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DEPARTMENT OF ENERGY,
MINES AND RESOURCES

BULLETIN 163

CONTRIBUTIONS TO CANADIAN PALAEONTOLOGY

Lower Cambrian Faunas from Ellesmere Island, District of Franklin

J. W. Cowie

A Middle Cambrian *Plagiura-Poliella* Faunule from Southwest District of Mackenzie

B. S. Norford

Price, $1.75

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PREFACE

Unlike their counterparts in the Rocky Mountains, Cambrian faunas of northern Canada have received relatively little attention. The two papers comprising this Bulletin present the results of two systematic studies. The first describes a Lower Cambrian fauna from Ellesmere Island, consisting mainly of trilobites; aside from the palaeontological interest, it helps to establish the stratigraphic position of the Precambrian–Cambrian boundary in the region. The other paper deals with a group of trilobites from strata higher in the Cambrian succession. It forms a complement to the first paper and provides good evidence for recognizing Middle Cambrian rocks in the Mackenzie Mountains that can be equated by their fossils with Middle Cambrian beds in the Canadian Rocky Mountains.

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

OTTAWA, November 29, 1966

BULLETIN 163 — Beiträge zur kanadischen Paläontologie

Unterkambrische Fauna von Ellesmereland (Franklindistrikt)

Von John William Cowie

Eine mittelkambrische *Plagiura-Poliella*-Faunula aus dem Südwesten des Mackenziedistrikts

Von Brian Seeley Norford

БЮЛЛЕТЕНЬ 163 — Материалы по палеонтологии Канады

Нижнекембрийские фауны из острова Элсмира, района Франклина

Джон Уильям Кауи

Среднекембрийская фаунула Plagiura-Poliella из юго-западного района Макензи

Брайен Сили Норфорд

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LOWER CAMBRIAN FAUNAS FROM ELLESMERE ISLAND, DISTRICT OF FRANKLIN

J. W. Cowie

Abstract

This report describes, in stratigraphic perspective, a Lower Cambrian fauna from Ellesmere Island comprising hyolithids and trilobites. The trilobites are assigned to five genera and include two new species.

Résumé

Le présent rapport décrit, dans une perspective stratigraphique, une faune du Cambrien inférieur de l'île Ellesmere comprenant des hyolithides et des trilobites. Les trilobites se répartissent dans cinq genres et comprennent deux nouvelles espèces.

INTRODUCTION

The Lower Cambrian faunas described in this paper were collected from Ellesmere Island in 1961 and 1962 by R. L. Christie and J. W. Kerr, of the Geological Survey of Canada. Ellesmere Island, the largest, northernmost, and most rugged of the Queen Elizabeth Islands in arctic Canada, has been visited over a comparatively long period, partly as an incidental result of the search in the past for a northwest passage around the north of the Americas to Asia, and also because it was used as a base for expeditions to the North Pole.

From the geological point of view, the most important of the early expeditions to that part of the east coast of Ellesmere Island shown on Text-figure 1 was the British Arctic Expedition, 1875–76, under Nares (Feilden & De Rance, 1878; Etheridge, 1878). The field observations and collections were made by H. W. Fielden, naturalist to the expedition. Earlier, P. C. Sutherland in 1852 and I. I. Hayes in 1854, both surgeons, had made only brief geological notes during expeditions led by Commander A. E. Inglefield and Dr. E. K. Kane, respectively. Hayes continued his observations while leading his own expedition in 1860–61.

Another twenty years and more elapsed before a trained geologist examined the area when Per Schei briefly explored ashore from the "Fram", discovering sediments containing Lower Palaeozoic fossils (Holtedahl, 1913). A. P. Low also visited the region (1906, pp. 43–50, 185–216, map), and R. Bentham (1936) made a longer investigation in 1935. In 1937 J. M. Wordie and H. I. Drever landed and made collections (Wordie, 1938, pp. 398–399). Between 1939 and 1941 J. C. Troelsen was on Bache Peninsula during his geological reconnaissance of northwest Greenland and adjacent parts of Canada (Troelsen, 1950). Fossil material collected by Per Schei, Bentham, and Troelsen was illustrated and described by Poulsen in 1946.

Since 1955, great progress has been made in the study of the Lower Palaeozoic rocks of eastern Ellesmere Island through the systematic work of field parties of the Geological Survey of Canada, led by Christie, Kerr, and Thorsteinsson.

Acknowledgments

The help and cooperation of R. L. Christie, J. W. Kerr, D. J. McLaren, R. Thorsteinsson, and E. T. Tozer, all of the Geological Survey of Canada, is gratefully acknowledged. A. J. Rowell of the Geology Department, University of Nottingham, England, identified the brachiopod *Paterina*. The photographs were prepared by E. W. Seavill, Geology Department, University of Bristol. S. J. Tester of the Department of Classics at Bristol assisted with the etymology of new specific names. The late Professor W. F. Whittard gave much time to reading and discussing an early draft of the manuscript.

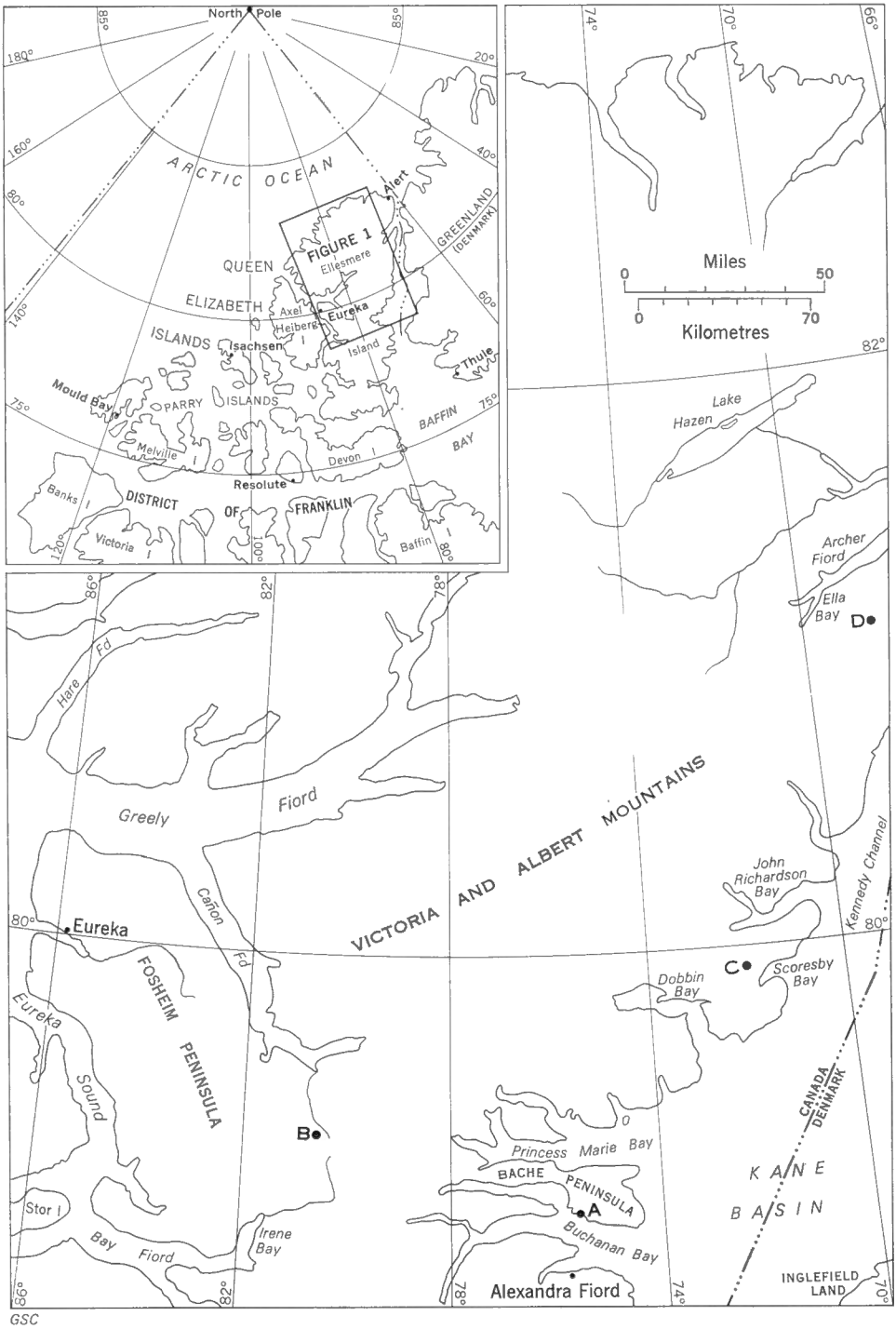

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FIGURE 1. Part of Ellesmere Island showing the four Lower Cambrian fossil localities: A, Bache Peninsula; B, northeast of Irene Bay; C, northwest of Scoresby Bay; D, East of Ella Bay. Inset map gives relationship of this area to rest of the Queen Elizabeth Islands, part of Greenland, and the Arctic Ocean.

STRATIGRAPHY AND FAUNAL LISTS

The detailed stratigraphy will be discussed in regional papers in preparation by Christie and Kerr but brief comment is appropriate here. Preliminary maps of parts of Ellesmere Island, with marginal notes, have been published (Christie, 1962; Kerr and Thorsteinsson, 1963).

