *pigra* (Barrande, 1872) (Prantl and Přibyl, 1949, p. 168, Pl. 2, figs. 14-20) from the Lower Devonian of Central Bohemia, the holotype of which is in the MCZ collections (MCZ 4396). The two species are most readily distinguished by cranidial features. *L.* (*K.*) *pigra* has no occipital spine, a less prominent eye ridge, a less inflated 2p glabellar lobe, a more inflated genal field and no spines on the inner edge of the genal spine. The pygidium of *L.* (*K.*) *pigra* like that of *L.* (*K.*) *elliptica* has seven pair of marginal spines, but unlike *L.* (*K.*) *elliptica* does not have the first two fused proximally. A further difference is that in *L.* (*K.*) *pigra* the seventh pair of spines is considerably longer than the fifth pair rather than of similar length as in *L.* (*K.*) *elliptica.*

Although less similar than the above-mentioned species, *L.* (*K.*) *tuberculatus* (Hall, 1859) (Whittington, 1956b, p. 507, Pl. 57, figs. 1-9) from the Lower Devonian of New York State has important cranidial similarities with *L.* (*K.*) *elliptica.* The course of the facial suture, the nature of the eye ridge and the glabellar lobation are especially similar. *L.* (*K.*) *tuberculatus* is distinguished from *L.* (*K.*) *elliptica* by its more prominent anterior border, parallel sided median glabellar lobe, stouter occipital spine, and pygidium which has only six pair of marginal spines (rather than seven) of which the pair between the major spines is short.

Leonaspis (Kettneraspis) eremia n. sp.

Plate VI, figures 1-2

Holotype. GSC No. 18130, partly exfoliated cranidium; Blue Fiord Formation, 1,011 to 1,161 feet above base, east of Blue Fiord, Ellesmere Island; coll. D. J. McLaren, 1955.

Discussion. This species is very close to *Leonaspis* (*K.*) *elliptica* the morphology of which is described above. *Leonaspis* (*K.*) *eremia* differs from *L.* (*K.*) *elliptica* in having (1) a more highly inflated frontal glabellar lobe (Pl. VI, fig. 2); (2) a more strongly divergent eye ridge; and (3) a wider (trans.) fixed cheek.

Leonaspis sp.

Plate VI, figure 3

Material. GSC No. 18131, a distorted partial cranidium; 400 feet above the base of the Stuart Bay Formation, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′; coll. Ormiston, 1962.

Description. Cranidium distorted so that 2p glabellar lobe on right side is far in advance of 2p lobe on left side. Occipital ring with median node which is backwardly directed. Other discernible features identical with those of *Leonaspis* (*K.*) *eremia* n. sp.

Family PROETIDAE Hawle and Corda, 1847

Subfamily PROETINAE Salter, 1864

Genus ***Proetus*** Steininger, 1831; emend. R. Richter, 1913

Type species: *Calymene concinna* Dalman, 1827

Subgenus ***Proetus*** (***Longiproetus***) Cavet and Pillet, 1958

Type species: *Proetus tenuimargo* R. Richter, 1909

Diagnosis. Cavet and Pillet, 1958, p. 23: "A subgenus of *Proetus* characterized by the general flattened shape, and that of glabella which is very elongated (at least one and one half times the width), the sides straight and subparallel. Preglabellar field absent. Genal spines variable, sometimes absent, sometimes distinctly developed and pointed. Eyes of large size, but not always reaching occipital furrow." (writer's translation)

Discussion. Although not discussed by Cavet and Pillet, the moderately divergent anterior branch of the facial suture forming an outwardly convex curve is another feature common to the type, *P.* (*L.*) *tenuimargo* R. Richter, 1909, and several other species of *Proetus* (*Longiproetus*) (*P.* (*L.*) *chamaeleo* R. and E. Richter, 1918; *P.* (*L.*) *dohmi* R. and E. Richter, 1918; *P.* (*L.*) *cultrijugatus* R. and E. Richter, 1918; and *P.* (*L.*) *aplanatus* Pillet, 1956) and one which, in conjunction with the elongate glabella and broad anterior border, would seem most clearly to distinguish *Proetus* (*Longiproetus*) from *Proetus* (*Proetus*) with its subquadrate glabella and weakly divergent anterior suture.

Geological range. Lower Devonian to Middle Devonian.

Proetus (Longiproetus) sverdrupi (Tolmachoff, 1926)

Plate VI, figures 4-9

1926 *Basidechenella sverdrupi* Tolmachoff; Tolmachoff, 1926, p. 22, Pl. 1, fig. 5.
1926 *Dalmanites scheii* Tolmachoff; Tolmachoff, 1926, p. 21, Pl. 1, fig. 1.
1950 *Basidechenella sverdrupi* Tolmachoff; R. and E. Richter, 1950, p. 173.

Holotype. PMO A28846, original of Tolmachoff, 1926, Pl. 1, fig. 5, Series Da (b) (= Blue Fiord Formation), east side of Goose Fiord, Ellesmere Island, lat. 76°40′, long. 88°35′; coll. Per Schei.

Hypotype. GSC No. 18132, incomplete cranidium; Blue Fiord Formation, about 300 feet above base, Sutherland River, Douro Range, Devon Island, lat. 76°22′, long. 92°48′; coll. Ormiston, 1961.

Other material. PMO A28841, *"Dalmanites scheii"*, original of Tolmachoff, 1926, Pl. 1, fig. 1, Series Db (= Blue Fiord Formation), east side of Goose Fiord, Ellesmere Island; coll. Per Schei.

Description. Cranidium– Anterior border inflated, broadest (sag.) and highest in front of glabella, narrowing laterally, semicylindrical in cross section with three prominent, parallel ridges on anterior half. Sagittal breadth of border equals one fifth cranidial length. Border furrow deep, medially separating glabella from anterior border. Glabella strongly convex transversely and longitudinally, high point in line with posterior edge of palpebral lobe. Glabellar width to length as 1:1.1, broadest in line with the midpoint of palpebral lobe. Glabellar outline trapezoidal, nearly parallel-sided from base to midpoint of palpebral lobe, then tapering moderately forward with straight sides, frontal lobe truncate. Two pair of lateral glabellar furrows (only 1p visible on holotype) are preserved as smooth areas on exoskeleton 1p begins at axial furrow curves inward and strongly backward, ending at point in line with posterior edge of palpebral lobe, broadest at midlength, cuts one fourth glabellar width. 2p begins at axial furrow opposite anterior edge of palpebral lobe, runs inward and slightly backward, short. Occipital furrow deeply incised, transverse. No occipital lobes. In profile occipital ring forwardly sloping, strongly convex transversely. Axial furrows deep, becoming deepest anterior to 2p furrows. Fixed cheeks in front of eyes transversely convex, sloping downward and outward anteriorly, vertical above border furrow. Palpebral lobes steeply inwardly sloping, of less than glabellar height, narrow. Anterior branch of facial suture moderately divergent anteriorly, forming a gentle outwardly convex curve, not angulate at border furrow, posterior branch not preserved. Fixed cheeks in front of eyes, posterior two thirds of glabella, and occipital ring tuberculate.

Free cheek– The free cheek described by Tolmachoff (1926, p. 21, Pl. 1, fig. 1) as *Dalmanites scheii* Tolmachoff has an opisthoparian suture and is obviously not a phacopid. Moreover, its semicylindrical lateral border is strikingly like the anterior border of the cranidium of *Proetus (Longiproetus) sverdrupi* (Tolmachoff, 1926) to which it is here assigned.

Eye lobe not preserved. Genal field gently convex upward, evenly downsloping from eye. Lateral and posterior border furrows deep. Lateral border as broad (trans.) as genal field, semicylindrical in cross section with three prominent parallel ridges on outer half. Posterior border narrower and less convex than lateral border. Stout genal spine has sulcate cross section for entire length. Exoskeletal surface appears smooth.

Dimensions.

	PMO A28846 holotype	GSC No. 18132 hypotype
cranidial length	5.6	8.5
glabellar length	3.7	5.5
glabellar width	3.3	5.0
length of anterior border	1.1	2.0
beta-beta width	4.5	6.5

Discussion. From Tolmachoff's illustration (1926, Pl. 1, fig. 5) of the holotype, R. and E. Richter recognized (1950, p. 174) that it had "no relations to *Dechenella*." The glabellar outline and convexity, glabellar furrows, high anterior border, and course of facial suture clearly show that *Basidechenella sverdrupi* is a *Proetus*. *Proetus sverdrupi* (Tolmachoff) is closely allied to *P. chamaeleo* R. and E. Richter, 1918 (1918b, p. 67, figs. 3a-c; R. and E. Richter, 1918b, Pl. 1, fig. 4) from the Eifelian of Germany, one of the species included by Cavet and Pillet in their recently (1958, p. 23) established subgenus, *Longiproetus*. *Proetus (Longiproetus) sverdrupi* resembles *P. (L.) chamaeleo* in (1) having a broad, high anterior border, (2) form of glabellar outline, (3) presence of two pair of faint glabellar furrows, and (4) the moderately divergent facial suture forming an outwardly convex curve; but differs in having a sagittally broader anterior border, slightly shorter glabella, in lacking occipital lobes, and in having distinct genal spines.

From the type species, *Proetus (Longiproetus) tenuimargo* R. Richter, 1909 (R. and E. Richter, 1952, p. 109, Pl. 4, figs. 25-26), which it also resembles, *P. (L.) sverdrupi* can be distinguished by the anterior border which is convex rather than concave in lateral profile, presence of a deep border furrow, by its broader glabella, and by having two rather than three pair of glabellar furrows.

Proetus cf. *bohemicus* Hawle and Corda, 1847

Plate VI, figures 10-11

Material. GSC No. 18134, external mould of pygidium; ?Blue Fiord Formation, occurs above *Atrypella* beds, Norfolk Inlet, Colin Archer Peninsula, Devon Island, lat. 76°26′, long. 91°05′; coll. McLaren, 1955.

Description. Pygidium– Outline sub-semicircular, straightened posteriorly. Ratio of length to width about 1:2. Broad axis tapers moderately, posterior end blunt, maximum axial width equals one fourth pygidial width. There are eight axial rings, those posterior to third becoming progressively shorter (sag.), posterior ring furrows weaken laterally. In longitudinal profile axial rings forwardly sloping with steep posterior edge, axis declines evenly posteriorly, posterior tip high above level of pleural field, drops off in a steep slightly concave slope to the border furrow. Axial furrows distinct. In transverse profile axis unevenly convex, steep sided but flattened along the crest, pleural fields weakly but evenly convex. Five pair of deep pleural furrows, with anterior boundary of each furrow steeply sloping and posterior boundary gently sloping thus asymmetric in cross section. Pleural furrows set off five pair of long (exs.) pleural ribs, the fifth bounded posteriorly by a change in slope not a furrow. Five pair of conspicuous, broad and moderately deep interpleural furrows approximately bisect pleural ribs, extend from axial furrow to border furrow. At midwidth (trans.) anterior and posterior pleural bands of equal length (exs.), anterior bands more evenly convex. Border furrow sets off a border as broad as second pleural rib is long (exs.). Border gently convex with subparallel terrace lines on distal edge. Entire exoskeletal surface of pygidium covered with densely packed, fine granules.

Dimensions.

	GSC No. 18134
pygidial length	9.2
pygidial width	19.0
axial length	7.2
axial width	4.8

Discussion. Proetus cf. *bohemicus* most closely resembles *Proetus (Proetus) bohemicus* Hawle and Corda, 1847 (1847, p. 73, Pl. 4, fig. 43; Barrande, 1852, p. 452, Pl. 16, figs. 1-15) from the Lower Devonian Koneprusy limestone of Bohemia. Characters shared by the two species include the moderately wide, convex border, the pygidial width equalling twice the length, the strong interpleural furrows, and the densely packed granulose prosopon. The Arctic specimen differs from *P. bohemicus* in having (1) axial width one fourth rather than one third of pygidial width; (2) pleural fields less convex transversely; (3) pleural furrows posterior to first much deeper than corresponding furrows of *P. bohemicus*; (4) fewer axial rings; and (5) a narrower border furrow. The pygidium of *Proetus (Longiproetus) chamaeleo* R. and E. Richter, 1918 (1918b, p. 67, figs. 3a-c) from the Eifelian of Germany is also similar to *P.* cf. *bohemicus* but can be distinguished by the presence of axial nodes, the smaller number of pleural ribs, and the angulate transverse profile of the pleural fields.

Because the differences between *Proetus (Longiproetus)* and *Proetus (Proetus)* involve cephalic characters, the subgeneric assignment of *P.* cf. *bohemicus* cannot now be determined.

Due to the complexly faulted nature of the Palaeozoic succession along Norfolk Inlet, there is uncertainty about the exact age of the beds from which *P.* cf. *bohemicus* comes. It definitely occurs above beds containing *Atrypella* sp. and is presumably Devonian.

Subfamily Proetidellinae Hupé, 1953

Discussion. Alberti (1963a, p. 148) classifies *Warburgella* in the Subfamily Tropidocoryphinae, presumably on account of its tropidium. He notes (p. 151) that *Warburgella* ". . . unites characters of the Proetidellinae Hupé (shape of pygidial axis and large number of axial rings) and of the Tropidocoryphinae (possession of a tropidium)." The writer prefers the classification of Hupé (1953a) and places *Warburgella* in the Proetidellinae. The pygidium of *Warburgella* has a fundamentally different construction from the tropidocoryphinid pygidium in which the pleural ribs are represented by the anterior pleural band only. Furthermore, a tropidium is not restricted to the Tropidocoryphinae. In all, the similarities to other members of the Proetidellinae far outweigh those to the Tropidocoryphinae.

Kielan (1959, p. 69) considers the Proetidellinae a synonym of the Proetinae, because Hupé's diagnosis of the Proetidellinae did not satisfactorily distinguish it from the Proetinae. The writer agrees with Dean (1962, p. 124) that the presence of a distinct preglabellar field in *Proetidella* Bancroft, 1949, and other genera of the Proetidellinae merits uniting them in a separate subfamily.

Genus *Warburgella* Reed, 1931

Type species: *Asaphus stokesi* Murchison, 1839

Diagnosis. Preglabellar field moderately long (sag.) to short. Tropidium well developed. Glabellar outline trapezoidal, slightly constricted at 2p furrow, characteristically blunt anteriorly, broadest in line with midpoint of palpebral lobes. Two pair lateral glabellar furrows. Basal glabellar lobes partly to completely isolated by strongly backwardly directed 1p furrows. 2p furrows short, strongly backwardly directed. Eyes large, extending from opposite occipital furrow to position anterior to 2p furrow. Occipital lobes distinct to incompletely isolated. Anterior branch of facial suture a smooth, outwardly convex curve.

Thorax of ten segments. Pygidial axis extends nearly to border, short post-axial ridge present. Up to eleven axial rings present, five broad (exs.) pleural ribs, border well defined to absent.

Discussion. Reed (1931, p. 14) gave no diagnosis for *Warburgella* and in establishing it was, in fact, following the earlier suggestion of Warburg (1925, p. 184) that the morphology of *Proetus stokesi* (Murchison, 1839) and *Phaetonides rugulosus* Lindstrom, 1855 required the erection of a new genus separate from *Proetus*. Warburg proposed no name for this genus but defined it briefly, mentioning (1925, p. 185) the presence of a tropidium and the distinct glabellar lobation. In 1938 Whittard redescribed the type species, *Warburgella stokesi,* without mentioning the characteristic tropidium and without giving a generic diagnosis. Begg (1939, p. 380) in a discussion of *Warburgella* incorrectly claims the absence of glabellar furrows other than 1p as a characteristic of the genus. The most recent diagnosis of *Warburgella* (R. and E. Richter and Struve, *in* Harrington, *et al.*, 1959, p. 396) mentions none of the features of the genus considered diagnostic here.

The genus to which *Warburgella* shows the greatest similarity is *Cyphoproetus* Kegel, 1927 (*see* diagnosis in Přibyl, 1946, p. 15) from which it is distinguished by having (1) a tropidium, (2) a moderately long preglabellar field, (3) a trapezoidal glabellar outline, (4) anterior border not broadened medially, (5) basal glabellar lobes commonly incompletely isolated, (6) more pygidial axial rings, and (7) a post-axial ridge.

Astroproetus Begg, 1939 is a possible synonym of *Warburgella*. The type species, *Astroproetus reedi* Begg, 1939 (p. 375, Pl. 6, fig. 2) is known only from the holotype specimen which shows ten thoracic segments, a post-axial ridge, a single pair of glabellar furrows isolating basal glabellar lobes, a long (sag.) preglabellar field, and possibly has a tropidium; all are features of *Warburgella*. Because the cephalon of the holotype is an internal mould, a tropidium is not preserved, but the preglabellar field does have a sharp flexure and the free cheek appears to preserve part of a tropidium. Definite generic assignment of *Astroproetus reedi* must await better preserved material.

The taxa regarded by the writer as belonging in *Warburgella* are *Warburgella stokesi* (Murchison, 1839), *W. rugulosa rugulosa* (Alth, 1874), *W. rugulosa* (Alth) *rugosa* (Bouček, 1934), *W. rugulosa* (Alth) *canadensis* n. subsp., and *W. binodosa* Whittard, 1938. *Warburgella rugulosa* (Lindstrom, 1885) (1885, p. 75, Pl. 16, fig. 13) from the Silurian of Gothland is a junior secondary homonym of *W. rugulosa* (Alth, 1874) for which Alberti (1963b) is proposing a new name. Differences between this new species and *W. rugulosa rugosa* are discussed by Alberti (1963a, p. 152).

Species assigned with doubt to *Warburgella* include: ?*W. rotundata* (Begg, 1939) from the Upper Starfish bed, Ladyburn, Girvan, ?*W. newlandensis* (Begg, 1950) from the Valentian of Girvan, and ?*W. reedi* (Begg, 1939) from the Upper Starfish bed, Ladyburn, Girvan.

Geological range. Ashgillian? or Lower Silurian (Llandoverian) to Lower Devonian (Gedinnian).

Warburgella rugulosa (Alth) *canadensis* n. subsp.

Plate VI, figures 12-15; Plate VII, figures 1-4

Holotype. GSC No. 18135, cephalon; unnamed Gedinnian limestones, a mile northwest of the sea, Washington Point, Baillie Hamilton Island, lat. 75°46′, long. 94°22′; coll. Ormiston, 1959.

Paratypes. GSC Nos. 18136 to 18141, three cranidia, three pygidia; same locality and horizon.

Other material. Numerous small cranidia and pygidia from same locality and horizon.

Description. This subspecies very closely resembles *Warburgella rugulosa rugulosa* (Alth, 1874) (equals *W. rugosa rhenana* Alberti, 1963a) from the Rhenish Gedinnian. Dr. Gerhard Alberti of the Geologisches Staatinstitut, Hamburg has had the opportunity to compare directly specimens of the new subspecies sent him by me with specimens of *W. rugulosa rugulosa* from the Rhenish Gedinnian and with specimens of *W. rugulosa rugosa* (Bouček, 1934) from the Lochkovium of Bohemia. He recognizes the following distinctive characters in *W. rugulosa canadensis* n. subsp. (1) the glabellar prosopon in all subspecies of *W. rugulosa* consists of well-developed ridges arranged in a Bertillon pattern. In *W. rugulosa canadensis* these ridges are shorter (i.e., less continuous) and considerably thicker than in *W. rugulosa rugulosa.* According to Dr. Alberti (pers. com.) there is among populations of *W. rugulosa rugosa* and *W. rugulosa rugulosa* considerable variation in the characters discussed below, and statistical studies of all three taxa are probably required to determine whether certain apparent differences are actually meaningful. With this in mind, the following possible differences between *W. rugulosa canadensis* and the other subspecies may be mentioned (2) the transverse ridge immediately posterior to the anterior border furrow (and anterior to the tropidium) seems to be higher in the new subspecies than in *W. rugulosa rugulosa;* (3) the fine granulation on the anterior border of *W. rugulosa canadensis* apparently does not occur in *W. rugulosa rugulosa* but does in *W. rugulosa rugosa.* This fine granulation does, however, occur on the pygidial border of *W. rugulosa rugulosa* as in the new subspecies; (4) the distance (sag.) between the preglabellar furrow and the tropidium seems shorter in *W. rugulosa canadensis* than in either of the other subspecies; and (5) rarely, part or all of the tropidium is absent from specimens of *W. rugulosa canadensis.*

Warburgella rugulosa rugulosa and *W. rugulosa canadensis* are very closely allied and contrast with *W. rugulosa rugosa* in the following: Although somewhat variable, the glabellar outline of *W. rugulosa rugosa* differs from that of *W. rugulosa rugulosa* and the new subspecies in that the constriction opposite the 2p furrow is less conspicuously developed. The glabellar prosopon of *W. rugulosa rugosa* (*see* Bouček, 1934, Pl. 1, fig. 7) also differs from that of the other two subspecies in not paralleling the glabellar margin so closely. The pygidia of *W. rugulosa rugulosa* and *W. rugulosa canadensis* are virtually identical whereas that of *W. rugulosa rugosa* differs (see Bouček, 1934, Pl. 1, figs. 9-10) in having less distinct pleural furrows.

Dimensions.

	GSC No. 18135	GSC No. 18137	GSC No. 18138	GSC No. 18136
cranidial length	4.0	4.2	5.2	4.8
cephalic width	7.0	—	—	—
glabellar length	2.4	2.6	3.2	2.9
glabellar width	2.4	2.4	3.1	2.9

	GSC No. 18141	GSC No. 18140	GSC No. 18139
pygidial length	2.7	4.7	3.9
pygidial width	4.6	7.7	6.1
axial length	2.3	4.1	3.3
axial width	1.25	2.1	1.8

Discussion. The species *Cyphaspis rugulosus* described by Alth (1874, p. 61, Pl. 5, figs. 17-19) from Podolia and *Cyphoproetus rugosus* described by Bouček are considered by Alberti (1963b) to belong in *Warburgella*, to be conspecific, and to represent independent subspecies. Alberti (1963b) has discussed *Warburgella rugulosa rugulosa* and *W. rugulosa rugosa* from the Lower Gedinnian of Germany, Poland, and Podolia and the Lower Lochkovium (= Lower Gedinnian) of Bohemia, respectively, each of which is restricted to the Lower Gedinnian and of considerable biostratigraphic significance (*see* Přibyl and Vanek, 1962, p. 39). *W. rugulosa rugosa* occurs only in Bohemia, whereas *W. rugulosa rugulosa* occurs in Podolia, Poland, and Germany.

The writer conceives of subspecies as defined by Mayr (1942, p. 106) to mean geographically localized subdivisions of a species and to exclude non-contemporaneous morphological variants. Thus the designation of the new subspecies *Warburgella rugulosa canadensis* implies that the beds in which it is contained are of Lower Gedinnian age.

Of great interest is the apparent faunal similarity between the Lower Devonian of the arctic islands and the Rhenish facies of Germany, Poland, and Podolia. This discovery of *Warburgella rugulosa* in the arctic islands is suggestive that Lower Devonian Arctic trilobites, like Middle Devonian ones, not only have affinity with Europe rather than North America but also with German rather than Bohemian fauna.

Subfamily CORNUPROETINAE R. and E. Richter, 1956

Genus *Cornuproetus* R. and E. Richter, 1919

Type species: *Gerastos cornutus* Goldfuss, 1843

Subgenus *Cornuproetus* (*Cornuproetus*) R. and E. Richter, 1919

(=*Proetus* (*Sculptoproetus*) Erben, 1951)

Cornuproetus tozeri n. sp.

Plate VII, figures 5-10

Holotype. GSC No. 18144, external mould of nearly complete cranidium; Middle Devonian beds, largest of the Princess Royal Islands, lat. 72°48′, long. 117°46′; coll. E. T. Tozer, 1959.

Paratypes. GSC No. 18143/$_1$, cranidium; GSC No. 18143/$_2$ and GSC No. 18145, two pygidia; and GSC No. 18142, free cheek; same locality and horizon; coll. E. T. Tozer, 1959.

Description. Cranidium– Outline of anterior margin equals an arc of a circle whose radius equals the cranidial length. Anterior border short (sag. and exs.) for genus, evenly convex, of less than glabellar height with terrace lines on outer edge. Anterior border furrow broad and deep. Preglabellar field minute. Glabella gently convex in longitudinal and transverse profile, anterior slope shallow. Occipital region below glabellar level in longitudinal profile. Glabellar width equals length, outline distinctly "fiddleshaped" with waisting opposite the anterior edge of palpebral lobe. Two pair of glabellar furrows represented by smooth areas in the fine granulation of the glabella; 1p subtriangular directed inward and strongly backward opposite the midlength of the palpebral lobe; 2p fainter, directed inward and slightly backward for a short distance opposite the waisted part of the glabella. Occipital furrow narrow and incised, transverse. Occipital ring long (sag. and exs.), moderately convex transversely, faintly inflated beneath posterolateral corner of glabella. Sagittally occipital ring bears a median node and a thorn-like, backwardly directed spine on its posterior margin. Axial furrows distinct. Fixed cheeks very narrow, upwardly convex anterolateral to glabella. Palpebral lobes long (exs.) and narrow (trans.), inwardly sloping and of less than glabellar height. Anterior branch of facial suture moderately divergent, beta situated proximal to a line tangential (exs.) to outer margin of palpebral lobe. Posterior branch runs backward for a short distance then turns abruptly outward nearly at right angles to midline. Glabella, occipital ring and palpebral lobes bear a fine, evenly distributed granulation.

Free cheek– Eye lobe large, twice as long as wide, visual surface with numerous small lenses arranged in diagonal rows. Genal field evenly convex transversely, dropping off abruptly above posterior border furrow. Lateral border furrow shallow, lateral border convex but low. Posterior border furrow broad, posterior border broad and gently convex. Posterior margin of cheek curving backward laterally and merging with broad based genal spine. Genal spine of length equal to one and one half times that of eye lobe, with sulcate cross section along entire length.

Pygidium– Width approximately twice length. Outline transversely elliptical. Anterolateral corner in line with the second ring furrow. Stout, rapidly tapering axis extends for four fifths total pygidial length. Maximum axial width nearly one half of overall pygidial width. There are four axial rings, each with a backwardly directed axial node. Articulating half ring of equal size and convexity to first axial ring. Ring furrows moderately deep medially, shallowing laterally. Axis strongly convex in transverse profile, rising high above pleural fields, in longitudinal profile sloping gently backwards. Axial furrows distinct, strongly convergent backwards. Pleural fields weakly convex. There are four pleural furrows extending from the axial furrow nearly to the lateral pygidial margin, the fourth considerably weaker than the others. These four furrows set off three conspicuous broad ribs that are weakly convex in cross section with a tendency to be flattened along their crests. Three pair of interpleural furrows are present on the outer part of the ribs and extend for less than half the width of each rib, shallower than pleural furrows. Anterior and posterior pleural bands of similar length (exs.) and convexity. A fairly broad but low and indistinct pygidial border is set off from the rest of the pleural field by a broad, shallow furrow that passes directly behind the axis and parallels the pygidial margin. Border has flattened cross section and is crossed by pleural and interpleural furrows. Width of doublure equal to that of border. Lateral parts of axial rings and all of pleural fields covered with a fine granulation.

Dimensions.

	GSC 18143/$_1$	GSC 18144
cranidial length	9.2	5.9
glabellar length	7.0	3.9
max. glabellar width	7.2	4.0
glabellar width at waist	6.0	3.1

Discussion. Cornuproetus tozeri most closely resembles *C. cacuminatus* (Kegel, 1926, p. 16, Pl. 1, figs. 19a, b, 20; Erben, 1951, p. 25, Pl. 4, fig. 3, text-fig. 5) from the Lower Devonian of Germany, being of similar size and position of glabellar furrows, glabellar outline, presence of median occipital node and thorn-like occipital spine, and the course of the facial suture. *C. tozeri* differs in having a less arcuate anterior cranidial margin, a lower, shorter anterior border, and a stronger glabellar convexity in longitudinal profile. Of these differences, that involving the structure of the anterior border is the most pronounced. The border of *C. tozeri* is of less than glabellar height and gently convex, whereas that of *C. cacuminatus* is as high as the glabella and appears to have a steeper posterior slope. The difference in curvature of the anterior margin between *C. tozeri* and *C. cacuminatus* is slight but apparently consistent. In the former species the anterior margin is the arc of a circle with a radius equal to the entire cranidial length; in the latter, of a circle with a radius equal to the preoccipital cranidial length.

Erben (1951, p. 26) suggested that the pygidium which Kegel (1926, Pl. 1, fig. 21) assigned with question to *C. cacuminatus* belongs instead to an undescribed species of *Eremiproetus*. It differs from the pygidia assigned by me to *C. tozeri* in its subtetragonal outline and the presence of a post-axial ridge, and I agree with Erben that it probably belongs in *Eremiproetus*.

C. tozeri also resembles *Cornuproetus dufresnoyi* (Hawle and Corda) subspecies *b* of Erben (1952a, p. 193, figs. 14a, b), from the Lower Middle Devonian of Greifenstein, Germany. They are similar in number and position of glabellar furrows, presence of axial nodes on midpart and posterior margin of occipital ring, longitudinal glabellar convexity, and the course of the posterior branch of facial suture, but *C. dufresnoyi* subsp. *b* Erben has a much longer and more inflated anterior border, a more nearly subquadrate glabellar outline, a sigmoidal curve in the midpart of the course of the occipital furrow, and a coarser granulation on the glabella (Harrington, *et al.*, 1959, fig. 294, 1a-b).

Specimens of *Cornuproetus cornutus* (Goldfuss, 1843), the type species, have been compared with *C. tozeri*. The species are similar in glabellar outline, the presence of a faintly inflated part of the occipital ring beneath the posterolateral glabellar corners, number of pygidial segments, shape of pygidial axis and nature of border, and overall pygidial outline, but differ in that *C. cornutus* has a much broader anterior border, more and differently directed glabellar furrows, and lacks two axial nodes on the occipital ring and any on the pygidial axis.

C. tozeri clearly belongs in the *Cornuproetus trautensteinensis* Erben group (Erben, 1951, p. 11) consisting of *C. trautensteinensis* Erben, *C. cacuminatus* (Kegel, 1926), and *C.* sp. *b* (Kegel, 1926), a group of species which have in common two axial nodes on the occipital ring and an uninflated border which forms a circular arc and is turned up flap-like. *C. tozeri* is the only one of these species whose pygidium is known, and it may prove that the presence of axial nodes on the pygidium (as in *C. tozeri*) is a further group character. The fauna with which it is associated suggests that *C. tozeri* is younger (Lower Middle Devonian) than the other members of the *C. trautensteinensis* group.

Subfamily DECHENELLINAE Přibyl, 1946

Discussion. R. and E. Richter (1950a) summarized knowledge of this subfamily, and Stumm (1953a, 1953b) demonstrated the presence of *Dechenella (Dechenella)* in beds of both Couvinian and Givetian age in North America. The species assigned to *Basidechenella* by Stumm cannot be accommodated in that subgenus. They are dechenellinids very close to *Proetus* and should probably be assigned to a new subgenus of *Dechenella.*

One new genus *Deltadechenella* and one new subgenus *Pedinodechenella* are here added to the Dechenellinae. The writer follows Hupé 1953 in considering *Cyrtodechenella* a member of this subfamily rather than of the Cyrtosymbolinae as the Richters (*in* Harrington, *et al.*, 1959) do.

The Phylogeny of the Dechenellinae

In Europe the Upper Emsian Heisdorfer beds with *Dechenella (Basidechenella) kayseri* are succeeded by Eifelian beds from which *Dechenella* is absent. It is not until late Eifelian time that *Dechenella (Dechenella)* first appears. The absence of forms that could be considered directly ancestral to *Dechenella (Dechenella)* prevented the construction of a complete phylogeny for the Dechenellinae. The Richters (cf. 1950) made isolated remarks about the probable relationship among several of the genera in the subfamily but never proposed a complete phylogeny.

The earlier appearance of *Dechenella* (*Dechenella*) in the arctic islands suggests that more might be revealed about the phylogeny of the subfamily from a study of its Arctic representatives. The Richters realized this (1950, p. 174) merely from an examination of Tolmachoff's (1926) illustrations of dechenellinids from Ellesmere Island. To a certain extent this has proven to be so. For example, the discovery of *Cyrtodechenella* in beds of Eifelian or perhaps partly Emsian age on Prince of Wales Island extends the range of that genus from at least Eifelian to Givetian. At the same time its association with and resemblances to *Dechenella* (*Basidechenella*) *laticaudata* seem to confirm the Richters' (1950, p. 166) suggestion that *Cyrtodechenella* may have been derived from *Basidechenella*. The writer suspects that *Cyrtodechenella*, which later gave rise to some of the Cyrtosymbolinae, branched off from *Basidechenella* some time in the Emsian and that *Cyrtodechenella macnairi* is very near the rootstock of the genus. *Basidechenella* was probably not on the main line of dechenellinid descent but an offshoot isolated from the branch that gave rise to *Dechenella* (*Dechenella*). The origin of *Dechenella* (*Dechenella*) cannot be traced to *Basidechenella* which lacks occipital lobes and the distinctive glabellar outline of *Dechenella*. This interpretation contrasts with that of the Richters (1950, p. 166) who proposed that *Basidechenella* gave rise to *Cyrtodechenella* and to *Dechenella* as separate branches.

Of great significance to the understanding of dechenellinid phylogeny is the dechenellinid fauna that Stumm has described from the Middle Devonian of Michigan (1953a, 1953b). The species in this fauna which Stumm assigned (1953a) to *Basidechenella* do not conform to R. Richter's diagnosis of that subgenus and should be placed in a new subgenus (*see* p. 101). They are, however, dechenellinids very similar to *Proetus* and the writer agrees with Hessler's (1963, p. 546) claim that the similarities between *Proetus* and these Michigan dechenellinids reflect close phyletic relations. *Dechenella* (subgen.?) *rowi* (Green) (Stumm, 1953a, Pl. 3, fig. 11; Pl. 4, figs. 1-2) from the Middle Devonian of New York State and Michigan has characters that are almost exactly intermediate between those of *Dechenella* and *Proetus*.

These Michigan dechenellinids are too young (Givetian) to be the actual phylogenetic intermediates between *Dechenella* and *Proetus* but probably represent little-altered descendants of such forms.

Of the many known species of *Proetus* those which have been assigned to the subgenus *Longiproetus* have characters most closely approaching those of *Dechenella*. The characters by which *Longiproetus* differs from *Proetus* (*Proetus*) (elongated glabella, less highly convex cephalon, moderate divergence of the anterior branch of facial suture) are exactly those in which it approaches *Dechenella* and suggest it as the probable ancestor of *Dechenella* (*Dechenella*). The oldest known species of *Longiproetus* are Lower Devonian, and species with and without occipital lobes are known so that both *Dechenella* and *Basidechenella* could have been independently derived from this subgenus.

The occurrence of *Longiproetus* very near the base of the Blue Fiord Formation and the presence of *Dechenella* (*Dechenella*) in the Arctic in beds older than those in which it appears in Europe together suggest the Arctic and nearby regions a more likely site of origin of the Dechenellinae than Europe. *Dechenella* (*Dechenella*) apparently also occurs in continental North America in beds of Eifelian age, e.g., *Dechenella* (*D*) *valentini* Stumm, 1953b; *D* (*D*) *delphinula*; and *D* (*D*) *planimarginata* (Meek, 1871), in beds of presumed Eifelian age. Thus North America may also be a site of origin of this subfamily.

Of the origin of certain other dechenellinid genera there is much less known. For example, there are in Europe no obvious ancestors for *Schizoproetus* which appears at the base of the Couvinian in Europe and in the Couvinian of the Canadian Arctic. However, the North American *Proetus* (*Crassiproetus*) *crassimarginatus* (Hall, 1843) (Stumm, 1953b, p. 15, Pl. 1, figs. 2-13; Pl. 2, figs. 9-10) which occurs in the Couvinian Onondaga limestone has a pygidium which with its strong longitudinal convexity and large number of axial rings and pleural ribs is reminiscent of *Schizoproetus ellesmerensis*. The cephalon of *Crassiproetus* is not at all like that of *Schizoproetus* and direct relation between them does not seem likely. This example does suffice to show that pygidia of the *Schizoproetus* type did evolve within the *Proetus* group. Possibly the origin of *Schizoproetus* is to be traced to some Lower Devonian *Proetus*. So far as the writer is aware, no *Crassiproetus*-like trilobites are known from the Devonian of Europe.

The cephala of *Paradechenella* and *Schizoproetus* are rather similar (longated, moderately tapering to parallel-sided glabella; facial suture not angulate at beta; strong tuberculation, deep glabellar furrows) as Richter (1912, p. 322) long ago noted, but the presence of a post-axial spine on the pygidium of *Paradechenella* readily distinguishes it from most species of *Schizoproetus*. Recently Maximova (1955, p. 91, Pl. 5, figs. 9-11) described from the Givetian of the U.S.S.R. *Schizoproetus baschkiricus*, a species with a post-axial spine. Thus *Paradechenella* and *Schizoproetus* parallel one another in many major characters which may reflect derivation from a common ancestor.