At Bache Peninsula (Fig. 1, loc. A) the succession is as follows (Christie, pers. comm.):

Middle Cambrian	Cape Wood Formation	130′	Dolomite, limestone, sandstone
Lower Cambrian	Cape Kent Formation	50′	Dolomite, limestone
Lower Cambrian	Police Post Formation	15′	Limestone
Cambrian (at least in part)	Cape Ingersoll Formation	80′	Mainly dolomite
	Cape Leiper Formation	100′–150′	Mainly dolomite
	Rensselaer Bay Formation	170′–670′	Mainly sandstone

unconformity

Precambrian gneiss, pegmatite, and granite

In the ravine behind the abandoned Royal Canadian Mounted Police post (79°05′N, 75°45′W) at Bache Peninsula, the following fauna was collected by Christie in 1961 from the basal 10 feet of the Police Post Formation (GSC locality 47287):

Bonniopsis sp.
Paedeumias turmalis n. sp.
olenellid gen. and sp. indet. 1
Hyolithes sp. indet. 1
Circotheca sp.

The association at the same horizon of olenellid and bonniid trilobites suggests that the strata belong to the Upper *Olenellus* Subzone of the Lower Cambrian. The complete faunal list for the Police Post Formation in Bache Peninsula now comprises:

Bonniopsis nasuta Poulsen, 1946
B. rostrata Poulsen, 1946
B. sp.
Paedeumias? *borealis* Poulsen, 1946
Paedeumias turmalis n. sp.
olenellid gen. and sp. indet. 1
olenellid indet.
Hyolithes spp.
Circotheca sp.
Acrothele? pulchra Poulsen, 1946

Northeast of the head of Irene Bay (Fig. 1, loc. B) the succession is as follows (Kerr 1968, pp. 61–62):

Middle Cambrian	Parrish Glacier Formation	942′	Limestone, sandstone
Lower Cambrian	Scoresby Bay Formation	850′	Dolomite, limestone
Lower Cambrian	Kane Basin Formation	275′	Sandstone, shale
Lower Cambrian	Rawlings Bay Formation	930′	Sandstone
	unconformity		
Upper Precambrian	Ella Bay Formation	800′	Dolomite
	thrust		

Kerr suggests that the equivalence of these formations with the Bache Peninsula sequence is as follows:

Northeast of Irene Bay	Bache Peninsula
Parrish Glacier Formation	Cape Wood Formation
Scoresby Bay Formation	Cape Kent Formation Police Post Formation Cape Ingersoll Formation Cape Leiper Formation
Kane Basin Formation Rawlings Bay Formation	Rensselaer Bay Formation
—unconformity—	
Ella Bay Formation	—unconformity—
——thrust——	Precambrian basement rocks

The following fauna was obtained by Kerr in 1962 from the Scoresby Bay Formation at about 350 feet above its base (GSC localities 51569 and 51571, from frost-shattered outcrop at about 79°21′N, 80°07′W, 22½ miles from the head of Irene Bay along a bearing of N20°E):

Bonniopsis? sp.
Fremontia sp.
ptychoparioid gen. and sp. indet.
(preserved in same piece of rock as the *Fremontia*)
Paterina sp.
Hyolithes sp. indet. 2

The association of an olenellid, *Fremontia*, with representatives of other trilobite families suggests that the strata belong to the Upper *Olenellus* Subzone of the Lower Cambrian.

Northwest of the head of Scoresby Bay (Fig. 1, loc. C) the succession is as follows (Kerr 1968, pp. 55–57):

Middle Cambrian	Parrish Glacier Formation	1510′	Limestone
Lower Cambrian	Scoresby Bay Formation	1850′	Dolomite

Lower Cambrian	Kane Basin Formation	530′	Limestone, sandstone, shale
Lower Cambrian	Rawlings Bay Formation	3131′	Sandstone
	unconformity		
Upper Precambrian	Ella Bay Formation	2500′	Dolomite
	unconformity?		
Upper Precambrian	Kennedy Channel Formation	350′	Sandstone
	thrust		

Six miles northwest of the head of Scoresby Bay, Kerr collected *Olenellus praenuntius* n. sp. in 1961 from the Kane Basin Formation, at 430 feet above its base (GSC locality 47522, at 79°55′N, 72°10′W). The absence of non-olenellid trilobites from this collection from the Kane Basin Formation suggests the possibility that the strata belong to the Lower *Olenellus* Subzone of the Lower Cambrian. This faunal criterion is unsatisfactorily negative, however, and cannot be regarded as other than a working hypothesis that may aid stratigraphical correlations.

East of Ella Bay (Fig. 1, loc. D) succession a composite section is as follows (Kerr, 1967):

Middle Cambrian	Parrish Glacier Formation	2125′	Limestone, dolomite, shale
Lower Cambrian	Scoresby Bay Formation	2550′	Dolomite
Lower Cambrian	Kane Basin Formation	1310′	Shale, siltstone, limestone
Lower Cambrian	Rawlings Bay Formation	1780′	Sandstone, siltstone, shale
Lower Cambrian	Ritter Bay Formation	1400′	Shale
Lower Cambrian	Archer Fiord Formation	300′	Sandstone
	unconformity		
Upper Precambrian	Ella Bay Formation	2050′	Dolomite
	unconformity		
Upper Precambrian	Kennedy Channel Formation	3650′	Limestone, dolomite, sandstone, shale
	thrust		

Kerr collected the following fossils from the Kane Basin Formation in 1962 at about 81°04′N, 68°30′W, at a distance of 17 miles on a bearing of S80°E from the head of Ella Bay.

GSC locality 51570 from 240 feet below the top of the formation: olenellid gen. and sp. indet. 3.

GSC locality 51572 from 245 feet below the top of the formation: olenellid gen. and sp. indet. 2.

The presence of olenellids alone may possibly suggest that the strata belong to the Lower *Olenellus* Subzone of the Lower Cambrian.

Kerr maintains that the Kane Basin Formation correlates with the Rensselaer Bay Formation at Bache Peninsula, and that the latter unit is therefore Lower Cambrian, at least in its upper beds. This is probably the most significant feature of the new fossil localities from the point of view of regional stratigraphy. The upper part of the Rensselaer Bay Formation, the Cape Leiper Formation, and the Cape Ingersoll Formation, all of which were formerly assigned by many geologists to the Precambrian, should now be included in the Cambrian. There is also a reasonable correlation between the faunal associations found at Bache Peninsula in the Police Post Formation and those found near Irene Bay in the Scoresby Bay Formation; these formations overlie the Rensselaer Bay and the Kane Basin Formations, respectively.

The realization of this greater downward extension of the Cambrian in the succession should have repercussions on stratigraphical interpretations for Greenland, not only for Inglefield Land, which shares many formations with Ellesmere Island, but also for other areas in North and East Greenland where similarly unfossiliferous sediments have been referred to the upper Precambrian.

SYSTEMATIC PALAEONTOLOGY

Morphological terms are used following Harrington, Moore, and Stubblefield (*in* Moore, 1959, pp. 117–126). The type and figured specimens are kept in the collections of the Geological Survey of Canada, Ottawa; their numbers are prefixed by GSC. Details of GSC localities have been given in the preceding discussion of stratigraphy.

All the specimens figured were whitened for photography with ammonium chloride.

Class TRILOBITA Walch, 1877

Family OLENELLIDAE Vogdes, 1893

Genus ***Olenellus*** Billings, 1861

Type species: *Olenus thompsoni* Hall, 1859

Olenellus praenuntius n. sp.

Plate I, figures 1–10

Material: More than twenty dorsal cephalic fragments of varying sizes and states of preservation, including small holaspides. The cephala show the dorsal surface of dorsal exoskeletal material. In some specimens, this material is partly abraded and exfoliated to expose internal moulds of the ventral side of the dorsal cephalic shield. Ten hypostomata were found in the same blocks of limestone with dorsal cephala, and are ascribed to this new species.

Description: Cephalon semicircular in outline with large moderately inflated convex cheek lobes; eyes, glabella, and occipital ring together are about as wide (tr.) as they are long (sag.). Length of glabella and occipital ring is slightly more than twice the average width (tr.). The proportion of the overall cephalic width that is occupied by the glabella and eyes is apparently related to the overall size of the cephalon. In the largest specimen (GSC 18039, fig. 3, which has a sagittal length of 12.5 mm) the calculated proportion, width of glabella and eyes: overall width is 1:2; a medium specimen (GSC 18040, figs. 1 and 2, sagittal length 9 mm) gives approximately 1:1.9; a small specimen (GSC 18041, fig. 7, sagittal length 5 mm) has about 1:1.8; the smallest specimen (GSC 18042, fig. 10, which is an holaspid, sagittal length 2.5 mm) has approximately 1:1.6. In side view the glabella appears to rise above the level of the eyes. Glabella and occipital ring are nearly parallel sided with

slight expansion in width near the first lateral glabellar lobes and the posterior part of the frontal lobe, but none at the occipital ring. The dorsal furrow is well defined. Frontal lobe moderately convex and smoothly confluent with the cheek lobes, with maximum curvature across the axis near the mid-point (sag.) and posterior to it; anterior margin ovoid in shape. The first lateral glabellar furrows (numbered from front to rear) join across the axial line, where they are well marked, with a clear sinuosity that is acutely concave towards the anterior direction giving further emphasis to the oval shape of the frontal lobe; followed outwards the furrows change direction and slope acutely but uniformly backwards towards their abaxial ends. Eye ridges are not preserved in many specimens, but in one (GSC 18039, fig. 3) they can be seen to arise from the postero-lateral margins of the frontal lobe, and be confluent with them. The second lateral glabellar furrows are more nearly at right-angles to the axial line which they cross with a slight backward curve; they change direction and slope backwards towards their abaxial ends. First lateral glabellar lobes have a sinuous curved shape, pinched somewhat at the axial line, swollen out and curved backwards abaxially, so that they wrap around the abaxial ends of the second lateral glabellar lobes; they follow, in their extremities, the line of the eye ridges and the proximal parts of the palpebral lobes. Second lateral glabellar lobes are of uniform width (sag.) and chevron-shaped; the third lateral glabellar furrows well impressed abaxially, faint on the axis. In one specimen (GSC 18039, fig. 3), the first and second lateral glabellar lobes each carry two faintly impressed furrows which run parallel with the second and third lateral glabellar furrows, respectively.

Occipital furrow absent near the axis but well impressed nearer the dorsal furrow. Third lateral glabellar lobes convex and slightly inflated near the dorsal furrow with shallow, broad depression on the axial line so that they form clearly defined lateral developments. Occipital ring moderately convex with a smooth convex posterior margin near which there is a small, clearly and acutely marked axial node.

Short eye ridge confluent with the frontal lobe, rises slightly (GSC 18039, fig. 3) as it passes into the smooth curve of the palpebral lobe, which is directed backwards with comparatively little curvature outwards away from the glabella; posterior end of palpebral lobe and eye curve back towards the axis and end near the occipital ring at about its mid-line (tr.). In one specimen (GSC 18039, fig. 3), a marked "outer" palpebral furrow (hereafter referred to as the eye furrow) is seen to run between the palpebral lobe and the eye and should not be confused with the "inner" palpebral furrow (= palpebral furrow *auctt*) which is well developed. The cheek lobe is moderately inflated between the palpebral lobe and the glabella.

In large specimens, the preglabellar field occupies only about one-twentieth part of the sagittal length of the cephalon: in the largest individuals the field is proportionately smaller than this with a tendency to be somewhat greater in proportion when the overall sagittal length is less. In the smallest individuals (young holaspides) the preglabellar field occupies about one-tenth part of the sagittal length of the cephalon. The anterior marginal border is moderately wide with a slightly elliptical cross-section due to a small degree of flattening in the dorsoventral dimension; the border is well elevated above the preglabellar field; followed laterally

towards the genal angles, it does not appreciably vary in width or shape. In young holaspides the marginal border is narrower and has a more circular cross-section. Genal spines, well-developed at the postero-lateral margins of the cephalon, smoothly continue the line and width of the marginal border, gradually taper towards their posterior extremities, and diverge at a definite angle to the axis. No completely preserved genal spines are found but it seems probable that they extended beyond the posterior margin of the cheek lobes by about half the sagittal length of the main part of the cephalon. In young holaspides, genal spines are about the same size and shape but do not follow the line of the posterior part of the marginal borders (GSC 18042, fig. 10), but appear instead to diverge at an angle of about 30° to the axis. Clear ridges run from the posterior terminations of the eye lobes to the posterior margins about halfway between the lateral margins of the occipital ring and the genal angles. The genal angles are slightly less than right angles and the posterior marginal border (which is similar in size and shape to the anterior and lateral marginal borders) is directed in slight backward curves to the posterior ends of the post-ocular ridges where there are thickenings which can be associated with inter-genal spines, particularly in smaller specimens (GSC 18043, fig. 4; GSC 18042, fig. 10). The adaxial portions of the posterior marginal border tapers rapidly between the terminations of the post-ocular ridges and the occipital ring.

Genal caecae can be seen in several specimens, radiating across the cheek lobes from the frontal glabellar lobe and the eyes to the marginal furrow. The ridges anastamose and branch so that the area is uniformly divided. Particularly well-defined ridges run from the mid-points of the lateral margins of the eyes to the genal angles, and, posterior to these, a reticulate pattern is shown by some specimens. Genal caecae are best displayed by internal moulds of the dorsal cephalic test. Other forms of markings are present: fine pitting on the glabella and other parts, similar to a Bertillon pattern; fine terrace lines on the marginal border running subparallel with the margin; and extremely fine tuberculation on the border near the genal angle.

The hypostomata vary in size to a certain extent but a representative sagittal length is about 7 mm. Median body ovoid and convex; anterior and lateral borders absent; large, wide posterior border is separated from the median body by a border furrow that is faint and shallow on the axis but abaxially is deeper, well-defined, and notched along its oblique course. Posterior margin serrated with eight or nine sharp protuberances separated by smoothly curved embayments; not angular but flattened near the axis and more curved laterally.

Geological horizon and locality: Kane Basin Formation, 430 feet above base, GSC locality 47522, near Scoresby Bay.

Holotype: GSC 18040; *paratypes:* GSC 18039 and 18043, all preserved in arenaceous limestone. Certain specimens show clear developments of specific features:

(i). palpebral lobe and furrows, furrows on first and second lateral glabellar lobes, genal caecae, terrace lines, and pitting similar to a Bertillon pattern (GSC 18039, fig. 3);

(ii). a relatively complete dorsal cephalic shield (GSC 18040, figs. 1, 2);

(iii). intergenal spines and post-ocular ridges (GSC 18043, fig. 4).

Remarks: The distinction of *Olenellus praenuntius* from species of *Paedeumias* is based on the small size of the preglabellar field in large forms, the shape of the frontal lobe of the glabella, and the width and cross-sectional shape of the marginal border. In addition no median ridge crosses the preglabellar field but it is interesting to note (in view of arguments presented in the discussion of the genus *Paedeumias*), that intergenal spines are present, associated with post-ocular ridges. The other genera of the family *Olenellidae* can be relatively easily discarded as possible assignments for *praenuntius* on the basis of various characteristic features.

It is clear from studies of the available material that certain changes in proportions are associated with variations in overall size, and these have been mentioned in the description above, which is based on selected and figured specimens. Fairly radical differences in proportions are obvious when the two specimens GSC 18044, figure 8, and GSC 18042, figure 10, are compared with the holotype and paratypes, and are here assumed to be due to different stages of maturity and not to a specific difference; this assumption is supported by the small overall size, the size and character of the glabella and eyes, and comparisons with specimens that have been described as immature by other authors, including those in the study of olenellid ontogeny by Palmer (1957).

Some features characteristic of *Olenellus praenuntius* can be seen in some of the illustrations of specimens assigned to *Olenellus gilberti* Meek, 1874, in Walcott's 1910 paper on the olenellids, (Pls. 36 and 41) and in a paper by Palmer (1957, Text-fig. 7 and Pl. 19). Differences between these figured specimens and *O. praenuntius* are considerable, however, and include the following:

(i). eyes continue to the posterior marginal border;

(ii). post-ocular ridges absent;

(iii). intergenal spines, when present, close, or comparatively close, to the genal angle;

(iv). markedly different development of the anterior part of the glabella. The hypostomata are comparable except for the degree of accentuation of the serrations.

Differences between *Olenellus getzi* Dunbar and *O. praenuntius* include the following:

(i). frontal lobe touches the anterior marginal border;

(ii). eyes extend only to occipital furrow;

(iii). absence of post-ocular ridges;

(iv). intergenal spines, when observable, close to the genal angle (Dunbar, 1925; Ruedemann and Howell, 1944).

There is not a major character of *O. praenuntius* that cannot be found in some other species but the combination of characters is unique.

The trivial name is derived from *praenuntius* (Latin), a harbinger, or one who announces the approach of others, so named because it may be one of the earliest Cambrian fossils in the arctic islands of Canada.

Genus ***Paedeumias*** Walcott, 1910

1927 *Paedeumias* Raw, pp. 137–141.
1928 *Paedeumias* Raymond, p. 169.
1928 *Paedeumias* Resser, pp. 4–5.
1931 *Olenellus* Bell, pp. 1–23.
1932 *Paedeumias* Poulsen, p. 36.
1936 *Paedeumias* Raw, pp. 242–243.
1938 *Paedeumias* Resser and Howell, pp. 225–226.
1952 *Paedeumias* Riccio, pp. 25–49.
1952 *Paedeumias* Best, pp. 15–16.
1955 *Olenellus* Shaw, pp. 790–794.
1957 *Paedeumias* Palmer, pp. 107, 108, 124, 126.
1959 *Paedeumias* Poulsen, p. 192.

Type species: *Paedeumias transitans* Walcott, 1910, Plate 34, figure 1. (U.S. National Museum No. 56808b)

Diagnosis of the dorsal cephalic features: Cephalon convex, large and broad, semicircular in outline. Glabella generally subcylindrical but may taper forward, about three-quarters the length of the cephalon; frontal lobe about one-third the total cephalic length, tapered rather bluntly, often conical in shape and situated some distance from the anterior border. Dorsal furrows well impressed. Glabellar furrows slightly oblique and extend towards the axis, occasionally across it. Occipital ring separated from the glabella by a strong furrow. Eye lobes elongate and crescentic, extend from the anterior lobe to near the occipital ring. Anterior border usually narrow (never wide), wirelike and rounded, but increases slightly towards the genal angles. A median ridge or ridges may sometimes connect the frontal glabellar lobe to the anterior border. Long slender spines extend backwards from the genal angle a distance equal to about half the length of the cephalon. Intergenal spines sometimes present.

Remarks: Olenellid trilobites can often be easily assigned to the generic group *Olenellus–Paedeumias*, but the distinction between these two genera has tended to become blurred in conception and difficult to apply. However, the genus *Paedeumias* is considered to be valid and useful for species with diagnostic features differing in important respects from species assigned to *Olenellus*.