As to what might represent the forerunner of *Deltadechenella* with its unusual triangular pygidium the writer can offer no suggestions. It is believed that the very similar pygidium of *Chaunoproetus tietzei* (R. and E. Richter, 1919) (*see* p. 104) indicates the derivation of that Upper Devonian genus from the Eifelian *Deltadechenella*. Another cyrtodechenellinid which probably was derived from a dechenellinid is *Cyrtosymbole* which is a probable descendant of *Cyrtodechenella* (*see* R. and E. Richter, 1950a, p. 168). *Cyrtodechenella* has a cyrtosymbolinid pygidium and like *Cyrtosymbole* lacks occipital lobes.

The proposed derivations of *Cyrtosymbole* and *Chaunoproetus* from different dechenellinid genera are in accord with Hessler's (1963, p. 546) recent claim that the Cyrtosymbolinae are polyphyletic.

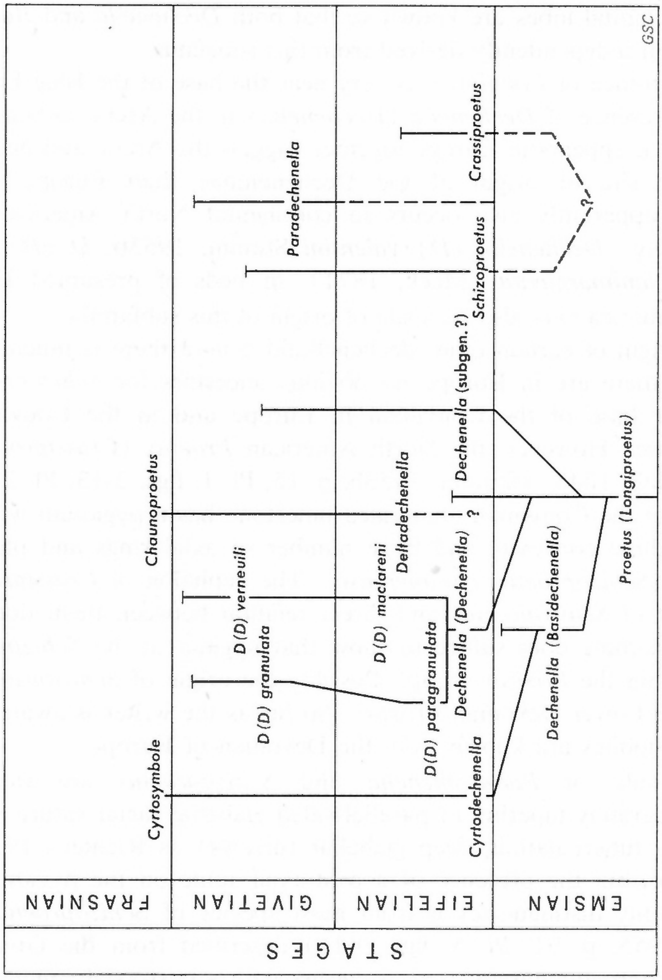


FIGURE 7. Phylogeny of the Dechenellinae.

Figure 7 graphically summarizes the writer's conception of the phylogeny of the Dechenellinae and a few of their descendants.

Genus *Dechenella* Kayser, 1880

Diagnosis. See R. and E. Richter (*in* Harrington, *et al.*, 1959, p. 387)

Subgenus *Dechenella* (*Dechenella*) Kayser, 1880

Type species: *Phillipsia verneuili* Barrande, 1852

Diagnosis. Glabella expanded across (trans.) basal lobes and with distinct constriction opposite the 2p furrow, tapering anteriorly, outline thus subconical to cloverleaf-shaped. Three to four pair of moderately deep to deep lateral glabellar furrows, 1p with adaxial branch. Anterior branch of facial suture strongly divergent, angulated at border furrow. Preglabellar field typically short (sag.). Occipital lobes prominent. Pygidium elongate and multisegmented, long, tapering axis with thirteen to nineteen rings; eight or more pleural ribs. Interpleural furrows usually present. Pygidial border present.

Geological range. Middle Devonian (Eifelian to Givetian).

Dechenella (Dechenella) bathurstensis n. sp.

Plate VII, figures 11-18; Plate VIII, figures 1-4

Holotype. GSC No. 18148, cranidium; Bird Fiord Formation, eastern Bathurst Island; coll. B. Glenister, 1955.

Paratypes. GSC No. 18146, partial cranidium; GSC No. 18147, free cheek; GSC Nos. 18150, 18151, two pygidia; and GSC No. 18149, hypostome; same horizon and locality.

Other material. GSC No. 18153, cranidium and GSC No. 18152, pygidium; Bird Fiord Formation, 760 feet above the base, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′.

Description. Cranidium– Anterior border broad, about one fourth of glabellar length, and flat, in profile a flat-topped, broad arc, outer edge bears a few indistinct terrace lines, inner edge slopes abruptly to border furrow. Border furrow broad. Preglabellar field flat to gently concave, about one half the width of the border. In profile glabella a low arc declining more steeply anteriorly, gently and evenly arched, transversely. Glabella longer than wide, length to breadth ratio averages 1.2:1 for ten specimens. Glabella tapers evenly forward with no waisting opposite lateral furrow 2p, anterior end rounded. In outline it is thus conical rather than cloverleaf-like as are many species of the genus. Greatest glabellar width is just posterior to the anterior end of lateral furrow 1p, glabella slightly narrowing posterior to that. Three pair of lateral glabellar furrows, 1p deeply incised, beginning just inside the axial furrow it is a gentle arc to a point opposite the middle of the palpebral lobe. There it straightens out and runs posteriorly as a backwardly directed line to join the occipital furrow, straight part of 1p twice as long as curving part. Furrow 1p deepest in the straight part of its course, broadens just anterior to the occipital furrow and is a broad, gentle depression at its juncture with that furrow. Faint, short adaxial branch of 1p furrow is separate from 1p a distance equal to its own length. Lateral furrow 2p faintly impressed, beginning just opposite the anterior edge of the palpebral lobe, passing inward and backward roughly parallel to the anterior part of furrow 1p as a gently curving line, length equal to the width of the anterior border. Lateral furrow 3p almost obsolete, visible on larger cranidia as a short, faintly impressed, curving line beginning at the axial furrow. Distance (exs.) between 3p and 2p lateral furrows about three fourths that between 2p and 1p. Basal glabellar lobes subtrigonal in outline, inflated. In profile posterior end of glabella is high above the occipital ring and declines with a steep, straight slope to the occipital furrow. The intersection of this slope with the dorsal surface of the glabella produces a sharp corner at the posterior end of the glabella in the midline. The posterior edge of the glabella in the midline is slightly raised by a median keel which disappears rapidly anteriorly. On specimens preserved as internal moulds this keel is more distinct. Occipital furrow deep, distal ends turning slightly anteriorly. Occipital lobes large and fairly prominent. Occipital ring broad (sag.), flattened and gently forward sloping in profile. Axial furrows lightly impressed but distinct. Fixed cheeks in front of eyes narrow and not sloping outward, declining gradually anteriorly with a slope consisting of two parts, a flat, gentle posterior slope, and a steeper, gently arched anterior slope. Palpebral lobes reniform, of slightly less than glabellar height. Anterior branch of facial suture strongly divergent anteriorly, at 36 degrees to the midline, a gently arcuate line reaching a point more distal than the most distal point on the palpebral lobe before turning sharply inwards to pass obliquely across the anterior edge of the anterior border. Posterior branch runs diagonally outward at an angle of about 60 degrees to the sagittal line. Cranidial exoskeleton smooth except for the posterior edge of glabella between proximal ends of 1p furrows which bears three or four tubercles.

Free cheek– Eye lobe large, extending from a point in line with 3p lateral furrow to a point in line with the distal end of the occipital furrow. The genal field consists of a broad, flat ocular platform which declines rapidly both posteriorly and laterally to the respective borders. Lateral border consists of two parts, a rounded outer edge and a horizontal inner part which is separated from the genal field by a change in slope but no border furrow. Posterior border is strongly convex (exs.), semicylindrical in shape and set off by a deep posterior border furrow. At the posterolateral corner the cheek is prolonged in a stout genal spine slightly longer than the eye. The posterior border furrow turns abruptly backward at the posterolateral corner and runs down the genal spine for about one half its length.

Hypostome– Outline of anterior margin converges anteriorly to a rounded point in the midline. Anterior border narrows distally, in profile curving ventrally. Anterior border furrow shallow. On the distal parts of the anterior border just ventral to the anterior wings and midway between the anterior margin and the anterior border furrow occurs a short, deep furrow oriented at an oblique angle to the margin. The triangular anterior wings are set off by a change in slope from the nearly vertically ascending sides of the anterior lobe of the middle body. Greatest width of hypostome across anterior wings slightly greater than length (sag.) of the medium body. Middle body gently convex longitudinally, sloping gradually backwards so that the posterior lobe lies lower than the anterior lobe, strongly convex transversely. Posterior lobe in profile somewhat flattened. Deep, short middle furrow commences at lateral furrow anterior to the shoulder, runs inward and backward. Outline of posterior lobe crescent-like, length (sag.) less than one third that of middle body. Lateral furrow a narrow deep slot setting off a strong, semicylindrical lateral border, beginning immediately posterior to anterior wings. Shoulder distinct. Posterior border only partly preserved, gently rounded in outline, about three times as broad (exs.) as the lateral border, in cross section broadly convex, set off by a posterior border furrow of moderate depth but shallower than the lateral furrow.

Pygidium– Length equals two thirds width. Outline bluntly rounded, outline of posterior margin behind axis, straight transversely. Convex axis tapers gradually and evenly. Axis narrow, greatest width (trans.) about half that of one pleural field plus border. Paratype GSC No. 18151 with sixteen axial rings, but seventeen rings are visible on pygidium of length (sag.) 11 mm or more. Short, unsegmented tip of axis merges insensibly with the border. Axial rings slope gradually forward, steeply rounded at the back. In profile axis declines only gently posteriorly. Dimension measured in profile from the lateral margin to the highest point on axis about 3.2 mm (GSC No. 18150). Axial furrows lightly incised. Pleural fields broadly arched and dipping gently outward. Thirteen pleural furrows, the last three indistinct and not visible on pygidia of less than about 11 mm length (sag.). Pleural furrows 1-3 extend on to but not across the border. Pleural furrows deep, breadth (exs.) about equal to one fourth that of posterior pleural band adjacent to axial furrow. Five faint interpleural furrows, extending slightly more than half way down the pleural field. Anterior and posterior pleural bands of equal convexity. Border furrow lacking, but border is set off by a change in slope between it and the pleural field. Border broad, gently arched, maintaining essentially the same breadth all around pygidium. Doublure as broad as pygidial border, bears a few, indistinct terrace lines. External surface of exoskeleton smooth.

Dimensions.

	GSC No. 18148	GSC No. 18146	GSC No. 18153
glabellar length	5.0	5.6	8.5
glabellar width	4.7	5.1	8.0
cranidial length	8.1	9.0	14.1
	GSC No. 18151	GSC No. 18150	GSC No. 18152
pygidial length	8.1	5.4	9.3
pygidial width	12.0	7.2	13.2

Discussion. This species most closely resembles *Dechenella setosa* Whidborne (1888, p. 27, Pl. 2, figs. 15–17), from the Middle Devonian of England, especially in the shape of the glabella and form of the anterior border. It is distinguished from that species in having three rather than four pair of lateral glabellar furrows, free cheek with a straight rather than backwardly curving posterior border, pygidium with a transversely straight posterior margin, and a smooth exoskeletal surface.

The outline of the pygidium of *Dechenella bathurstensis* readily distinguishes it from almost all other species of the genus. The pygidial outline of *Dechenella*? *platycaudata* Maximova, 1955, is somewhat similar, but that species is distinguished by its smaller number of axial rings (12) and pleural furrows (3).

This is the most abundant trilobite species in the Bird Fiord Formation of Bathurst Island. On Twilight Creek it ranges through 300 feet of strata from 460 to 760 feet above the base of the formation. On Tucker River, Grinnell Peninsula, Devon Island a species very close to or identical with *D. bathurstensis* (GSC No. 27769) occurs in Bird Fiord beds just below the Okse Bay Formation.

Dechenella (*Dechenella*) *algida* n. sp.

Plate VIII, figures 5-11

Holotype. GSC No. 18154, cranidium; 880 feet above the base of the Bird Fiord Formation, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′; coll. Ormiston, 1962.

Paratypes. GSC No. 18157, hypostome; GSC No. 18155, pygidium, same horizon and locality as holotype; GSC No. 18156, cranidium; 955 feet above base of Bird Fiord Formation, Twilight Creek, Bathurst Island; coll. Ormiston, 1962.

Description. Cranidium— Height of anterior border somewhat variable. In holotype GSC No. 18154 anterior border semicylindrical in cross section, half as high as long (sag.), longer than occipital ring, bearing faint terrace lines on anterior quarter. Border furrow broad and deep. Preglabellar field minute. In longitudinal profile posterior third of glabella horizontal and equal in height to occipital ring, anterior two thirds moderately convex. Transverse glabellar convexity moderate. Glabella nearly as wide as long, outline pinched in opposite 3p furrow, parallel-sided for a short distance anterior to 3p furrows, then tapering abruptly. Glabella anterior to 3p furrows broad for genus. Four pair of lateral glabellar furrows: 1p deep and broad, running in a smooth backward-inward directed curve from axial furrow to occipital furrow, adaxial branch 1p weakly developed on adaxial wall of 1p furrow at midlength, barely perceptible; 2p shallower than 1p but deep, nearly attains midline, proximal half strongly backwardly directed; 3p runs from axial furrow, nearly transverse in distal half, proximal half curving backward; 4p a faint transversely ovate depression far from axial furrow. Anterior glabellar lobe broad, width is twice length. Occipital furrow deeply incised with distal ends turning only slightly forward, attains axial furrow. Occipital lobes subcircular, prominent. Occipital ring moderately convex transversely. Axial furrows deepest opposite 3p furrow, elsewhere of uniform depth. Fixed cheeks in front of eyes rapidly broadening anteriorly, slope interrupted at midlength by flexure of triangular cross section. Palpebral lobes broad (trans.), low lying and gently inward sloping. Anterior branch of facial suture strongly divergent, between point in line with 4p furrow and border furrow a straight line diverging at 40 degrees to midline, turning sharply at border furrow to run at 75 degrees to midline before cutting back abruptly to cross anterior margin. Angle at beta thus very acute, beta in line (exs.) with most distal part of palpebral lobe. Anterior border, glabella and occipital ring finely pitted.

Pygidium— Outline roughly semioval, distinctly truncated posteriorly. Ratio of length to width as 1:1.5. Axis tapers strongly to eighth axial ring, more gradually thereafter. Maximum axial width four fifths that of one pleural field plus border. Axis with fourteen axial rings, the last five of which are fused medially. Ring furrows deep and transverse. In longitudinal profile pygidial height of paratype is 4.0 mm, axis strongly downsloping in an even, flat slope, axial rings vertical and of uniform height. Axial furrows deep, exceptionally deep on specimens preserved as internal moulds. In transverse profile axis is distinctly flat topped, more so on internal moulds than on specimens with exoskeleton intact, pleural fields moderately convex. Twelve deep pleural furrows set off eleven ribs of evenly convex cross section, width of furrows one third that of ribs. No interpleural furrows are visible. Border furrow deep and of moderate breadth. Border broad, of uniform width all around pygidium, gently convex, bearing oblique ridges distally. Exoskeleton appears smooth.

Dimensions.

	GSC No. 18154 holotype	GSC No. 18156	GSC No. 18155
cranidial length	8.3	12.0	
glabellar length	5.3	8.5	
glabellar width	5.1	8.0	
length (sag.) anterior border	1.2	1.5	
pygidial length			11.2
pygidial width			16.6
axial length			9.2
axial width			4.6

Discussion. Dechenella algida resembles closely *D.* (*D.*) *burmeisteri* R. Richter, 1909 (1912, p. 297, Pl. 19, figs. 15-21) from the Givetian of Westphalia. Several characters of *D. algida* approach those of *D. burmeisteri* but are less strongly developed. For example, the 2p and 3p glabellar furrows of *D. algida* are deep for the genus but still less deep than those of *D. burmeisteri*; the glabella is pitted but less coarsely pitted than in *D. burmeisteri*; the pygidial axial furrows are deep for the genus but shallower than in *D. burmeisteri*; and the pygidial axis flat topped in cross section but less pronouncedly than in *D. burmeisteri*. Other similarities between these species are: the number and position of glabellar furrows, the height of the anterior border, the sharp flexure on the fixed cheek, the blunted outline of the pygidium, median fusion of the last five axial rings, the axis more gradually tapering posterior to the eighth axial ring, and the absence of visible interpleural furrows.

Dechenella algida differs from *D. burmeisteri* in that (1) the glabella tapers much less rapidly anterior to the 3p furrow and consequently has a conspicuously different outline; (2) the palpebral lobe is not steeply inwardly sloping; (3) there is only one adaxial branch from the 1p glabellar furrow; (4) the pygidial border is more convex; and (5) it has fewer axial rings and pleural ribs.

The pygidium of *D. algida* also resembles that of *D. bathurstensis* n. sp. (this paper) from 660 feet above the base of the Bird Fiord Formation, being especially similar in outline and convexity. The pygidia of these species are distinguishable by the proportionately broader axis, more convex border, and absence of interpleural furrows in *D. algida.* The cranidia of *D. algida* and *D. bathurstensis* are quite dissimilar.

On Twilight Creek the minimum stratigraphic range of *D. algida* is from 880 to 955 feet above the base of the Bird Fiord Formation. No other trilobite species have yet been found in association with *D. algida.*

Dechenella (*Dechenella*) *osborni* n. sp.

Plate VIII, figures 12-18

Holotype. GSC No. 18158, nearly complete cranidium; Bird Fiord Formation 375 feet above the base, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′; coll. Ormiston, 1962.

Paratypes. GSC No. 18160, external mould of cranidium, and GSC No. 18159, partial pygidium, same locality and horizon.

Description. The morphology of this species is closely comparable to that of *Dechenella bathurstensis* n. sp. with the following exceptions:

Cranidium— The anterior border carries a faint sagittal ridge which extends from the vicinity of the anterior margin to just above the border furrow. This ridge is conspicuous only with strong sidelighting. The 1p glabellar furrow is deeper and curves evenly along its entire length. An adaxial branch to the 1p furrow is present, separated from the 1p furrow by its own length and nearly paralleling the midpart of 1p. The 2p and 3p furrows are longer and deeper. Palpebral lobes broader (trans.) and more steeply inwardly sloping. The anterior border and anterior two thirds of the glabella are finely pitted, posterior third of glabella tuberculate.

Pygidium— The pygidium is nearly semioval in outline and lacks the posterior truncation of *D. bathurstensis.* Other differences are minor and include: the presence of prominent tubercles on the posterior edge of axial rings, and the slightly sigmoidal outline of the anterior pleural ribs.

Dimensions.

	GSC No. 18160	GSC No. 18158	GSC No. 18159
cranidial length	10.0	10.8	
glabellar length	6.6	7.2	
glabellar width	5.8	6.6	
anterior border length	1.5	1.5	
pygidial length			7.7
pygidial width			10.2
axial length			6.3
axial width			3.1

Discussion. This species is not only similar to *Dechenella bathurstensis* n. sp. but also to *D. crista* n. sp. which occurs with *D. bathurstensis* at 500 to 530 feet above the base of the Bird Fiord Formation on Twilight Creek. The most obvious similarity is the presence of an even stronger sagittal preglabellar ridge in *D. crista.* The 2p and 3p furrows of these species are closely comparable in position and depth, and *D. crista* has an adaxial branch of the 1p furrow and palpebral lobes of the *D. osborni* type. *Dechenella osborni* differs from *D. crista* in having: a narrower (sag.) anterior border of different cross section, less strongly sloping fixed cheeks, an evenly curving 1p furrow, a proportionately longer glabella, in lacking a tuberculate occipital ring and in having less densely packed tubercles on the posterior third of the glabella.

Dechenella osborni, which combines unit characters of both *D. crista* and *D. bathurstensis,* is considered to be either closely related to or identical with the common ancestor of both those species. The morphological characters and stratigraphic occurrence of these three species of *Dechenella* are consistent with such an interpretation. *Dechenella osborni* appears 125 feet stratigraphically below the lowest known occurrence of *D. crista* and 100 feet below that of *D. bathurstensis.*

Little structural modification is required to derive *D. bathurstensis* from *D. osborni;* the major changes being the disappearance of the faint sagittal ridge, the shallowing and shortening of the 2p and 3p furrows, a steepening and broadening of the palpebral lobes, virtual disappearance of cranidial prosopon, and a change in pygidial outline. The great abundance and great stratigraphic range of *D. bathurstensis* suggest that it represents a relatively successful lineage.

The rare and short ranging *D. crista* apparently represents a less successful branch of the *D. osborni* stock in which the anterior border became considerably lengthened, the sagittal preglabellar ridge more pronounced, and the glabella proportionately shortened.

In the derivation of both *D. crista* and *D. bathurstensis* from the *Dechenella osborni* stock there must be a change in the outline of the 1p furrow from evenly curving to angulated.

Dechenella (*Dechenella*) *crista* n. sp.

Plate IX, figures 1-4

Holotype. GSC No. 18161, external mould and rubber cast of cranidium; 500 feet above base of Bird Fiord Formation, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′; coll. Ormiston, 1962.

Paratypes. GSC No. 18162, external mould, and GSC No. 18163, internal mould of cranidium; Bird Fiord Formation, 530 feet above base of Bird Fiord Formation, Twilight Creek, Bathurst Island; coll. Ormiston, 1962.

Description. Cranidium— Anterior border long (sag.), equalling about one fifth of cranidial length, in profile gently downsloping posteriorly. Border furrow broad and shallow, indistinct. A sagittal ridge arises from the floor of the border furrow immediately in front of the glabella and extends to the anterior margin. This low, narrow ridge is barely perceptible on internal moulds of the cranidium, but fairly obvious on specimens with the exoskeleton preserved. Glabellar width approximately equals length. Three pair of lateral glabellar furrows, 1p like that of *D. bathurstensis* n. sp. (this paper), 2p and 3p like those of *D. bathurstensis* but deeper. In specimens preserved as internal moulds a median keel extends from the posterior edge of the glabella to the vicinity of the proximal ends of the 2p furrows. Occipital furrow and ring as in *D. bathurstensis.* Axial furrows everywhere of uniform depth. Fixed cheeks in front of eyes somewhat inflated and steeply downsloping. Palpebral lobes as in *D. bathurstensis.* Posterior third of glabella bears small tubercles, occipital ring with densely packed tubercles.

Free cheeks, thorax and pygidium unknown.

Dimensions.

	GSC No. 18162	GSC No. 18163	GSC No. 18161
cranidial length	8.5	8.1	7.8
glabellar length	4.5	4.4	4.8
glabellar width	4.3	4.2	4.4
anterior border length	1.8	1.8	1.5

Discussion. The presence of a sagittal preglabellar ridge and a broad border make this species easily recognized, but it has strong similarities to *Dechenella bathurstensis* n. sp. with which it occurs at between 500 and 530 feet above the base of the Bird Fiord Formation on Twilight Creek. The two species are particularly close in: the outline and depth of the 1p furrow, glabellar convexity (transverse and longitudinal), the presence of a median keel on the posterior third of the glabella of internal moulds, the course of the facial suture, and the structure of the occipital region. They differ in that (1) *D. crista* has a sagittal preglabellar ridge; (2) the border of *D. crista* is considerably broader (sag.) than that of *D. bathurstensis;* (3) the glabella of *D. crista,* although approaching in outline that of *D.*

bathurstensis, is slightly shorter; (4) the 2p and 3p furrows of *D. crista* are deeper than those of *D. bathurstensis;* (5) the glabella and occipital ring of *D. crista* are tuberculate, those of *D. bathurstensis* smooth.

A sagittal preglabellar ridge is fairly common in certain trilobite groups. For example, nearly all species of the asaphid *Megistaspis* display such a structure, which is termed a median ridge of the preglabellar field by Bohlin (1960, text-fig. 1). Within the genus *Dechenella,* however, *D. crista* is unique in the strength of this ridge and is therefore a distinctive species.

The structural similarity between *D. crista* and *D. bathurstensis* is suggestive of a common ancestry, and *D. osborni* is proposed as their common ancestor.

Dechenella (*Dechenella*) *neotesca* n. sp.

Plate IX, figures 5-10

Holotype. GSC No. $18164/_1$, cranidium with damaged palpebral lobes; Bird Fiord Formation 220 feet above the base, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′; coll. Ormiston, 1962.

Paratypes. GSC Nos. 18165, 18166, two pygidia, same horizon and locality as holotype; GSC No. 18167, pygidium, Bird Fiord Formation between 225 and 365 feet above the base, Twilight Creek, Bathurst Island; coll. McLaren, 1955.

Description. Cranidium— The cranidium differs from that of *D.* (*D.*) *tesca* n. sp. in (1) anterior branch of facial suture much less divergent (at an angle of 28 degrees to the midline compared with 43 degrees for *D. tesca*); (2) anterior border more rounded in cross section, lacking a flat posterior slope; (3) glabella more convex transversely; (4) palpebral lobes more steeply inwardly sloping, and with narrower (trans.) distal part; and (5) occipital ring with a more prominent median tubercle.

Pygidium— Ratio of length to width averages 1:1.43 for three specimens. Pygidial outline resembles the letter W, having a conspicuous sagittal indentation in posterior margin, depth of indentation about one fifteenth of pygidial length. Convex axis tapers gradually, maximum width about one fourth pygidial width. Paratype GSC No. 18167 has fourteen axial rings, smaller pygidia with thirteen visible rings. Ring furrows transverse, deep. In longitudinal profile first axial ring rises high above others, axis declines in flat slope to posterior tip where it drops off abruptly. Axial furrows deepen posterior to sixth axial ring. In transverse profile slope of pleural field consists of three parts: horizontal adjacent to axis, a steep flat slope beginning at one fourth the width of the pleural field and extending to three fourths the width of the field to the border furrow. Pleural fields crossed by ten broad, trough-like pleural furrows setting off nine pleural ribs, pleural furrows as broad as pleural ribs which have a highly convex cross section. At the position of the first change in slope of pleural field the first, second, sixth and seventh ribs have low nodes, all ribs have low nodes at the position of the second (outer) change in slope. Five faint interpleural furrows are present and extend one fourth the way down pleural field. Border furrow shallow. Border convex and steeply inclined, broadest adjacent to sagittal indentation so that there is a lobate prolongation of the border on either side of the indentation. Posterior edge of axial rings granulose, remainder of exoskeleton appears smooth.

Dimensions.

	GSC No. 18164/i	GSC No. 18165	GSC No. 18166	GSC No. 18167
cranidial length	4.8			
glabellar length	3.3			
glabellar width	2.9			
beta width	3.9			
pygidial length (sag.)		4.2	2.8	6.1
pygidial length (exs.)		4.5	3.0	6.6
pygidial width		6.3	4.2	10.0
axial length		3.5	2.4	5.0
axial width		1.8	1.1	2.5

Discussion. The pygidium of *D. neotesca* differs from that of *D. tesca* n. sp. (this paper) in: the W-shaped outline, the more pronounced sagittal indentation of the posterior margin, the narrower border, and the tripartite slope of the pleural field.

Dechenella neotesca and *Dechenella tesca,* although fairly readily distinguished from each other, have many characters that are nearly identical, and these important similarities in conjuntion with other general structural similarities such as the indented posterior pygidial margin suggest to the writer that *D. tesca* is ancestral to *D. neotesca.* Among characters considered identical are: the glabellar outline and lobation, the apical node on the occipital lobe, the cranidial prosopon, the broad, trough-like pleural furrows, the highly convex cross section of the pleural ribs, and the number of ribs.

On Twilight Creek *D. neotesca* occurs some 440 feet stratigraphically higher than its presumed ancestor *D. tesca,* and no transitional form has yet been found in the intervening strata. The derivation of *D. neotesca* from *D. tesca* would involve the following structural changes (1) a pronounced deepening of the barely perceptible sagittal indentation in the pygidium of *D. tesca;* (2) an increase in the convexity of the cranidial and pygidial borders; (3) a steeping of the pygidial pleural field; (4) a steepening of the slope of palpebral lobes; (5) an increase in transverse convexity of the glabella; and (6) a change in the course of the anterior branch of the facial suture.

Dechenella (*D.*) *retusa* n. sp. from the Devonian of Victoria Island resembles *D. neotesca* in having a pronounced indentation in the posterior pygidial margin, but lacks the broad pleural furrows and highly convex pleural ribs which *D. tesca* and *D. neotesca* share.

Dechenella (*Dechenella*) *crepuscula* n. sp.

Plate IX, figures 11-16

Holotype. GSC No. 18168, small cranidium; Bird Fiord Formation, 622 feet above the base, Twilight Creek, Bathurst Island; coll. Ormiston, 1962.

Paratypes. GSC No. 18169, immature pygidium; GSC No. 18170, external mould of pygidium, same locality and horizon, lat. 76°18′, long. 99°12′.

Description. This species closely resembles *Dechenella algida* n. sp. but can be distinguished from it by (1) palpebral lobes are narrower (trans.) and more steeply inward sloping; (2) the anterior glabellar lobe is narrower (trans.) in proportion to the rest of glabella; (3) 2p and 3p glabellar furrows are nearly straight in plan rather than curving; (4) adaxial branch of the 1p furrow is much deeper and longer; (5) the occipital furrow is less steep-sided in profile; (6) the occipital lobes are less inflated; and (7) the glabella is tuberculate rather than pitted. The pygidium differs from that of *D. algida* only in having a posteriorly more rounded outline and a uniformly tapering axis. The pygidia of these two species are otherwise extremely close and difficult to distinguish.

Development. An immature pygidium of length (sag.) 1.5 mm differs from the holaspid pygidium in having a conspicuous sagittal indentation in the posterior margin and well developed interpleural furrows (*see* Pl. IX, fig. 13). A sagittal indentation in meraspid pygidia of Cyrtosymbolinae has been termed a *larval notch* by Osmolska (1962, p. 57) and was observed by her on the meraspid pygidia of all the Famennian and Lower Carboniferous Cyrtosymbolinae that she examined. In these species the larval notch typically disappears gradually during ontogeny.

Discussion. Dechenella crepuscula is apparently a relatively rare species, the stratigraphic range of which is not known. Poorly preserved cranidia occurring at other horizons may belong to this species but cannot be positively assigned. Because the vertical distribution of this species is inadequately established, the writer has elected to avoid speculation about its phylogenetic relations with *D. algida,* which it obviously resembles.

The writer considers it unlikely that *D. crepuscula* represents the extreme end members of a highly variable population of *D. algida* rather than an independent species. A large number of cranidia of *D. algida* have been prepared and examined and do not show much variability except in the cross sectional outline of the anterior border, a feature that has not been used to discriminate between *D. algida* and *D. crepuscula.* Furthermore, the first occurrence of *D. crepuscula* is fully 180 feet below the lowest occurrence of *D. algida* and the intervening beds contain only *Dechenella bathurstensis,* a species which has never been found together with *D. algida.* Both morphological and stratigraphical evidence thus confirm *D. crepuscula* as an independent species.

The immature pygidium assigned to this species is one of very few immature specimens recovered from all the Canadian Arctic Devonian trilobite collections.

To judge from Osmolska's work (1962, p. 57), the larval notch in the meraspid pygidium is a general phenomenon among the Cyrtosymbolinae. Possibly it is also of widespread occurrence among the Dechenellinae which are closely related to the Cyrtosymbolinae and probably transitional to them through the *Cyrtodechenella* lineage.

Dechenella (*Dechenella*) *maclareni* n. sp.

Plate IX, figure 17; Plate X, figures 1-10

Holotype. GSC No. 18174, nearly complete specimen; Blue Fiord Formation, 315 feet above the base, Twilight Creek, lat. 76°18′, long. 99°12′.

Paratypes. GSC No. 18173, cranidium; GSC No. 18178, hypostome, same horizon and locality as holotype; GSC No. 18175, pygidium, 270 feet above the base of Blue Fiord Formation, Twilight Creek; coll. Ormiston, 1962.

Other material. GSC No. 18172, hypostome (figured) and cranidium, same horizon as holotype; GSC No. 18176, pathological pygidium; GSC No. 18177, inner (ventral) surface of pygidium, 270 feet above the base of Blue Fiord Formation, Twilight Creek; coll. Ormiston, 1962.

Description. Cranidium— Anterior border low and broad, gently arched in profile, bearing terrace lines on outer edge. Border furrow shallow. Preglabellar field narrow, flat and inclined anteriorly. In profile glabella strongly arched longitudinally, transversely very little arched and low lying. Glabella as wide as long, glabellar length two thirds that of cranidium. Glabella rapidly tapering forward, anterior end rounded, outline conical. Greatest glabellar width is posterior to anterior end of lateral furrow 1p. Four pair of lateral glabellar furrows, 1p beginning just inside the axial furrow runs backward and inward in a broad arc and ends far forward of the occipital furrow, much broader in the middle part of its course than at anterior or posterior ends. Furrow 1p with an adaxial branch separated from the main furrow by about half the distance (exs.) between 1p and 2p, much shallower than the main furrow. Furrow 2p less deep than 1p, begins just inside the axial furrow and runs backward and inward parallel to the anterior part of 1p as a very gently curving line almost reaching the midline. Furrow 3p shallower than 2p of depth about equal to that of the adaxial branch of 1p, begins inside the axial furrow and curves backward and inward more sharply than 2p. Furrow 4p very lightly impressed and indistinct, best seen on the inner surface of the exoskeleton, not visible on specimens preserved as internal moulds. Furrow 4p is a short, straight line less than half as long as 3p, separated from the axial furrow by a distance three times its own length. Distance (exs.) between 3p and 4p less than half that between 2p and 3p. Basal glabellar lobe subtrigonal in outline, 2p and 3p glabellar lobes subrectangular. In profile the posterior edge of the glabella only slightly higher than occipital ring. Occipital furrow narrow and deep, medial part of its course transverse changing to posteriorly directed at a point just behind the posterior end of glabellar furrow 1p, and then curving anteriorly so that the distal end of the occipital furrow is concave anteriorly. Occipital lobes large but depressed, triangular, less distinctly separated from the occipital ring than in many species of the subgenus. Occipital ring long (sag.) gently convex to somewhat flattened in profile. Axial furrows shallow, disappearing anterior to lateral glabellar furrow 3p. Anterior to that furrow the glabella is separated from the fixed cheeks only by a change in slope. Fixed cheeks in front of eyes narrow, sloping uniformly anteriorly and outward. Palpebral lobes broad (1.25 mm on holotype), slightly less than one third as wide as glabella, almost flat; horizontal adjacent to glabella, sloping gently downwards distally. Anterior branch of facial suture almost a straight line except for anteriormost part, strongly divergent at an angle of 38.5 degrees to midline but most distal point reached is proximal to the most distal point on the broad palpebral lobe. Posterior branch runs back parallel to midline for a short distance, turns abruptly to run outward and backward at about 70 degrees to the midline and cuts the posterior margin at about three fourths the width of the cheek. External surface of glabella finely pitted, remainder of cranidium smooth.

Free cheek— Available specimens are preserved as internal moulds. Eye lobe large, reaching from a point opposite lateral glabellar furrow 4p to a point opposite the midpoint of the occipital lobe. Visual surface appears smooth at 30x. Ocular platform moderately broad, slopes gradually outward to a point halfway between the base of the eye and lateral border furrow where the slope steepens and continues down to the border furrow. Lateral border broadly convex, bearing terrace lines. Lateral border furrow shallow and broad. Posterior border steeply convex and set off by a deep broad border furrow. Genal spine long, broadly convex in cross section, length of genal spine greater than maximum width of free cheek.

Hypostome— Greatest width across anterior wings about three fourths of greatest length (sag.). Outline of anterior margin arcuate, anterior border narrow, anterior border furrow distinct. Triangular anterior wing of moderate size set off by a change in slope from the steeply ascending side of the anterior lobe of the middle body. Middle body elongate oval in outline, gently convex longitudinally, strongly convex transversely. In profile posterior lobe not clearly set off from anterior lobe. Distinct middle furrow commences at lateral furrow just anterior to the shoulder, runs inward and backward cutting about one third the width (trans.) of the middle body. Length of posterior lobe (sag.) less than one third that of middle body. Lateral furrow deep, setting off a strongly convex lateral border. Shoulder distinct. Lateral furrow shallows posteriorly. Margin of posterior border transversely straight. Angular posterolateral corners are produced by the intersection of the straight posterior margin with the backwardly converging lateral margins. Posterior border gently convex, about twice as wide (sag.) as the lateral border, set off by a posterior border furrow that is distinctly shallower than the lateral furrow. Exoskeletal surface of median body bears very fine, scattered granules.

Thorax— consisting of ten segments. Width of axis approximately equal to that of one pleural field. In longitudinal profile narrow (sag.) axial rings slope slightly forward. In transverse profile axis moderately convex, pleural field nearly horizontal for half its width then flexed abruptly downward. Pleural furrows begin at axial furrow, become deep distally. At change in slope of pleural field anterior and posterior pleural bands of nearly equal length (sag.).