Paedeumias was originally proposed by Walcott in 1910 to receive forms possessing an opisthothorax with two to six segments transitional between *Mesonacis* (since suppressed) and *Olenellus*. The specimens figured by Walcott under the type species *P. transitans*, although satisfying the generic diagnosis in the thorax and pygidium, have cephala that differ considerably from each other.

Raw (1927, pp. 137–141) claimed that the end form in the evolution of the olenellids was *Olenellus* and recognized an earlier *Paedeumias* stage in the phylogeny; by referring to "*Paedeumias transitans*", in inverted commas, and coupling it with

Olenellus thompsoni as being probably different forms of the same species, he went far towards suggesting the suppression of *Paedeumias*. Raymond in 1928 (p. 169) noted with approval that "Mr. Raw has come to the conclusion that I reached years ago, namely, that *Paedeumias transitans* is merely a complete *Olenellus thompsoni*".

The well-preserved specimen (1910, Pl. 33, fig. 1) that seems to have been favoured by Walcott as the type specimen for *P. transitans* (although no holotype was explicitly designated) was assigned by Resser in 1928 to *Olenellus*, and another specimen (1910, Pl. 34, fig. 1), figured as *P. transitans* by Walcott, was taken as lectotype because it fitted in well with Walcott's remarks that "the typical cephalon of *P. transitans* . . . (has) the anterior lobe of the glabella . . . some distance from the frontal rim of the head, while in typical *Olenellus thompsoni* . . . the anterior lobe touches the frontal rim".

Bell in 1931 pointed out that *Olenellus* and *Paedeumias* have similar opisthothoracic structures, have glabellae that do not reach the anterior margin of the cephalon, and do not always possess intergenal spines; he considered the genera to be identical but retained *Olenellus* on the grounds of priority. Brief characterizations of olenellid genera were published by Poulsen in 1932. *Paedeumias* was noted as possessing intergenal spines, a glabella that is expanded in front, subcylindrical, or slightly conical, and a frontal lobe constituting more than half the length of the glabella (occipital ring not included). Raw (1936, p. 243), referring to Resser's 1928 paper, revised his own earlier opinion and claimed that *Paedeumias* cannot be ancestral to *Olenellus* and apparently accepted Resser's characterization of the genus. Resser, with Howell (1938, pp. 217–227), later gave a revised diagnosis for *Paedeumias*, emphasizing the importance of cephalic features, re-illustrated the lectotype of *P. transitans*, and assigned four new species to the genus. Riccio (1952, p. 33) utilized the criteria given by Resser and Howell in his descriptions of Californian olenellids and attempted to distinguish further between *Olenellus* and *Paedeumias* on certain features of the hypostoma, a course that was later criticized by Palmer (1957, p. 124) who maintained that the distinctions observed by Riccio are due entirely to ontogeny and do not constitute distinctions of generic value. Best (1952, pp. 15–16) briefly discussed *Olenellus* and *Paedeumias* with particular reference to *Olenellus gilberti*, but deliberately refrained from a definite recommendation that *Paedeumias* "should be referred back to *Olenellus*". Shaw (1955, pp. 791–794) claimed that *Paedeumias* should be suppressed as a synonym of *Olenellus* because diagnostic features, such as the position of the glabella and the stalked character of the hypostoma, cannot be uniformly used to segregate species assigned to one or the other genus. The generic status of *Paedeumias* was maintained by Palmer (1957, pp. 105–128), and his ontogenetic studies show consistent differences between *Olenellus gilberti* and *Paedeumias clarki*, even in the earliest instars; he considered the relative breadth of the border to be a character of generic value, observed that specimens of *Paedeumias* have a consistently narrower border than those of *Olenellus*, and claimed that other characteristics that earlier workers have selected to distinguish the two genera have been shown to be inadequate. Poulsen's most recent opinion (1959, p. 192) is that *Paedeumias* differs from *Olenellus* in having a median ridge

extending from the frontal glabellar lobe to the anterior border and a stalk connecting the hypostoma with the rostral plate.

Resser and Howell (1938, pp. 225–227) stipulated that *Paedeumias* should possess the following features:

(i). a glabella situated some distance from the anterior border;
(ii). a frontal lobe to the glabella that tapers rather bluntly;
(iii). an anterior border that is usually narrow (never wide) and increases only slightly towards the genal angles;
(iv). a ridge that connects the median point of the frontal glabellar lobe with the anterior border;
(v). intergenal spines.

With reference to (iv), Resser claimed that the median ridge did not always show on the living animal but resulted from compression of the dorsal test against the stalk of the hypostoma during fossilization. Evidence is often lacking that species that have the median ridge possessed a hypostoma connected by a stalk to the rostral plate. It seems unlikely that a feature of the ventral shield would necessarily be pressed through to appear on the dorsal surface of the dorsal shield. Flattened specimens collected from shales and assigned to *Paedeumias* sometimes do not show the median ridge, whereas other fossils of considerable convexity and preserved in limestone do show it. *Paedeumias tricarinatus* Poulsen and some other species show median ridges that bifurcate; such species may possess as many as seven ridges (Poulsen, 1932, Pl. 11, figs. 12 and 13). This splitting suggests relationships to the soft parts of the trilobite. The median ridges of *Paedeumias* are never significantly out of line with the frontal lobe and have a symmetrical sagittal position; if they were caused only by compression during fossilization it could be expected that occasionally, at least, a ridge would be impressed with a more random, asymmetrical, exsagittal orientation. It seems improbable that the median ridge seen dorsally in species of *Paedeumias* was impressed from the ventral side by the stalk of the hypostoma during fossilization.

Since Resser's publications, difficulties seem to have arisen because specimens are known that satisfy some but not all the diagnostic features listed above; some have been referred to *Paedeumias* while other specimens which display some of the features have been assigned to *Olenellus*. Authors have often agreed in criticizing the difficulties presented by generic distinctions between *Olenellus* and *Paedeumias*, but have been divided in their views as to the correct policy to adopt in dealing with them. Bell and Shaw have argued for the suppression of *Paedeumias*, but Riccio, Palmer, and Poulsen have favoured retention of the genus.

There appear to be a number of species of olenellids which, although resembling *Olenellus* comparatively closely, have a number of features which may not be of generic status taken separately, but which collectively present a morphology that seems to merit assignment to *Paedeumias*. In specimens which possess all five of the diagnostic features enumerated above, as does the holotype of the type species, there seems to be little doubt; in others where only a proportion of the features are present, a difficult decision may have to be made. If features (i), (ii), and (iii) are present, I

maintain that specimens should be assigned to *Paedeumias*, which is here retained as a valid and useful genus.

Paedeumias turmalis n. sp.

Plate II, figures 1–3

Material: The inner surface of the dorsal test of a single fragmentary cephalon.

Description: Cephalon semielliptical in outline, sagittal length 16 mm. Eyes, glabella, and occipital ring together are wider (tr.) than they are long (sag.). In side view, the glabella rises a little above the level of the right eye, which has a vertical surface at its abaxial margin, and stands well above the cheek, which falls away comparatively steeply towards the genal angle. The highest point of the glabella is on the axial line of the frontal lobe opposite the anterior ends of the eye lobes. The glabella and occipital ring appear to be nearly parallel-sided, slightly hour-glass shaped, but increase in width towards the posterior margin. The dorsal furrow is well-defined. The frontal lobe is moderately convex with a change of slope as it reaches the preglabellar field, forming a definite, marked furrow; this anterior margin is bluntly acuminate, including an angle of about 120°. The broad, high eye ridges that arise from the postero-lateral margins of the frontal lobe, and are confluent with them, have at their anterior ends shallow pits that are joined by faint furrows to the dorsal furrow and to the first lateral glabellar furrows. The first lateral glabellar furrows slope acutely but uniformly backwards towards their adaxial ends, just fail to cross the axial line but are deeper and narrower abaxially; they become shallow and swing smoothly backward behind the eye ridges to the dorsal furrow. The second lateral glabellar furrows are more nearly at right-angles to the axial line (towards which they become shallow and disappear), but abaxially they swing smoothly backwards and are faint as they pass to the dorsal furrow. The first lateral glabellar lobes become much larger (exsag.) as they are followed away from the axial line, and have nodular swellings at their abaxial extremities which overlap (exsag.) the frontal lobe and the second glabellar lobe. These swellings are separated from the eye ridge and the palpebral lobe by the abaxial, posteriorly directed extension of the first lateral glabellar furrow. The third lateral glabellar furrows are shallow but well defined and curve gently backwards as traced inwards from the dorsal furrow; they do not meet across the glabella. The third glabellar lobe is wider (tr.) than the second lateral and frontal lobes, and is apparently slightly exceeded in width by the occipital ring, which is preserved only at one abaxial extremity where a small part of the occipital furrow can be seen.

The preglabellar field occupies about one-fifth the sagittal length of the cephalon. A narrow median ridge crosses it from the anterior apex of the bluntly acuminate frontal lobe to the marginal furrow where it bifurcates and disappears. The anterior marginal border is narrow and rises sharply above the preglabellar field; followed laterally towards the genal angles, it does not appreciably vary in width. The preglabellar field and the cheeks are comparatively smooth with only a faint indication of genal caecae; the few cracks traversing the specimen do not represent sutures.