Pygidium— Ratio of length to breadth averages 1:1.35 for six specimens. Outline semioval. Convex, evenly tapering axis of greatest width nearly two thirds that of one pleural field plus border. Eighteen axial rings are visible on specimens about 11 mm long (sag.) and seventeen rings on specimens about 8 mm long (sag.). First five axial rings anteriorly curved along the midline. Ring furrows deep, those posterior to the fifth are interrupted along the midline so that all axial rings posterior to the fifth are fused medially. Each axial ring posterior to the third bears a circular depression on either side just above axial furrow. On the inner (ventral) surface of the exoskeleton these depressions appear as darkly pigmented circular spots. They are interpreted as positions of muscle attachment similar to those well known in asaphid and illaenid trilobites. In profile axis declines rapidly posteriorly. Axial furrows moderately incised anteriorly becoming deeper and broader posteriorly. Pleural fields strongly and evenly convex, crossed by twelve deep pleural furrows which have a sigmoidal course. Six faint interpleural furrows are developed, extending all the way down the pleural field. First two interpleural furrows extend on to border. Anterior and posterior pleural bands of similar length (exs.) and convexity. The dimension (pygidial height) measured in profile from top of axis to lateral margin is 8 mm in GSC No. 18175. Border furrow absent, border set off by sharp change in slope. Border of moderate breadth, narrowing anteriorly, gently convex and downsloping. Doublure convex downwards of breadth equal to that of border. Exoskeletal surface smooth, except for fine pits on post axial part of border.

Dimensions.

	GSC No. 18172	GSC No. 18174	GSC No. 18173	GSC No. 18175	GSC No. 18176
cranidial length	6.0	7.9	9		
glabellar length	4.1	5.0	6.3		
glabellar width	4.0	5.0	6.2		
pygidial length				13.0	7.0
pygidial width				18.0	10.9

Discussion. Dechenella (*D.*) *maclareni* most closely resembles the type species, *D.* (*D.*) *verneuili* (Barrande, 1852; Richter, 1950, p. 153, Pl. 1, figs. 1-2; Pl. 3, fig. 27) from the Givetian of Germany. Comparison of topotype specimens of *D.* (*D.*) *verneuili* (MCZ 6838) with *D.* (*D.*) *maclareni* shows the following similarities: the number and position of glabellar furrows, punctate glabella, pygidial axial rings which are forwardly curved medially and the posterior ones of which are fused medially, sigmoidal pygidial pleurae, and pygidial border which narrows anteriorly. The differences by which these species may be distinguished are: the shorter, more rapidly tapering and transversely weakly convex glabella, broader palpebral lobes, broader and lower anterior border, less distinct interpleural furrows and wider pygidium of *D.* (*D.*) *maclareni.*

D. (*D.*) *maclareni* also closely resembles *D.* (*D.*) *alpenensis* Stumm, 1953 (p. 116, Pl. 2, figs. 1-15) from the Middle Devonian of Michigan, a species that is at present inadequately distinguished from *D.* (*D.*)*verneuili.* Stumm (1953b, p. 117) gives as features distinguishing the two: the lack of a fourth pair of glabellar furrows and the fact that the 1p furrows terminate anterior to the occipital furrow in *D.* (*D.*) *alpenensis.* The 1p furrow of *D.* (*D.*) *verneuili* also stops short of the occipital furrow and the 4p furrow is so faint that it cannot be seen on specimens whose exoskeleton is at all eroded as is that of all specimens of *D.* (*D.*) *alpenensis* figured by Stumm. Thus, *D.* (*D.*) *alpenensis* is possibly a synonym of *D.* (*D.*) *verneuili.*

D. (*D.*) *maclareni* is one of the most abundant trilobite species in the Blue Fiord Formation of Bathurst Island and ranges through the whole thickness of the formation.

Dechenella (*Dechenella*) *paramaclareni* n. sp.

Plate X, figures 11-12

Holotype. GSC No. 18179, cranidium; Blue Fiord Formation, about 1,300 feet above base, south side of Eids Fiord, Ellesmere Island, lat. 77°15′, long. 86°55′; coll. McLaren, 1955.

Description. Dechenella paramaclareni differs from *D. maclareni* n. sp. (this paper) in that (1) the anterior border is more convex in cross section and slightly shorter (sag.); (2) there is no preglabellar field; (3) the palpebral lobes are narrower, equal to only 0.2 of the glabellar width rather than 0.3 as in *D. maclareni;* and (4) the glabella is less rapidly tapering anterior to the 2p glabellar furrow.

Dimensions.

	GSC No. 18179 holotype
cranidial length	8.1
glabellar length	5.8
glabellar width	5.5
sag. length of border	1.1

Discussion. Only the holotype specimen of *D. paramaclareni* is known, but this single specimen is sufficient to indicate its very close relationship to *D. maclareni* from the Blue Fiord Formation of Bathurst and Melville Islands. Unfortunately, the relative stratigraphic position of these species is not known.

Dechenella (Dechenella) paragranulata n. sp.
Plate X, figures 13-15; Plate XI, figures 1-5, 7

Holotype. GSC No. 18182, nearly complete cranidium; Blue Fiord Formation, 270 feet above the base, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′; coll. Ormiston, 1962.

Paratypes. GSC No. 18184, 18185, two cranidia, same locality and horizon as holotype. GSC No. 18180, 18181, two pygidia; GSC No. 18183, one free cheek, Blue Fiord Formation, 240 feet above base, Twilight Creek, Bathurst Island; coll. Ormiston, 1962.

Description. Cranidium— Outline of anterior margin the arc of a circle the radius of which equals the cranidial length. Anterior border of two parts, strongly convex outer part bears terrace lines, inner part nearly flat, slopes posteriorly, width (sag.) of border greater than that of occipital ring. Border furrow broad laterally, medially glabella impinges on border and is separated from it by a narrow, slot-like furrow. Glabella strongly convex longitudinally, anterior part declines vertically, anterior glabellar lobe projecting slightly beyond anterior tip of glabella, posteriorly occipital ring slightly higher than glabella. In transverse profile glabella high and strongly convex. Glabella longer than wide, ratio of width to length averages 1:1.15 for three specimens. Glabellar outline complex, nearly parallel sided opposite basal glabellar lobe, rapidly tapering between 1p and 3p furrows, slightly tapering anterior to 3p, bluntly rounded anteriorly. Four pair of lateral glabellar furrows: 1p curves inward and backward from axial furrow, curves strongly inward at posterior end so that 1p is asymmetrically sigmoidal in outline with the anterior part the more gently curving. Adaxial branch backwardly and inwardly directed from the middle of 1p, nearly attains midline; 2p runs from axial furrow parallel to anterior half of 1p; 3p shallower and less backwardly curving than 2p, about half as long; 4p immediately anterior to 3p short, faint and transversely directed. Anterior glabellar lobe one third of total glabellar length, subquadrate in outline. Occipital furrow deep. Occipital ring short (sag.), moderately convex transversely with large, low axial tubercle. Occipital lobes large, subtrigonal in outline. Axial furrow broad and deep. Palpebral lobe narrow, crescentic in outline, anterior and posterior margins run inward at low angle to midline, in profile scarcely higher than the axial furrow. Fixed cheek anterior to eye steeply downsloping crossed at midlength by narrow (exs.) prominent ridge directed outward and slightly backward. Fixed cheek narrow (trans.) posterior to eye. Anterior branch of facial suture forwardly divergent, at 26.5 degrees to midline, a straight line between 3p furrow and anterior border furrow, then curving sharply outward before cutting inward across anterior margin. Posterior branch slightly convergent posteriorly before turning to run nearly at right angles to midline. Glabella bears coarse tubercles which diminish in size anteriorly. Palpebral lobes with granules on distal edge. Anterior border is sparsely pitted and coalescing pits occur on fixed cheek anterior to ridge.

Free cheek— At one fourth the way down the genal field from the eye there is a pronounced ridge that parallels lateral margin and dies out anterior to posterior border furrow. Lateral border furrow broad; posterior border furrow deep and narrow. Lateral border subtriangular in cross section. Slender genal spine of length equal to that of eye lobe, with sulcate cross section.

Pygidium— Pygidial length about three fourths width. Axis with fourteen rings medially curved posteriorly. Ring furrows deep. There are nine pleural furrows setting off eight ribs of sigmoidal outline. Seven distinct interpleural furrows extend all the way down pleural field. Posterior pleural bands about twice as long (exs.) as anterior bands. In transverse profile pleural fields are strongly arched, inner half essentially horizontal, outer half steeply to vertically down-sloping. No border furrow. Border set off by a change in slope posteriorly, downsloping and not convex, anteriorly slope of border is continuous with that of pleural field. Fine tubercles occur on axial crests and pleural ribs.

Dimensions.

	GSC No. 18182	GSC No. 18185	GSC No. 18184
cranidial length	10.5	9.8	9.2
occipital length	1.1	1.0	0.9
glabellar length	8.0	7.3	6.7
glabellar width	6.9	6.2	6.0

Discussion. As the name implies, this species resembles *Dechenella* (*D.*) *granulata* Richter, 1912 (Richter, 1912, p. 304, Pl. 21, fig. 9a-d) (Richter, R. and E., 1956a, Pl. 1, fig. 5) from the Givetian of the Eifel District, Germany. *D. paragranulata* and *D. granulata* are similar in height and convexity of anterior border, glabellar convexity, outline of anterior glabellar lobe, size of palpebral lobes, course of anterior branch of facial suture, number of glabellar furrows, presence of prominent ridge on fixed and free cheeks, and strongly arched pleural fields of pygidium. *D. paragranulata* differs from *D. granulata* in the following features: glabella longer than wide rather than equidimensional, 3p lateral furrow backwardly curving rather than transverse, 4p closer to 3p, 1p sigmoidal in outline and shallower than occipital furrow, posterior branch of facial suture initially weakly convergent rather than divergent, and much finer tubercles on posterior edge of occipital ring.

The pygidium of *D. paragranulata*, although similar to that of *D. granulata*, differs in having fewer pleural ribs and axial rings and in having the axial rings posteriorly recurved.

On Twilight Creek, Bathurst Island, *D. paragranulata* ranges from 130 to 400 feet above the base of the Blue Fiord Formation; it commonly occurs with *D. maclareni* but never in such abundance as that species.

Dechenella (Dechenella) tesca n. sp.

Plate XI, figures 6, 8-14

Holotype. GSC No. 18188, nearly complete cranidium; Middle Devonian Blue Fiord Formation, 395 to 420 feet above base, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′; coll. Ormiston, 1962.

Paratypes. GSC Nos. 18186, 18187, two pygidia; GSC No. 18191, cranidium; GSC No. 18190, external mould of pygidium; GSC No. 18189, free cheek; same locality and horizon.

Description. Cranidium— Outline of anterior margin a gentle curve, arc of a circle the radius of which is greater than the cranidial length. Broad anterior border consisting of short, gently convex anterior part and long, flat posterior slope. Anterior border furrow broad. Preglabellar field short, forwardly sloping. In longitudinal profile glabella steep anteriorly, evenly convex posterior to anterior glabellar lobe, declining smoothly to occipital furrow, gently convex transversely. Glabellar length equals width. Glabella forwardly tapering, outline subconical with a slight waisting opposite anterior edge of palpebral lobe. Three pair of lateral glabellar furrows, 1p as deep as occipital furrow, begins just proximal to axial furrow, runs in a straight line directed at opposite occipital lobe, turns abruptly at midlength to run more strongly backward stopping just above occipital furrow. From the angle in 1p emerges a short, transverse adaxial branch. The shallower 2p furrow begins well inside axial furrow, parallels the anterior half of 1p and nearly reaches the midline. 3p furrow at two thirds glabellar length, shallow, runs parallel to 2p but is shorter. Basal glabellar lobe trapezoidal in outline. 2p and 3p lobes are rectangular, 2p one and one half times as long (exs.) as 3p. Occipital furrow deepest and slightly backwardly curved behind inner corner of basal glabellar lobe, distally curving slightly anteriorly, stops short of axial furrow. Occipital lobes subtriangular prominent with apical node-like protuberance. Occipital ring gently forwardly sloping in profile, gently convex transversely. Axial furrows moderately deep, shallowing anterior to 3p furrow. Fixed cheeks anterior to eyes broad (trans.), evenly convex above border furrow. Palpebral lobe broad and long, broader (trans.) than anterior border (sag.), of less than glabellar height, inner two thirds a large concave depression, outer third weakly convex upward. Anterior branch of facial suture strongly divergent, at 43 degrees to midline, short, beta and sigma nearly equally distant from midline. Posterior branch parallels midline opposite occipital lobe, then turns to run transverse to midline before cutting posterior margin. Tubercles occur on that part of glabella between proximal ends of the three glabellar furrows, on the basal glabellar lobes and along posterior edge of occipital ring. Fine granules are present on distal part of palpebral lobe.

Free cheek— Eye lobe not preserved. A broad, shallow furrow borders the eye. Genal field with narrow (trans.) gently declining inner part and long, steep outer slope. Lateral border furrow and border like that of cranidium. Posterior border furrow deep, border convex and narrower than lateral border. Posterior margin curving posteriorly. Strongly tapering genal spine of sulcate cross section for half its length, length slightly greater than that of eye lobe. Granules occur along the change in slope of genal field.

Pygidium— Length equals two thirds width. Outline truncate posteriorly with a faint sagittal indentation in the posterior margin, indentation barely perceptible in specimens less than 6 mm long. Convex axis tapers gradually and evenly, greatest width little more than one fifth overall pygidial width, axial length equals three fourths pygidial length. GSC No. 18190 with sixteen axial rings, but seventeen are visible on pygidia 15 mm or more long. Ring furrows deep and broad medially, shallowing rapidly laterally. In longitudinal profile axis declines gently posteriorly, in transverse profile flattened along crest. Axial furrows lightly incised anteriorly, becoming progressively deep posterior to the ninth axial ring, deep and broad at end of axis. Pleural fields broadly and evenly arched. Ten broad trough-like pleural furrows, continue on to border furrow. Breadth of pleural furrows equals that of pleural ribs. Five shallow interpleural furrows continue about three fourths the way down pleural field. Pleural ribs highly convex in cross section. Border furrow broad and fairly shallow, border broadly convex bearing numerous anastomosing terrace lines. Axial rings tuberculate along their crests. Granules occur along posterior edge of anterior pleural bands.

Dimensions.

	GSC No. 18188	GSC No. 18191	GSC No. 18186	GSC No.18187
cranidial length	8.1	7.8		
cranidial width at beta	8.0	7.7		
glabellar width	4.8	4.5		
glabellar length	5.0	4.6		
pygidial length			17.5	16.5
pygidial width			28.5	25.4
axial length			13.0	12.0
axial width			6.0	5.6

Discussion. The sagittal indentation in the posterior pygidial margin of *Dechenella* (*D.*) *tesca* n. sp. is reminiscent of *D.* (*D.*) *retusa* n. sp. (this paper) from the Middle Devonian of Victoria Island. The pygidia of these species are also similar in the number of axial and pleural segments, but they can be readily distinguished by the much more pronounced sagittal indentation of *D.* (*D.*) *retusa.* Other differences include: the slightly longer axis, broader pleural regions, more convex pleural ribs, broader pleural furrows, and more convex border of *D.* (*D.*) *tesca.*

The cranidium of *D.* (*D.*) *tesca* resembles that of *D.* (*D.*) *bathurstensis* n. sp. (this paper) from the Bird Fiord Formation. They are close in the shape of anterior border, length of preglabellar field, nature of border furrow, glabellar convexity, and shape of occipital ring and occipital lobes. They differ in that *D.* (*D.*) *tesca* has: a shorter anterior glabellar lobe, broader palpebral lobes with a concavely depressed inner part, more symmetrical 1p furrow which has inwardly and backwardly directed parts of equal length, deeper glabellar furrows, and anterior branch of facial suture which begins to diverge closer to the palpebral lobe. The pygidia of these species are also similar in number of axial and pleural segments, but are easily distinguished by the lack of a sagittal indentation in the posterior margin of *D.* (*D.*) *bathurstensis.*

Dechenella (*Dechenella*) cf. *planimarginata* (Meek, 1871)

Plate XII, figures 1-2

Material. GSC No. 18192, poorly preserved pygidium, counterpart mould, and rubber cast; Blue Fiord Formation, 3,100 feet above base, east of Blue Fiord, Ellesmere Island, lat. 77°12′, long. 86°55′; coll. D. J. McLaren, 1955.

Description. Pygidium— Semioval, ratio of length to width as 1:1.3. Axis tapers rapidly and evenly, greatest axial width about one third pygidial width. There are seventeen visible axial rings, the anterior half of the axis bearing only six of these. Ring furrows transverse. In longitudinal profile axial rings forwardly sloping, axis declines gradually to position of the twelfth axial ring, then curves more strongly downward to border furrow. Pygidial height is 2.1 mm. Axial furrows lightly incised. Pleural fields evenly convex transversely. Nine pleural furrows set off eight convex pleural ribs. At least the first four ribs bear interpleural furrows. Border furrow broad and shallow. The lateral border is broad (1.5 mm), flat, horizontally directed, and narrows very abruptly opposite the first pleural rib to merge with the faceted anterolateral pygidial corner. Strong oblique ridges are present along the distal edge of border. Exoskeletal surface too poorly preserved to retain prosopon.

Dimensions.

	GSC No. 18192
pygidial length	8.8
pygidial width	11.1
axial length	7.3
axial width	3.4

Discussion. Although too poorly preserved for definite specific assignment, this species is very similar to *Dechenella planimarginata* (Meek, 1871) from the Lower Middle Devonian of Ohio and Michigan (Stumm, 1953a, p. 20, Pl. 2, figs. 8–13). On the basis of R. and E. Richters' (1950a, p. 158, Pl. 2, figs. 11–13) description and illustration of *Dechenella gigouti* from the Givetian of West Morocco, that species is indistinguishable from *D. planimarginata* and is regarded by the writer as its junior subjective synonym.

Characters common to *D. planimarginata* (Meek, 1871) and the Arctic pygidium include the broad, flat pygidial border, convexity of pleural fields, number of pleural furrows, and pygidial height. The Ellesmere Island specimen appears to differ from *D. planimarginata* in that the border is horizontal rather than downsloping; in the abrupt narrowing of the border opposite the first pleural rib; and in being relatively shorter. The slope of the border could have been changed by distortion, but the writer considers the Arctic specimen as probably distinct from *D. planimarginata.*

Dechenella (*Dechenella*) *franklini*? n. sp.

Plate XII, figures 3-4

Material. GSC No. 18193, pygidium and counterpart external mould; Bird Fiord Formation, basal 50 feet, Tucker Point anticline, Grinnell Peninsula, Devon Island, lat. 76°46′, long. 93°47′; coll. D. J. McLaren, 1955.

Description. Pygidium— nearly semicircular. Convex axis strongly tapering, tapers more rapidly posterior to sixth axial ring than anterior to it, maximum axial width about twice minimum axial width. Axial length five sixths of pygidial length, posterior tip of axis reaches border furrow. Deep, transverse ring furrows set off nineteen axial rings, length (sag.) of rings decreases very gradually posteriorly. In longitudinal profile pygidial height is 2.1 mm, first axial ring rises high above others, axis declines gently. Axial furrows die out anterior to end of axis so that posterior one eighth of axis is laterally confluent with pleural fields. In transverse profile axis evenly convex, moderately low lying, inner four fifths of pleural fields gently downsloping, outer one fifth drops off steeply to border furrow. Eight broad pleural furrows set off seven pleural ribs of rounded cross section. At midwidth (trans.) pleural furrows nearly as broad (exs.) as ribs. Pleural ribs with lobate terminus just above furrow, only the first interpleural furrow is visible. Border furrow broad and shallow, sets off a gently convex, horizontally directed border. Exoskeletal surface appears smooth.

Dimensions.

	GSC No. 18193
pygidial length	8.8
pygidial width	13.0
axial length	7.5
maximum axial width	3.1
minimum axial width	1.7

Discussion. This pygidium occurs with an incomplete cranidium closely resembling *D. franklini* n. sp. from the Blue Fiord Formation of Bathurst Island, the pygidium of which has not been recognized. Although this single association is too slight evidence to permit definite assignment of the pygidium, the possibility exists that it belongs to *D. franklini*. It is therefore assigned with query to that species.

A unique feature of *D. franklini*? is the great disparity between the number of pleural ribs (7) and axial rings (19).

Dechenella (*D.*) *burmeisteri* R. Richter, 1909 (1912, p. 297, Pl. 19, figs. 15-21) from the Givetian of Westphalia resembles *D.* (*D.*) *franklini*? in the large number of axial rings (each has 19) and in having a broad, nearly horizontal border. The two species are otherwise dissimilar, however, and are distinguished by pygidial outline, more rapidly tapering axis, fewer ribs, much shallower axial furrow and gently downsloping pleural fields of *Dechenella* (*D.*) *franklini*?.

Occurring with *D. franklini*? are *Dechenella* (*D.*) aff. *franklini* n. sp., *Cyrtodechenella* sp., and *Leonaspis* sp. This assemblage is reminiscent of the Blue Fiord Formation as it occurs on Twilight Creek, Bathurst Island.

Dechenella (*Dechenella*) *franklini* n. sp.

Plate XII, figures 5-8

Holotype. GSC No. 18195/$_1$, cranidium; Blue Fiord Formation, 440 feet above the base, Cut Through Creek, Bathurst Island, lat. 76°12′, long. 98°58′; coll. Ormiston, 1962.

Paratypes. GSC Nos. 18194, 18195/$_2$, two cranidia; same horizon and locality.

Description. Cranidium— Anterior margin strongly arcuate, the arc of a circle the radius of which is less than half the cranidial length. Anterior border posteriorly continuous with preglabellar field, horizontal with anteriormost part downflexed and bearing terrace lines. No border furrow. Ratio of length of frontal area to glabellar length averages 1:1.36 for three specimens. In profile glabella moderately arched longitudinally with posterior end high above level of occipital ring; moderately convex transversely. Glabella as long as wide, tapering anteriorly, slightly constricted opposite 2p furrow, anterior end pointed. Three pair of lateral glabellar furrows, 1p deepest, begins at axial furrow, runs inward and progressively more strongly backward to join occipital furrow, cuts one third total glabellar width. 2p a straight line directed at opposite occipital lobe, begins inside axial furrow. 3p at two thirds glabellar length, parallels 2p but is shorter and weaker. Occipital furrow incised, deepest behind basal glabellar lobes. Occipital lobes subtrigonal in outline, prominent. In profile occipital ring weakly convex longitudinally, length of occipital ring (sag.) equals about one fourth glabellar length (long for genus). Axial furrows moderately incised, shallowing slightly anteriorly. Fixed cheeks in front of eyes long (exs.), distally with a broad (exs.) low ridge, transverse, in line with anterior end of glabella. Ridge finely granulate. Palpebral lobes nearly of glabellar height, inner part steeply downsloping. Anterior branch of facial suture diverges anteriorly at 33 degrees to midline, a line gently concave outward. Posterior branch parallels midline for only a short distance before turning sharply outward. Glabella and occipital ring tuberculate.

Dimensions.

	GSC No. $18195/_1$	GSC No. $18195/_2$	GSC No. 18194
cranidial length	8.6	8.6	9.4
glabellar length	4.5	4.3	4.7
glabellar width	4.5	4.5	4.6
preglabellar cranidial length	3.0	3.3	3.6
length occipital ring	1.1	1.0	1.1

Development. A small cranidium 3.7 mm long differs from the larger cranidia described here in that preglabellar cranidial length is a smaller proportion of total cranidial length (0.33 versus 0.38 in the larger specimens), the anterior glabellar lobe tapers less rapidly, the glabella is more densely tuberculate, and the terrace lines on the anterior margin run traversely rather than paralleling the margin.

Discussion. The great preglabellar cranidial length of *D.* (*D.*) *franklini* is unusual for the genus and makes this species easily recognizable. *Dechenella* (*D.*) *welleri* (Stauffer) (Stumm, 1953a, p. 21, Pl. 3, figs. 3-5) from the Middle Devonian of Ohio is another species which has an exceptionally large preglabellar length and one that resembles *D.* (*D.*) *franklini.* These species can be distinguished by the lesser preglabellar length, more rapidly tapering glabella, less prominent occipital lobes, and punctate test of *D.* (*D.*) *welleri.* The ratio of preglabellar cranidial length to glabellar length is 1:1.4 for *D.* (*D.*) *franklini* as compared with 1:1.8 for *D.* (*D.*) *welleri* (dimensions measured on Pl. 3, fig. 3 of Stumm, 1953).

Dechenella (*D.*) *planimarginata* (Meek) (Stumm, 1953a, p. 20, Pl. 3, figs. 8-13) from the Middle Devonian of Michigan and *D.* (*D.*) *delphinula* (Hall and Clarke) (Stumm, 1953a, p. 21, Pl. 3, fig. 6) from the Middle Devonian of Ontario are other species of the genus that have very long frontal areas, but in both a distinct anterior border furrow is present. Excepting the great length of the frontal area, neither of these species is particularly similar to *D.* (*D.*) *franklini.*

On Cut Through Creek *D. franklini* occurs with pygidia of *Dechenella tesca* n. sp. in light coloured bioclastic limestone. A single cranidium was found at 400 feet above the base of the Blue Fiord Formation on Warner River, lat. 76°20′, long. 98°50′.

Dechenella (*Dechenella*) *spaekkassensis* (Tolmachoff, 1926)

Plate XII, figures 9-17

1926 *Basidechenella spaekkassensis* Tolmachoff; Tolmachoff, 1926, p. 23, Pl. 1, figs. 6-8.
1926 *Basidechenella* sp.; Tolmachoff, 1926, p. 25, Pl. 1, fig. 10.
1950 *Basidechenella spaekkassensis* Tolmachoff; R. and E. Richter, 1950, p. 173.

Syntypes. PMO A28845 and A28845a, pygidium and counterpart mould, Series Dh, Middle Devonian, Spaekkassen, lat. 76°42′, long. 89°40′, Ellesmere Island, coll. Per Schei; PMO A28838, pygidium, Series Db, Middle Devonian, Ostre Borgen, Goose Fiord, Ellesmere Island, lat. 76°40′, long. 88°35′, coll. Per Schei.

Hypotypes. GSC Nos. $18199/_1$, 18197, 18198, three cranidia; GSC No. $18199/_2$, free cheek; GSC No. $18199/_3$, pygidium, about 230 feet above the base of Blue Fiord Formation, 8 miles east of Blue Fiord, Ellesmere Island; coll. D. J. McLaren, 1955. GSC No. 18196, pygidium; base of Blue Fiord Formation, same locality.

Other material. PMO A28837, *Basidechenella* sp. of Tolmachoff, 1926, p. 25, Pl. 1, fig. 10, pygidium, Series Db, Vestre Borgen, Goose Fiord, Ellesmere Island; coll. Per Schei.

Description. Cranidium— Anterior border long (sag.), nearly semicircular in cross section. Border furrow broad and deep, not incised. No preglabellar field. Glabella strongly convex longitudinally, gently convex transversely. Glabella as long as wide, outline as in *Dechenella maclareni* n. sp. Three pair of lateral glabellar furrows, 1p nearly as deep as occipital furrow, posterior half nearly straight, joins occipital furrow. Adaxial branch of 1p runs transversely, deepest adaxially. 2p shallow, runs inward and backward from axial furrow, nearly reaches midline. 3p parallel to and one third as long as 2p. Width of basal glabellar lobe (trans.) less than one third that of glabella. Occipital furrow deep, nearly transverse, occipital lobes as in *D. maclareni.* In longitudinal profile occipital ring at same level as posterior end of glabella, moderately convex transversely, with median tubercle. Axial furrows faint. Fixed cheek in front of eyes evenly downsloping to border furrow. Palpebral lobe narrow (trans.) for genus, gently inward sloping. Anterior branch of facial suture a straight line diverging anteriorly at 29 degrees to midline. Posterior branch turns outward at right angles opposite posterior edge of occipital lobe. Anterior border covered with densely packed granules. Anterior glabellar lobe also granulose, posterior two thirds of glabellar tuberculate. Fixed cheeks and palpebral lobes appear smooth.

Free cheek— Genal field gently downsloping with no sharp break in slope. Lateral border furrow shallow. Posterior border furrow moderately deep. Lateral border broad and broadly convex. Posterior border slightly more convex than lateral border. Genal spine longer than eye lobe, directed strongly outward and not curving, sulcate in cross section.

Pygidium— Nearly semicircular, ratio of length to width about 1:1.5. Maximum axial width nearly one third of pygidial width. Unevenly convex, high axis strongly tapering. On syntype specimens fifteen axial rings are visible, the hypotype specimens show a maximum of thirteen. Segmentation persists to tip of axis. Ring furrows deep, those posterior to first are backwardly bowed medially. In longitudinal profile first axial ring rises vertically, succeeding rings flexed posteriorly at their apices, axis steeply downsloping, convex, posterior tip continued to level of pleural field by this slope. Axial furrows distinct. In transverse profile axis rises high above pleural fields, outline approaches that of an inverted U, pleural fields strongly convex, sloping in a continuous curve. On syntype A28845 ten deep, narrow pleural furrows are visible, the last two very faint. Nine pleural furrows are visible on syntype A28838 and on the hypotype specimens from the vicinity of Blue Fiord which are comparable in size to A28838. Interpleural furrows are present on all visible ribs, ten being present on A28845 and eight on other specimens. On all specimens interpleural furrows continue all the way down pleural field. Adaxially posterior pleural is higher than anterior band, abaxially of equal height. Border furrow distinct but shallow. Border broadly convex and broad, narrowing rapidly anterior to third pleural rib. Axial rings with small tubercles along their crests. Small tubercles occur on anterior and posterior pleural bands at the fulcrum of pleural field. The pygidial border is covered with densely packed granules and bears short, oblique ridges near the outer margin.

Dimensions.

	GSC No. 18198	GSC No. 18197
cranidial length	6.8	6.1
glabellar length	4.7	4.2
glabellar width	4.6	4.1

	Syntype PMO A28845	Syntype PMO A28838	GSC No. 18196
pygidial length	11.2	4.3	4.7
pygidial width	17.2	6.5	6.9
axial length	9.7	3.6	3.8
axial width	5.2	1.9	2.1

Discussion. R. and E. Richter (1950, p. 173) suggested that Tolmachoff's generic assignment of *Basidechenella spaekkassensis* was incorrect, the proper assignment being to *Dechenella*. Confirmation of the Richters' opinion is found in features of the newly discovered cranidia which indicate that this species belongs to the subgenus *Dechenella*.

The internal pygidial mould (Paleont. Mus. Oslo A28837) figured by Tolmachoff on Plate 1, figure 10 was regarded by him as a species of *Basidechenella* distinct from *B. spaekkassensis*. The differences detected by Tolmachoff result from the fact that the specimen was partly buried in the rock matrix. Excavation of the specimen reveals its identity with *Dechenella* (*D.*) *spaekkassensis* (Tolmachoff).

Dechenella (*Dechenella*) *spaekkassensis* (Tolmachoff) appears to be most like *Dechenella* (D.) *arschensis* Maximova, 1955 (1955, p. 65, Pl. 3, figs. 6-11) from the upper Givetian of the west slope of the Ceneral Urals, but illustrations of that species are not entirely satisfactory for detailed comparisons. Similarities between these species include (1) the length (sag.) and convexity of the anterior border; (2) outline and lobation of the glabella; (3) size and convexity of the occipital lobes; (4) breadth of the pygidial border; and (5) pygidial outline. They are distinguished by (1) failure of 1p glabellar furrow of *D. arschensis* to reach the occipital furrow; (2) 1p furrow of *D. spaekkassensis* is considerably deeper than 2p and 3p; (3) pygidium of *D. spaekkassensis* has stronger longitudinal convexity, higher axis, border less rapidly narrowing anteriorly, more axial rings, and backwardly bowed axial rings. The prosopon of the two species is also distinctly different; the granulose cranidial and pygidial borders of *D. spaekkassensis* contrast with smooth borders of *D. arschensis* and the granulo-tuberculate glabella with the pitted glabella of *D. arschensis*.

The pygidium of *D. spaekkassensis* somewhat resembles that of *Dechenella* (*D.*) *haldemani* (Hall, 1861) (Hall and Clarke, 1888, p. 113, Pl. 21, figs. 7-9; Pl. 23, figs. 13-15) from the Middle Devonian of Pennsylvania and New York State, but the "clover-leaf" shaped glabellar outline, four lateral glabellar furrows, and lack of genal spines readily distinguish *D. haldemani* from *D. spaekkassensis*. Tolmachoff (1926, p. 24) also compared *D. spaekkassensis* with *D. romanovski* Tschernyschew, 1887 from the Middle Devonian of the Urals (R. Richter, 1912, p. 313, Pl. 21, figs. 1-5) and with *D. setosa* Whidborne, 1889 from the Middle Devonian of England (R. Richter, 1912, p. 310, Pl. 20, figs. 8-9). *Dechenella spaekkassensis* has little resemblance to either of these species.

In Per Schei's Series Db on Goose Fiord and at the base of the Blue Fiord Formation at Blue Fiord *Dechenella* (*D.*) *spaekkassensis* occurs with *Proetus* (*L.*) *sverdrupi*, *Schizoproetus richteri*, and *Otarion* aff. *balanops*. This faunal similarity suggests that Series Db is correlative with the basal part of the Blue Fiord Formation on Ellesmere Island. At Spaekkassen on the west coast of Ellesmere *D. spaekkassensis* occurs in Series Dh, which is presumably near the top of the Blue Fiord Formation. This species therefore ranges through most of the Blue Fiord Formation.

Dechenella (*Dechenella*) *retusa* n. sp.

Plate XIII, figures 1-2

Holotype. GSC No. 18200, one nearly complete pygidium; Blue Fiord Formation, Middle Devonian, 16 miles southwest of Peel Point, northwest Victoria Island, lat. 73°10′, long. 115°13′; coll. E. T. Tozer, 1959.

Description. Pygidium— Ratio of length to breadth is 1:1.4. Outline truncate elliptical with broad indentation of posterior margin behind axis. Width (trans.) of indentation equals two thirds maximum width of axis (3 mm). Broadly convex axis evenly tapering. Axis with sixteen rings showing a gentle, posteriorly directed curvature along the crest of the axis. Unsegmented tip of axis very short. Ring furrows deep. In profile the axis is gently convex anteriorly, but posteriorly it declines in a gentle straight slope. Axial rings sloping anteriorly, posterior edge steep. Posterior tip of axis is separated from border furrow by a narrow interspace which slopes posteriorly at the same angle as the tip of the axis (about 70 degrees) thus forming in profile a long, even slope from the apex of the axial tip to the border furrow. Axial furrows shallow. Pleural field weakly and unevenly convex, horizontal adjacent to axis and gently dipping distally. There are thirteen pleural furrows, the last three faint, the first ten broad and deep. The first three pleural furrows cross the border furrow. Five faint interpleural furrows are developed, extending all the way down the pleural field and all crossing the border furrow. Anterior pleural band about half the width (exs.) of the posterior band, bearing faint row of tubercles. Border furrow broad and deep. Border broad and low with proximal and distal margins on a horizontal plane, gently convex, bearing terrace lines on its apical portion and short oblique ridges on its distal portion. External surface smooth except for terrace lines.

Dimensions.

	GSC No. 18200 holotype
pygidial length	8.9
pygidial width	12.4
axial length	6.8
maximum axial width	3.0

Discussion. The deeply indented posterior margin of this species makes it very distinctive. There can be little doubt that the new species belongs in *Dechenella* (*Dechenella*). The pygidial proportions, large number of axial rings and pleural furrows, the faint interpleural furrows, and the posteriorly curving axial rings all suggest this assignment. The breadth of the border furrow and gentle convexity of the pygidial border of *Dechenella retusa* are unusual for the genus and nearly as distinctive as the posterior indentation.

The pygidium of *Dechenella* (*Dechenella*) *burmeisteri* Richter, 1909 (Richter, 1912, Pl. 19, figs. 15-21) is most nearly comparable to that of *D. retusa.* Except for lacking a posterior indentation, it is similar in outline and has a similar broad, low, horizontally directed border. It differs in its greater number of axial rings (18) and pleural furrows (14) and in having deep axial furrows.

Cyrtosymbole (*Cyrtodechenella*?) *uralica* Richter (Richter, 1912, Pl. 21, fig. 16), a proetid pygidium of uncertain generic status, has an indented posterior margin and proportions similar to those of *Dechenella retusa*, but has fewer axial rings (12) and pleural furrows (7) and a steeply declining border and seems not closely related to the new species.

Dechenella (*Dechenella*) n. sp. a, aff. *struvei* R. and E. Richter, 1950

Plate XIII, figures 3-5

Material. GSC Nos. 18201, 18202, two incomplete cranidia; Melville Island Formation, south of Ibbett Bay, Melville Island, lat. 75°22′, long. 117°20′; coll. E. T. Tozer, 1954.

Description. This species can be distinguished from the closely similar *Dechenella struvei* R. and E. Richter, 1950 (p. 154, Pl. 1, figs. 3-10) by the following:

Cranidium— (1) anterior border lower and differently shaped in profile, not consisting of two parts; (2) glabellar outline differs in that anterior glabellar lobe tapers less rapidly and has a blunter anterior end; (3) although the palpebral lobe is close in outline to that of *D. struvei*, its inner part is strongly concave rather than nearly flat as in *D. struvei*.

Dimensions.