If attention is confined to the more completely preserved right side of the cephalon, the short eye ridge is seen to be confluent with the frontal lobe and rises slightly as it passes into the smooth widely sweeping curve of the palpebral lobe. At its anterior end, the palpebral lobe is directed in an approximately straight line laterally and backwards away from the glabella at about 80° to an exsagittal line; this direction changes in the posterior part to a smooth curve so that the palpebral lobe approaches, but does not reach, the occipital ring. The eye follows the same course, commencing close to the frontal lobe and extending to the posterior end of the palpebral lobe where both taper; the eye is clearly convex although the actual surface is poorly preserved. A marked eye furrow runs between the palpebral lobe and the eye and there is a strong palpebral furrow. Between the palpebral furrow and the dorsal furrow is a rounded hump that is most strongly developed opposite the second and third lateral glabellar lobes.

The posterior margin is partly preserved and commences adaxially as a straight line but outwards takes on a slightly concave shape beyond the eye. The genal angle is not preserved. The border is little raised posterior to the eye and is narrow; it attains greater relief and width with a tumid character as followed towards the genal angle. No intergenal spine can be seen in the preserved length of margin.

Geological horizon and locality: The basal 10 feet of the Police Post Formation, Bache Peninsula. GSC locality 47287.

Holotype: GSC 18046, preserved in limestone.

Remarks: P. turmalis bears no close resemblance to other species of *Paedeumias* but a specimen referred to *Olenellus gilberti* by Palmer (1957, Pl. 19, fig. 19) shows a number of points of similarity. The most striking features of this new species are the pronounced eye furrows, the swollen character of the abaxial portions of the first lateral glabellar lobes, and the marked furrow at the anterior margin of the glabella. The single fragmentary cranidium is well defined; the damage to the occipital ring does not affect the certainty of the diagnosis as a new species of *Paedeumias*. In addition, so much of the marginal border is preserved that there can be no doubt that the spine, if present, must be at, or close to, the genal angle and cannot be advanced in position to any considerable extent. The clearly defined features described above should allow confident identification of other specimens with this species.

The trivial name is derived from *turmalis*, a trooper, so named because the specimens were found near the Royal Canadian Mounted Police Post.

Genus ***Fremontia*** Raw, 1936

Type species: *Olenellus fremonti* Walcott, 1910

Fremontia sp.

Plate II, figures 4–5

Material: One fragmentary cephalon. Closely associated with this cephalic fragment is part of a long slender spine which, although overturned and lying at a slightly different level, may be part of a cephalic spine from the same species.

Description: The fragmentary cephalon has a calculated sagittal length of 10 mm. The glabella is clearly preserved only in the frontal lobe, which is strongly convex and attains its maximum width near the anterior end, giving a blunt appearance with forward expansion. The first lateral glabellar lobe furrow is clearly visible and is directed obliquely backwards. The first lateral glabellar lobe and the second lateral glabellar furrow can be made out but the form of the posterior part of the glabella is almost indistinguishable. The eye and the palpebral lobe curve smoothly, connect by an eye ridge to the posterior part of the frontal lobe, and terminate opposite the anterior half of the third lateral glabellar lobe (the preoccipital glabellar lobe), at some distance from both the glabella and the estimated position of the posterior margin of the cephalon. The dorsal furrow is well impressed except for interruption by the eye ridge. The cheek lobe rises from the dorsal furrow to the adaxial margin of the palpebral lobe, where there is a marked swelling. The distal end of the eye lobe is sharp. The remainder of the cheek is inflated and has a marginal border, moderately wide, well-rounded, and slightly tapered, more raised and convex near the axis. There is no preglabellar field and the glabella abuts against the marginal furrow over a considerable distance due to the blunt anterior termination of the frontal lobe. The posterior lateral margins of the cephalon are not preserved. Cephalic spines (which would be consistent with the other generic features) are not seen but could have been present in the missing portions.

A long slender, curved, tapering spine lies close to the cephalic fragment described above. The minimum length of the spine is 14 mm and the spine may have been much longer. The spine is attached to divergent portions of test which include an angle of about 80° (fig. 5).

Geological horizon and locality: Scoresby Bay Formation, frost-shattered outcrop about 350 feet above base; near Irene Bay, GSC locality 51569.

Figured specimens: GSC 18047 and 18048, preserved in arenaceous limestone.

Remarks: The cephalic fragment agrees with *Fremontia*, Raw's short-eyed olenellid genus (1936, p. 243), in:

(i). the terminations of the eye and palpebral lobe lying opposite the anterior half of the third lateral glabellar lobe at some distance from the glabella;

(ii). the shape of the frontal lobe;

(iii). the manner in which the frontal lobe abuts against the anterior marginal border.

It differs from *Bristolia* in the apparent lack of "hour-glass" constriction in the glabella and in the width and taper of the anterior marginal border. A comparison with *Wanneria* indicates differences in the glabellar shape and segmentation, in the position of the posterior ends of the eyes, and in the width of the marginal border.

The association of the long spine and the cephalic fragment may be fortuitous. It is possible, however, that the spine may belong to the same species as the cephalic fragment, if not to the same individual. If this is so, the genal spine is slightly advanced in position and is of broadly similar shape and position to that of the specimen illustrated as *Olenellus fremonti* by Walcott (1886; 1890; and 1910, Pl. 37, fig. 7). When Resser discussed "*Mesonacis fremonti* (Walcott) Restricted" in 1928, he referred to other figures of *Olenellus fremonti* on Plate 37 of Walcott's 1910 paper but did not include a reference to figure 7. Harrington, in 1956, discussed olenellids with advanced cephalic spines, and redefined *Fremontia* but also ignored this striking figure. A restudy of the specimen would be of interest because, although the development of the spines is bizarre, their position and the other cephalic features agree with an assignment to *Fremontia*.

olenellid gen. and sp. indet. 1

Plate II, figure 6

Material: One internal mould of a fragmentary glabella and occipital ring, with a few fragments of test.

Description: A parallel-sided glabella and occipital ring, sagittal length 12 mm. The frontal lobe is roughly circular in plan.

Geological horizon and locality: Basal 10 feet of the Police Post Formation, Bache Peninsula, GSC locality 47287.

Figured specimen: GSC 18049, preserved in limestone.

Remarks: The preservation precludes generic determination but the parallel-sided glabella and occipital ring, and the circular frontal lobe suggests inclusion in either *Olenellus* or *Paedeumias*. The shape of the frontal lobe suggests, but does not prove, affinity with *Olenellus*.

olenellid gen. and sp. indet. 2

Plate II, figure 7

Material: One fragmentary dorsal shield.

Description: The preserved portion of the cephalon suggests an approximately semi-circular shape. The occipital ring and glabella are parallel-sided with a rounded frontal lobe.

The fragmentary thorax consists of eleven axial rings with parts of the same number of pleural segments on one side.

Geological horizon and locality: Kane Basin Formation, 245 feet below its top, near Ella Bay, GSC locality 51572.

Figured specimen: GSC 18050, preserved in limestone.

Remarks: The state of preservation precludes generic determination but the specimen almost certainly is a species of either *Olenellus* or *Paedeumias*.

olenellid gen. and sp. indet. 3

Plate II, figure 8

Material: A fragment, probably of a cheek.

Description: The small fragment is about 4 mm long and has a network of furrows on the surface.

Geological horizon and locality: Kane Basin Formation, 240 feet below its top, near Ella Bay, GSC locality 51570.

Figured specimen: GSC 18051, preserved in limestone.

Remarks: The ornamentation in conjunction with the concave curve (fig. 8) suggests assignment to the Olenellidae.

Family DORYPYGIDAE Kobayashi, 1935

Genus ***Bonniopsis*** Poulsen, 1946

Type species: *Bonniopsis nasuta* Poulsen, 1946

Bonniopsis was proposed to include small trilobites which differ from *Bonnia* Walcott, 1916, mainly in the shape of the glabella, but also in that the pygidium has a less arched axis and completely lacks a marginal border. The material on which Poulsen based *Bonniopsis* was collected by Bentham from Bache Peninsula and may have been *in situ* (Poulsen, 1946, pp. 300–301).

Bonniopsis sp.

Plate III, figures 1–5

Material: One fragmentary cranidium and three incomplete pygidia (some of which may have thoracic segments attached) consisting of internal moulds and fragments of test.

Description: The incomplete cranidium and pygidia appear to belong to *Bonniopsis* but the state of preservation precludes specific determination. The fragments of test have an average thickness of 0.5 mm and a smooth exterior; details seen on internal moulds do not show through on to the dorsal surface of the test.

Geological horizon and locality: Basal 10 feet of the Police Post Formation, Bache Peninsula, GSC locality 47287.

Figured specimens: GSC 18054 to 18057, preserved in limestone.

Superfamily PTYCHOPARIOIDAE Rasetti, 1951

The superfamily name Ptychoparioidae is used instead of Ptychopariacea Matthew, 1887, because it has a wider scope. Rasetti (1951 and 1963) has cast doubt on the validity and utility of existing suprageneric taxa for this group; accordingly no family or subfamily assignment is given for the specimens described below.

ptychoparioid gen. and sp. indet.

Plate III, figures 6–9

Material: Fourteen cranidia.

Description: Cranidium small, equant, with medium relief. Glabella rises above the level of the cheeks, slightly tapering, straight-sided, truncated anteriorly but with round lateral margins. Glabellar furrows absent; occipital furrow faintly impressed; occipital ring smooth or with only faint medial node. Preglabellar field extremely short (sag.) or absent, so that the dorsal furrow comes close to the anterior border furrow, or merges with it. Anterior border tumid, elevated, upturned, and thickened, particularly medially, with a crescentic outline, slightly arched transversely. Fixigenae convex and slightly inflated at mid-line (tr.) of the cranidium where they are each approximately as wide as the glabella; they rise to palpebral lobes which are moderately large and convex. Eye ridges absent except for a faint "ghost" on one specimen near the glabella (fig. 7). Anterior facial sutures convergent forward, turning inwards near the margin as strongly convergent lines. Posterior facial sutures directed outward and backward. Posterior border rounded, broadens laterally. Surface of test smooth with faint overall pitting that is probably due to the arenaceous character of the limestone and not to corrosion.

Geological horizon and locality: Scoresby Bay Formation, frost-shattered outcrop about 350 feet above the base, near Irene Bay. GSC locality 51569.

Figured specimens: GSC 18061 to 18063, preserved in arenaceous limestone. Each specimen shows a clearer development of a certain feature:

(i). median furrow: GSC 18063, figure 6;

(ii). truncated glabella: GSC 18062, figure 8;

(iii). node on occipital ring and "ghost" eye ridge: GSC 18061, figure 7.

Remarks: The specimens above resemble a number of ptychoparioid trilobites but differ from genera previously established in important respects, as shown by comparisons with:

(1). *Onchocephalus* Resser, 1937; *Periomma* Resser, 1937; *Crassifimbra* Lochman, 1947; and *Proliostracus* Poulsen, 1932.

(2). *Spencia* Resser, 1939; *Stauroholcus* Resser, 1939; and *Spencella* Rasetti, 1963.

The differences of the specimens GSC 18061 to 18063 from the first group of genera are:

(i). the anterior facial sutures definitely converge forwards, turning inwards near the margin; the fixigenae taper forwards;

(ii). eye ridges are absent except for a faint "ghost" on one specimen near the glabella;

(iii). glabellar furrows are absent;

(iv). anterior border is tumid and thickened medially with a crescentic outline showing no sign of median bulge towards glabella;

(v). surface granulations are faint or absent.

Additional points of difference from *Onchocephalus* are shape of occipital ring and depth of occipital furrow; from *Periomma*, preglabellar field small or absent with no median boss, palpebral lobes lying on the mid-line (tr.) of the cranidium, and posterior marginal furrows usually reaching lateral ends of fixigenae; from *Crassifimbra*, fixigenae approximately as wide as the glabella at the mid-line (tr.), occipital ring not narrow and triangular, and preglabellar field small or absent with no prominent median posteriorly directed extension of the marginal border.

The second group of genera are known only from the Middle Cambrian of North America. The specimens GSC 18061 to 18063 are found at the same horizon as olenellid trilobites (in the same rock-fragment in Plate II, fig. 4) and are therefore considered to be Lower Cambrian. They differ from *Spencia*, *Strauroholcus*, and *Spencella* in:

(i). the anterior border of the cranidium is much wider medially, thicker, more swollen, and has a more curved crescentic outline;

(ii). eye ridges are absent or present only as faint "ghosts";

(iii). the palpebral lobes have a greater size and medial (exsag.) position;

(iv). occipital furrow is shallow and lightly impressed.

Additional points of difference from *Spencia* are anterior end of the glabella more truncated, surface of the cranidium smooth, without granulations; from *Strauroholcus*, the absence of an occipital spine; and from *Spencella*, the absence of glabellar furrows, glabella only approximately one-third the total width of the cranidium, no short occipital spine present, or if occipital node is present it is extremely faint, and fixed cheeks more inflated and not declining laterally on the mid-line (tr.) (hence the glabella does not rise as far above the cheeks as it does in *Spencella*).

Poulsen listed *Strauroholcus* as a synonym of *Spencia* in 1954 (p. 445) but these genera are here considered distinct. *Strauroholcus* differs from *Spencia* in that:

(i). the glabella does not extend to the anterior border furrow;

(ii). a median furrow crosses the preglabellar field;

(iii). the anterior border of cranidium is less swollen and comparatively straight in its transverse course;

(iv). the anterior facial sutures run forward with little convergence until close to the margin.

Class CALYPTOPTOMATIDA Fisher, 1962

Family HYOLITHIDAE Nicholson, 1872

Genus ***Hyolithes*** Eichwald, 1840

Type species: *Hyolithes acutus* Eichwald, 1840

Hyolithes sp. indet. 1

Plate III, figure 10

Material: A single fragmentary shell.

Description: A simple straight cone 6½ mm long and 3 mm wide at the apertural end that is incomplete; with a blunt apical termination that is probably also fractured. Cross-section appears to be roughly circular. No surface marking preserved.

Geological horizon and locality: Basal 10 feet of the Police Post Formation, Bache Peninsula, GSC locality 47287.

Figured specimen: GSC 18064, preserved in limestone.

Remarks: The shape agrees with that of *Hyolithes*. The specimen appears to lack a curved and irregular apical extremity and therefore cannot belong to the Family Hyolithellidae.

Hyolithes sp. indet. 2

Plate III, figure 11

Material: A single shell that is little damaged.

Description: A simple straight cone 13 mm long and 4 mm by 3 mm at the apertural end that is elliptical; in cross-section the sharp apical termination is slightly fractured. The surface appears to be somewhat corroded and shows no significant detail. Part of the apertural margin is preserved intact and indicates a smooth convex curve with radius approximately equal to the aperture width.

Geological horizon and locality: Scoresby Bay Formation, frost-shattered outcrop about 350 feet above its base, near Irene Bay, GSC locality 51569.

Figured specimen: GSC 18065, preserved in arenaceous limestone.

Remarks: Agrees with the genus in shape, size, and cross-section, in the apertural convexity of the margin, and in its proportionate radius.

Family ORTHOTHECIDAE Syssoiev, 1958

Genus ***Circotheca*** Syssoiev, 1958

Type species: *Hyolithes stylus* Holm, 1893

Circotheca sp.

Plate III, figure 12

Material: One fragmentary shell.

Description: A simple straight cone 4 mm long and $1\frac{1}{4}$ mm wide at the apertural end that may be complete; somewhat broken at the apex. Cross-section apparently circular. No surface markings preserved.

Geological horizon and locality: Basal 10 feet of the Police Post Formation, Bache Peninsula, GSC locality 47287.

Figured specimen: GSC 18066, preserved in limestone.

Remarks: The specimen is small but agrees with *Circotheca* in its shape.

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A MIDDLE CAMBRIAN PLAGIURA-POLIELLA FAUNULE FROM SOUTHWEST DISTRICT OF MACKENZIE

B. S. Norford

Abstract

A lower Middle Cambrian faunule is described from unnamed beds near the South Nahanni River, District of Mackenzie. The faunule indicates the *Plagiura-Poliella* Zone. Rocks of similar age include the Mount Whyte Formation of southwest Alberta and possibly part of the Cape Kent Formation of northwest Greenland. Two new trilobite species are proposed, *Fieldaspis*? *nahanniensis* and *Kochiella mackenziensis*.

Résumé

L'auteur décrit une faune du Cambrien moyen inférieur provenant de couches anonymes près de la rivière Nahanni-Sud, dans le district de Mackenzie. Il s'agit d'une zone à *Plagiura-Poliella*. Des roches d'âge semblable comprennent la formation de Mount Whyte, dans le sud-ouest de l'Alberta, et peut-être une partie de la formation de Cape Kent, dans le nord-ouest du Groenland. L'auteur propose de nommer les nouvelles espèces de trilobites, *Fieldaspis*? *nahanniensis* et *Kochiella mackenziensis*.

STRATIGRAPHY AND CORRELATION

The trilobites described in this paper were collected by the author in 1963 from a stratigraphic section measured on the northeast limb of a broad anticline east of Broken Skull River. The regional stratigraphy has been described by Gabrielse, Roddick, and Blusson (1965), whose map shows the site of the measured section. The fossils were collected from just above a regional unconformity at the base of map-unit 17 which, at this locality, directly overlies map-unit 13a of Cambrian and/or Precambrian age. The collection was made at 62°21′N, 127°20′W, from limy, silty claystones and siltstones throughout the interval 35 to 50 feet (GSC locality 58467) above the top bed of map-unit 13a. No fossils were found below the collection. Upper Cambrian fossils collected from 1913 to 1917 feet (GSC locality 58468) above the top of map-unit 13a include *Briscoia*? sp. and *Ptychaspis* sp. and indicate the upper Franconian *Ptychaspis-Prosaukia* Zone.

The faunal list for locality 58467 follows:

inarticulate and orthid brachiopods
Fieldaspis? *nahanniensis* n. sp.
Fieldaspis cf. *F. superba* Rasetti
Inglefieldia sp.
Kochiella mackenziensis n. sp.

Each species of trilobite is associated with each of the other three on one or more slabs of rock. The possibility of an Early Cambrian age for the faunule can be discounted on two grounds. Firstly, the genus *Fieldaspis* has been reported only from lower Middle Cambrian rocks in western North America (Lochman-Balk and Wilson 1958). Secondly, olenellid trilobites are widely distributed in Lower Cambrian rocks of the District of Mackenzie and the Yukon Territory, but none are present in the abundant material of the present faunule. The faunule is early Middle Cambrian and represents part of the *Plagiura-Poliella* Zone, the lowest Middle Cambrian zone recognized in western North America by Lochman-Balk and Wilson.