	GSC No. 18202	GSC No. 18201
cranidial length	4.9	2.6
beta-beta width	4.5	2.1
glabellar length	3.3	1.7
glabellar width	3.5	1.8

Discussion. Study of the topotype specimens of *Dechenella struvei* (MCZ 5814, 6719) indicates that the very close similarities of the Arctic species with *D. struvei* include (1) the glabellar outline except for that of the anterior lobe; (2) the width of the glabella being greater than the length; (3) the deep and sharply angulate 1p furrow; (4) the very broad (trans.) palpebral lobe; (5) the position of the occipital lobe deep beneath the 1p glabellar lobe; (6) the slight independent convexity of the 1p and 2p glabellar lobes; (7) the presence on the internal mould of a median keel on the posterior half of the glabella.

The differences pointed out in the description do seem to indicate that the Arctic specimens constitute an independent species of which, however, more and better specimens are needed before a new species is established.

Dechenella n. sp. a, aff. *struvei* occurs in beds stratigraphically slightly higher than those containing *Dechenella* (*Pedinodechenella*) *melvillensis* n. sp., and there is little possibility that there is close relationship between them, as they are quite distinct morphologically.

Dechenella struvei R. Richter, 1950 occurs in beds of the Bellerophon Limestone of the Eifel District, Germany, which are of middle Givetian age. On the basis of the striking similarity of the Arctic species described here to *D. struvei* the writer suggests a Givetian age for the beds south of Ibbett Bay, Melville Island.

Subgenus *Dechenella* (*Pedinodechenella*) n. subgen.

Type species: *Dechenella* (*Pedinodechenella*) *melvillensis* n. subgen., n. sp.

Diagnosis. Glabella wider than long, tapering rapidly anteriorly with a constriction opposite the 2p glabellar furrow. In longitudinal and transverse profiles the glabella is flat and low lying. Three pair of equally deep lateral glabellar furrows. On either side of the glabella anterior to the 3p furrow a conspicuous node occurs in the axial furrow. These nodes occupy the position at which anterior pits are located in trilobites which have those structures. Glabella punctate. Occipital lobes well developed. In transverse profile the pygidial axis has only a slight independent convexity barely interrupting the curvature of the pleural fields. On the internal mould the axial rings are truncate at their crests. Pleural ribs have almost no relief in cross section.

Geological range. Middle Devonian.

Discussion. *Pedinodechenella* is distinguished from *Dechenella* (*Dechenella*) by its remarkably depressed and flat glabella, by having a rapidly tapering glabella which is wider than long, and by the presence of anterior nodes (*see* Glossary).

From *Basidechenella* it is distinguished by its well-developed occipital lobes, by its glabellar outline, and by the distinct lateral glabellar furrows. The same characters that distinguish it from *Basidechenella* also serve to distinguish it from *Monodechenella* Stumm, 1953.

Dechenella (*Pedinodechenella*) *melvillensis* n. subgen., n. sp.

Plate XIII, figures 6-11

Holotype. GSC No. 18203, cranidium; Middle Devonian "Bird Fiord Formation", south side of Ibbett Bay, Melville Island, lat. 75°22′, long. 117°20′; coll. E. E. Tozer, 1954.

Paratype. GSC No. 18204, partly exfoliated pygidium; same locality and horizon.

Description. Cranidium— Anterior border broadly convex, length (sag.) one and one half times that of occipital ring. Anterior border furrow deep and broad. Short preglabellar field steeply downsloping. Glabella wider than long, rapidly tapering anteriorly with constriction opposite the 2p furrow, anterior end pointed. In longitudinal profile glabella is flat and slopes forward at about 5 degrees when cranidium is oriented so that anterior and posterior edges of palpebral lobe lie on the horizontal, anterior to the 3p furrows glabellar slope steepens, glabella drops off abruptly at anterior margin. In transverse profile glabella is flat, drops off abruptly to axial furrows. Three pair of lateral glabellar furrows none of which reaches axial furrow. 1p shallow, a smooth, adaxially convex curve stopping above occipital furrow. 2p and 3p furrows are as deep as 1p and parallel the anterior half of 1p. Occipital furrow broad and deep, in outline convex anteriorly. Occipital ring incompletely preserved, forwardly sloping in profile, strongly convex transversely. Occipital lobes distinct, triangular. Axial furrows broad and deep. On either side of the glabella anterior to the 3p furrow a conspicuous node occurs in the axial furrow. Because of their position these nodes are here termed, by analogy to anterior pits, anterior nodes. The writer knows of no other trilobite in which anterior nodes occur, although anterior pits are common. Palpebral lobes of glabellar height, reniform in outline, sloping steeply inward. Fixed cheek anterior to eye sloping downward and outward. Anterior branch of facial suture diverges anteriorly at about 31 degrees to the midline, angulate at beta. Posterior branch of facial suture parallels midline for a short distance then runs transverse. Glabella finely pitted.

Pygidium— Outline semioval, ratio of length to width about 1:1.5. Axis moderately tapering. In longitudinal profile axis curves strongly and smoothly downward. In transverse profile it has only slight independent convexity, hardly elevated above curvature of pleural fields. Axial rings (preserved as internal mould) are truncate at their crests. About ten axial rings are visible on internal mould, anterior two rings are convex anteriorly. On the internal mould the axial furrows are distinct, but appear nearly obsolete on the part of the paratype pygidium where the exoskeleton is preserved. Pleural fields strongly convex transversely. Nine pleural furrows are visible on the internal mould. On the part of the paratype with the exoskeleton intact the pleural ribs are seen to have a sigmoidal outline, the pleural furrows are narrow (exs.) and shallow, and the pleural ribs have virtually no relief in cross section (exs.). No interpleural furrows. No border furrow. Gently convex border is set off by change in slope.

Dimensions.

	GSC No. 18203 holotype		GSC No. 18204 paratype
cranidial length	7.4	pygidial length	6.2
beta-beta cranidial width	6.4	pygidial width	9.0
glabellar length	4.5	axial length	5.5
glabellar width	4.7	axial width	2.5

Discussion. The unique glabellar shape of *D.* (P.) *melvillensis* n. sp. readily distinguishes it from other species of *Dechenella.* This flatness is clearly an original feature and not the result of distortion; the specimen is symmetrical and the anterior border retains its original convexity.

Another unique feature of *D.* (*P.*) *melvillensis* is the presence of anterior nodes. Their possible function is problematical, but one is tempted to infer from the coincidence of their position with that of the anterior pits of other trilobites that they are situated above apodemes. Possibly in this species the exoskeleton is greatly thickened above these apodemes resulting in nodes on the dorsal surface. The relations between *Pedinodechenella* and other subgenera of *Dechenella* cannot presently be ascertained, because the new subgenus occurs far from any known trilobite succession in rocks whose exact age is unknown. The glabellar shape exhibited by *Pedinodechenella* is rare among trilobites and some idea as to how it arose would be of interest.

Subgenus *Dechenella* (*Basidechenella*) R. Richter, 1912

Type species: by subsequent designation of Vodges (1925, p. 91) *Dechenella* (*Basidechenella*) *kayseri* R. Richter, 1912.

Diagnosis. Glabella more moderately tapering than in *D.* (*Dechenella*), not so expanded across basal lobes, anterior end broader. Glabellar furrows directed as in *D.* (*D.*) but more weakly impressed. Occipital lobes not completely separate. Genal platforms plane. Pygidium shorter, more highly convex and with fewer segments (10 to 13 rings, 7 to 10 pleural ribs) than that of *D.* (*Dechenella*), interpleural furrows pronounced.

Discussion. The several North American species recently assigned by Stumm (1953a, pp. 118-122; 1953b, pp. 23-26) to the subgenus *Basidechenella* differ from European species of *Basidechenella* in having large, completely separated occiptal lobes. In fact, Stumm (1953a, p. 118) cites large, prominent occipital lobes as one of the diagnostic characters of *Basidechenella.* Such a diagnosis is at variance with the characters of the type species, *D.* (*B.*) *kayseri* R. Richter, 1912 and with Richter's recent diagnosis of the subgenus (Richter *in* Harrington, *et al.*, 1959, p. 388) as having "occipital lobes not separated." The Richters were acquainted with some of the North American species treated by Stumm and referred to one (R. and E. Richter, 1950, p. 173) which Stumm later (1953a, p. 120) placed in *Basidechenella* as *Dechenella* (subg.?) *rowi* (Green). It is clear that the North American species assigned to *Basidechenella* by Stumm (1953a, 1953b) do not entirely conform to the conception of the subgenus held by its author and should, perhaps, be placed in a new subgenus.

Dechenella (*Basidechenella*) *laticaudata* n. sp.

Plate XIII, figures 12-15; Plate XIV, figure 1

Holotype. GSC No. 18206, cranidium with part of anterior border and left palpebral lobe missing, strata exposed about 20 miles northeast of Drake Bay, Prince of Wales Island, lat. 74°43′, long. 100°26′.

Paratypes. GSC No. 18205, partial cranidium; GSC No. 18208, free cheek; GSC No. 18207, partial pygidium, same horizon and locality.

Description. Cranidium— Anterior border broad and low, forwardly sloping, posterior part is evenly convex, anterior part declines in a gentle, even slope to the anterior margin. Breadth of border greater than sagittal length of occipital ring. Anterior edge bears anastomosing terrace lines. Border furrow broad, appears deep because it is bounded posteriorly by steeply rising glabellae, but is seen to be shallow in profile. In profile the glabella is strongly and evenly convex, anterior end reaches the border furrow and rises nearly vertically. In transverse profile the sides of the glabella rise steeply initially, then flatten to form gentle, little arched slopes, the intersection of which at the midline is only slightly rounded, giving the glabella a somewhat peaked profile. Glabella longer than wide, ratio of length to breadth averages 1.24:1 for two specimens. Glabella tapers gradually to a position opposite 2p furrows where there is a slight constriction in its outline, between 2p and 3p furrows glabella is nearly parallel-sided. Anterior to 3p furrows glabellar sides taper rapidly and merge with the bluntly rounded anterior end. Greatest glabellar width across anterior end of 1p glabellar furrows, glabella slightly narrowing posterior to that. Four pair of lateral glabellar furrows, all are short and shallow but fairly easily detected because glabellar test is smooth in furrows, but pustulose outside of them. On the internal mould the impressions of the furrows are broader and more easily seen than on the test. Glabellar furrow 1p begins at the axial furrow. The anterior part is directed nearly at right angles to the midline, turns sharply and runs towards the midpoint of the occipital ring, terminates well short of the occipital furrow and the posterior end turns inward slightly. 1p broadest in anterior part, narrows posteriorly. Adaxial branch of 1p inwardly and backwardly directed, separated from 1p by a distance equal to half that between 1p and 2p. Furrow 2p begins at axial furrow, runs backward and inward in a slightly curving course directed at the opposite postero-lateral corner of the glabella. Furrow 3p short, separated from the axial furrow by a distance greater than its own length, runs backward and inward parallel to the middle part of 2p. Distance (exs.) between 1p and 2p equals about one and one half the 2p-3p distance. Basal glabellar lobe triangular, lobe low-lying, bent down sharply at postero-lateral corner. 2p and 3p lobes subrectangular. In profile the posterior end of the glabella is lower than the forwardly sloping occipital ring. Occipital furrow moderately deep, shallows medially. Occipital lobes triangular, depressed, not entirely separate from the occipital ring, boundary between lobe and ring is not a furrow but a sharp change in slope. Occipital ring longest sagittally, strongly convex transversely, bears a large axial node. Axial furrows deep and narrow. Fixed cheeks in front of eyes narrow, declining anteriorly in a moderately steep and gently convex slope. Palpebral lobe reniform, long, reaching from in front of 2p glabellar furrow to a point opposite the midpoint of the basal glabellar lobe, of less than glabellar height. Breadth (trans.) of palpebral lobe about equal to sagittal length of occipital ring. Anterior branch of facial suture diverges anteriorly at 26 degrees to the midline, opposite interspace between 2p and 3p furrows suture is almost parallel to midline, but rapidly curves outward and runs forward as an almost straight line before turning in to cut across the anterior border. Posterior branch runs parallel to midline for a short distance before turning sharply outward at an angle of 70 degrees to the midline. External surface of glabella (except for furrows) and palpebral lobes covered with coarse pustules, that of occipital ring, fixed cheeks, and anterior border with fine pustules. The internal mould is finely pitted.

Free cheek— Eye lobe large, extending from a point opposite the midpoint of the basal glabellar lobe to a point opposite furrow 2p. Genal field slopes gently downwards from the base of the eye lobe to a distance two thirds of its total width, then more steeply down to the lateral and posterior border furrows. Lateral border furrow broad and shallow. Lateral border broadly convex to somewhat flattened on its distal edge, bearing terrace lines. Posterior border furrow broad and deep. Posterior border broadly convex, rising nearly as high as the apex of the genal field. Genal spine broad and short, shorter than the eye lobe (exs.), sulcate in cross section. External surface of free cheek bears fine pustules, becoming coarser adjacent to the eye.

Pygidium— Ratio of length to width averages 1:1.7 for two specimens. Semicircular. Broad, convex axis rapidly tapering posterior end blunt. Maximum axial width equals two thirds that of one pleural field plus border. Axis with ten rings, unsegmented posterior tip very short. Ring furrows shallow. In profile the axis is gently convex, declining posteriorly. Posterior end of axis drops off sharply in a nearly vertical slope to the level of the pleural field. A short (sag.), posteriorly sloping interspace separates the axis from the border. Pleural fields moderately convex. Seven pleural furrows, the first narrower than the succeeding furrows and extending on to the border. Pleural ribs broad (exs.) and low-lying in cross section. There are seven distinct interpleural furrows extending all the way down the pleural field. Interpleural furrows are also distinct on the internal mould. Anterior and posterior pleural bands are of equal length (exs.) and convexity. Border furrow shallow. Border not convex, sloping at about the same angle as the pleural fields to the lateral and posterior margin. Distal edge of border bears anastomosing terrace lines. External surface of pygidium has numerous fine pustules. On the internal mould the pleural bands and axis are pitted.

Dimensions.

	GSC No. 18206 holotype	GSC No. 18205	GSC No. 18207
glabellar length	3.8	6.1	
glabellar width	3.0	5.0	
cranidial length	x	8.0	
pygidial length			8.0
pygidial width			13.8
axial length			6.6

Discussion. Although differing in some important respects, this species has a strong overall resemblance to *Dechenella* (*Basidechenella*) *dombrowiensis* (Sobolew, 1909) (Richter, R., 1912, p. 281, Pl. 18, figs. 9-14) from Dombrow, Poland. The outline and convexity of the glabella, height and convexity of anterior border, course of facial suture, indistinctness of the occipital lobes, and conspicuous interpleural furrows are much alike in the two species. Features of *D.* (*B.*) *laticaudata* which distinguish it from *D.* (*B.*) *dombrowiensis* are the longer anterior border (sag.), deeper axial furrows, presence of an adaxial branch of glabellar furrow 1p and of a 4p furrow, a deeper occipital furrow, less distinct occipital lobes, and a relatively much broader pygidium which has fewer axial rings and pleural furrows.

Unfortunately, the age of the horizon from which *D.* (*B.*) *laticaudata* comes is not surely known. Associated fossils suggest a Middle Devonian, but the possibility of a Lower Devonian cannot be excluded. *D.* (*B.*) *dombrowiensis* comes from the base of the Middle Devonian, and the horizon of *D.* (*B.*) *laticaudata* is possibly of the same age.

The holotype cranidium, GSC No. 18206, shows signs of lateral compression. The occipital ring is broken and its transverse convexity may have been increased by compression, but in the uncompressed paratype cranidium, GSC No. 18205, it is still strongly convex transversely.

Genus *Deltadechenella* n. gen.

Type species: *Deltadechenella bathurstensis* n. gen., n. sp.

Diagnosis. Glabellar outline as in *Dechenella* (*Dechenella*), three pair of deep lateral glabellar furrows, 1p evenly curving, 2p and 3p separate from axial furrow. Glabella impinges on anterior border. Occipital lobes triangular in outline, depressed. Anterior branch of facial suture less divergent (diverges at 21 degrees to midline) than that of *Dechenella* (that of *D. verneuili* diverges at 30 degrees to midline), not angulate at border furrow. Eye bordered by weak furrow.

Thorax of ten segments, thoracic axis tapers more rapidly than that of *Dechenella*. Pygidial outline an equilateral triangle. Pygidium with nine or ten axial rings, ring furrows shallowing rapidly posteriorly, five pleural ribs, posterior third of pleural field unfurrowed. No pygidial border furrow, border indistinctly set off from pleural field.

Geological range. Middle Devonian, Eifelian.

Discussion. Although, with the exception of the lesser divergence of the anterior branch of the facial suture, the cephalon of *Deltadechenella* resembles that of *Dechenella*, the pygidium with its triangular outline and few pleural segments is unlike that of *Dechenella* and is similar instead to the Upper Devonian *Chaunoproetus* R. and E. Richter, 1919 (Richter, R. and E., 1926, p. 92, Pl. 6, figs. 86-87). *Chaunoproetus tietzei* is known only from the pygidium which is triangular, has a short axis with seven rings, has five pleural ribs and lacks a border. The pygidia are thus similar; the most important difference being the longer, more segmented, dechenellinae-like pygidial axis of *Deltadechenella,* and it is possible that the Middle Devonian *Deltadechenella* is a forerunner of the Upper Devonian *Chaunoproetus*. *Deltadechenella* is considered a member of the subfamily Dechenellinae because of (1) the resemblance of the cephalon to *Dechenella*, (2) the presence of ten thoracic segments, (3) the presence of a long, multisegmented pygidial axis.

Deltadechenella bathurstensis n. gen., n. sp.
Plate XIV, figures 2-12

Holotype. GSC No. 18213, enrolled specimen lacking the right free cheek; Blue Fiord Formation, 440 feet above base, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′; coll. Ormiston, 1962.

Paratypes. GSC No. 18214, cranidium; GSC No. 18211, free cheek; GSC Nos. 18212, 18210, two pygidia; GSC No. 18209, cranidium; Blue Fiord Formation, 481 feet above base, Twilight Creek, Bathurst Island; coll. Ormiston, 1962.

Description. Cranidium— Anterior border gently and evenly convex, cross section equals a quarter circle, terrace lines on anterior half. Border furrow distinct laterally, medially glabella impinges on border from which it is separated by a deep furrow. Glabella strongly convex longitudinally, nearly vertical anteriorly, occipital ring as high as posterior end of glabella. Glabella evenly convex transversely. Glabellar width four fifths of glabellar length. Glabellar outline like that of *Dechenella paragranulata* n. sp. Three pair of lateral glabellar furrows, 1p begins at axial furrow, an arcuate curve, not angular as in most species of *Dechenella*, reaching anterior wall of occipital furrow, 2p and 3p of equal depth, shallower than 1p, separate from axial furrow, paralleling anterior part of 1p, 3p at three fifths glabellar length. The distance separating the 2p and 3p furrows from axial furrow is variable; on holotype they are very close to it, on other specimens distinctly separate from it. Occipital furrow transverse, narrow. Occipital ring short (sag.), in profile slightly forwardly sloping, bearing faint medial tubercle. Occipital lobes triangular, depressed. Axial furrows distinct. Palpebral lobes essentially horizontal, midpoint slightly anterior to proximal end of 1p furrow. Fixed cheek anterior to eye steeply downsloping, slightly inflated just posterior to border furrow, narrow (trans.). Anterior branch of facial suture a straight line, moderately divergent at angle of 21 degrees to midline, not angulate at border furrow but curving gradually to cut anterior margin. The angle of divergence of facial suture from midline is appreciably less than in *Dechenella* (*Dechenella*) in nearly all species of which the angle is 30 degrees or greater. Posterior branch parallels midline before turning sharply outward to cut posterior margin at three fourths total distance (trans.) from midline to cephalic margin. Glabella finely pitted anteriorly, with pits becoming coarser posteriorly. On some specimens glabellar area between 1p furrows tuberculate.

Free cheek— Eye lobe large, extending from midpoint of 1p glabellar lobe to 3p furrow. Base of eye bordered by weak but persistent furrow. Genal field narrow (trans.), steeply downsloping adjacent to eye, merging with broad lateral border furrow. Lateral and posterior borders of comparable breadth and convexity, in cross section equal to a quarter circle. Posterior border furrow incised, continues down genal spine for one fourth its length. Genal spine as long as eye lobe, semi-cylindrical in cross section. Terrace lines occur on outer edge of lateral border and on inner and outer edges of genal spine.

Thorax— of ten segments. Greatest axial width equals one third thoracic width, thoracic axis more rapidly tapering than in *Dechenella* (*Dechenella*), minimum width equals three fourths maximum width. Sharp break in slope divides axial ring into low-lying preannulus and elevated postannulus (*see* Richter, R. and E., 1956a, p. 346), articulating furrow incised. Fulcrum at midwidth (trans.) of pleural field. Pleural furrow begins distal to axial furrow, moderately deep. Pleural termination blade-like.

Pygidium— Outline approximates an equilateral triangle. Ratio of length to width averages 1:1.3 for three specimens. Convex axis, anterior part tapers moderately, posterior half weakly tapering, posterior end bluntly rounded, greatest axial width nearly one third pygidial width. GSC No. 18210 with nine visible axial rings posterior to which is an unsegmented portion of axis equal to one third total axial length, a tenth axial ring perceptible on GSC No. 18212. Axial rings two to nine bowed gently backwards medially. Anterior ring furrows deep, shallowing rapidly posterior to the fourth, laterally each axial ring bears a circular depression (position of muscle attachment) on either side just above axial furrow. In longitudinal profile first axial ring rises high above succeeding rings, sixth through ninth rings have no relief in profile, axis declines gently posteriorly. Axial furrows distinct. In transverse profile axis high above pleural fields which are moderately and evenly convex. There are five pair of deep, narrow pleural furrows crossing the anterior two thirds of pleural fields, posterior third unfurrowed, first two pleural furrows continue on to border. Pleural furrows set off five pleural ribs, the last of which is bounded posteriorly by a change in slope not a furrow. Five pair of interpleural furrows extend all the way down pleural fields. Posterior pleural bands twice as long (exs.) at midwidth as anterior pleural bands. No border furrow, but a weak change in slope (imperceptible on some specimens) marks the boundary of the pygidial border which passes directly behind axis and parallels lateral margins. Slope of border steep, essentially continuous with pleural field. Postaxially border is prolonged in a blunt point. Doublure strongly convex downward, of width equal to border. Exoskeleton smooth except for oblique ridges on distal part of border.

Dimensions.

	GSC No. 18213	GSC No. 18214	GSC No. 18209	GSC No. 18210	GSC No. 18212
cranidial length	5.2	5.5	4.4		
glabellar length	3.9	4.2	3.2		
glabellar width	3.5	3.6	2.7		
cranidial width at beta	——	4.1	3.2		
occipital length	0.6	0.6	0.5		
width across palpebral lobes ...	——	5.0	3.9		
pygidial length				3.5	3.9
pygidial width				4.7	5.2
axial length				2.7	3.1
axial width				1.4	1.6

Discussion. The cranidium of *Deltadechenella bathurstensis* resembles that of *Dechenella (D.) paragranulata* n. sp. in glabellar outline and convexity, in the presence of a deep preglabellar furrow, and in the shape of the occipital ring, but differs in many important features: anterior branch of facial suture less divergent and not angulate at border furrow, 1p furrow an even arc, and occipital lobes depressed. The pygidia of these species are quite dissimilar.

Chaunoproetus tietzei (R. and E. Richter, 1919) (Richter, R. and E., 1926, p. 92, Pl. 6, figs. 86-87) from the Upper Devonian of Germany, known only from the pygidium, closely resembles the pygidium of *Deltadechenella bathurstensis.* The two pygidia have in common: a triangular outline, five pleural ribs, evenly convex pleural fields, and a weakly defined border prolonged postaxially into a blunt point, but can be distinguished by the longer, more segmented axis, unsegmented portion of pleural fields, weaker interpleural furrows and smooth exoskeleton of *Deltadechenella bathurstensis. Deltadechenella* is structurally and stratigraphically a possible ancestor to *Chaunoproetus.* The major structural change involved in such a derivation would be the shortening of the pygidial axis. A comparable change would be involved in R. and E. Richters' (1950, p. 166) proposed derivation of the cyrtosymbolinid *Cyrtodechenella* from *Dechenella* (*Basidechenella*).

Deltadechenella bathurstensis has been found at only two horizons in the Blue Fiord Formation, one 440 the other 481 feet above the base. At each horizon the species is represented by abundant specimens associated with a small number of *Dechenella maclareni* occurring in a richly fossiliferous limestone. A large number of specimens have been examined, and the populations at both horizons are found to show great variability which is not related to stratigraphic position. The posterior half of the glabella varies from tuberculate to nearly smooth, axial furrows from distinct to deep, palpebral lobes from nearly horizontal to slightly inwardly sloping, 2p and 3p furrows from nearly joining to separate from axial furrows, and fixed cheeks above border furrow from inflated to evenly downsloping. These variations appear to occur independently of one another, and all specimens are interpreted as part of a highly variable population of a single species.

An unusual feature of *Deltadechenella* is the lack of correspondence between the cephalic and pygidial outlines. Such correspondence is required to insure a close fit of head and tail during enrollment and is typical of trilobites capable of enrollment. The Dalmanitinae and Pterygometopinae provide many examples of trilobites in which a triangular pygidium is associated with a cephalon of similar outline. This can be considered the typical condition, and *Deltadechenella* is a conspicuous exception.

Dechenella sp. indet.

Plate XVII, figure 10

Material. GSC No. 18244, internal mould of pygidium; Blue Fiord Formation, largest of the Princess Royal Islands, lat. 72°48′, long. 117°46′; coll. E. T. Tozer, 1959.

Description. Pygidial outline subsemicircular; ratio of length to width as 1:1.5. Maximum axial width one fourth of total pygidial width. At least eleven axial rings, anterior rings curved posteriorly. Axis moderately tapering. Pleural fields evenly convex transversely. There are eleven pleural furrows; ribs of internal mould with conspicuous interpleural furrows. Pygidial doublure broad and gently concave.

Discussion. The material is too poorly preserved to permit worthwhile comparisons with other species.

Proetid gen. et sp. indet.

Plate XVII, figure 11

Material. PMO A28836, original of Tolmachoff, 1926, Plate 1, figure 2, external mould of right free cheek, Series Db, Vestre Borgen; Goose Fiord, Ellesmere Island, lat. 76°40′, long. 88°35′.

Description. A latex cast of this small external mould reveals a genal field evenly downsloping, narrow (trans.); lateral and posterior border furrows equally deep; eye lobe large; genal spine of length equal to that of the eye lobe; facial suture opisthoparian; exoskeletal surface of borders finely granulose.

Discussion. Tolmachoff (1926, p. 21) described this specimen as *Dalmanites* sp. which it obviously is not. The conspicuous opisthoparian suture (Pl. XVII, fig. 11) belies the assignment to the dalmanitids, but no generic assignment is possible.

Genus ***Cyrtodechenella*** R. and E. Richter, 1950

Type species: *Cyrtodechenella cyrto* R. and E. Richter, 1950

Diagnosis. Broad preglabellar field, anterior border lacking or very narrow, 2p and 3p lateral furrows indistinct, glabellar outline conical, occipital ring abruptly narrowing laterally, then expanding near ends. No occipital lobes.

Palpebral lobes extending far backward, facial suture evenly curving at beta. Pygidium relatively long, with broad, steeply sloping border not delimited by furrow, axis with ten to eleven rings, pleural fields with seven or more ribs.

Discussion. R. and E. Richter (1950, p. 165) proposed *Cyrtodechenella* as a subgenus of *Cyrtosymbole.* It was later promoted to generic rank by Hupé (1953a, p. 219), who regarded it as a member of the Dechenellidae (considered a family by Hupé, 1953a). The writer prefers Hupé's classification to that of Harrington, *et al.*, 1959 in which *Cyrtodechenella* is placed in the Cyrtosymbolinae.

Cyrtodechenella differs from *Dechenella* in lacking a clover-leaf-shaped glabellar outline, in lacking occipital lobes, in lacking an angular bend in the suture at beta, and in having a shorter pygidium with a shorter axis and fewer axial rings and pleural ribs.

Cyrtodechenella macnairi n. sp.

Plate XIV, figures 13-14

Holotype. GSC No. 18215, eroded cranidium; strata exposed in canyon of a west-flowing stream, about 9 miles northwest of the south end of Drake Bay, Prince of Wales Island, lat. 75°22′, long. 117°20′; coll. A. H. McNair, 1960.

Description. Cranidium— The anterior half of the glabella is somewhat eroded on this specimen. Anterior border horizontal to weakly forwardly sloping, occupying two fifths of total preglabellar length (sag.), medially confluent with preglabellar field, laterally set off by a change in slope. Preglabellar field long (sag.), forwardly sloping. In longitudinal profile glabella strongly convex posteriorly and steeply downsloping anteriorly with anterior end protruding conspicuously above preglabellar field, occipital ring as high as glabella, glabella strongly and evenly convex transversely. Glabellar width equals nine tenths of glabellar length. Glabellar outline conical, strongly tapering anterior to 2p furrow, glabellar width in line with 3p furrows equals three fourths maximum width. Three pair of lateral glabellar furrows, all weakly impressed and all beginning at axial furrow, 1p runs initially inward and slightly backward, turns abruptly to parallel midline for a short distance, curves strongly inward and terminates anterior to occipital furrow, outline sigmoidal, broadest at position of first turn, deepest and narrowest at proximal end; 2p a straight line, runs diagonally to a point in line with (exs.) proximal end of 1p; 3p at two thirds glabellar length, half as long as 2p. Occipital furrow deep and broad, deepest behind midwidth of basal glabellar lobe, curving anteriorly distal to that position, and joining axial furrow. Occipital ring evenly convex in cross section, gently convex transversely. Ring length little more than one tenth cranidial length, ring narrows laterally, then expands so that distal parts of ring continue the posterior profile (exs.) of glabella. No occipital lobes. Axial furrows deep, but markedly shallowed between 1p and 2p glabellar furrows, merging anteriorly with equally deep preglabellar furrow. Palpebral lobes not preserved, but anterior edge situated posterior to distal end of 2p furrow. Fixed cheeks in front of eyes inflated anterolateral to glabella and steeply declining anteriorly. Anterior branch of facial suture diverges anteriorly at an angle of 27 degrees to midline, gamma gradually curved, beta evenly rounded. Posterior branch short, initially paralleling midline then turning outward at right angles. The occipital ring, glabella, and inflated parts of free cheeks are coarsely tuberculate.

Free cheek, thorax, and pygidium unknown.

Dimensions.

	GSC No. 18215 holotype
cranidial length	22.5
glabellar length	13.1
glabellar width	11.8
frontal area length	7.0
beta-beta width	18.6

Diagnosis. Species hitherto assigned to *Cyrtodechenella* are the type species, *Cyrtodechenella cyrto* R. and E. Richter, 1950 (p. 166, Pl. 3, figs. 19-24; Pl. 4, figs. 28-29), from the Givetian Fleringer beds of the Eifel District; *Cyrtodechenella meles* R. and E. Richter, 1950 (p. 169, Pl. 3, fig. 25; Pl. 4, figs. 30-31) from the same locality and horizon; and *C. martenbergensis* (R. and E. Richter, 1926) (p. 23, Pl. 1, figs. 4-7) from the Frasnian of the Rhenish Schiefergebirge. *Cyrtodechenella*? *uralica* (R. Richter, 1912) (Maximova, 1955, p. 109, Pl. 16, figs. 8-12) from the Givetian of the Urals and *C.*? *dubia* (R. Richter, 1912) (p. 327, Pl. 21, fig. 15) from near the Middle Devonian-Upper Devonian boundary are known only from pygidia and cannot be compared with *C. macnairi*.

Cyrtodechenella macnairi most closely resembles the type species, *C. cyrto* R. and E. Richter. The two are especially similar in the complete absence of occipital lobes, weakness of glabellar furrows, glabellar outline, course of anterior branch of facial suture, and nature of the axial furrows but are easily distinguished. *C. macnairi* differs from both *C. cyrto* and *C. meles* in having (1) free cheek inflated anterolateral to glabella; (2) anterior border more distinctly delimited than in *C. cyrto* and less convex than in *C. meles*; (3) glabella more convex longitudinally and transversely; (4) a more pointed anterior glabellar end; (5) a more posteriorly situated anterior edge of the palpebral lobe; and (6) a sigmoidal 1p furrow.

C. macnairi does not resemble the Upper Devonian *C. martenbergensis* (R. and E. Richter, 1926), which has the preglabellar field concave in lateral profile, posterior branch of suture long, and flattened occipital lobes.

The age of *C. macnairi* is, unfortunately, not known, but the regional westward dip of beds on northwestern Prince of Wales Island indicates that it lies stratigraphically above beds farther east which contain *Dechenella* (*Basidechenella*) *laticaudata* n. sp. (this paper) provided that the succession is not faulted between these localities. Although *C. cyrto* is readily distinguished from *D.* (*B.*) *laticaudata* by its long preglabellar field, low anterior border, and conical glabellar outline, the two species do show some notable similarities. The structure of the distal part of the occipital ring is very similar, but in *D.* (*B.*) *laticaudata* there is a faint break in slope which sets off an occipital lobe. Also notable are similarities in the course of the facial suture and in the strength, if not the outline and number, of the glabellar furrows. These similarities are interesting in light of the possible derivation of *Cyrtodechenella* from *Dechenella* (*Basidechenella*) suggested by R. and E. Richter (1950, p. 166). Whatever their exact ages, *Cyrtodechenella macnairi* n. sp. and *Dechenella* (*Basidechenella*) *laticaudata* n. sp. undoubtedly occur within a few hundred feet stratigraphically of one another on northwestern Prince of Wales Island. Their morphological similarity supports the Richters' above mentioned phylogeny; possibly *Cyrtodechenella macnairi* and *D.* (*B.*) *laticaudata* evolved from a common *Basidechenella*-like stock.

Genus *Schizoproetoides* n. gen.

Type species: *Cyrtosymbole richteri* Tolmachoff, 1926

Diagnosis. Glabellar outline as in *Schizoproetus* R. Richter, but with deeper glabellar furrows and a distinctive pear-shaped median glabellar lobe. Lateral glabellar lobes have independent convexity. Axial furrows exceptionally deep. Anterolateral parts of fixed cheeks inflated. A prominent, transversely directed preglabellar ridge is present. Anterior branch of facial suture strongly divergent. Occipital lobes prominent.

Free cheek with or without genal spine. Eye socle well developed. Radiating pattern of genal caecae present.

Pygidium multisegmented. Axis elongate with sixteen or more axial rings. There are ten or more pleural furrows.

Discussion. Tolmachoff (1926, p. 26, Pl. 1, figs. 13-14) described and figured *Cyrtosymbole richteri* from Devonian rocks on the east side of Goose Fiord, Ellesmere Island. The Richters (1951, p. 222) rejected the assignment to *Cyrtosymbole* and suggested that *C. richteri* might be a *Schizoproetus*. Tolmachoff's species certainly has some resemblances to *Schizoproetus celechovicensis* (Smycka, 1895), the type species of *Schizoproetus*, but these are only general resemblances. The distinctive glabellar lobation, deep axial furrows, and prominent preglabellar ridge of Tolmachoff's species have no counterpart in *Schizoproetus*.

Schizoproetoides richteri (Tolmachoff, 1926)

Plate XIV, figures 15-18; Plate XV, figures 1-6

1926 *Cyrtosymbole richteri* Tolmachoff, p. 26, Pl. 1, fig. 14 (*non* fig. 13).
1926 *Dalmanites* sp. Tolmachoff, p. 22, Pl. 1, fig. 3.
1926 *Dalmanites* sp. Tolmachoff, p. 22, Pl. 1, fig. 4 (*non* Pl. 2, figs. 20-21).

Holotype. PMO A28847, partial cranidium, Schei's series Db; a horizon now known to lie within the Blue Fiord Formation, Middle Devonian, east side of Goose Fiord, Ellesmere Island, lat. 76°40′, long. 88°35′.

Hypotypes. GSC No. 18216, cranidium; GSC No. 18218, external mould of pygidium; GSC No. 18219, external mould of free cheek; GSC No. 18222/$_1$, external mould of cranidium; GSC No. 18220, pygidium; Blue Fiord Formation, upper 200 feet, southeast corner of Svendsen Peninsula, Ellesmere Island; coll. J. W. Kerr, 1961. GSC No. 18217, cranidium; GSC No. 18221, pygidium; Blue Fiord Formation, near base, 8 miles east of Blue Fiord, Ellesmere Island; coll. D. J. McLaren, 1955.

Other material. GSC No. 18223/$_{1-8}$, eight cranidia, same locality and horizon as GSC No. 18216.