The *Plagiura-Poliella* Zone is well developed in the Mount Whyte Formation of the Lake Louise region of southwest Alberta (Rasetti, 1951, pp. 87–93; 1957, p. 957; Lochman-Balk and Wilson, 1958). The abundant trilobite fauna of the upper part of the Mount Whyte Formation includes two species of *Kochiella*(?) and four of *Fieldaspis*, including *Fieldaspis superba* Rasetti that may also be present (viz. *Fieldaspis* cf. *F. superba*) in the faunule from the anticline east of Broken Skull

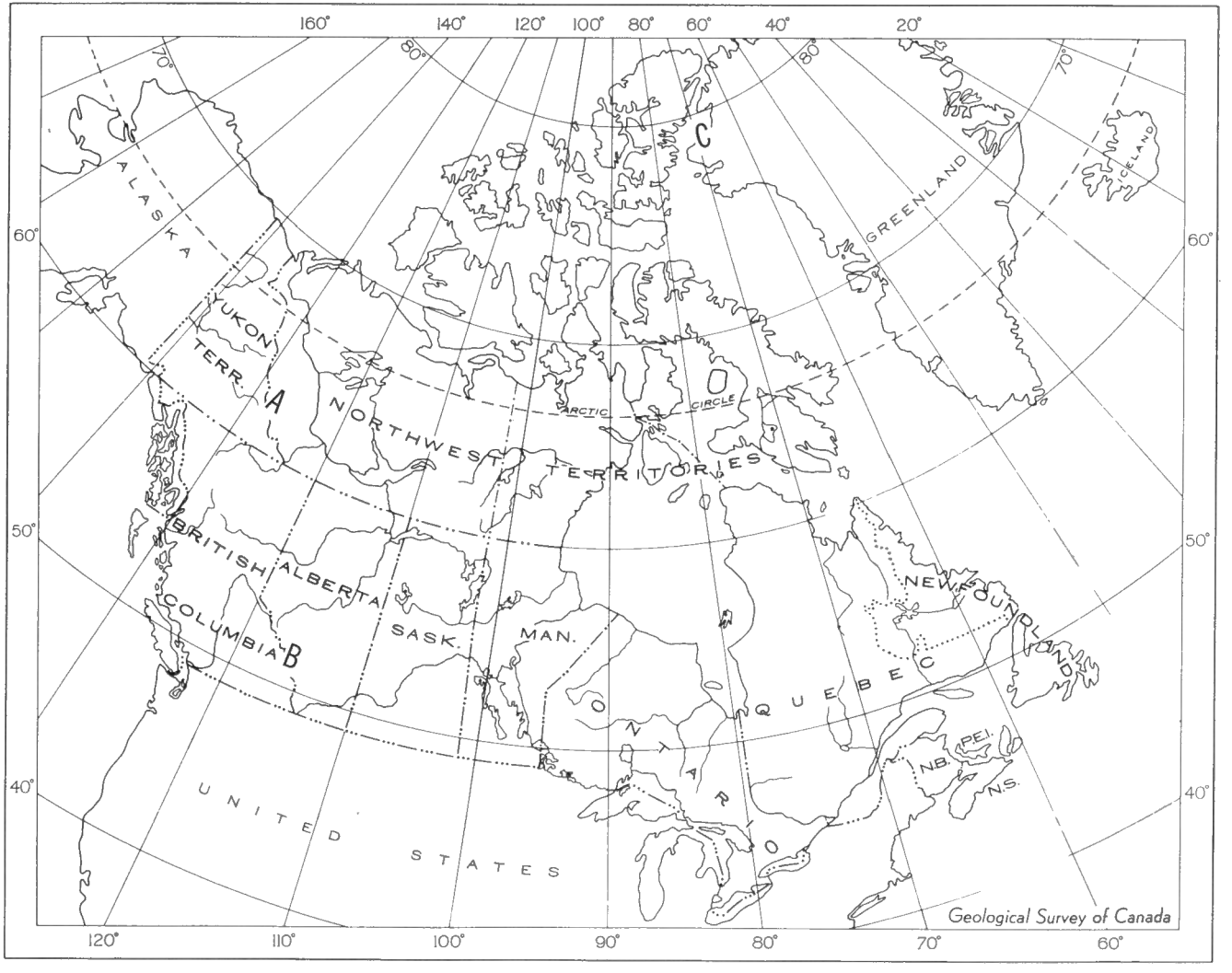

FIGURE 2. Locality map: A, Broken Skull River, District of Mackenzie; B, Lake Louise region, southwest Alberta; C, Cape Kent, Inglefield Land, northwest Greenland.

River. The uppermost part of the underlying Saint Piran Formation contains the *Bonnia fieldensis* faunule (Rasetti, 1951, pp. 82–83) of the Upper *Olenellus* Zone (of Lochman-Balk and Wilson, 1958) of the uppermost Lower Cambrian.

Kochiella and *Inglefieldia* were originally described from eastern Arctic America, where a sequence of thin Lower and Middle Cambrian formations is preserved below disconformable Lower Ordovician rocks in Bache Peninsula, eastern Ellesmere Island, and also on the north coast of adjacent Inglefield Land, northwest Greenland (Chr. Poulsen, 1927 and 1946; Troelsen, 1950 and 1956; V. Poulsen, 1964; Christie, 1967). Poulsen (1927) has described many species from material collected by Lauge Koch from the Cape Kent Formation at Cape Kent, Inglefield Land. The faunule includes species of *Chancia*, *Dolichometopsis*, *Inglefieldia*, *Kochiella*, *Poulsenia*, and *Solenopleura* (Chr. Poulsen, 1927, p. 242; V. Poulsen, 1964, p. 60) but has been dated as Lower Cambrian on the presence of olenellid trilobites. Troelsen (1950, p. 41) considers that most of Koch's material was collected from talus. No fossils have yet been collected from the Cape Kent Formation at Bache Peninsula. The Cape Kent Formation is disconformably overlain by the Middle Cambrian Cape Wood Formation that carries *Glossopleura* in its lower part in both Inglefield Land and Bache Peninsula. At Bache Peninsula, the Cape Kent Formation overlies the Lower Cambrian Police Post Formation that carries fossils of the Upper *Olenellus* Zone (Cowie, *this volume*). In Inglefield Land, the Cape Kent Formation rests disconformably on the Lower Cambrian Wulff River Formation. Wulff River faunal lists (Chr. Poulsen, 1927, 1958; Troelsen, 1956) suggest the Upper *Olenellus* Zone. The presence of *Kochiella* and *Inglefieldia* in the Cape Kent Formation and also in the Middle Cambrian beds near Broken Skull River suggests either a range of the genera from uppermost Lower Cambrian to low Middle Cambrian, or the presence of a low Middle Cambrian horizon within the Cape Kent Formation. A trilobite pygidium, collected from a pebble in a conglomerate within the *Glossopleura* Zone in the lower part of the Cape Wood Formation, has been identified as *Fieldaspis* (V. Poulsen, 1964, pp. 34, 62–63). Poulsen uses this identification as the main evidence for postulating the deposition of rocks of the *Plagiura-Poliella* Zone in northwest Greenland, followed by their removal by erosion prior to deposition of the basal Cape Wood Formation of *Glossopleura* Zone age. The pebble containing the pygidium could possibly have been derived from beds of the Cape Kent Formation.

The beds near Broken Skull River can be correlated with the upper part of the Mount Whyte Formation at Lake Louise and probably with part of the Cape Kent Formation of Inglefield Land. All three faunal deposits are younger than local faunules of the Upper *Olenellus* Zone, but an anomaly is present in Inglefield Land where olenellid trilobites have been reported in association with the *Kochiella-Inglefieldia* assemblage.

Acknowledgments

This report has benefitted greatly from comments and criticism by Dr. Franco Rasetti of Johns Hopkins University and by Dr. W. H. Fritz of the Geological Survey.

SYSTEMATIC DESCRIPTIONS

The type numbers in the descriptions and plate legends are those of the Geological Survey of Canada. All the studied material is stored at the Survey in Ottawa. All of the trilobite species except *Fieldaspis* cf. *F. superba* Rasetti are represented by abundant material, but almost all the specimens are preserved as internal moulds.

TRILOBITA

Genus ***Fieldaspis*** Rasetti, 1951

Type species: *Fieldaspis furcata* Rasetti, 1951, from the Mount Whyte Formation of southwest Alberta

Fieldaspis? *nahanniensis* n. sp.

Plate IV, figures 1–8, 10

Types. Holotype cranidium GSC 19893, paratypes GSC 19889 to 19892, 19894 to 19896, and 19898, all from GSC loc. 58467.

Material studied. Numerous cranidia, several pygidia, fragments of thoraxes and free cheeks.

Description. Glabella gently convex, slightly expanded anteriorly, axial and preglabellar furrows strong, occipital furrow shallow mesially. Occipital ring slightly wider (transverse) than rear of glabella, bearing slender mesial spine. Four pairs of lateral glabellar furrows: 1p strong, trends diagonally rearwards; 2p almost transverse; 3p and 4p inclined slightly forward. Frontal area without border furrow, narrow at sides of glabella, very narrow but continuous in front of glabella. Fixed cheeks moderately convex, maximum width about half minimum glabellar width, width of posterior areas slightly less than that of occipital ring. Palpebral lobes large, crescentic, extend from just in front of wide, shallow, posterior border furrow to just behind 4p. Front part of facial suture subparallels axial furrow but diverges slightly more strongly, rear part transverse for most of course. Free cheek with broad genal spine.