Description. Cranidium— Anterior border moderately broad, in profile consisting of two parts, a long, flat posteriorly sloping posterior part and a short, steeply convex anterior part which bears terrace lines. Border furrow broad and deep. Preglabellar field of moderate breadth, occupied by a semicylindrical transverse ridge which dies out rapidly laterally, of width (trans.) equal to greatest width of median glabellar lobe. The preglabellar ridge is bounded anteriorly by the border furrow and posteriorly by the deep preglabellar furrow. In longitudinal profile glabella is evenly convex anteriorly, but flattens somewhat posteriorly. Anterior end of glabella rises nearly vertically. In transverse profile glabella is gently convex at the top, steeply convex laterally. Glabella slightly longer than wide, length to width ratio averages 1.1:1 for seven specimens. Glabella tapering anteriorly, outlines subconical, anterior end evenly rounded. Greatest glabellar width is anterior to midpoint of basal glabellar lobe, glabella slightly narrowing posterior to that. Three pair of broad, deep lateral glabellar furrows, 1p and 2p furrows with sharply bent courses. Furrow 1p begins at the axial furrow and runs inward at right angles to the midline for a distance equal to one third the glabellar width, there making a right angle bend to run backward parallel to the midline. Posterior end of 1p broadens and turns inward slightly before joining the occipital furrow. Furrow 2p begins at the axial furrow, runs inward and very slightly backward nearly at right angles to the midline for a distance equal to one third the glabellar width where it bends around in a sharp curve to run parallel to the midline for a short distance and finally to run backward and outward before joining with the 1p furrow at the point where that furrow makes a right angle bend; 3p separated from axial furrow by a distance nearly equal to its own length, considerably shallower than 1p and 2p, runs inward and backward in a curving course directed at the midpoint of the opposite occipital lobe, short. Median glabellar lobe is isolated posteriorly, has an incompletely pyriform outline and is moderately inflated. Length (exs.) of 2p lobe equals two thirds that of basal lobe and twice that of 3p lobe; 3p lobe subrectangular. In profile the posterior end of glabella stands above the level of the convex occipital ring. Occipital furrow deep. Occipital lobes large and prominent, triangular, set in beneath basal glabellar lobe. Occipital ring moderately broad, strongly convex transversely, with axial node on posterior edge. Axial furrows deeply incised, having a U-shaped cross section.

Fixed cheeks in front of eyes narrow. Anterior to the position of 3p furrow, fixed cheeks have a strong independent convexity and decline rapidly anteriorly. Anteriorly a change in slope to nearly vertical coincides with the anterior boundary of the tuberculated part of the fixed cheek. Palpebral lobe of less than glabellar height, narrow (trans.), reaching from a position opposite the midpoint of 2p glabellar lobe to position opposite midpoint of 1p lobe. Anterior branch of facial suture strongly divergent anteriorly, runs parallel to midline opposite anterior part of 2p lobe, then diverges abruptly and forms an outwardly convex curve reaching a point more distal than the most distal point on the palpebral lobe before cutting obliquely across the anterior border. From here connective suture runs initially inward and slightly backward across doublure then turns to run backward and slightly inward before cutting the inner margin of the doublure. Posterior branch runs subparallel to midline and very close to axial furrow between a position opposite midpoint of 1p lobe and one opposite base of occipital lobe, then turns abruptly outward and cuts the posterior margin at three fourths the total width of the cheek. Cephalic doublure convex, greatest width one fourth greater than that of anterior border.

The exoskeletal surface of the glabella, fixed cheeks, preglabellar ridge, palpebral lobes, occipital ring, and occipital lobes is tuberculate, the tubercles on glabella being coarsest. The tubercles of the palpebral lobes are transversely elongate and arranged in transverse rows which radiate outwards slightly.

Free cheek— Eye lobe moderately large. Visual surface rests on an eye socle like that of *S. ellesmerensis* n. sp. Genal field inflated, consists of two parts, a flat, horizontal part extends outward from the base of the eye a distance equalling one fourth the width of the field, then declines in a steep, convex slope both laterally and posteriorly to the respective border furrows. Lateral border furrow broad. Lateral border rather narrow, gently convex, with four or five persistent terrace lines. Posterior border furrow deep and narrow. Posterior border broad, convex, sloping anteriorly in profile. Posterolateral corner prolonged into a genal spine of length one fifth greater than that of eye lobe, cross section semicylindrical.

Upper part of declining slope of genal field bears scattered tubercles, replaced distally by a network of fine, discontinuous furrows persisting to the edge of the border furrow.

Pygidium— Ratio of length to width averages 1:1.2 for four specimens. Outline semioval. Axis moderately broad, maximum width equals that of one pleural field plus border, evenly tapering, posterior end smoothly rounded. An external mould shows sixteen axial rings, the last interrupted at the midline, the others with a prominent axial node. The last ring is followed by a short unsegmented section of axis which terminates in a node-like protuberance. Only fifteen axial rings are discernible on internal moulds of size comparable to that of the external mould mentioned. Axial rings bend sharply backwards at their lateral extremities. Ring furrows deep. In profile axis evenly convex, declining posteriorly;

a saddle-like depression follows the segmented portion of the axis, posterior edge of saddle formed by a node-like rise at the terminus of axis. Posterior edge of axis drops off sharply to the border furrow. Axial furrows deep. Pleural field strongly convex, climbs steeply from the axial furrow to a crest at one third the width of the field, the first two pleurae bear prominent nodes at this position, then descends in a steep convex slope to the border. There are ten pleural furrows, the first nine deep, the last shallow. Pleurae posterior to three die out before reaching the distal edge of the field but are represented again by nodes occurring opposite their distal ends on a convex ridge which runs parallel to and just above the border. Border furrow broad and deep behind axis, shallowing anteriorly and disappearing opposite the fourth pleural furrow. Border narrow and convex behind axis, becoming less convex anteriorly and anterior to the third pleural furrow forming a continuation of the steep slope of the pleural field.

On the exoskeleton there are seven nodes on each axial ring, a prominent sagittal one, and equally spaced lateral ones. The pleurae bear scattered tubercles. Doublure strongly convex, broader than border.

Dimensions. All measurements given in millimetres.

	GSC No. 18216	GSC No. $18223/_{3}$	GSC No. $18223/_{4}$	GSC No. $18223/_{5}$	GSC No. $18223/_{7}$	GSC No. $18223/_{1}$	GSC No. $18223/_{2}$	GSC No. 18220
cranidial length	22.4	23.0	22.8	25.8	22.0	——	ca. 8.0	
glabellar length	15.0	15.0	15.1	16.0	13.1	10.2	ca. 5.5	
glabellar width	13.0	13.8	13.2	14.5	11.5	8.6	4.5	
pygidial length								26.0
pygidial width								32.1
axial length								22.4
axial width								9.7

Discussion. That the abundant new material is conspecific with the partial cranidium featured by Tolmachoff (1926, Pl. 1, fig. 14) is indicated by the following features detectable in the holotype and the material described here: (1) the preglabellar ridge; (2) the course of the anterior branch of the facial suture; (3) the deep axial furrows; (4) the glabellar lobation; and (5) the distribution of tubercles on fixed cheeks and glabella. The holotype cranidium is about one fifth as large as the newly discovered cranidia. However, five or more fold increases in the size of the holaspid stage during growth are well documented (Whittington, in Harrington, *et al.*, 1959, p. 143) and this size difference is not considered important.

The pygidium and partial thorax assigned to *C. richteri* by Tolmachoff (1926, Pl. 1, fig. 13) is unrelated to the holotype cranidium; it belongs instead to *Otarion* cf. *O. balanops* Erben and consists of the posterior seven thoracic segments and a pygidium. Among the trilobites described by Tolmachoff are two partial pygidia (PMO A28844 and A28835) which he considered (1926, p. 22, Pl. 1, fig. 3; Pl. 1, fig. 4; *not* Pl. 2, figs. 20-21) to be separate species of *Dalmanites*. These pygidia both belong to *Schizoproetoides richteri* (*see* Pl. XV, fig. 1).

On Svendsen Peninsula cranidia belonging to *S. richteri* occur together with two different structural types of tails and of free cheeks. Elsewhere (e.g., Blue Fiord and Goose Fiord) the cranidium of *S. richteri* occurs with only one of those structural types, and that type, characterized by a more inflated genal field and more convex border, is assigned to *S. richteri*. Because of the marked structural differences and nature of their occurrence, the possibility that the two types of pygidia and free cheeks represent sexual dimorphs of a single species is rejected, and the second structural type is assigned to *Schizoproetoides ellesmerensis* n. sp. (this paper).

Tolmachoff (1926, p. 101) assigned Schei's series Db from which the holotype of *S. richteri* comes to the Middle Devonian, and it is apparent from comparing his map of Goose Fiord (1926, p. 11) with GSC Map 21-1959 that that series must be part of what is now called the Blue Fiord Formation, the same unit from which the new material was collected.

The cranidium of *Schizoproetoides richteri* somewhat resembles that of *Schizoproetus onyx* Richter (1950, p. 162, Pl. 2, figs. 14-17), being similar in its broad anterior border, glabellar outline, and longitudinal glabellar profile, but differing in the features mentioned in the generic diagnosis.

Schizoproetoides ellesmerensis n. sp.

Plate XV, figures 7-9

Holotype. GSC No. 18224, internal mould of pygidium; upper 200 feet of Blue Fiord Formation, 16 miles north of S.E. corner of Svendsen Peninsula, Ellesmere Island, lat. 77°35′, long. 83°40′; coll. J. W. Kerr, 1961.

Paratypes. GSC No. $18222/_2$, free cheek; GSC No. $18225/_1$, external mould of free cheek; same locality and horizon.

Description. Free cheek— External surface of eye appears smooth but numerous small lenses are visible at 20× on the internal mould of eye. There are an estimated 9,000 lenses on an eye of 5 mm long. Eye lobe reaches from midpoint of 2p lobe to midpoint of 1p lobe. The visual surface of the eye rests on a curb-like eye socle from which it is separated by a furrow. The eye socle, convex in its upper part, descends nearly vertically in its lower part and is separated from the genal field by a sharp change in slope. The eye socle is absent from the internal mould. Genal field strongly and evenly convex transversely, but descends more steeply posteriorly with a downward flexure at a distance behind the eye equal to its own length. On the internal mould the transverse cross section of the genal field consists of two parts, an upper flattened slope and an evenly convex lower slope. Lateral border flat and horizontally directed, broad, not set off by a furrow, bearing four or five persistent terrace lines on its distal edge. Posterior border furrow broad and moderately deep. Posterior border broadly convex. Posterolateral corner of cheek has smoothly rounded outline. Adjacent to the base of the eye socle the exoskeleton bears shallow, transversely elongated pits which are arranged in crude rows radiating outward from the base of the eye. Distally the pits give way to tubercles and the radiating pattern becomes less distinct. This radiating prosopon is apparently analogous to the genal caecae (Raymond, 1920, p. 82) which are known in many trilobite groups and have been well illustrated and discussed in a recent paper by Öpik (1961, pp. 410-438).

Pygidium— Based on two internal moulds and a fragmental pygidium with the test intact. Ratio of length to width averages 1:1.4 for three specimens. Outline semielliptical. Broad, convex axis tapers rapidly, width near posterior end only half of maximum width, posterior tip bluntly rounded. Maximum axial width equals about five sixths that of one pleural field plus border. GSC No. 18224, an internal mould, shows eighteen axial rings with segmentation persisting to the posterior tip of axis. Axial rings have a pronounced posteriorly directed curvature along the crest of the axis. In longitudinal profile the axis is moderately and evenly convex, declining posteriorly. In transverse profile axis is subtriangular in outline because of a pronounced peaking along the sagittal line. Posterior tip of axis separated from border by a short interspace. Axial furrows distinct. Pleural field strongly and unevenly convex, dipping most steeply just above border. There are twelve pleural furrows, those posterior to two having a sigmoidal course. At least six faint interpleural furrows are present, extending all the way down the pleural field. Border furrow absent. Border moderately broad and flat, horizontal, set off by a change in slope from the pleural field, narrowing anteriorly. The exoskeleton of each axial ring bears nine coarse pustules, one sagittal, the others evenly spaced laterally. These pustules are arranged in longitudinal rows parallel to the axis. Bordering the anterior and posterior edge of each interpleural furrow and parallel to it is a row of fine pustules. The internal mould of border is finely pitted.

Dimensions.

	GSC No. 18224
pygidial length	26.1
pygidial width	38.0
axial length	22.3
axial width	11.8

Discussion. The free cheek of *S. ellesmerensis* resembles that of *Schizoproetus celechovicensis* (Smycka, 1895) (R. Richter, 1912, p. 331, Pl. 20, figs. 10-16) in outline and especially in the unusual exoskeletal sculpture on the genal field. In both species the pits and tubercles are arranged in crude rows radiating outward from the base of the eye, but the cheek of *S. ellesmerensis* is not carinate and has no genal spine. The pygidium is like that of *Schizoproetus onyx* (Richter, 1912) (1950, p. 162, Pl. 2, figs. 14-17) in outline, form of the border and exoskeletal prosopon, but has a broader, more strongly tapering axis, more pleural furrows, and a non-sloping border.

The material on which *S. ellesmerensis* is based occurs at the same horizon and intimately mixed with cranidia, free cheeks, and pygidia of *S. richteri* (Tolmachoff, 1926). The cranidium of *S. ellesmerensis* is either unknown, or possibly, in view of the species' occurrence, is indistinguishable from that of *S. richteri*. The free cheek and pygidium are distinguished from those of *S. richteri* by (1) the absence of a genal spine; (2) the less inflated genal field; (3) the prosopon of the genal field; (4) the flat, nearly horizontal border of the free cheek and pygidium; (5) the less strongly convex pleural fields; and (6) the absence of strong axial nodes on the pygidium.

?*Schizoproetoides* sp. indet.

Plate XV, figure 10

Material. GSC No. 18226, two overlapping partial cranidia and partial external mould of one; strata exposed 20 miles northeast of the head of Drake Bay, Prince of Wales Island, lat. 100°08′, long. 73°37′; coll. Ormiston, 1960.

Description. Cranidium— Preglabellar region not preserved. Glabella longer than wide, ratio of width to length about 1:1.2. Glabella moderately tapering forward, widest at midpoint of basal lobe, but not greatly expanded across the base. Glabella strongly convex in transverse profile. Three pair of lateral glabellar furrows, 1p deep and broad, runs from axial furrow in a sigmoidal course, dying out before joining occipital furrow. Adaxial branch of 1p is a deep, subcircular depression opposite the midpoint of 1p course. 2p considerably shallower than 1p, runs from axial furrow parallel to anterior part of 1p then turns abruptly backward for a short distance before terminating. 3p separate from axial furrow, parallels anterior part of 2p and nearly attains the midline. Basal glabellar lobe inflated, 2p lobe subquadrate in outline with slight independent convexity. Occipital furrow deep and broad, transverse. Occipital ring strongly convex transversely. Occipital lobes large, transversely elongate, ovate in outline. Axial furrows incised and deepest opposite palpebral lobe. Palpebral lobe steeply inwardly sloping. Anterior branch of facial suture moderately divergent anteriorly, incompletely preserved. Cranidial exoskeleton strongly tuberculate.

Discussion. Because of its glabellar lobation and outline, the large occipital lobes, and the long posterior branch of the facial suture, this cranidium can be assigned with question to *Schizoproetoides*. It is readily distinguished from *S. richteri* (Tolmachoff) by the courses of the glabellar furrows and the lesser independent convexity of its glabellar lobes. It has little resemblance to any described species and could represent a new species of *Schizoproetoides.* A second possibility is equally probable, however. A pygidium of *S. ellesmerensis* n. sp. has been identified from beds at the mouth of Drake Bay which are of approximately the same age and only 20 miles away. The cranidium of *S. ellesmerensis* n. sp. has not been identified, and it is conceivable that the cranidium described here belongs to that species.

Subfamily TROPIDOCORYPHINAE Přibyl, 1946

Genus *Astycoryphe* R. and E. Richter, 1919

Type species: *Astycoryphe senckenbergiana* R. and E. Richter, 1919

Diagnosis. See Přibyl, 1946, p. 22

Astycoryphe cimelia n. sp.

Plate XV, figures 11-13; Plate XVI, figures 1-5

1954 *Astycoryphe senckenbergiana* R. and E. Richter; Kielan, p. 22, Pl. 4, figs. 1-4.

Holotype. GSC No. 18227, cranidium; Blue Fiord Formation, 500 feet above base, Cut Through Creek, Bathurst Island, lat. 76°12′, long. 98°58′; coll. Ormiston, 1962.

Paratype. GSC No. 18228, pygidium, same locality and horizon.

Other material probably belonging to this species. GSC Nos. 18229, 18230; two pygidia; strata exposed on largest of Princess Royal Islands, lat. 72°48′, long. 117°46′; coll. E. T. Tozer, 1959.

Discussion. Astycoryphe cimelia n. sp. generally resembles the type species, *A. senckenbergiana* R. and E. Richter, 1919 from which it is distinguished by the following features:

Cranidium—In cross section the posterior slope of the anterior border does not rise nearly so steeply as in the type species nor is the anterior border furrow so deep. The preglabellar furrow is distinctly deeper. In lateral profile the tropidium coincides with a break in the slope of the preglabellar field with the anterior part of the field sloping more steeply than the posterior part (*see* Pl. XV, fig. 13). The cranidial prosopon is distinctly finer in *A. cimelia.* The anterior part of the glabella carries a Bertillon pattern which is replaced posteriorly by fine granules. The glabella of *A. senckenbergiana* is largely covered with coarser granules. Short, transverse ridges are developed on the lateral edges of the palpebral lobes of the type species, but are not present in *A. cimelia* (Pl. XV, fig. 11).

Pygidium—The pygidial axis of *A. cimelia* tapers more strongly and the pygidium is longer post-axially with a more conspicuous post-axial ridge. In

A. cimelia there are six pleural ribs (Pl. XVI, fig. 1) except on very small specimens which have five (Pl. XVI, fig. 5). There are five pleural ribs in *A. senckenbergiana*. The pleural ribs (anterior pleural bands) also appear to have sharper crests in *A. cimelia.*

Although the original description of *A. senckenbergiana* (R. and E. Richter, 1919, pp. 3-10) is excellent the original drawings are inadequate as illustrations of the species. The comparisons made here are based on photographs of the holotype and several paratypes of *A. senckenbergiana* kindly made available to me by Professor H. K. Erben of Bonn University.

Kielan (1954, p. 22, Pl. 4, figs. 1-4, text-fig. 14) described and figured material from the Middle Devonian of the Holy Cross Mountains, Poland, which she assigned to *Astycoryphe senckenbergiana.* The differences between that material and *A. senckenbergiana* which she herself pointed out (op. cit., p. 24) and which are evident from her description are exactly those by which *A. cimelia* is distinguished. I suggest that the Polish material because of having (1) fine granulation on the glabella and palebral lobes; (2) a tropidium which coincides with a break in slope (Kielan, 1954, text-fig. 14); (3) a moderately convex anterior border; (4) five or six pleural ribs (ibid., Pl. 4, figs. 3, 4); (5) a strongly tapering axis with seven or eight rings; and (6) a long post-axial ridge, belongs to *A. cimelia* rather than to *A. senckenbergiana.*

Dimensions.

	GSC No. 18228
pygidial length	4.1
pygidial width	7.8
axial length	2.8
axial width	2.8

	GSC No. 18227
cranidial length	5.0
glabellar length	2.7
glabellar width	2.7
length occipital ring	0.4
tropidium from glabella	0.8

Astycoryphe arcticus n. sp.

Plate XVI, figures 6-10

Holotype. GSC No. 18233, partly exfoliated cranidium; Blue Fiord Formation, upper 200 feet, S.E. Svendsen Peninsula, Ellesmere Island, lat. 77°35′, long. 83°46′; coll. J. W. Kerr, 1961.

Paratypes. GSC No. 18231, incomplete cranidium with exoskeleton; GSC No. 18232, cranidium; same locality and horizon.

Description. Cranidium— Anterior border convex, semicylindrical in cross section, moderately broad (sag.) with three to four persistent terrace lines. Preglabellar field forwardly sloping, of length (sag.) equal to one third that of glabella. Two narrow but distinct ridges, the tropidium, cross the field anterior to the preglabellar furrow and parallel to the anterior border; the ridge nearest glabella is separated from preglabellar furrow by a distance equal to twice the length (sag.)

of the furrow, the second ridge an equal distance from the first. Glabella gently and evenly convex longitudinally and transversely. Glabellar length approximately equal to width. Glabella tapers gradually forward to a point near the anterior edge of palpebral lobe, then more rapidly, terminating in a bluntly rounded anterior end, greatest width across base. Two pair of lateral glabellar furrows appear as smooth, faint impressions; furrow 1p crescentic, begins at axial furrow opposite midpoint of palpebral lobe, runs inward and progressively more strongly backward until it nearly parallels the midline, stopping just anterior to occipital furrow, broadest and deepest at midlength. 2p furrow is a short, backwardly and inwardly curving depression situated opposite anterior edge of palpebral lobe and separated from axial furrow. In profile glabella and occipital ring of equal height, posterior edge of glabella drops off abruptly, occipital ring slopes anteriorly. Occipital ring broad (sag. and exs.) with a median tubercle. Occipital furrow deep and narrow, swings forward medially making greatest width of ring sagittal. Axial furrows moderately deep. Fixed cheeks in front of eyes narrow, convex. Palpebral lobes exceptionally narrow (trans.) and long (exs.), extending from opposite 2p furrow to base of glabella. Anterior branch of facial suture straight, weakly divergent. Posterior branch short, curves strongly outward starting immediately behind palpebral lobe. Exoskeletal surface of glabella, except for furrows, and occipital ring bear fine, raised lines in a Bertillon pattern.

Dimensions.

	GSC No. 18233	GSC No. 18232
cranidial length	4.4	5.6
glabellar length	2.5	3.3
glabellar width	2.8	——
length preglabellar field	0.8	1.1
tropidium from glabella	0.25	0.25
length anterior border	0.4	0.45

Discussion. Astycoryphe arcticus resembles *Astycoryphe junius* (Billings, 1869) (Whittington, 1960, p. 418, Pl. 54, figs. 11, 17-19, 22, 23, 26, 27) from the Lower Devonian Square Lake Limestone of Maine. They are distinguished by the two tropidia, more strongly tapering glabella, and more prominent median occipital node of *A. arcticus*. *A. junius* does not have a typically developed tropidium (*see* Whittington, 1960, p. 419) and is thereby most easily distinguished from *A. arcticus*. The other differences between the species are not nearly so obvious.

Astycoryphe cimelia n. sp. is readily distinguished from *A. arcticus* by the nature of its cranidial prosopon, in having a single tropidium, and in having a break in the slope of the preglabellar field at the position of the tropidium. The cranidial prosopon of *A. arcticus* is best shown on Plate XVI, figure 6.

Family OTARIONIDAE R. and E. Richter, 1926

Subfamily OTARIONINAE R. and E. Richter, 1926

Genus ***Otarion*** Zenker, 1833, emend. R. and E. Richter, 1926

Type species: *Otarion diffractum* Zenker, 1833, selected by R. and E. Richter, 1926 (=*Cyphaspis burmeisteri*, Barrande, 1846)

Diagnosis. See Prantl and Přibyl, 1950, p. 442

Subgenus ***Otarion*** Zenker, 1833, emend. R. and E. Richter, 1926

Type species: same as for genus

Otarion (*Otarion*) *balanops* Erben, 1953

Plate XVI, figures 11-15, 16

f. 1899 *Cyphaspis hydrocephala* Burhenne, p. 16, Pl. 1, figs. 11, 12, 13, 14.
1914 *Cyphaspis hydrocephala* R. Richter p. 313, text-fig. 2.
1947 *Novákaspis hydrocephala* Přibyl, pp. 5, 6, fig. 3 (taken from R. Richter, 1914, text-fig. 2).
1950 *Otarion* (*Otarion*) *hydrocephalum* Prantl and Přibyl, pp. 378, 379.
1952 *Otarion* (*Otarion*) n. sp. A. Erben, pp. 233, 238.

Material. Hypotypes: GSC No. 18234, cranidium preserved as internal mould, 315 feet above base; GSC No. 18236, pygidium; GSC No. 18235, cranidium; 530 feet above base, Blue Fiord Formation, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′; coll. Ormiston, 1962.

Description. Erben's recent description (1953, pp. 74-76) of *Otarion balanops* applies to the Bathurst Island material with the following exceptions:

Free cheek— The genal spine is broken on Erben's holotype, but the Arctic material shows that the length of the genal spine is at least equal to that of the genal field (exs.).

Pygidium— The pygidium described by Erben is a young individual which differs in some respects from the larger pygidia from Bathurst Island. A description of the larger pygidia is, therefore, given here. Ratio of width to length (including the articulating half ring) as 1.8:1. Transversely elliptical, anterior margin straight for about half the pleural width, then curving backward so that anterolateral corner of pygidium is in line with the furrow between the first and second axial rings. Axis broad, width equal to pleural width at position of third pleural furrows, tapering little posteriorly, posterior end blunt. There are five axial rings distinctly set off by ring furrows, sixth and seventh are indicated by transverse rows of tubercles. In longitudinal profile axis and pleural fields slope posteriorly at about 20 degrees, then drop off abruptly at 80 degrees to posterior margin. Axial furrows distinct. In transverse profile axis is flattened along its crest. Inner half of pleural regions gently convex, outer part downsloping at 80 degrees along a line parallel to the margin. There are five distinct pleural furrows which begin distal to the axial furrow and do not reach the lateral margin. The five interpleural furrows are more conspicuous than the pleural furrows, begin at axial furrow and extend laterally as far as pleural furrows do. With the exception of the first, the anterior pleural bands are short (exs.) and gently convex, posterior pleural bands twice as long (exs.), higher and more convex than anterior bands (first anterior band equal in size and convexity to posterior bands). Transverse rows of tubercles are present on axial rings and posterior pleural bands. No pygidial border.

Discussion. Otarion balanops Erben (Erben, 1953, p. 74, figs. 1a-c) most closely resembles *Otarion druida* Erben (Erben, 1952a, p. 242, Pl. 19, figs. 13, 14, text-fig. 27a-b) from the Lower Devonian of the Lower Harz region. According to Erben (1952a, p. 245) *Otarion balanops* (=*Otarion* n. sp. A) differs in having: glabellar surface bearing more numerous, smaller tubercles, highest point on glabella more forwardly located, steeper decline of anterior glabellar lobe, a more deeply incised anterior border furrow, and a stronger transverse arching of the frontal area of cranidium.

Another species which *Otarion balanops* resembles and for which it has been mistaken in the past is *Otarion hydrocephalum* (A. Roemer) (Erben, 1952a, p. 233, Pl. 19, figs. 11, 12, text-fig. 26a-e) from the Lower Devonian of the Lower Harz region. According to Erben (1953, p. 77) the major distinction between the two species is that in longitudinal profile the anterior part of the glabella of *O. hydrocephalum* overhangs the preglabellar area, whereas in *O. balanops* this is never the case. Other differences pointed out by Erben (p. 77) include the absence of a median pit in the preglabellar furrow, the weakly incised anterior border furrow, and the more rounded, smaller glabellar tubercles of *O. hydrocephalum.*

The differences between the pygidia of *O. balanops* described by Erben and those from Bathurst Island involve the number of discernible segments and are probably a function of the different sizes of the specimens from the two areas.

The German specimens of *O. balanops* occur in the Middle Devonian Geeser horizon of the Eifel District. On Bathurst Island this species has been collected from 90, 270, 315, 410, 500, and 530 feet above the base of the Blue Fiord Formation.

Otarion (*Otarion*) sp. A

Plate XVII, figure 1

Material. GSC No. 18238, a single crushed cranidium; Blue Fiord Formation, 315 feet above base, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′; coll. Ormiston, 1962.

Description. Because the original convexity of the cranidium is not preserved, many features important in discriminating among species cannot be ascertained. There are, however, features which distinguish this species from *O. balanops* Erben with which it occurs. Anterior border bears evenly spaced large tubercles. Anterior border furrow deep and broad. Anterior branch of facial suture runs parallel to midline, slightly convex outward. Glabellar outline egg-shaped. Basal glabellar lobes drop-shaped. Occipital ring with a slender median spine.

Discussion. Otarion convexum (Hawle and Corda, 1847) (Prantl and Přibyl, 1950, p. 455, Pl. 1, figs. 13-14; Pl. 2, fig. 15; Pl. 5, figs. 3, 12), a Middle Devonian species from Central Bohemia has a characteristic short, strong medial occipital spine somewhat like that of *Otarion* sp. A and is otherwise similar, also. Until more satisfactorily preserved material of *O.* sp. A is collected, detailed comparisons with known species are not possible.

Family AULACOPLEURIDAE Angelin, 1854

Genus *Aulacopleura* Hawle and Corda, 1847

Type species: *Arethusa koninckii* Barrande, 1846

Subgenus *Aulacopleura* (*Paraaulacopleura*) Chaubet, 1937

Type species: *Aulacopleura* (*P.*) *roquemaillerensis* Chaubet, 1937

Diagnosis. See Prantl and Přibyl, 1950, p. 145

Aulacopleura (*Paraaulacopleura*) cf. *beyrichi* (Novak, 1890)
Plate XVII, figures 14, 16-19

1963 *Cordania* sp., Cumming *in* Fortier, *et al.*, 1963, p. 609.

Material. GSC No. $18247/_{1-4}$, four internal moulds of cranidia; GSC No. $18247/_{5}$, one external mould of cranidium; GSC No. $18247/_{6}$, one external mould of pygidium; basal 90 feet, Eids Formation, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′; coll. D. J. McLaren, 1955.

Description. Cranidium— Anterior border set off by a deep furrow. A prominent median pit is present immediately anterior to glabella. Glabellar outline bullet-shaped, tapering from the base. Axial furrows deep. In lateral profile glabella declines steeply at anterior end (Pl. XVII, fig. 18); preglabellar field slightly inflated immediately anterior to pit. There are three pair of glabellar furrows. The 1p furrow begins opposite midpoint of palpebral lobe, runs obliquely backward gradually turning to parallel midline and finally turning outward before joining occipital furrow. Anterior half of 1p furrow deep, posterior half considerably shallower. The 2p and 3p furrows are short, transverse linear depressions. The 1p glabellar lobes are conspicuous, isolated, and have a semioval outline. Occipital furrow transverse. Fixed cheeks are moderately broad (trans.). Palpebral lobe short (exs.), inwardly sloping in transverse profile. Anterior branch of facial suture weakly convex outward; posterior branch runs at about 45 degrees to the midline. Glabella is tuberculate.

Pygidium— The following description is based on a latex cast.

Pygidial outline semicircular. Ratio of length to width as 1.8:1. Axis moderately tapering, long, nearly reaching posterior margin of pygidium. There are at least nine axial rings; ring furrows sharp. In longitudinal profile axis declines only slightly posteriorly, immediately posterior to axis pleural fields decline almost vertically. Pleural fields broad (trans.) and gently convex transversely. Eight discernible pleural furrows. Each of the seven pleural ribs is bifurcated for its entire width (trans.) by an interpleural furrow. Steeply declining part of pleural fields behind axis and extending for a short distance on either side of it bears numerous fine tubercles. Border furrow and border absent. Anterior axial rings are tuberculate.

Dimensions.

	GSC No. 18247/1		GSC No. 18247/6
cranidial length	4.9	pygidial width	4.0
glabellar length	3.7	pygidial length	2.25
glabellar width	3.1		

Discussion. This species most closely resembles a cranidium from the Lower Devonian of the east side of the Urals which was figured but not described by Tschernyschew (1893, Pl. 1, fig. 4). Tschernyschew designated his specimen only as *Proetus* and made no morphologic remarks. From his figure it is apparent, however, that in glabellar outline and lobation and other primary cranidial features his *Proetus* sp. is similar to the Bathurst Island specimens.

The Bathurst Island specimens generally resemble *Aulacopleura* (*P.*) *beyrichi* (Novak) (1890, p. 18, Pl. 2, fig. 7a-e; Pl. 4, fig. 11a-d) from the Middle Devonian of Bicken, Germany. Important differences between them include a more tapering glabella, larger basal glabellar lobes, and a shorter preglabellar field in the Arctic material. The Arctic cranidia have a median pit in the preglabellar furrow which is deep on the internal mould and shallower but still present on a rubber cast of an external mould.

Aulacopleura (*P.*) cf. *beyrichi* differs from *A.* (*P.*) *sandbergeri* (Barrande, 1868, p. 3, Pl. 1, figs. 1-3) from the Middle Devonian (*see* R. and E. Richter, 1926, p. 19) of Hagen, Germany in having a deep, preglabellar pit, a shorter preglabellar field, and a longer pygidium with more axial rings.

The Arctic material differs from *Aulacopleura* (*P.*) *inexpectata* (Barrande, 1882) (Prantl and Přibyl, 1950, p. 498, Pl. 2, fig. 1; Pl. 5, fig. 13) from the Middle Devonian of Bohemia and Germany in having three rather than one pair of lateral glabellar furrows and the eyes relatively closer to the glabella. From *Aulacopleura (P.) halfari* Strnad, 1956 (p. 80, Pl. 1, figs. 1, 2; Pl. 2, figs. 3, 4) from the Middle Devonian of Moravia, *A.* (*P.*) cf. *beyrichi* differs in having a relatively longer (sag.) pygidium, distinct basal glabellar lobes, and a deep, preglabellar pit.

Superfamily LICHACEA Tripp, 1957

Family LICHIDAE Hawle and Corda, 1847

Subfamily CERATARGINAE Tripp, 1957

Genus *Ceratarges* Gürich, 1901

Type species: *Arges armatus* Goldfuss, 1839

Ceratarges sp.

Plate XVII, figures 2-5, 7

Material. GSC No. 18239, incomplete internal mould of cranidium; GSC Nos. 18240, 18241, two nearly complete hypostomes; Blue Fiord Formation, upper 200 feet, southeastern Svendsen Peninsula, 16 miles north of southeast corner, 4½ miles inland from shore, Ellesmere Island, lat. 77°35′, long. 83°46′; coll. J. W. Kerr, 1961.

Description. Cranidium— Cranidial length about three fourths of width, height four fifths of length. Anterior border not preserved. Border furrow becoming deep at anterolateral corner of cranidium, possibly the position of an anterior pit. Glabellar outline transversely oval. In longitudinal profile glabella is highest slightly in advance of midlength, unevenly convex, declining in a steep, convex slope anterior to maximum height and in a less convex shallower slope posterior to it. In transverse profile median glabellar lobe rises above bicomposite lobes and had independent convexity, bicomposite lobes slope downward from longitudinal furrow. Basal glabellar lobes short (exs.) and broad (trans.), declining posteriorly in nearly vertical slope, proximally continuous with postero-median lobe. Posteromedian lobe very short (sag.) about one fifth of total glabellar length, separated from front median lobe by shallow transverse depression in line with proximal end of 1p glabellar furrow. Anteromedian lobe long (sag.), greatest width anterior to bicomposite lobes equals slightly more than one third of glabellar width. Outline of anteromedian lobe initially expands forward to a point anterior to midlength, then tapers slightly to a point at one fourth total glabellar length, finally expanding more strongly forward to maximum width at anterior margin. A pair of large glabellar spines is located in advance of midlength of frontomedian lobe which is also the position of greatest glabellar height. These spines are pre-served as spine bases, the diameter of a single spine equalling one third the width of the lobe at that point. Bicomposite lateral glabellar lobe defined on all sides by furrows, maximum width anterior to midlength. Lateral glabellar furrow 1p runs inward and backward as a nearly straight line from the axial furrow to join longitudinal furrow at one third of glabellar width from lateral margin. Junction of 1p and longitudinal furrows forms a deep oval-shaped pit at inner posterior corner of bicomposite lobe. Longitudinal furrow moderately deep. Occipital furrow deep and broad. Occipital ring strongly convex transversely, narrow (sag.), in longitudinal profile lying below the posterior end of the glabella. Fixed cheeks and palpebral area not preserved. Internal mould of glabella and occipital ring pustulose.

Hypostome— GSC No. 18240, of length 4.7 mm, width at shoulders 6.8 mm. No anterior border. Anterior wings not preserved. Middle body trapezoidal in outline, short (sag.), maximum width twice maximum length. In longitudinal profile middle body low lying, gently convex in transverse profile. Middle furrow short, moderately deep, directed inward and slightly backward, forming anterior margin of independently convex macula at posterolateral corner of middle body. Lateral and posterior borders broad. Posterior border furrow deep and narrow. Median part of posterior border inflated, in profile rising above the level of the middle body, inflated area subcircular. Outline of posterior margin swings slightly forward on either side of midline, then backward again at posterolateral corner. Lateral and posterior borders bear numerous faint tubercles.

Discussion. The cranidium here assigned to *Ceratarges* does not have a depressed area at the base of the median glabellar lobe, a character typical of the genus *Acanthopyge* (Tripp, *in* Harrington, *et al.,* 1959, p. 503). Thus, despite a general similarity in glabellar lobation, the specimen is regarded as not belonging in *Acanthopyge.* The hypostome clearly indicates that the specimen belongs to the subfamily Ceratarginae (Tripp, 1957, text-fig. 4), and among Devonian species of this group *Ceratarges armatus* (Goldfuss) (Richter, R. and E., 1917a, p. 52, Pl. 6, figs. 1-2) (Richter, R. and E., 1930, text-figs. 5a, 5b) is most like the Arctic specimen. The two are especially similar in the possession of a major pair of median glabellar spines, in longitudinal glabellar profile, and in the nature of glabellar lobation. So far as the writer is aware no other Devonian ceratarginid besides *Ceratarges* possesses a major pair of median glabellar spines. There are, however, some important differences between *Ceratarges armatus* and the specimen described here. Comparison of the new specimen with a specimen of *Ceratarges armatus* (MCZ 3803) reveals the following differences: the occipital ring of *C. armatus* is much longer (sag.) and more inflated; the glabellar furrows of *C. armatus* appear shallower, although this may in part be due to the fact that the Arctic form is preserved as an internal mould; *C. armatus* has long eye stalks; and the longitudinal glabellar profile of *C. armatus* is more sharply peaked. There is a possibility that there were eye stalks on the Arctic form, but the fixed cheeks of the specimen are not preserved. The hypostome is very like that of *C. armatus* figured by Beyrich (1845, Pl. 1, fig. 2c) differing only in the outline of the posterior margin, that of *C. armatus* being slightly indented medially rather than posteriorly convex medially as in the Arctic form. The figure of a *C. armatus* hypostome given by Tripp (*in* Harrington, *et al.,* 1959, p. 501, fig. 395, 2b) is inaccurate.

If correctly assigned to *Ceratarges,* the specimen from Ellesmere Island must represent a new species of the genus which is fairly close to *Ceratarges armatus.* The Ellesmere Island material may also represent the first extra-European occurrence of *Ceratarges,* as *C. armatus* is restricted to the Middle Devonian of Germany and Belgium (Richter, R. and E., 1917a, p. 54). Because neither an illustration nor a description of the subspecies *C. armatus berolinensis* Richter, 1909 is available to the writer, its relations to *Ceratarges* sp. cannot be discussed.

Dimensions.

	GSC No. 18239
cranidial length	10.4
cranidial width	13.2
maximum width median lobe	5.7
minimum width median lobe	4.0
maximum width bicomposite lobe	5.2

?*Ceratarges* sp.

Plate XVII, figure 6

Material. GSC No. 18242, internal mould of a hypostome; Stuart Bay Formation, 400 feet above the base, Twilight Creek, Bathurst Island, lat. 76°18′, long. 99°12′; coll. Ormiston, 1962.

Description. This hypostome is closely comparable to that of *Ceratarges* sp. (Pl. XVII, figs. 4, 5, 7) from the Blue Fiord Formation of Svendsen Pininsula. The Stuart Bay Formation hypostome is more coarsely tuberculate than either the internal mould or the specimen with the test preserved from Svendsen Peninsula, but differs in no other way from those hypostomes.

Genus *Acanthopyge* Hawle and Corda, 1847

Type species: *Acanthopyge leuchtenbergii* Hawle and Corda, 1847

?*Acanthopyge* sp.

Plate XVII, figures 8-9

Material. GSC No. 18243, hypostome; strata exposed on largest of the Princess Royal Islands, lat. 72°48′, long. 117°46′; coll. Tozer, 1959.

Description. Hypostome— Outline of anterior margin broadly and smoothly curving. No anterior border. Middle body transversely ovate, length (sag.) is one half of hypostomal length (sag.). Anterior edge of middle body carries a transversely elongate depression occupying the median third of middle body. In longitudinal profile anterior edge of middle body a flat forward slope, remainder of middle body slopes gently posteriorly and drops off steeply at posterior edge, broadly convex transversely. Small anterior wing upwardly and outwardly directed. Lateral notch conspicuous and lateral shoulder strongly protuberant. Deep, short middle furrow runs inward and backward from border furrow opposite lateral shoulder and nearly transverse for a short distance on middle body. Outline of posterior lobe of middle body is rectangular, posterolateral regions of posterior lobe slightly inflated to form maculae. Lateral and posterior borders broad, posterior margin incompletely preserved. Posterior border furrow deep and broad, nearly U-shaped in cross section. Median part of posterior border gently inflated, posterior margin indented medially.

Middle body coarsely pitted, diameter of largest pits about 0.25 mm, anterior edge of middle body tuberculate. Tubercles of assorted sizes also occur adjacent to lateral and posterior border furrows. Posteriorly from the lateral shoulder the lateral border carries ridge-like, subparallel terrace lines.

Dimensions.

	GSC No. 18243
hypostomal length (sag.)	4.3
hypostomal width at shoulders	6.0
width median body	4.7
length median body	2.1

Discussion. The hypostome described here clearly has ceratarginid characters (Tripp, 1957, text-fig. 4), but cannot be positively assigned generically. It does, however, resemble hypostomes from the Lower Devonian of New York State and the Eifelian of the Urals which have been assigned with doubt to *Acanthopyge.*

A silicified hypostome from the Lower Devonian New Scotland limestone of New York State assigned with doubt to *Acanthopyge consanguinea* (Clarke, 1894) by Whittington (1956c, p. 1202, Pl. 131, figs. 21-22) resembles the Arctic specimen in outline, in the coarse pitting of the middle body, in the indented posterior margin, in the position and direction of the middle furrows, and in the rib-like terrace lines on the lateral border. Two features distinguish these hypostomes: the presence of a transverse depression on the anterior edge of the middle body and the proportionately shorter (sag.) middle body of the Arctic specimen.

A hypostome from Eifelian beds on the Loktevk River near Kurya, U.S.S.R. described and figured by Maximova (1960, p. 67, Pl. 6, fig. 10) as *Acanthopyge*? sp. closely resembles the one figured by Whittington (1956, Pl. 131, figs. 21-22) and differs in the same characters from the Arctic hypostome.

This hypostome is the only known lichid remain from Princess Royal Island and cannot be identified by association with other parts.

Genus *Hemiarges* Gürich, 1901

Type species: *Lichas wesenbergensis* Schmidt, 1885

Hemiarges n. sp. A

Plate XVII, figures 12, 13, 15

Material. GSC No. 18245, partly exfoliated thorax and pygidium; in float associated with Devonian fossils, Marshall Peninsula, Cornwallis Island, lat. 75°24′, long. 96°14′; coll. R. Thorsteinsson, 1953.

Description. Thorax— Consisting of at least nine segments. Width of axis slightly more than half that of one pleural field. Axial rings narrow (sag.), flat in longitudinal profile, articulating furrow deep and narrow. Axis gently convex in transverse profile. Pleurae broad (trans.) and short (exs.), distally sloping downward in a flat, even slope, slightly backward directed. Pleural furrow begins just distal to axial furrow, becoming deep and narrow distally. Adjacent to axis posterior pleural band is twice as long (sag.) as anterior pleural band. Lateral pleural extremities blade-like, backwardly directed. Posterior pleural bands bear tubercles, the most prominent ones located on each successive pleura midway between those on preceding pleural so that those on alternate pleurae are aligned on longitudinal rows.

Pygidium— Approximately as long as wide, outline semielliptical. Broad, convex axis tapering slightly posteriorly, posterior tip blunt, continued to posterior margin by a long low post-axial ridge of maximum width equal to one fourth that of axis. Axial length about one third of total pygidial length. Maximum axial width slightly more than half that of one pleural field. Axis with four distinct axial rings posterior to which an additional six axial segments are indicated by paired axial nodes visible on the internal mould. Axial rings backwardly deflected at about halfway down the flank of axis. In longitudinal profile the axis slopes posteriorly from the anterior margin to the fourth axial ring, then flattens out to run nearly horizontally before dropping off steeply at the posterior edge. Axis gently convex in transverse profile. Axial furrows faint. Pleural fields slope downward from axial furrow, gently convex in transverse profile; in longitudinal profile nearly horizontal adjacent to axis but forming a flat downward slope posterior to axis. First and second interpleural furrows strong. Posterior edge of first and second pleurae raised above anterior part of succeeding pleura. Interpleural furrows curve outward and backward, distal part of pleura is produced in a blade-like backwardly directed spine. Anterior band of first pleura shorter (exs.) than posterior band, that of second pleura up to twice as long (exs.) as posterior band. First and second pleural furrows moderately deep, persisting to bases of pleural spines. Additional pleurae posterior to the second are indicated by the presence of third and fourth pleural spines which are blunter than the first two and by aligned tubercles indicating the crests of the third and fourth posterior pleural bands. The posterior pygidial margin is not preserved but may have been produced in a blunt median spine.

Large tubercles occur along the crests of the posterior pleural bands and smaller tubercles are scattered over the whole pygidial exoskeleton.

Dimensions.

	GSC No. 18245	Topotype *H. aquilonius*
pygidial length	32.0	9.2
pygidial width	34.0	12.2
axial length	10.1	4.7
axial width	7.0	—
post-axial pygidial length	21.1	4.5

Discussion. Tripp (1957, p. 117) and Whittington (1961, p. 435) have pointed out that the genera *Hemiarges* and *Acanthopyge* are quite closely related. *Hemiarges* n. sp. A bears this out in that the pygidium resembles *Acanthopyge haueri* (Barrande, 1852, p. 604, Pl. 28, figs. 39-44), the type species of *Acanthopyge,* in the great length of its post-axial area and resembles the *Acanthopyge nitidula* (Barrande, 1872) Přibyl and Erben, 1952, p. 151, Pl. 12, figs. 3-6) group in having four pair of pygidial pleurae. In fact, from this thorax and pygidium alone it would not be possible to choose between *Hemiarges* and *Acanthopyge* as genera to which the material should be assigned.

Dr. T. E. Bolton of the Geological Survey of Canada is at present studying material from the Canadian Arctic which includes a complete specimen conspecific with *Hemiarges* n. sp. A. The cephalon of that specimen shows characters which require assigning it to *Hemiarges.*

The age of *Hemiarges* n. sp. A is problematic. Specimen GSC No. 18245 comes from float on Marshall Peninsula, Cornwallis Island where it is associated with fossils which McLaren (*in* Thorsteinsson, 1958, p. 109) considered Devonian. McLaren also wrote (p. 109), "it seems possible that more than one age is represented." Assigning this fossil a definite age from such evidence is tenuous at best. According to Bolton (pers. com.) the material of *Hemiarges* n. sp. A that he is studying comes from strata of Skala age. Possibly the age of the Marshall Peninsula specimen is also Skala, but this does not answer the question of whether *H.* n. sp. A is Devonian. Boucot (Boucot and Pankiwskyj, 1962, p. 4) has not indicated whether his Skala Stage should be considered Silurian or Devonian. Presumably *Hemiarges* n. sp. A can equally well be considered Late Silurian or Early Devonian.

Because more complete material of *Hemiarges* n. sp. A than is available to me is currently being studied by Dr. T. E. Bolton, it seems advisable not to propose a new specific name at this time.[1]

Hemiarges n. sp. A most closely resembles *H. aquilonius* Whittington (1961, p. 439, Pl. 56, figs. 1-34; Pl. 57, figs. 1-28) from the middle Ludlovian of Cornwallis Island. It differs in having a much greater post-axial pygidial length and fewer axial rings. Whereas the post-axial length of *Hemiarges* n. sp. A is nearly two thirds of the total pygidial length, that of *H. aquilonius* is only one half of the total pygidial length.

So closely similar are these species that the writer considers *H. aquilonius* (middle Ludlovian) ancestral to *H.* n. sp. A (post-Ludlovian).

[1]*Hemiarges bigener* Bolton;Bolton, T. E., *Geol. Surv. Can.*, Bull. 134, p. 10, 1965. The specimen illustrated on Pl. XVII, figs. 12, 13, 15 of this paper is the same one (GSC No. 18245) figured by Bolton on his Pl. III, fig. 7.

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APPENDIX

Measured Sections

DEVONIAN STRATA EXPOSED AT DRAKE BAY

This section was measured on northwestern Prince of Wales Island 20 miles northeast of the head of Drake Bay. At this locality a low escarpment of tan weathering Devonian limestones is cut by a small creek for a distance of 0.5 mile. The section begins at the base of the escarpment and continues to the top. Measured by Ormiston, 1960.

Top not exposed

Calcareous sandstone and limestone: brownish grey, fine-grained, medium-bedded, fossiliferous sandstone, weathers tan; interbedded with dark grey, aphanitic, thin- to medium-bedded limestone with petroliferous odour, weathers grey, unit forms top of escarpment	6′
Limestone: brown, finely crystalline, medium-bedded, weathers tannish grey and blocky, *Atrypa*	10.5′
Calcareous sandstone: light brown, fine-grained, medium-bedded, quartzose, weathers tan and slabby	5.7′
Argillaceous limestone: very dark brown, finely crystalline, thin-bedded, weathers tan and flaggy, *Atrypa, Cymostrophia*	10.5′
Limestone and quartzose limestone; brown, finely crystalline, medium- to thick-bedded limestone, weathers tan; interbedded with brown, finely crystalline, medium-bedded, quartzose limestone, weathers tan, *Cymostrophia, Dechenella* (?*Basidechenella*) sp.	6′
Argillaceous limestone: dark brown, finely crystalline, thin-bedded, weathers tan and slabby, somewhat resistant. Laterally this unit grades into shale: brown, fissile, with concretion-like limestone lenses, bryozoans, *Atrypa*, ?*Schizoproetus* sp. indet., unidentified lichid	14.2′
Sandstone and siltstone: light brown, fine-grained, medium-bedded, calcareous sandstone, weathers tan and slabby; interbedded with dark brown, fine-grained, calcareous siltstone, weathers greyish tan and slabby, *Atrypa* and unidentified brachiopods	18′
Limestone: dark brown, finely crystalline, medium- to thin-bedded, slightly argillaceous, slight petroliferous odour, weathers grey and slabby, *Styliolina*, unidentified placoderms	5.7′
Limestone: dark brown, finely crystalline, medium-bedded, slightly sandy, slight petroliferous odour, weathers greyish tan and blocky, favositids, *Schizoproetus* sp. indet., *Otarion* sp., *Harpes* sp. indet., brachiopods, *Dechenella* (*B.*) *laticaudata* n. sp.	3′

Base not exposed

Total thickness measured is 79.5 feet

TWILIGHT CREEK SECTION

Okse Bay Formation (Upper Devonian)

Sandstone: yellow-brown, medium-grained, quartzose sandstone, thick-bedded, weathers yellow-brown, blocky and resistant	5′

Bird Fiord Formation (Middle Devonian)

Covered interval: unexposed section possibly underlain by rocks like those of underlying unit. Thickness estimated from air photographs as	300′
Bioclastic limestone: yellow-brown, coarsely crystalline, thin- to medium-bedded, weathers yellow-brown and non-resistant, *Dechenella algida, Atrypa, Schizophoria* ..	10′

Quartzose bioclastic limestone; yellow-brown, very coarsely crystalline, medium-bedded, weathers yellow-brown, blocky and resistant, *Dechenella algida, Emanuella, Atrypa, Schizophoria*, pelecypods .... 75′

Calcareous sandstone and minor shale: grey brown, medium-grained, medium-bedded, with grey-green, fissile shale, weathers brown and non-resistant, *Emanuella* .... 83′

Quartzose limestone and shale: brownish grey, medium-crystalline, medium-bedded, bioclastic limestone interbedded with grey-green, calcareous shale, non-resistant unit, *Dechenella algida, Atrypa, Emanuella, Camarotoechia* .... 20′

Calcareous sandstone: light grey, medium-grained, thick-bedded, weathers blocky and resistant, *Dechenella algida* .... 34′

Bioclastic quartzose limestone: light grey to light brown, coarsely crystalline, thin- to medium-bedded, highly fossiliferous. *Emanuella*, etc., *Dechenella bathurstensis* .... 88′

Bioclastic limestone: grey-brown to yellow-brown, coarsely crystalline, thin-bedded, sandy and highly fossiliferous, brachiopods and trilobites abundant: *Emanuella, "Camarotoechia princeps", Atrypa, Schizophoria, Productella, Dechenella bathurstensis*, weathers yellow-brown and slabby .... 35′

Quartzose, argillaceous limestone: greenish grey, medium to coarsely crystalline, medium-bedded, weathers greenish grey and non-resistant, *Dechenella crepuscula, Dechenella* sp., *Atrypa* .... 110′

Bioclastic limestone: light grey, coarsely crystalline, medium- to thin-bedded, locally sandy, weathers grey brown and blocky, resistant, *Dechenella bathurstensis, Dechenella crista* .... 130′

Bioclastic limestone and calcareous sandstone: very light grey, coarse-grained, medium-bedded, with numerous lenses of quartzose, calcareous sandstone, weathers brown, blocky and resistant, *Dechenella bathurstensis, Atrypa, Schizophoria*, pelecypods .... 32′

Limestone: greyish brown, medium-crystalline, thin-bedded, weathers brown and non-resistant, *Dechenella osborni, Ancyropyge fuscina, Otarion* sp. .... 67′

Quartzose limestone and calcareous sandstone: light grey, medium-crystalline, bioclastic, sandy limestone, and minor calcareous, micaceous, quartzose sandstone. *Dechenella osborni, Atrypa, Schizophoria* .... 17′

Calcareous sandstone and quartzose limestone: light grey, fine-grained, thin-bedded, quartzose sandstone interbedded with minor, light grey, medium-crystalline, medium-bedded, bioclastic limestone, somewhat resistant. *Dechenella neotesca, Dechenella* sp., *Atrypa* .... 56′

Shale and calcareous sandstone: greenish grey, fissile, micaceous shale interbedded with thin beds of sandy, bioclastic limestone, soft weathering and partly covered .... 290′

Calcareous siltstone and shale: greyish green, fine-grained, thin-bedded, soft weathering siltstone interbedded with fissile grey shale, *Dechenella maclareni* at 20 feet above base .... 30′

Total thickness of Bird Fiord Formation is approximately 1,377 feet

Blue Fiord Formation (Middle Devonian)

Limestone: light brown, finely crystalline, micaceous, medium-bedded, weathers brown and blocky, resistant, *Dechenella maclareni* .... 20′

Limestone: light brown, finely crystalline, medium-bedded, weathers grey-brown and somewhat resistant, *Dechenella maclareni* .... 39′

Limestone: light brown to cream, finely or medium crystalline, medium-bedded, weathers yellow-brown and blocky, resistant, *D. maclareni, Otarion balanops* .... 41′

Shale: brownish grey, calcareous fissile and soft weathering, interval partly covered .... 21′

Limestone: brownish grey and grey, medium-grained, bioclastic, abundantly fossiliferous with fossils concentrated in thin horizons, thin-bedded at the base, medium-bedded above that, weathers grey and blocky, resistant in upper part, *Deltadechenella bathurstensis, Dechenella* sp., *Asterolepis, Otarion* sp., cf. *Bollia* sp., unidentified pelecypods .... 24′

Shale: brownish grey, calcareous, fissile and soft weathering, interval largely covered with blocky limestone float from overlying unit. At a distance of less than a mile along strike this interval is represented by limestone with abundant tetracorals, *Dialytophyllum, Zonodigonophyllum* .... 15′

Limestone: grey, fine- to medium-grained, bioclastic, richly fossiliferous, fauna dominated by *Deltadechenella bathurstensis,* thin-bedded to medium-bedded at top of unit, weathers dark grey, resistant, *Dechenella maclareni,* ostracods .... 31′

Shale: grey, calcareous, fissile, soft weathering, poorly exposed but not covered .... 20′

Limestone: dark grey-brown, finely crystalline, thick-bedded, weathers yellow-brown, blocky and resistant, abundant *Dechenella tesca,* also *D. maclareni, Warrenella* .... 30′

Shale and argillaceous limestone: brownish grey, calcareous, fissile with interbedded grey, fine-grained, thin-bedded, silty limestone, partly covered .... 36′

Cherty limestone: bluish grey, medium-crystalline, thin- to medium-bedded, containing much blue chert, and with thin chert beds, abundant trilobites, locally bioclastic, weathers yellow-brown, slabby and resistant, *D. maclareni, Otarion balanops, Ancyropyge arcticus, Leonaspis eremia, Harpes macrocephalus, D. paragranulata, Warrenella, Atrypa* .... 49′

Limestone and argillaceous limestone: brownish grey, finely crystalline, limestone grading upward into brown, argillaceous limestone which is crowded with trilobites, weathers yellow-brown, moderately resistant, *D. maclareni, D. paragranulata, Warrenella, Ancyropyge arcticus, Otarion balanops, Asterolepis* .... 25′

Limestone, brown, finely crystalline, medium-bedded, minor amount of blue chert, *D. paragranulata, D. maclareni, Scutellum depressum, Warrenella* .... 65′

Bioclastic limestone: grey-brown, medium-crystalline, medium-bedded to thin-bedded, weathers yellow-brown, *D. paragranulata, D. tesca* .... 55′

Argillaceous limestone and limestone: brown, finely crystalline, thin-bedded, argillaceous, weathers brown and slabby with a minor amount of pale brown limestone, *D. paragranulata, ?Deltadechenella* sp., *Productella* sp., *?Douvillina* sp., inarticulate brachiopods .... 35′

Argillaceous limestone: grey, finely crystalline, thin-bedded, weathers brown and non-resistant, *Harpes macrocephalus, Otarion balanops, Warrenella* .... 61′

Argillaceous limestone and shale: grey, finely crystalline, thin-bedded, weathers brown and non-resistant interbedded with a minor amount of greenish grey shale, calcareous and soft weathering. *Dechenella maclareni* at 28 feet above base of formation .... 50′

Total thickness of Blue Fiord Formation is 617 feet

Eids Formation (Middle Devonian)

Calcareous shale and argillaceous limestone: dark grey, fine-grained, calcareous shale and interbedded dark grey, finely crystalline, laminated, highly silty limestone, weathers bluish grey and platy, non-resistant. Grades into overlying Blue Fiord Formation without obvious break .... 40′

Remainder of Eids Formation not measured but known to be about 1,000 feet thick

Great Day Creek Section

Great Day Creek is the westernmost north-flowing creek on the south limb of the large doubly plunging anticline south of Young Inlet. The section begins at the headwaters of the creek and extends about a mile north to its confluence with a major west-flowing river. Measured August 16, 1960, by tape, Ormiston and DeLong.

Bird Fiord Formation (Middle Devonian)

Calcareous sandstone: light grey, fine-grained, thin-bedded, contains some black detritus, weathers brown and slabby .... 5′

Shale and siltstone: olive-green, fine-grained, thin-bedded, fissile, calcareous, weathers olive-green and non-resistant. Grades imperceptibly into siltstone, olive-green, fine-grained, thin-bedded, weathers olive-green .... 47′

Argillaceous limestone: light grey, finely crystalline, medium-bedded, fossiliferous, (*Emanuella, "Camarotoechia princeps"*, unidentified brachiopods), weathers brown and slabby .... 23.5′

Incomplete thickness of Bird Fiord Formation 75.5 feet

Blue Fiord Formation (Middle Devonian)

Limestone: purplish brown, finely crystalline, medium- to thin-bedded, weathers splotchy blue-grey and brown, blocky and somewhat resistant, *Dechenella maclareni* 27.5′

Limestone: light brown, medium to finely crystalline, bioclastic, medium-bedded, fossiliferous (*Nucleospira, Atrypa*), weathers blue-grey and blocky .... 36′

Limestone: brown, finely crystalline, medium-bedded, weathers blue-grey and blocky .. 72′

Bioclastic limestone: purplish brown, medium crystalline, thin-bedded, fossiliferous (*Nucleospira*, unidentified bryozoans). Ostracod, *D. paragranulata*, weathers blue-grey and slabby .... 66.5′

Limestone: dark brown, finely crystalline, thin-bedded, fossiliferous (*Gypidula, Athyris, Cranaena*), weathers blue-grey and slabby .... 37′

Fossiliferous bioclastic limestone: brown, fine- to medium-crystalline, thin-bedded (*Warrenella, Nucleospira, Gypidula, Stropheodonta* cf. *S. erratica, Atrypa, Athyris, Cranaena*, rugose corals, *Dechenella maclareni*, weathers blue-grey and slabby ...... 38′

Fossiliferous limestone and shale: brown, fine- to medium-crystalline, thin-bedded, abundantly fossiliferous (*Warrenella, Cranaena, Productella, Schizophoria, Atrypa*) unidentified brachiopods, rugose corals, *Leonaspis* sp., *Dechenella tesca*, weathers blue-grey and slabby; interbedded with shale: grey, fine-grained, fissile, weathers brown and non-resistant .... 112.5′

Limestone: brown, finely crystalline, medium-bedded, fossiliferous (*Alveolites, Hexagonaria, Favosites, Dialytophyllum*, many large *Digonophyllid* corals), *Dechenella tesca*, weathers blue-grey, blocky and resistant. The dolomitic cores of small bioherms (about 10 feet across) crop out on the ridge formed by this resistant unit 32′

Limestone: dark brown, very finely crystalline, medium-bedded, fossiliferous, (*Favosites, Thamnopora*, many stromatoporoids), *Scutella depressum, Dechenella paragranulata*, grey and rubbly .... 33′

Fossiliferous limestone: dark brown, very finely crystalline, thin and irregularly bedded, contains many colonial corals, weathers blue-grey and rubbly .... 66.5′

Limestone: brown, finely crystalline, medium and irregularly bedded, grades locally into bioclastic limestone, weathers purplish grey and rubbly, resistant, *Dechenella* sp. .... 68′

Total thickness of Blue Fiord Formation 589 feet

A pronounced escarpment marks the base of the Blue Fiord here

Eids Formation (Middle Devonian)

Argillaceous limestone: very dark brown, fine-grained, thin-bedded to laminated, slight petroliferous odour, weathers slabby and tan	68′
Limestone: black, aphanitic, laminated, slight petroliferous odour, weathers tannish grey and into lenticular fragments	47′
Limestone and calcareous mudstone: black, aphanitic, slight petroliferous odour, weathers tannish grey and into lenticular fragments; interbedded with minor calcareous mudstone, black, fine-grained, thin-bedded, weathers grey and non-resistant	42′
Organic limestone: black, aphanitic, dense, medium- to thin-bedded, rings when struck, weathers slabby and greyish tan	36′
Organic limestone and calcareous mudstone: black, aphanitic, dense, medium- to thin-bedded, rings when struck, weathers slabby and greyish tan; interbedded with calcareous mudstone, dark brown, fine-grained, thin-bedded, weathers tan and non-resistant	17.5′
Organic limestone: black, aphantic, laminated, weathers tan and slabby	84.5′
Organic limestone: black, fine-grained, laminated, weathers tannish grey, slabby to somewhat flaggy, contains *Styliolina*	462.5′
Limestone: black, aphanitic, dense, slight petroliferous odour, medium- to thin-bedded, weathers blue-grey and slabby	127′

Total thickness of Eids Formation 884.5 feet

Stuart Bay Formation (Lower Devonian)

Sandstone: light grey, fine-grained, medium-bedded, calcareous, weathers brown and blocky; interbedded with siltstone, dark brown, fine-grained, thin-bedded, calcareous, weathers brown and slabby	58′

Total thickness of all units measured on Great Day Creek 1,607 feet

Plates I to XVII

Plate I

Scutellum depressum Cooper and Cloud, 1938 (Page 36)

Blue Fiord Formation, Warner River

Figure 1.	Latex cast of external mould of complete specimen, GSC No. 18089, dorsal view, $\times 6$.
Figure 2.	Hypotype pygidium, GSC No. 18092, dorsal view, $\times 2$.
Figures 3-4.	Hypotype cranidium, GSC No. 18091, dorsal and left lateral views, $\times 2$.
Figures 5-6.	Hypotype cranidium, GSC No. 18090, dorsal and right lateral views, $\times 2$.

Platyscutellum brevicephalus n. sp. (Page 39)

Figure 7.	Latex cast, external mould of left free cheek, GSC No. 18094, dorsal view, $\times 1\frac{1}{3}$; largest of Princess Royal Islands.
Figures 8-10.	Holotype, latex cast of external mould of cranidium, GSC No. 18095, dorsal, anterior, and right lateral views, $\times 1\frac{1}{3}$; Eids Formation, Dyke Creek.
Figure 11.	Hypotype pygidium, GSC No. 18096, dorsal view, $\times 1\frac{1}{3}$; largest of Princess Royal Islands.

Ancyropyge arcticus n. sp. (Page 42)

Figure 12.	Paratype pygidium, GSC No. 18100, dorsal view showing pygidial doublure on left side, $\times 3$; Blue Fiord Formation, Twilight Creek.

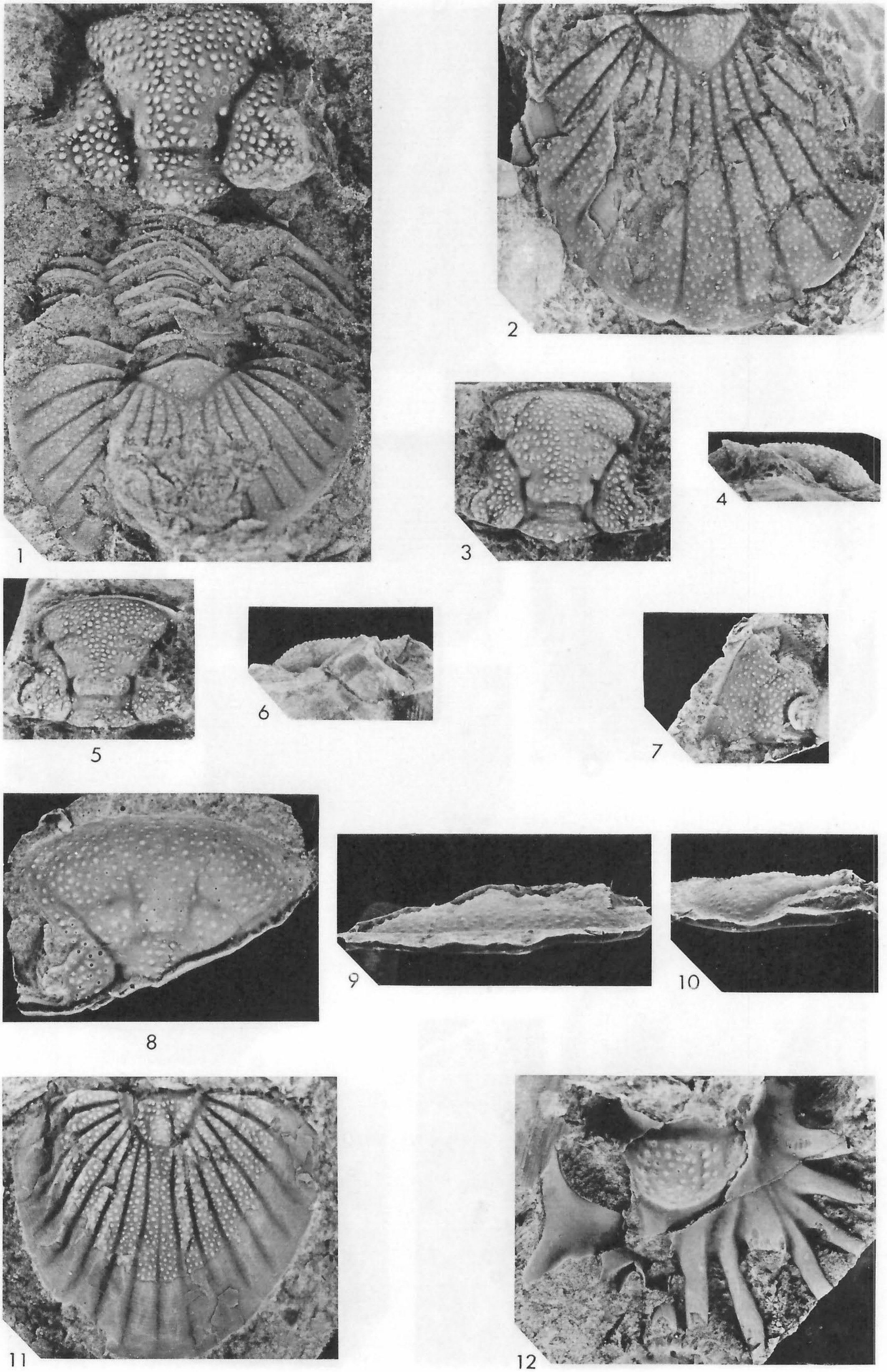
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PLATE II

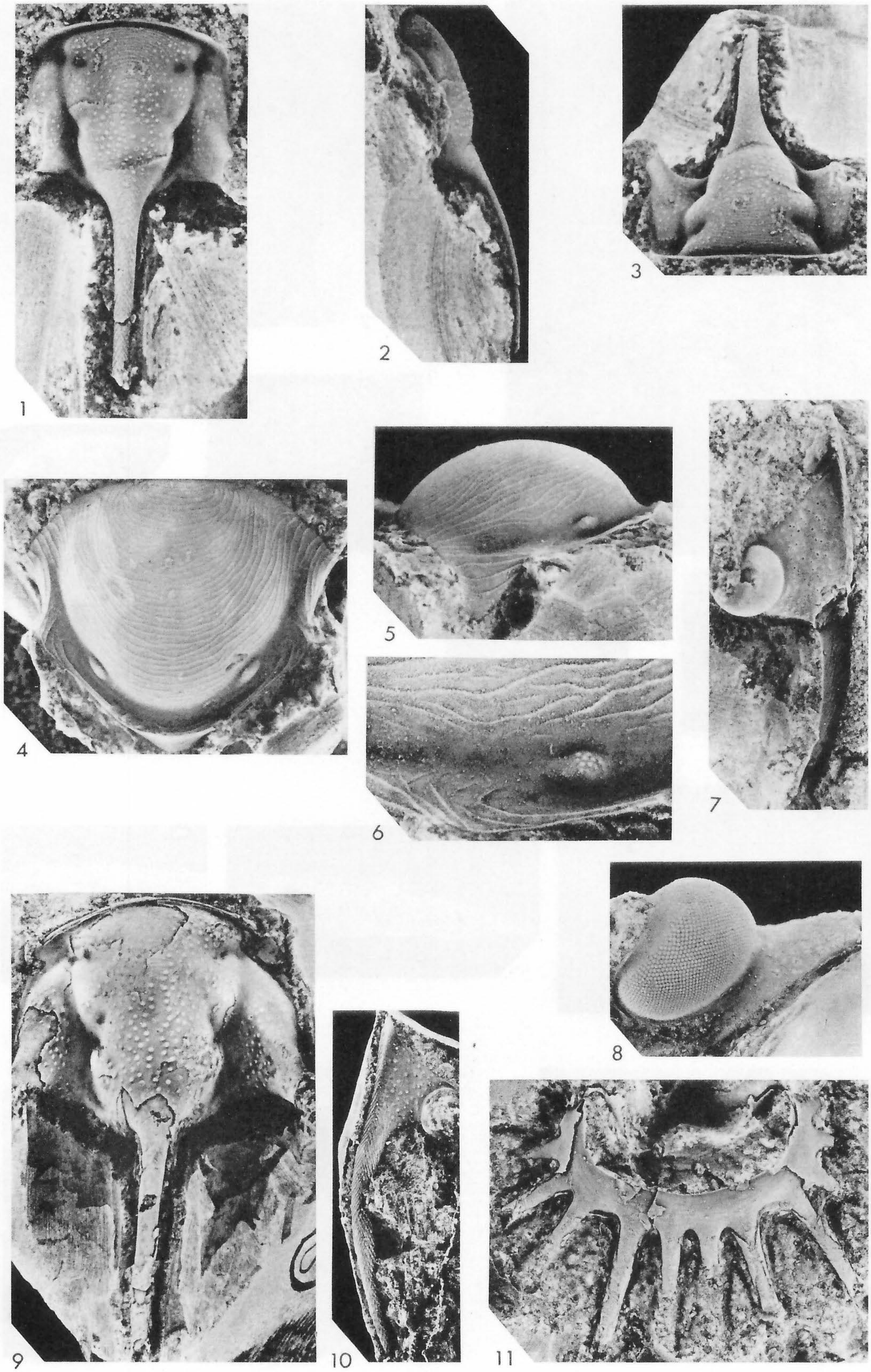


Plate II

Ancyropyge arcticus n. sp. (Page 42)

Blue Fiord Formation, Twilight Creek

Figures 1-3.	Holotype cranidium, GSC No. 18101, dorsal, left lateral, and anterior views, $\times 4$.
Figures 4-6.	Paratype hypostome, GSC No. 18102, dorsal and left lateral views, $\times 6$; enlargement of left macula showing "lenses", $\times 13$.
Figures 7-8.	Paratype free cheek with eye surface preserved, GSC No. 18103, dorsal view, $\times 2\frac{2}{3}$; posterior view of eye also showing posterior branch of facial suture, $\times 6$.
Figure 9.	Paratype cranidium, GSC No. 18104, dorsal view, $\times 2$.
Figure 10.	Latex cast, external mould of free cheek, GSC No. 18105, dorsal view, $\times 2\frac{2}{3}$.
Figure 11.	Pygidial doublure, GSC No. 18106, ventral view, $\times 3$.

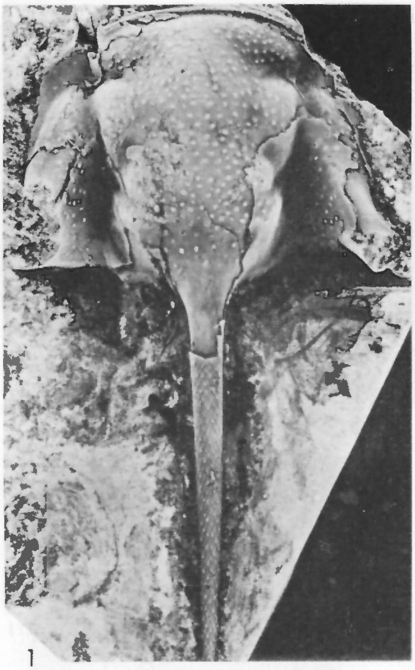
Plate III

Ancyropyge arcticus n. sp. (Page 42)
Blue Fiord Formation, Twilight Creek

Figure 1.	Paratype cranidium, GSC No. 18107, dorsal view showing "fish scale" prosopon on occipital spine, ×2.
Figure 2.	Eroded paratype pygidium, GSC No. 18108, dorsal view showing length of pygidial spines, ×1⅓.
Figure 3.	Paratype pygidium, GSC No. 18109, dorsal view, ×2.
Figure 4.	Crushed cranidium with major cranidial spines preserved, GSC No. 18110, ×1½.
Figure 5.	Latex cast, external mould of pygidium, GSC No. 18111, dorsal view, ×2.

Ancyropyge manitobensis (Whiteaves, 1892) (Page 46)
Bird Fiord Formation, Twilight Creek

Figures 6-8.	Complete cranidium showing three major cranidial spines, GSC No. 18112, dorsal, anterior, and right lateral views, ×2.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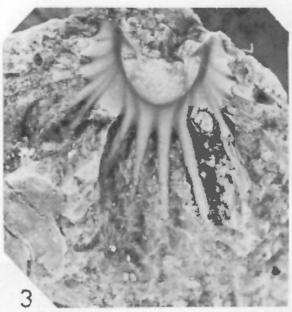
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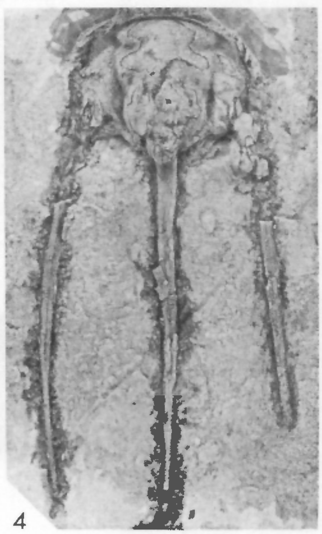
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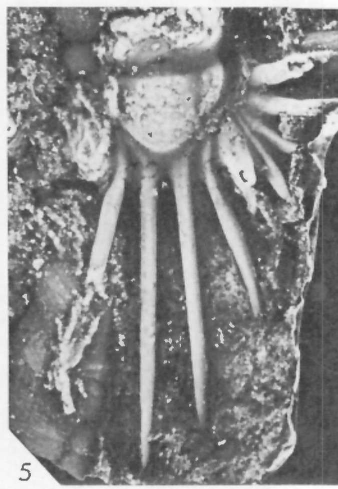
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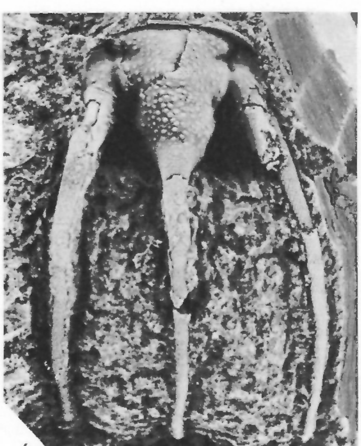
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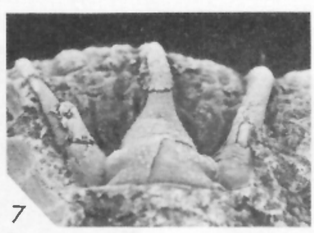
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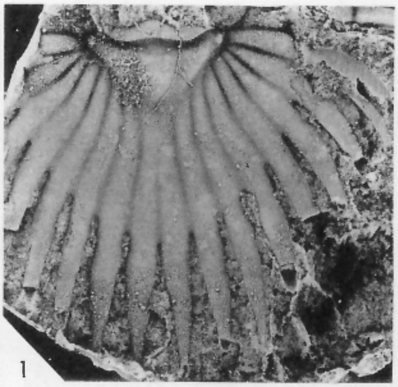
PLATE IV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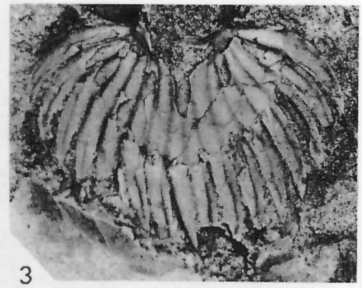
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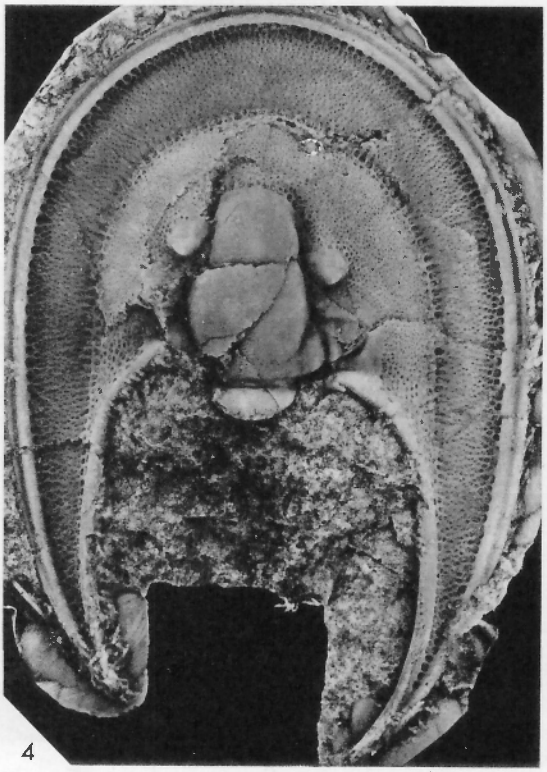
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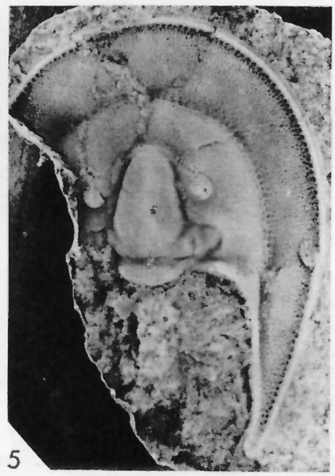
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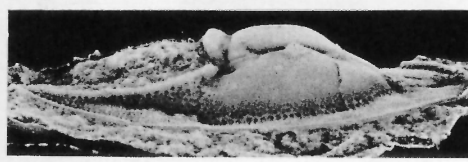
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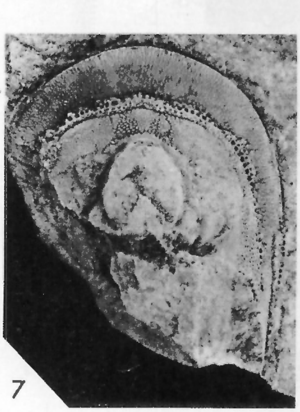
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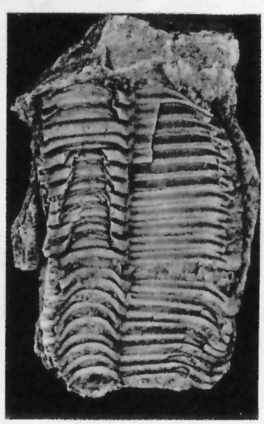
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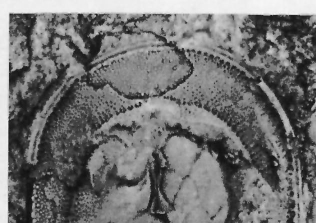
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Plate IV

Weberopeltis aff. *arcticum* (Weber, 1945) (Page 47)

Blue Fiord Formation, Ellesmere Island

Figures 1-2. Latex cast of external mould of pygidium, GSC No. 18114, dorsal and left lateral views, $\times 2\frac{1}{2}$; east of Blue Fiord.

Figure 3. Pygidium, GSC No. 18115, dorsal view, $\times 2\frac{2}{3}$; Svendsen Peninsula.

Harpes macrocephalus Goldfuss, 1839 (Page 50)

Blue Fiord Formation

Figure 4. Latex cast of external mould of entire cephalon, GSC No. 18116, dorsal view, $\times 1\frac{1}{3}$; Svendsen Peninsula.

Figures 5-6. Latex cast of external mould of partial cephalon, GSC No. 18117, dorsal and right lateral views, $\times 2$; Svendsen Peninsula.

Figure 7. Cephalon with lamellae partly preserved, GSC No. 18119, dorsal view, $\times \frac{3}{4}$; Twilight Creek.

Harpes sp. indet. (Page 52)

largest of the Princess Royal Islands

Figure 8. Thorax showing 21 segments (incomplete), GSC No. 18120, dorsal view, $\times 1\frac{1}{2}$.

Figure 9. Partial crushed cephalon, GSC No. 18121, dorsal view, $\times 2$.

Plate V

Leonaspis (*Kettneraspis*) *elliptica* (Burmeister, 1843) (Page 53)

Blue Fiord Formation, Twilight Creek

Figures 1, 3, 5.	Specimen lacking only right free cheek, GSC No. 18122, dorsal and right lateral views, $\times 2$; anterior view, $\times 4$.
Figure 2.	Thoracic segments showing anterior pleural spines, GSC No. 18123, dorsal view, $\times 6$.
Figure 4.	Latex cast of external mould of hypostome, GSC No. 18124, dorsal view, $\times 4$.
Figure 6.	Right free cheek, GSC No. 18125, dorsal view, $\times 2$.
Figure 7.	Cranidium, GSC No. 18126, dorsal view, $\times 2\frac{2}{3}$.

Largest of the Princess Royal Islands

Figure 8.	Latex cast of external mould of pygidium, GSC No. 18127, dorsal view, $\times 4$.

PLATE V

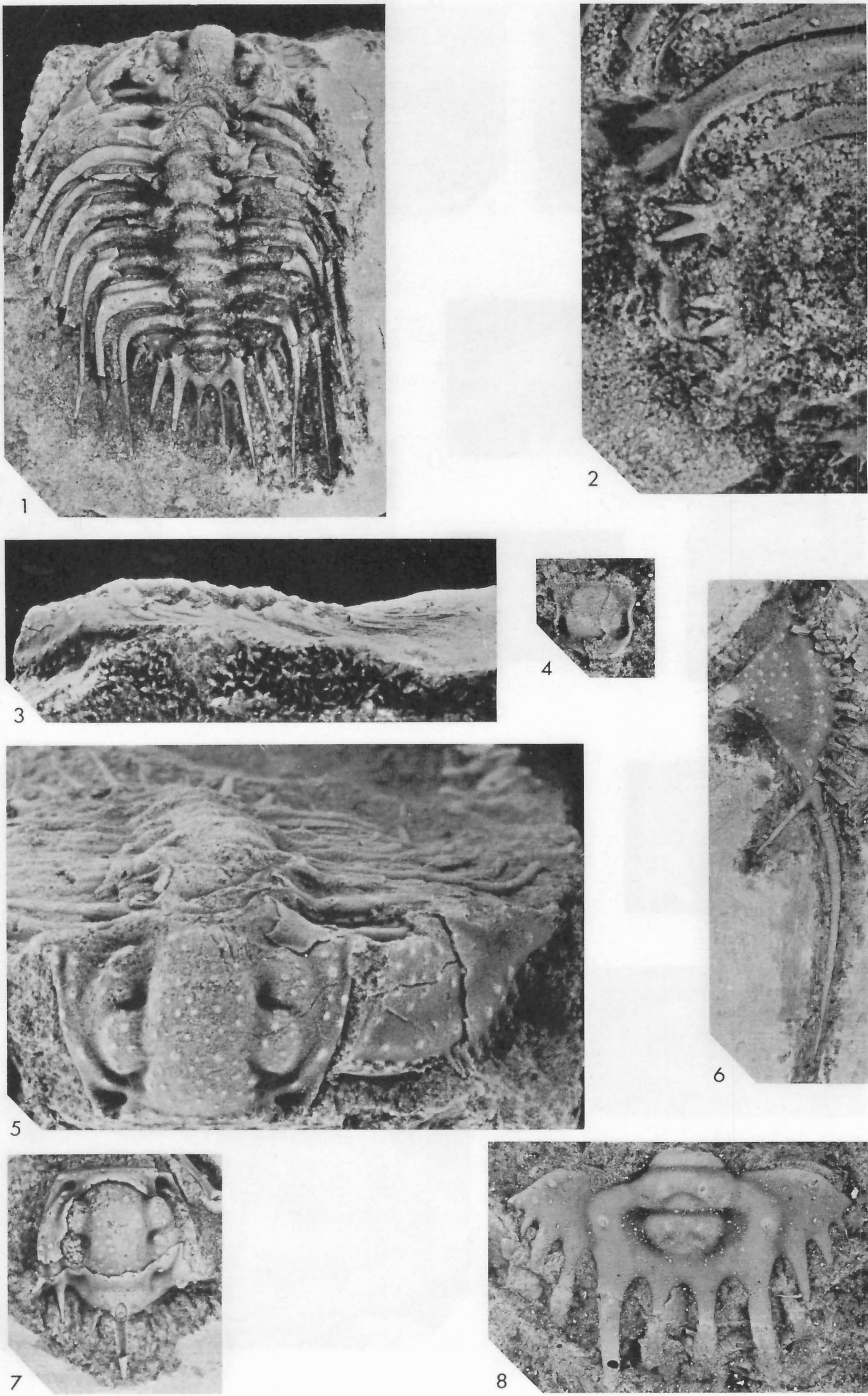

PLATE VI

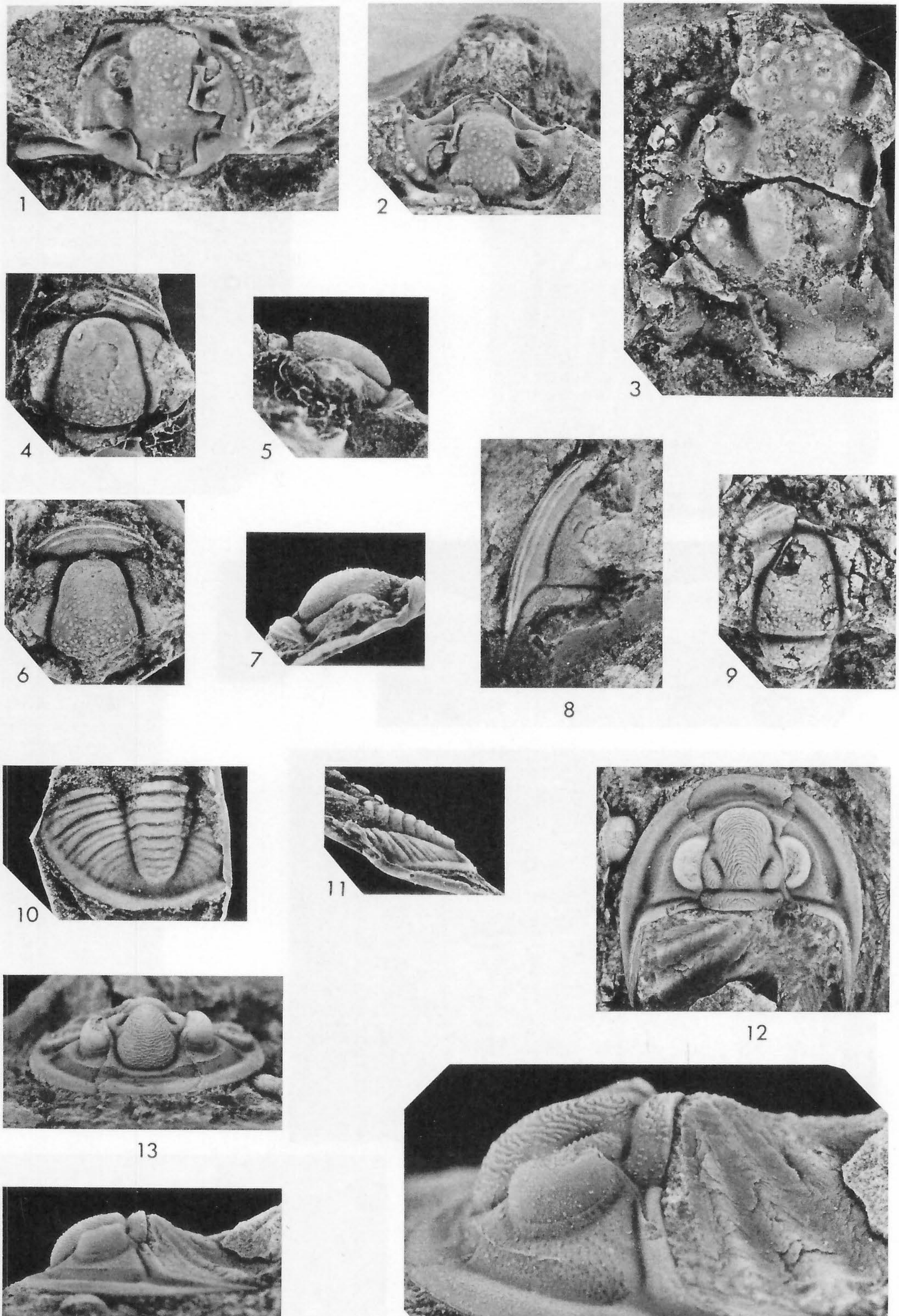

PLATE VI

Leonaspis (*Kettneraspis*) *eremia* n. sp. (Page 56)

Figures 1-2. Holotype cranidium, GSC No. 18130, dorsal and anterior views, ×2; Blue Fiord Formation, Blue Fiord.

Leonaspis sp. (Page 57)

Figure 3. Poorly preserved cranidium, GSC No. 18131, dorsal view, ×6; Stuart Bay Formation, Twilight Creek.

Proetus (*Longiproetus*) *sverdrupi* (Tolmachoff, 1926) (Page 57)

Blue Fiord Formation

Figures 4-5. Holotype cranidium, PMO A28846, dorsal and right lateral views, ×4; Goose Fiord.

Figures 6-7. Hypotype, latex cast of external mould of cranidium, GSC No. 18132, dorsal and right lateral views, $\times 2\frac{2}{3}$; Sutherland River, Devon Island.

Figure 8. Free cheek, original of *Dalmanites scheii* Tolm., 1926, PMO A28841, dorsal view, ×4; Goose Fiord.

Figure 9. Poorly preserved cranidium, GSC No. 18133, dorsal view, ×6; Blue Fiord.

Proetus cf. *bohemicus* Hawle and Corda, 1847 (Page 59)

Figures 10-11 Latex cast of external mould of pygidium, GSC No. 18134, dorsal and left lateral views, ×2; Colin Archer Peninsula, Devon Island.

Warburgella rugulosa (Alth) *canadensis* n. subsp. (Page 62)

Lower Gedinnian limestones, Baillie Hamilton Island

Figures 12-15. Holotype cephalon, GSC No. 18135, dorsal, anterior, left lateral, views, $\times 5\frac{1}{3}$; exterior view to show fine granulation of border, ×12.

Plate VII

Warburgella rugulosa (Alth) *canadensis* n. subsp. (Page 62)
Lower Gedinnian limestones, Baillie Hamilton Island

Figure 1. Paratype cranidium, GSC No. 18136, dorsal view, $\times 5\frac{1}{3}$.

Figures 2-3. Paratype pygidium, GSC No. 18139, dorsal and posterior views, $\times 6$.

Figure 4. Paratype pygidium, GSC No. 18140, dorsal view, $\times 5\frac{1}{3}$.

Cornuproetus tozeri n. sp. (Page 64)
largest of the Princess Royal Islands

Figure 5. Paratype free cheek, GSC No. 18142, dorsal view, $\times 3$.

Figure 6. Paratype cranidium, GSC No. $18143/_1$, dorsal view, $\times 2\frac{2}{3}$.

Figures 7-8. Holotype cranidium, GSC No. 18144a and b, dorsal view, $\times 4$; dorsal view of latex cast of counterpart mould showing occipital spine, $\times 5\frac{1}{3}$.

Figure 9. Paratype pygidium, GSC No. 18145, dorsal view, $\times 5\frac{1}{3}$.

Figure 10. Paratype pygidium, GSC No. $18143/_2$, dorsal view, $\times 2\frac{2}{3}$.

Dechenella (*Dechenella*) *bathurstensis* n. sp. (Page 71)
Bird Fiord Formation, Bathurst Island

Figures 11-13. Holotype cranidium, GSC No. 18148, dorsal, anterior, and left lateral views, $\times 4$.

Figure 14. Paratype free cheek, GSC No. 18147, dorsal view, $\times 4$.

Figure 15. Paratype cranidium, GSC No. 18146, dorsal view, $\times 4$.

Figures 16-17. Paratype hypostome, GSC No. 18149, dorsal and left lateral views, $\times 4$.

Figure 18. Paratype pygidium, GSC No. 18150, dorsal view, $\times 2$.

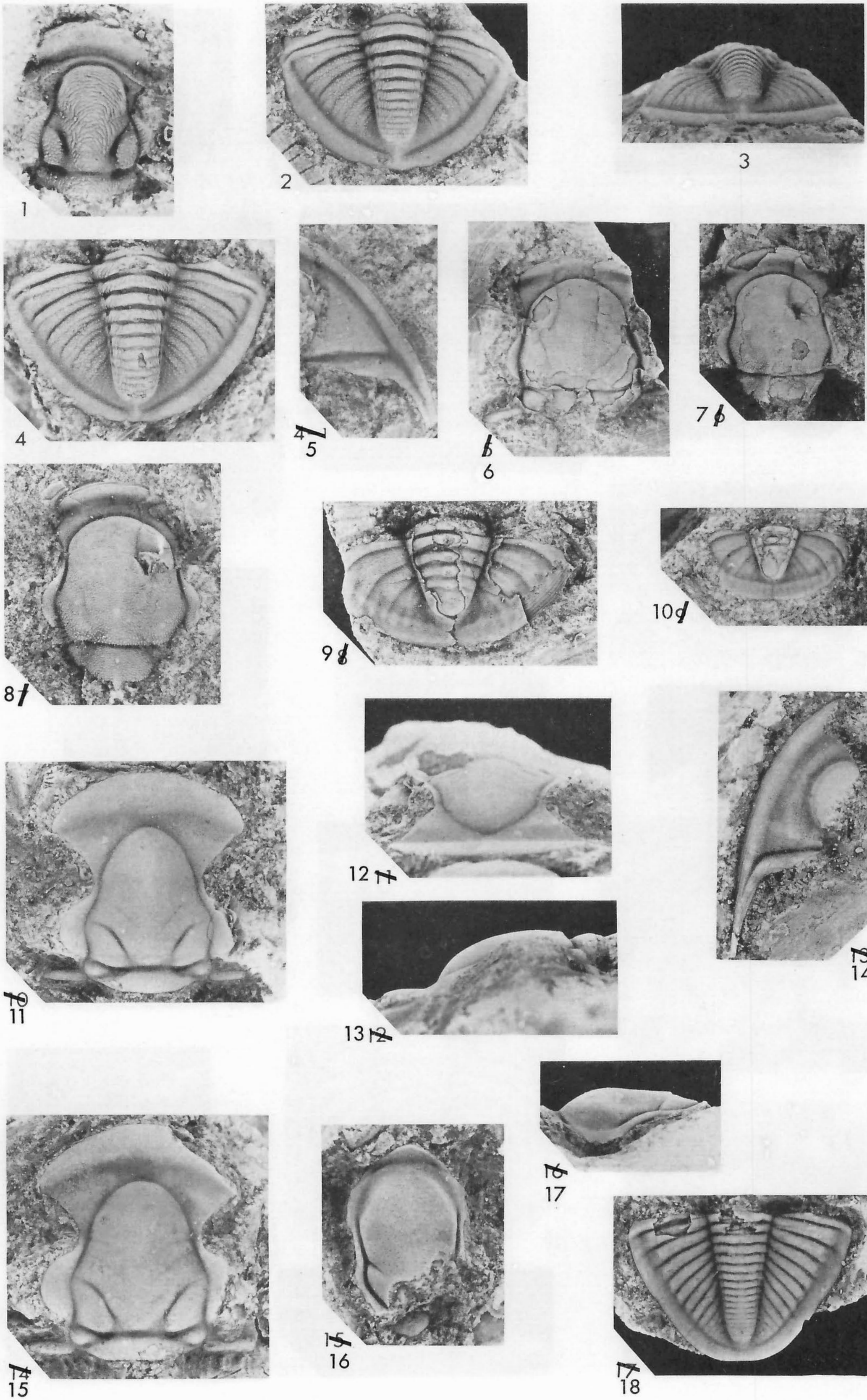
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PLATE VIII

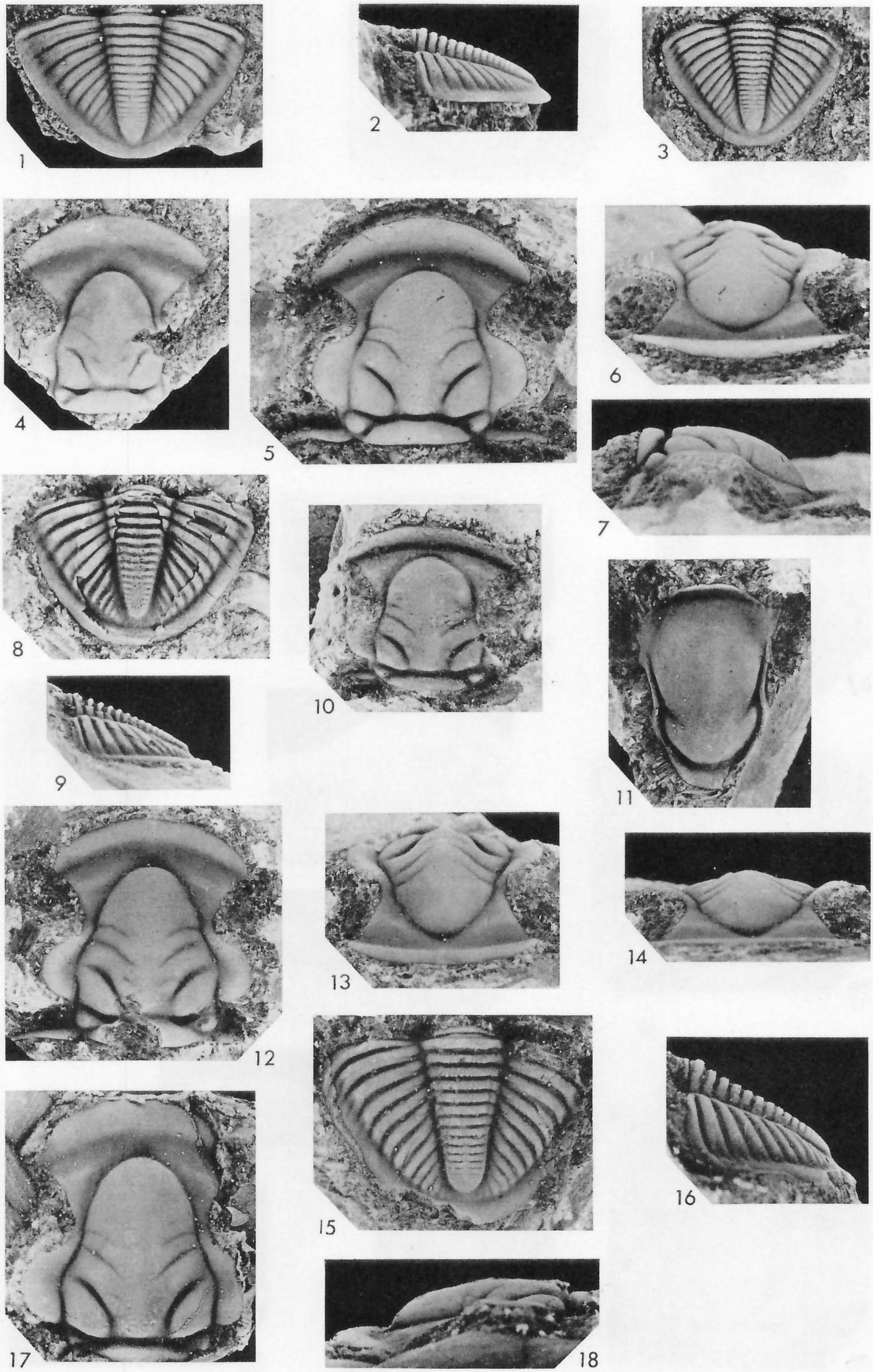

Plate VIII

Dechenella (Dechenella) bathurstensis n. sp. (Page 71)
Bird Fiord Formation, Bathurst Island

Figures 1-2.	Paratype pygidium, GSC No. 18151, dorsal and left lateral views, ×4.
Figure 3.	Paratype pygidium, GSC No. 18152, dorsal view, ×2.
Figure 4.	Paratype cranidium, GSC No. 18153, dorsal view, ×2.

Dechenella (Dechenella) algida n. sp. (Page 74)
Bird Fiord Formation, Twilight Creek

Figures 5-7.	Holotype cranidium, GSC No. 18154, dorsal, anterior, and right lateral views, ×4.
Figures 8-9.	Paratype pygidium, GSC No. 18155, dorsal and left lateral views, ×2.
Figure 10.	Paratype cranidium, GSC No. 18156, dorsal view, ×2.
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Dechenella (Dechenella) osborni n. sp. (Page 76)
Bird Fiord Formation, Twilight Creek

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Figures 15-16.	Paratype pygidium, GSC No. 18159, dorsal and left lateral views, ×4.
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Dechenella (*Dechenella*) *crista* n. sp. (Page 78)

Bird Fiord Formation, Twilight Creek

Figures 1-2. Holotype, latex cast of external mould of cranidium, GSC No. 18161, dorsal and right lateral views, ×4.

Figure 3. Paratype, latex cast of external mould of cranidium, GSC No. 18162, dorsal view, ×4.

Figure 4. Paratype, partly exfoliated cranidium, GSC No. 18163, dorsal view, ×4.

Dechenella (*Dechenella*) *neotesca* n. sp. (Page 79)

Bird Fiord Formation, Twilight Creek

Figures 5-6. Holotype cranidium, GSC No. $18164/_1$, dorsal and left lateral views, $\times 5\frac{1}{3}$.

Figure 7. Paratype pygidium, GSC No. 18165, dorsal view, ×4.

Figures 8-9. Paratype pygidium, GSC No. 18166, dorsal and posterior views, $\times 5\frac{1}{3}$.

Figure 10. Paratype pygidium, GSC No. 18167, dorsal view, ×4.

Dechenella (*Dechenella*) *crepuscula* n. sp. (Page 81)

Bird Fiord Formation, Twilight Creek

Figures 11-12. Holotype cranidium, GSC No. 18168, dorsal and right lateral views, ×4.

Figure 13. Immature pygidium showing larval notch, GSC No. 18169, dorsal view, ×12.

Figures 14-15. Paratype pygidium, latex cast, GSC No. 18170, dorsal and left lateral views, $\times 2\frac{2}{3}$.

Dechenella (*Dechenella*) aff. *crepuscula* n. sp. (Page 81)

Bird Fiord Formation, Twilight Creek

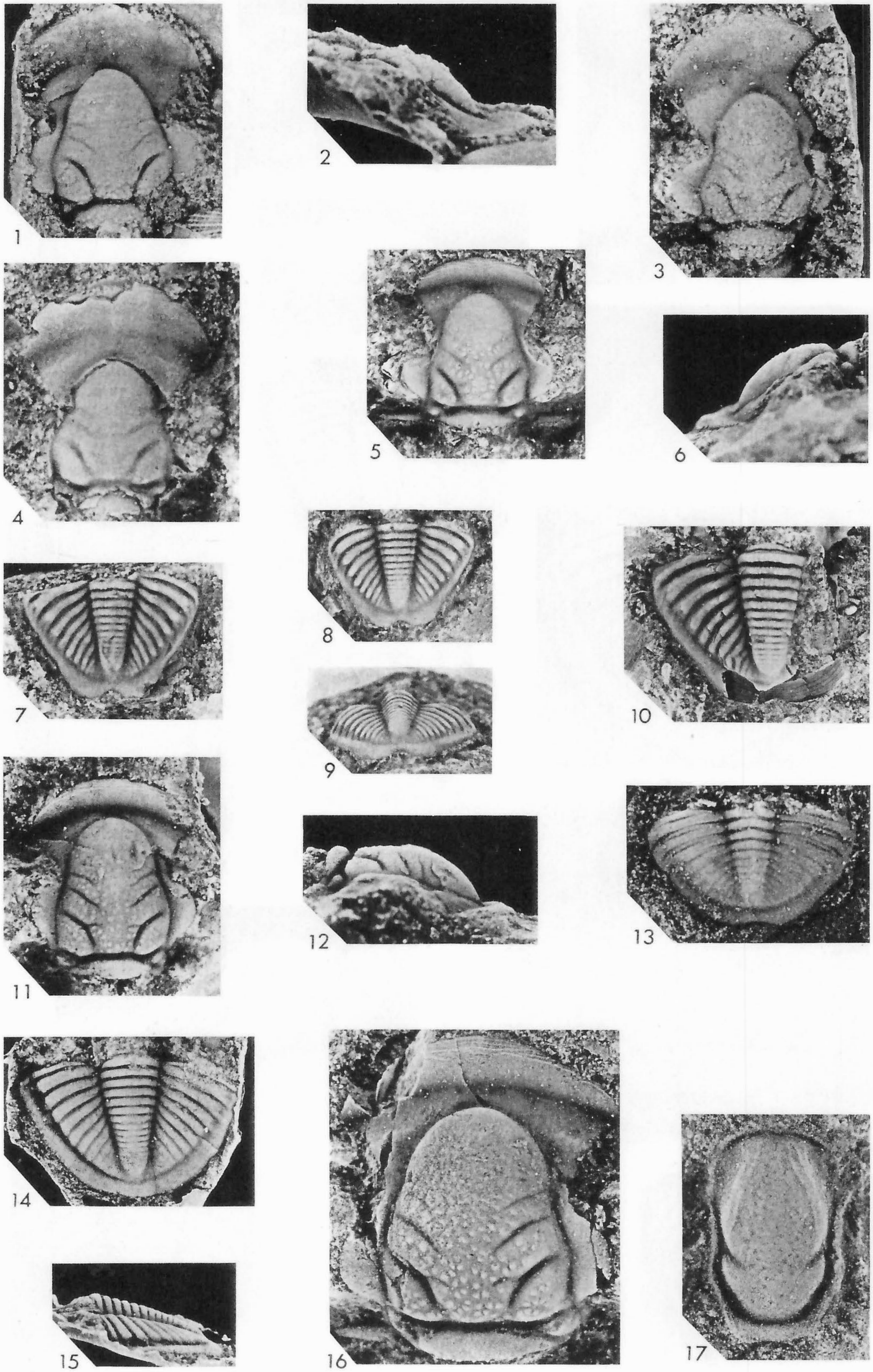
Figure 16. Cranidium, GSC No. 18171, dorsal view, ×6.

Dechenella (*Dechenella*) *maclareni* n. sp. (Page 82)

Blue Fiord Formation, Twilight Creek

Figure 17. Hypostome, exterior view, GSC No. 18172, ×8.

PLATE IX



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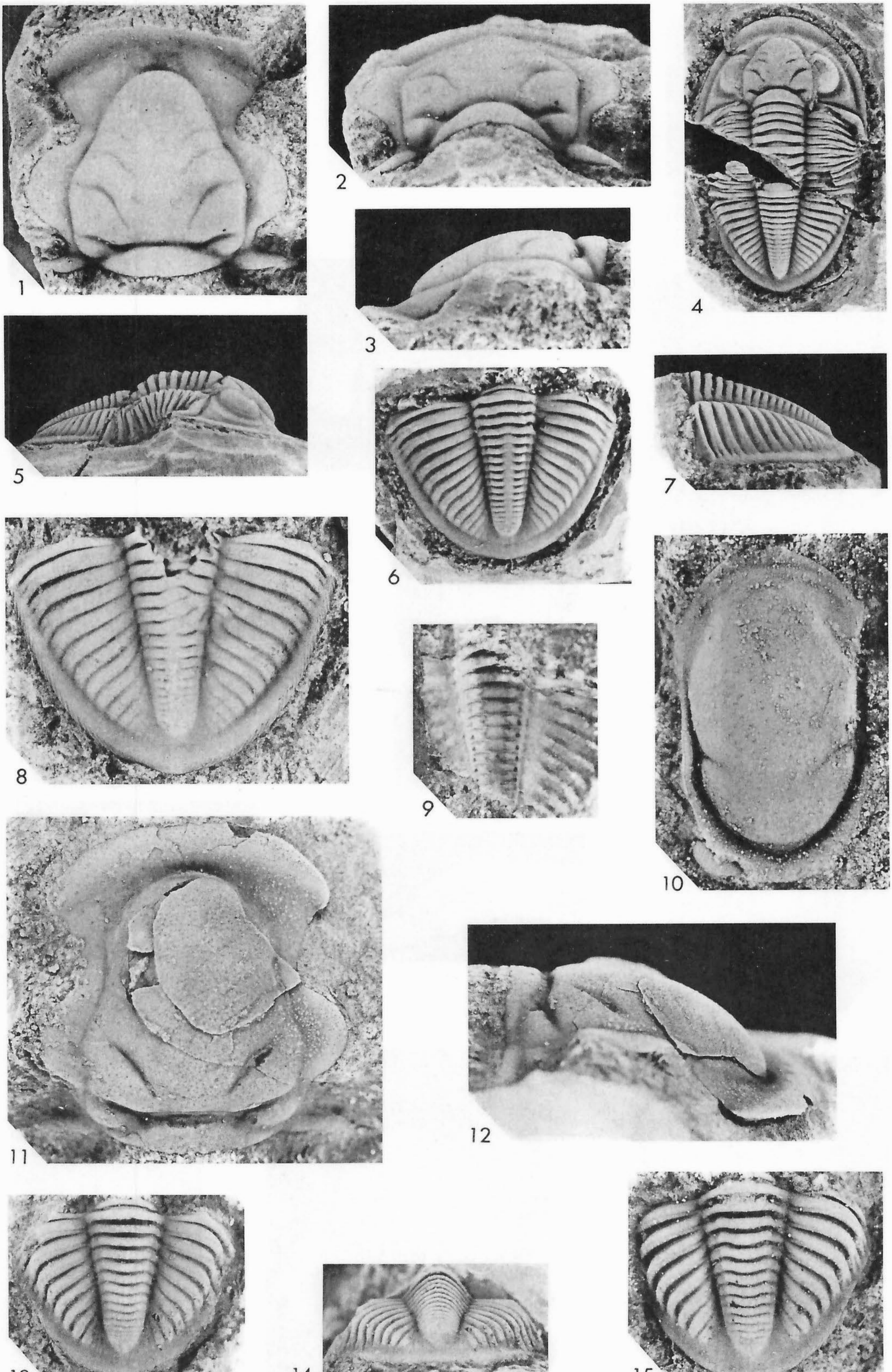

Plate X

Dechenella (*Dechenella*) *maclareni* n. sp. (Page 82)
Blue Fiord Formation, Twilight Creek

Figures 1-3.	Paratype cranidium with anterior border broken, GSC No. 18173, dorsal, posterior, and left lateral views, ×4.
Figures 4-5.	Holotype, complete specimen, GSC No. 18174, dorsal and right lateral views, ×2.
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Dechenella (*Dechenella*) *paramaclareni* n. sp. (Page 85)
Blue Fiord Formation, Eids Fiord

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Dechenella (*Dechenella*) *paragranulata* n. sp. (Page 86)
Blue Fiord Formation, Twilight Creek

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Figure 15.	Paratype pygidium, latex cast of external mould, GSC No. 18181, dorsal view, ×6.

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Dechenella (Dechenella) paragranulata n. sp. (Page 86)
Blue Fiord Formation, Twilight Creek

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Dechenella (Dechenella) tesca n. sp. (Page 88)
Blue Fiord Formation, Twilight Creek

Figure 6.	Paratype pygidium, GSC No. 18186, dorsal view, $\times 1\frac{1}{2}$.
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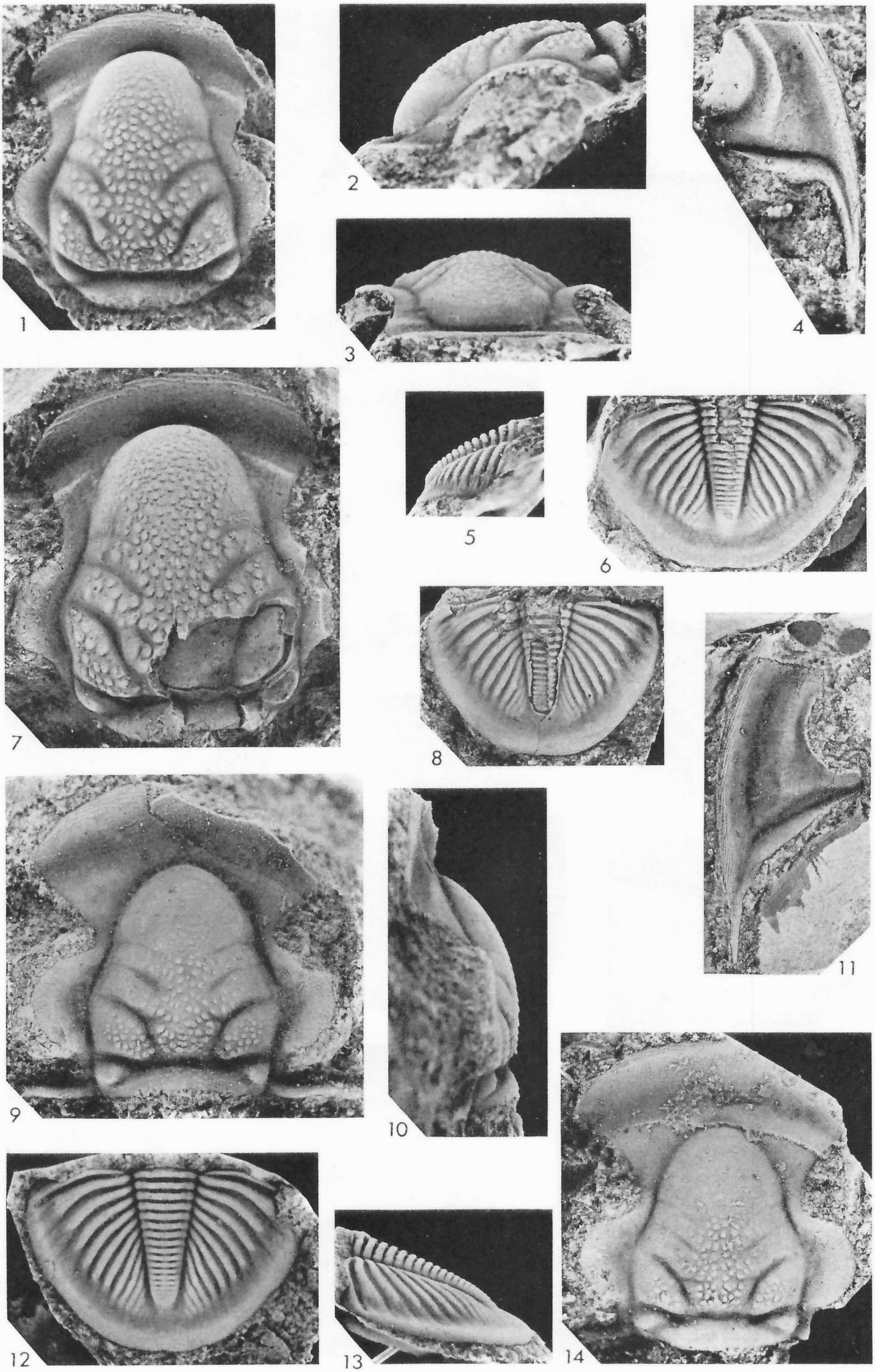

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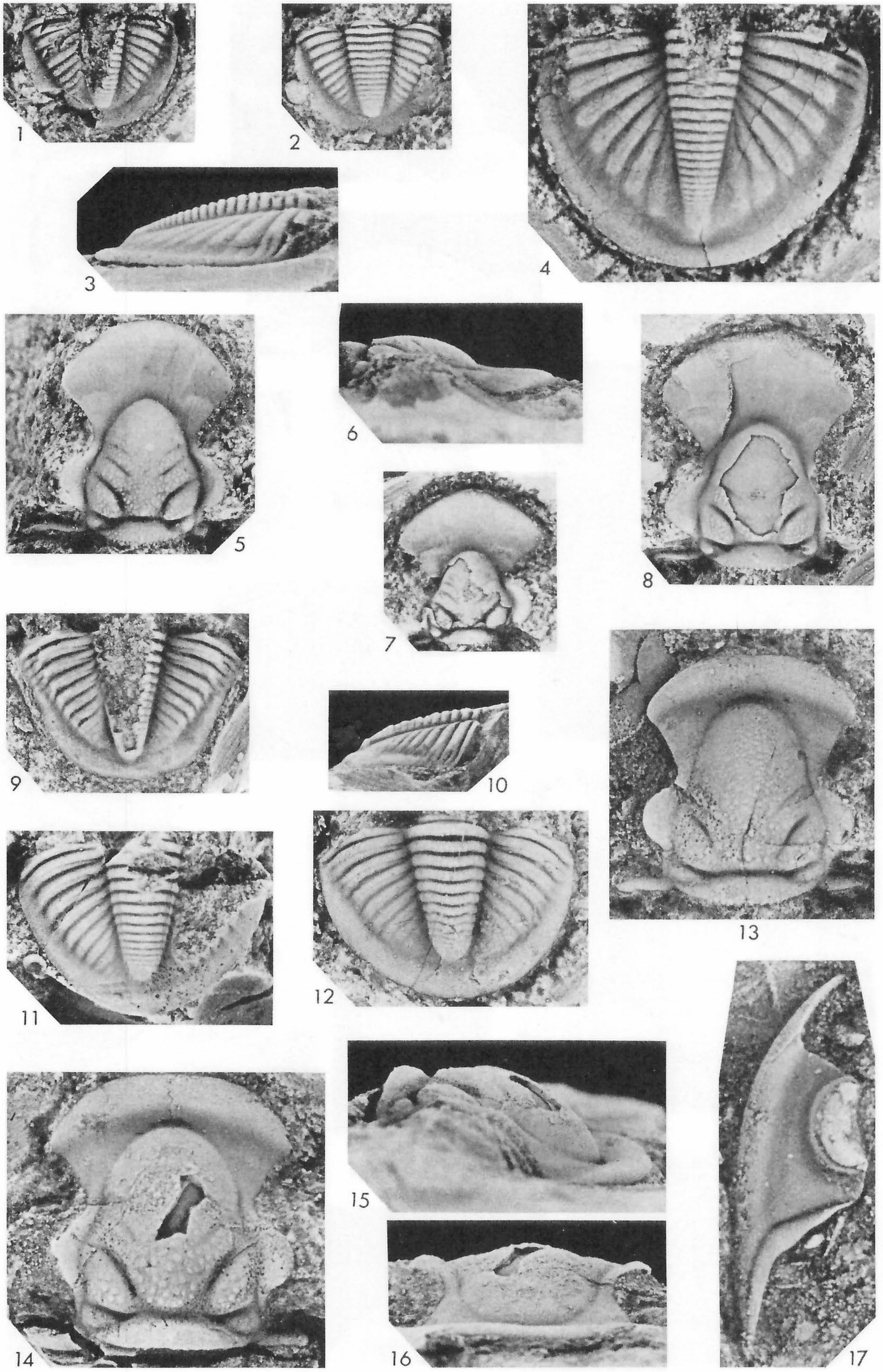

Plate XII

Dechenella (Dechenella) cf. *planimarginata* (Meek, 1871) (Page 90)
Blue Fiord Formation, east of Blue Fiord

Figures 1-2. Pygidium, GSC No. 18192a and b, dorsal view of poorly preserved specimen and latex cast of counterpart mould, ×2.

Dechenella (Dechenella) franklini? n. sp. (Page 91)
Bird Fiord Formation, Tucker Point anticline

Figures 3-4. Pygidium, GSC No. 18193a, dorsal and right lateral views, ×4.

Dechenella (Dechenella) franklini n. sp. (Page 92)
Blue Fiord Formation, Cut Through Creek

Figures 5-6. Holotype cranidium, GSC No. $18195/_1$, dorsal and right lateral views, ×4.

Figure 7. Paratype cranidium, GSC No. $18195/_2$, dorsal view, $\times 2\frac{2}{3}$.

Figure 8. Paratype cranidium, GSC No. 18194, dorsal view, ×4.

Dechenella (Dechenella) spaekkassensis (Tolmachoff, 1926) (Page 94)
Blue Fiord Formation

Figures 9-10. Syntype pygidium, PMO A28845, dorsal and right lateral views, ×2; Spaekkassen, Ellesmere Island.

Figure 11. Syntype pygidium, PMO A28838, dorsal view, ×4; Goose Fiord.

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Figure 13. Hypotype cranidium, GSC No. 18197, dorsal view, ×6; east of Blue Fiord.

Figures 14-16. Hypotype cranidium, GSC No. 18198, dorsal, right lateral, and anterior views, ×6; east of Blue Fiord.

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Dechenella (Dechenella) retusa n. sp. (Page 96)
Blue Fiord Formation, Victoria Island

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Dechenella (Dechenella) aff. *struvei* R. and E. Richter, 1950 (Page 98)
Melville Island Formation, Ibbett Bay

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Figures 4-5. Cranidium, GSC No. 18202, dorsal and anterior views, ×6.

Dechenella (Pedinodechenella) melvillensis n. subgen., n. sp. (Page 99)
Melville Island Formation, Ibbett Bay

Figures 6-9. Holotype cranidium, GSC No. 18203, dorsal, anterior, posterior, and exterior views, ×4.

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Dechenella (Basidechenella) laticaudata n. sp. (Page 101)
strata exposed at Drake Bay, Prince of Wales Island

Figure 12. Paratype cranidium, GSC No. 18205, dorsal view, ×6.

Figures 13, 15. Holotype cranidium, GSC No. 18206, dorsal and left lateral views, ×8.

Figure 14. Paratype pygidium, GSC No. 18207, dorsal view, ×4.

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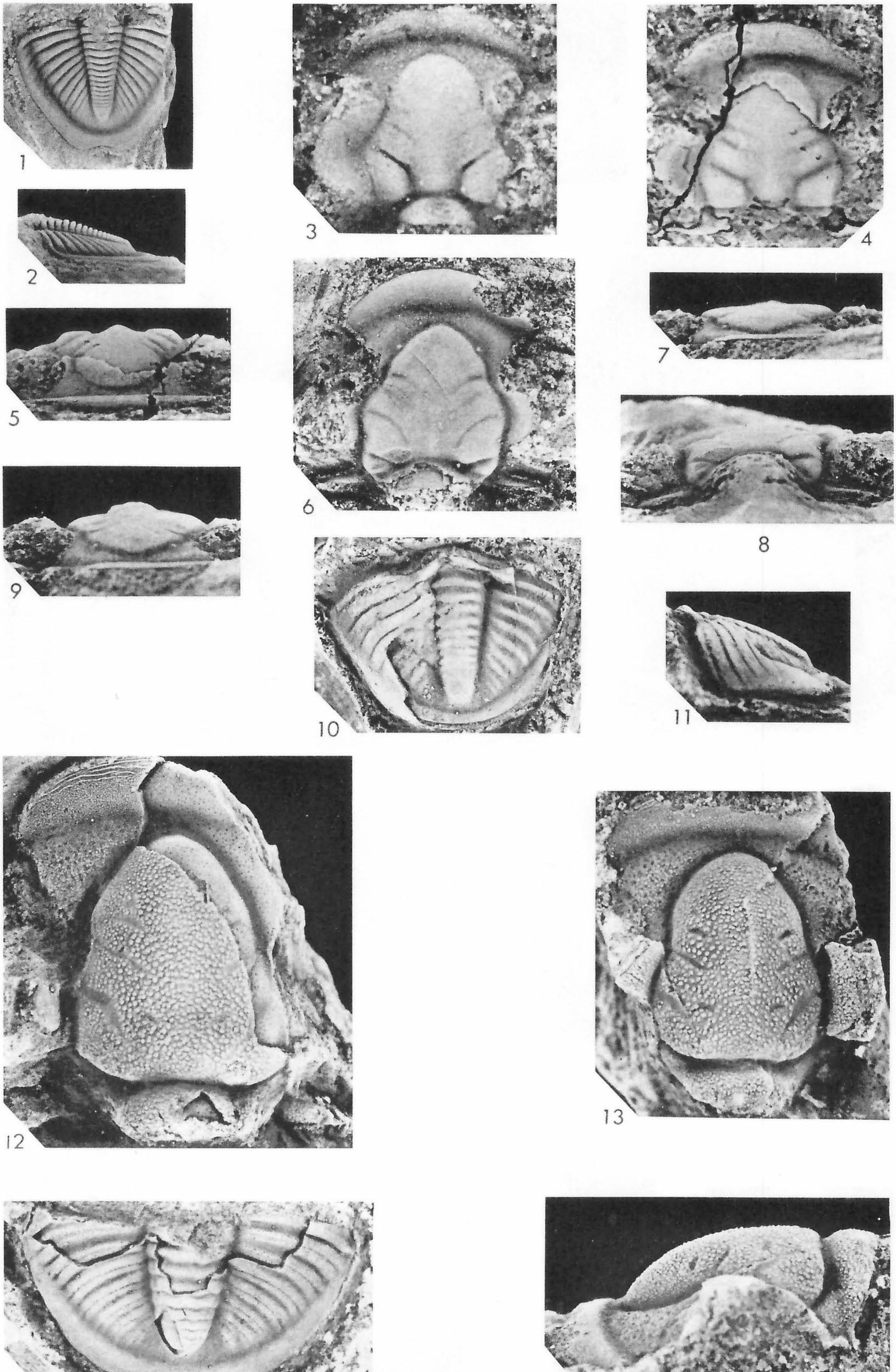

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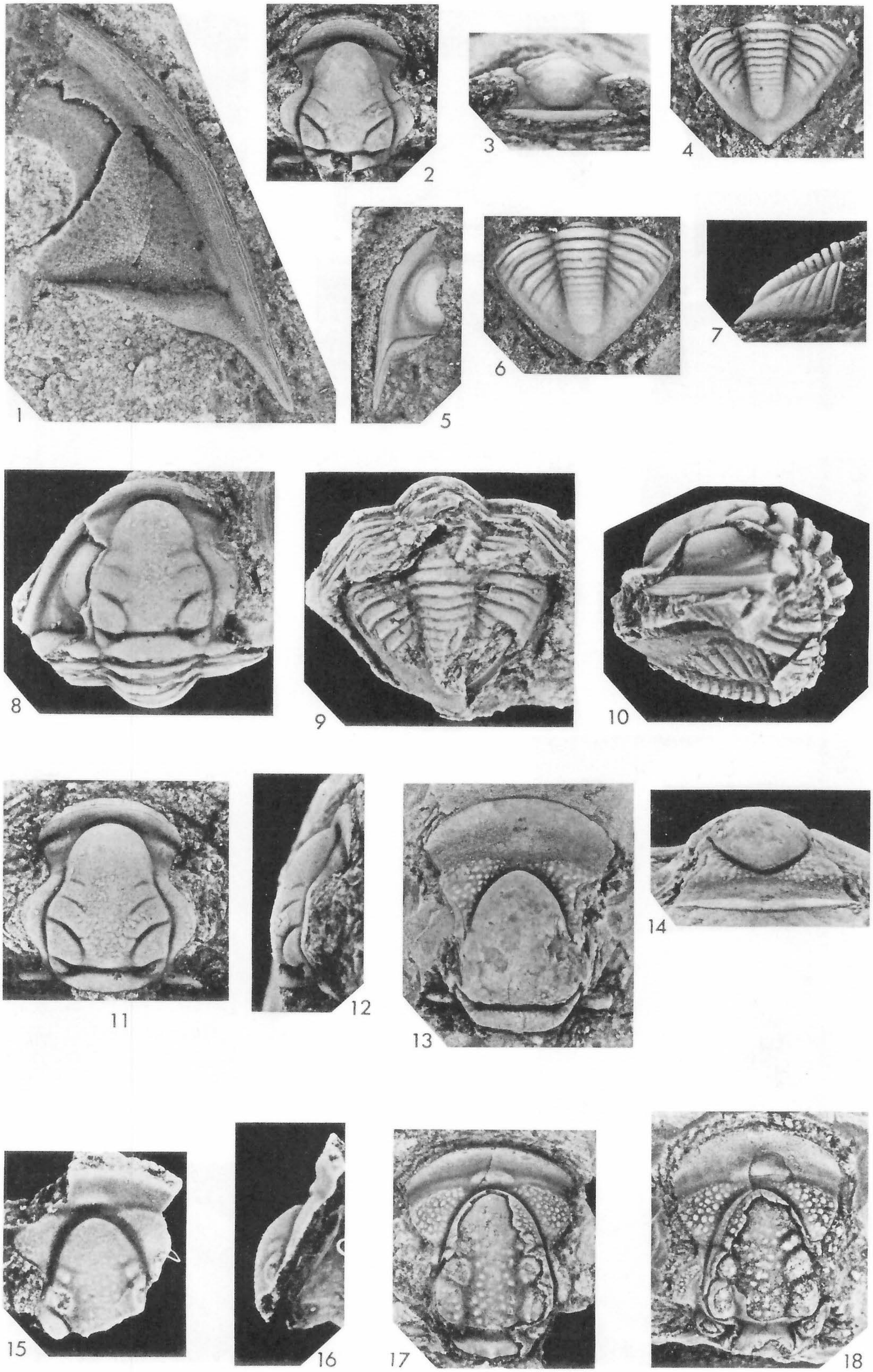

Plate XIV

Dechenella (*Basidechenella*) *laticaudata* n. sp. (Page 101)
strata exposed at Drake Bay, Prince of Wales Island

Figure 1. Paratype free cheek, GSC No. 18208, dorsal view, $\times 6$.

Deltadechenella bathurstensis n. gen., n. sp. (Page 105)
Blue Fiord Formation, Twilight Creek

Figures 2-3. Paratype cranidium, GSC No. 18209, dorsal and anterior views, $\times 5\frac{1}{3}$.

Figure 4. Paratype pygidium, GSC No. 18210, dorsal view, $\times 5\frac{1}{3}$.

Figure 5. Paratype free cheek, GSC No. 18211, dorsal view, $\times 5\frac{1}{3}$.

Figures 6-7. Paratype pygidium, GSC No. 18212, dorsal and right lateral views, $\times 5\frac{1}{3}$.

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Figures 11-12. Paratype cranidium, GSC No. 18214, dorsal and right lateral views, $\times 5\frac{1}{3}$.

Cyrtodechenella macnairi n. sp. (Page 109)

Figures 13-14. Holotype cranidium, GSC No. 18215, dorsal and anterior views, $\times 1\frac{1}{3}$, near the head of Drake Bay, Prince of Wales Island.

Schizoproetoides richteri (Tolmachoff, 1926) (Page 111)
Blue Fiord Formation, Ellesmere Island

Figures 15-16. Holotype cranidium, PMO A28847, dorsal and right lateral views, $\times 6$.

Figure 17. Hypotype cranidium, GSC No. 18216, dorsal view, $\times 1\frac{1}{2}$.

Figure 18. Hypotype cranidium, GSC No. 18217, dorsal view, $\times 2$.

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Schizoproetoides richteri (Tolmachoff, 1926) (Page 111)

Blue Fiord Formation, Ellesmere Island

Figure 1. Pygidium, PMO A28835, original of Tolmachoff's "*Dalmanites* sp.", dorsal view, $\times 1$; Goose Fiord.

Figure 2. Hypotype pygidium, latex cast showing pygidial prosopon, GSC No. 18218, dorsal view, $\times 1\frac{1}{2}$; Svendsen Peninsula.

Figure 3. Hypotype free cheek, latex cast showing genal spine, GSC No. 18219, dorsal view, $\times 3$; Svendsen Peninsula.

Figures 4-5. Hypotype pygidium, internal mould, GSC No. 18220, dorsal view, $\times 2$, lateral view, $\times 1\frac{1}{2}$; Svendsen Peninsula.

Figure 6. Hypotype cranidium, latex cast showing cranidial prosopon, GSC No. 18222/$_1$, dorsal view, $\times 1\frac{1}{2}$; Svendsen Peninsula.

Schizoproetoides ellesmerensis n. sp. (Page 115)

Blue Fiord Formation, Svendsen Peninsula

Figure 7. Holotype pygidium, internal mould, GSC No. 18224, dorsal view, $\times 1\frac{1}{3}$.

Figure 8. Incomplete free cheek showing pattern of genal caecae, GSC No. 18222/$_2$, dorsal view, $\times 2$.

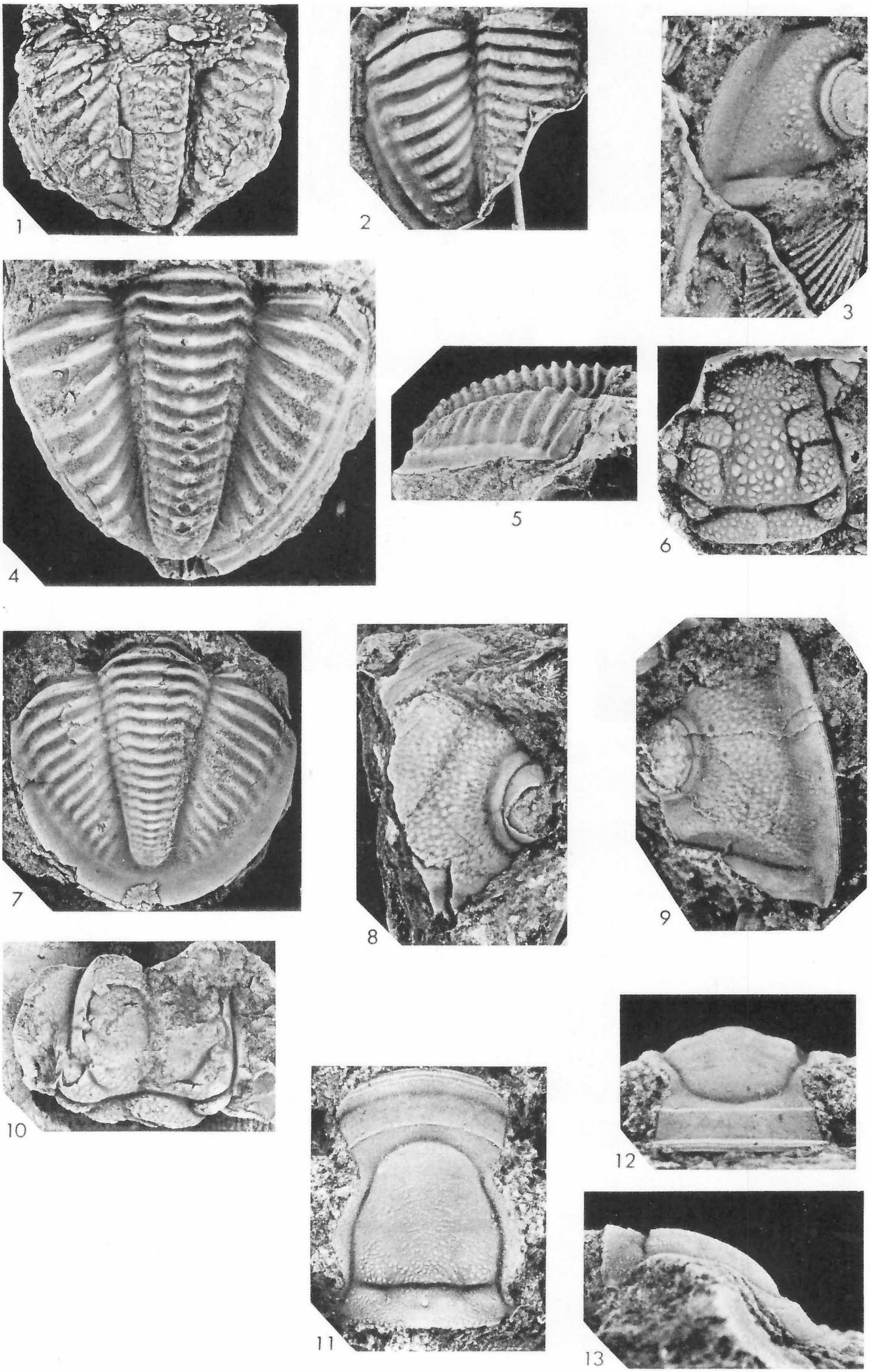
Figure 9. Paratype free cheek showing genal angle and genal caecae, latex cast, GSC No. 18225/$_1$, dorsal view, $\times 2$.

?*Schizoproetoides* sp. indet. (Page 117)

Figure 10. Two overlapping cranidia, GSC No. 18226, dorsal view, $\times 1\frac{1}{3}$; 20 miles northeast of Drake Bay, Prince of Wales Island.

Astycoryphe cimelia n. sp. (Page 118)

Figures 11-13. Holotype cranidium, GSC No. 18227, dorsal, anterior, and right lateral views, $\times 8$; Blue Fiord Formation, Cut Through Creek.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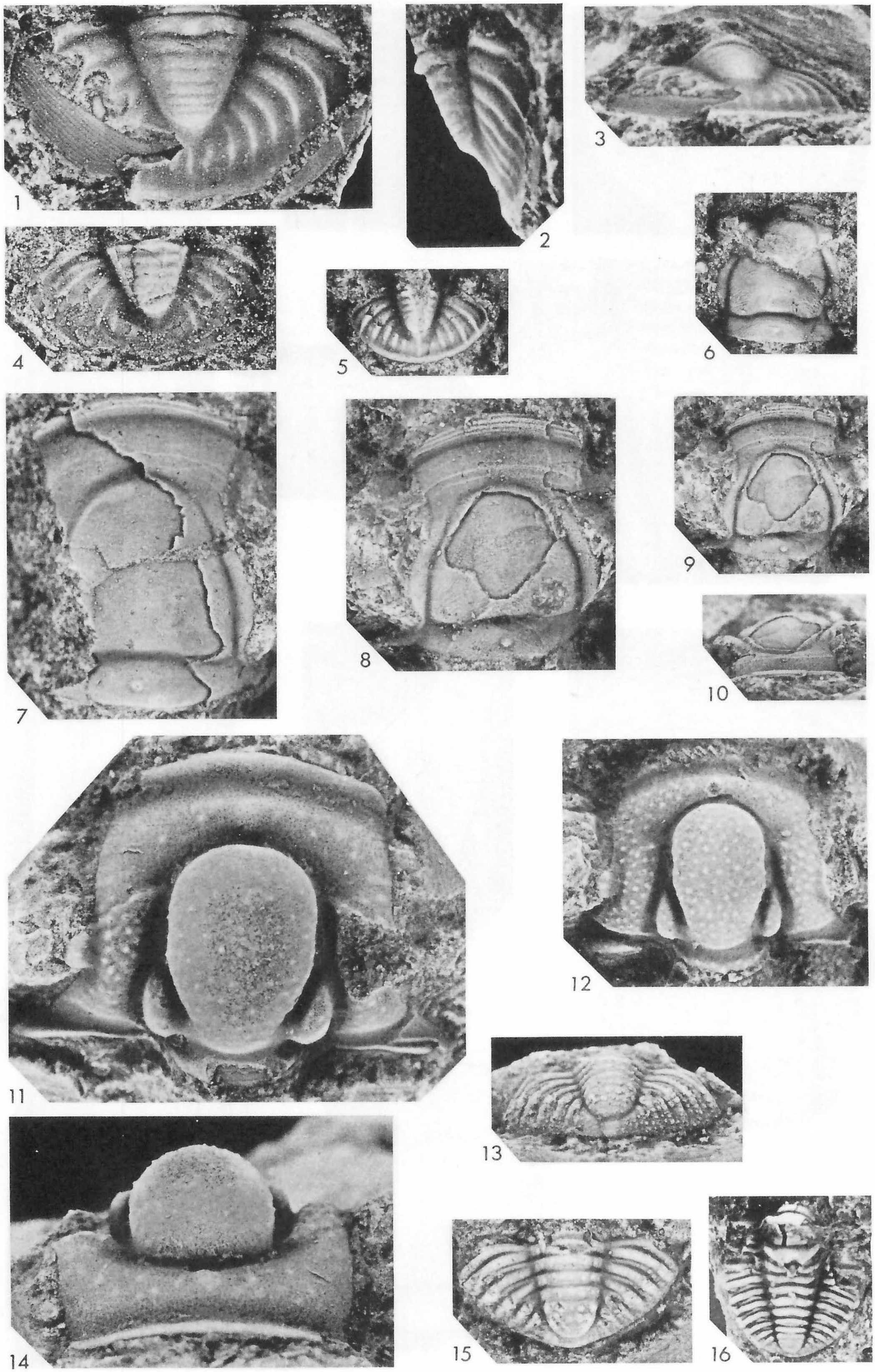

Plate XVI

Astycoryphe cimelia n. sp. (Page 118)

Figures 1-3.	Paratype pygidium, GSC No. 18228, dorsal, right lateral, and posterior views, ×8; Blue Fiord Formation, Cut Through Creek.

Astycoryphe aff. *A. cimelia* n. sp. (Page 118)

largest of the Princess Royal Islands

Figure 4.	Latex cast of pygidium, GSC No. 18229, dorsal view, ×6.
Figure 5.	Pygidium, GSC No. 18230, dorsal view, ×6.

Astycoryphe arcticus n. sp. (Page 119)

Blue Fiord Formation, Svendsen Peninsula

Figure 6.	Paratype, latex cast of cranidium showing prosopon, GSC No. 18231a, dorsal view, ×5⅓.
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Otarion balanops Erben, 1953 (Page 121)

Blue Fiord Formation, Twilight Creek

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Otarion aff. *balanops* Erben, 1953 (Page 121)

Blue Fiord Formation, Goose Fiord

Figure 16.	Latex cast of external mould of pygidium and seven thoracic segments, PMO A28843a, original of "*Cyrtosymbole richteri*" Tolmachoff, 1926, dorsal view, ×4.

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Otarion sp. A (Page 122)

Figure 1. Crushed cranidium, GSC No. 18238, dorsal view showing occipital spine, $\times 4$; Blue Fiord Formation, Twilight Creek.

Ceratarges sp. (Page 125)

Blue Fiord Formation, Svendsen Peninsula

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?*Ceratarges* sp. (Page 127)

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?*Acanthopyge* sp. (Page 127)

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Dechenella sp. indet. (Page 108)

Figure 10. Pygidium, internal mould, GSC No. 18244, dorsal view, $\times 2\frac{2}{3}$; largest of the Princess Royal Islands.

Proetid gen. et sp. indet. (Page 108)

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Hemiarges n. sp. A (Page 128)

Marshall Peninsula, Cornwallis Island

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Aulacopleura (*Paraaulacopleura*) cf. *beyrichi* (Novak, 1890) (Page 123)

Eids Formation, Twilight Creek

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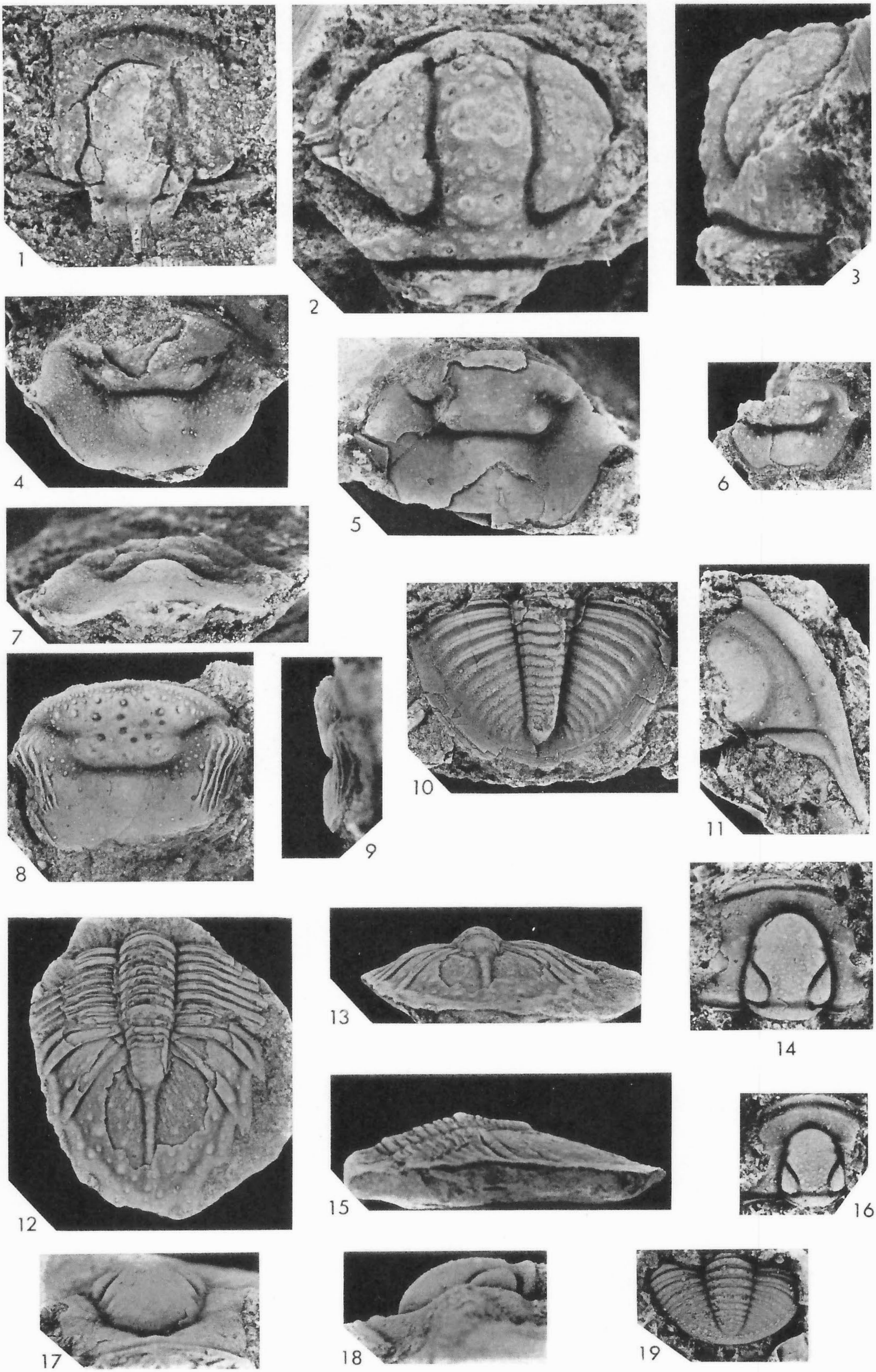
Figure 16. Cranidium, internal mould showing faint 3p furrow, GSC No. $18247/_2$, dorsal view, $\times 6$.

Figure 19. Pygidium, latex cast of external mould, GSC No. $18247/_6$, dorsal view, $\times 6$.

PLATE XVII



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