Thorax with long, broad, sharp pleural spines.

Pygidium wider than long, greatest width opposite rear of terminal piece. Axis strongly elevated, tapers rearward, just reaches border furrow, with three rings,

articulating half ring, and terminal piece; rear ring furrow lightly impressed; indistinct low postaxial ridge. Border furrow axially indistinct, meets margin opposite second axial ring furrow. Pleural regions flat, border lobes broadly rounded, with median notch behind axis. Two distinct pairs of pleural furrows and a trace of a third, front one or two just discernible on front of border.

Discussion. The pygidium has a shape similar to that of *Fieldaspis bilobata* Rasetti but has one less axial ring, and the pleural furrows are straight and trend diagonally back from the axial furrow instead of gradually curving back. The anterolateral outline of the pygidium parallels the course of the pleural furrows and thus is more rounded in *F. bilobata.*

Assignment of the species to *Fieldaspis* is difficult and the species may be generically distinct. Rasetti (personal communication, 1965) suggests that a definite border in front of the glabella, the rounded anterolateral corners of the glabella, and the slight curve of the rather short (transverse) posterior area are cranidial features different from those of described species of *Fieldaspis*, and that these features make reference to the genus somewhat questionable.

Fieldaspis cf. *F. superba* Rasetti

Plate IV, figures 9, 11
Plate V, figures 1–3

(?) *Fieldaspis superba* Rasetti, 1951, pp. 162–163

Material studied. Four fragments of cranidia, a pygidium, a fragment of a pygidium, and a free cheek.

Description. Glabella low, strongly expanded anteriorly, axial and preglabellar furrows broad but distinct, occipital furrow indistinct mesially. Occipital ring slightly wider than rear of glabella, bearing slender mesial node. Four pairs of lateral glabellar furrows; 1p trends diagonally rearward; 2p inclined slightly rearward; 3p and 4p inclined slightly forward. Frontal area slightly upturned, very narrow in front of glabella, wider laterally. Course of facial suture from front of palpebral lobe subparallels axial furrow. Border of free cheek and palpebral area has anastomosing markings (Pl. IV, fig. 9 and Pl. V, fig. 2).

Thorax unknown.

Pygidium (excluding spines) wider than long. Axis convex, tapers rearward, composed of four rings, articulating half ring, and terminal piece; ring furrows broad, shallow; very low poorly defined postaxial ridge does not reach border furrow. Border furrow very indistinct, border lobes extend rearward as pair of long marginal spines. Pleural fields slightly convex, marked by four pairs of broad, shallow pleural furrows that just extend onto border. Interpleural furrows indistinct.

Discussion. Fieldaspis superba was described from the Mount Whyte Formation. The present pygidium is slightly narrower than the types of the species, has a shorter

and less distinct postaxial ridge, the pleural furrows are shallower on the border, and the marginal spines diverge at a smaller angle.

Genus ***Inglefieldia*** Poulsen, 1927

Type species: *Inglefieldia porosa* Poulsen, 1927, from the Cape Kent Formation of northwest Greenland

Inglefieldia sp.

Plate V, figures 4, 6–8
Plate VI, figures 9, 10

Material studied. Numerous small cranidia, several free cheeks, one complete cephalon with about eight thoracic segments attached, and two incomplete cephala with thoracic segments attached.

Description. Cephalon suboval, much wider than long. Cranidium subrectangular, low. Glabella faintly convex, tapering forward, with rounded anterolateral corners, axial furrows straight, preglabellar furrow gently curved. Occipital ring bears mesial node near rear; occipital furrow shallow mesially. Four pairs of weakly impressed lateral glabellar furrows: 1p and 2p trend diagonally rearward, 3p and 4p very weak, trend roughly transverse. Preglabellar field flat, almost as wide as border. Border wide, gently convex, a slight axial swelling can be seen on the border of many specimens; anterior border furrow least distinct in axial region where most specimens show a gentle rearward indentation. Palpebral lobes large, strong, crescentic, extend from opposite 3p to just in front of level of occipital furrow. Eye ridges strong, join axial furrows just behind anterolateral corners of glabella. Facial sutures flare laterally from rear of palpebral lobes to cross broad shallow posterior border furrow close to bases of genal spines, slightly divergent from palpebral lobes to anterior border furrow, curve sagitally on border. Free cheek with long genal spine.

Thoracic fragments show a minimum of eight segments.

Pygidium unknown.

Discussion. The cranidium resembles *Inglefieldia porosa* in its general shape and the pattern of the glabellar furrows. The material is not sufficiently well preserved to show fine detail on the small specimens, and no specific identification is attempted.

Genus ***Kochiella*** Poulsen, 1927

Type species: *Kochiella tuberculata* Poulsen, 1927, from the Cape Kent Formation of northwest Greenland

Kochiella mackenziensis n. sp.

Plate V, figures 5, 9
Plate VI, figures 1–8, 11

Types. Holotype cranidium GSC 19908, paratypes GSC 19909 to 19916, all from GSC loc. 58467.

Material studied. Several cranidia, fragments of free cheeks and thoraxes.

Description. Cranidium subtrapezoidal, wider than long. Glabella slightly convex, tapering forward, slightly more raised than palpebral lobes. Axial furrows moderately impressed with shallow fossulae at junctions with faint preglabellar furrow; occipital furrow very faint mesially, strongly impressed laterally. Occipital ring wider than glabella, bearing small mesial spine that is much coarser than the tuberculate ornament. Four pairs of lateral glabellar furrows: 1p trends diagonally rearward; 2p inclined slightly rearward; 1p and 2p shallow adaxially, not quite continuous across axis; 3p short, 4p very short, both pairs inclined slightly forward. Frontal area wide, shallow anterior border furrow swings slightly rearward axially and is not axially continuous, border wide, slightly concave. Palpebral lobes crescentic, extending from opposite 2p to level of occipital furrow. Eye ridges strong, thick, join axial furrows just in front of 4p. Facial sutures trend almost directly forward from palpebral lobes to anterior border furrow, curve across border; posterior portions flare laterally from the palpebral lobes, gently curve to cross moderately deep posterior border furrow. Posterior area of fixed cheek wider than occipital ring. Free cheek incompletely known, with broad blade-like genal spine. Ornament of sparse, coarse tubercles on all parts of cranidium, more abundant on frontal area.

Two fragmentary thoraxes are referred to the species because of their ornament of extremely sparse coarse tubercles. These incomplete thoraxes show twelve and sixteen segments, thus a complete thorax would consist of at least sixteen segments. The segments have flat, recurved, blade-shaped pleural spines. Spines of the front segments are shortened to accommodate the broad genal spine (Pl. V, figs. 5 and 9) that encroaches rearward on the thoracic segments.

Pygidium unknown.

Discussion. Kochiella tuberculata from northwest Greenland, as described by Poulsen, is similar to *K. mackenziensis* but the tubercular ornament is more sparse and the anterior border furrow is continuous in front of the glabella. *Kochiella? maxeyi* Rasetti from the Mount Whyte Formation resembles *K. mackenziensis* but the anterior border furrow is continuous and is not recurved in front of the glabella.

The pygidium here assigned to *Fieldaspis* cf. *F. superba* might be thought to belong in *K. mackenziensis*, but it seems too wide to fit with the rearward tapering thorax of *K. mackenziensis* (Pl. V, fig. 9) and lacks the tuberculate ornament found on all the known parts of the skeleton of the species. The pygidium also lacks the mesial indentation at the rear margin of the pygidia assigned to *Kochiella* by V. Poulsen (1964, pp. 21–23).

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PLATES I-VI

PLATE I

Olenellus praenuntius n. sp. (Page 9)

All specimens from GSC Locality 47522, Kane Basin Formation, 430 feet above base.

Figure 1. Holotype, showing dorsal surface of cephalon, relatively complete except for eyes and genal spines; note post-ocular ridges and occipital node. GSC 18040. x3¾.

Figure 2. Oblique view of same cephalon as figure 1. About x4.

Figure 3. Paratype, incomplete cephalic fragment, part showing dorsal surface and part showing internal mould of dorsal shield; note genal caecae, pitting, terrace lines, reticulation, palpebral lobe, and furrows on first and second lateral glabellar lobes. GSC 18039. x3¾.

Figure 4. Paratype, part of a cephalon showing dorsal shield; note intergenal spines and post-ocular ridges. GSC 18043. x3¾.

Figure 5. Hypostome showing border furrow and serrated posterior margin. Hypotype GSC 18045. x4.

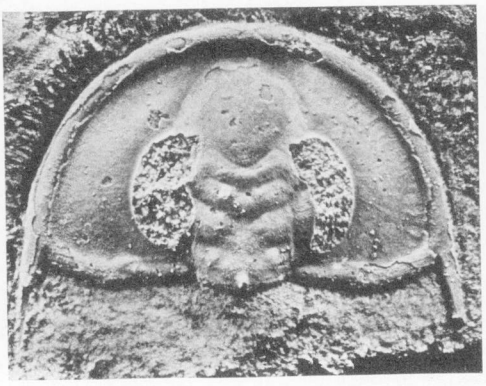
Figure 6. Same specimen as figure 5 in side view. x4.

Figure 7. Latex impression from internal surface of dorsal shield of a small specimen. Hypotype GSC 18041. x5.

Figure 8. Dorsal surface of a young holaspid showing variation in proportions from the holotype and paratypes. Hypotype GSC 18044. x4¼.

Figure 9. Oblique view of same specimen as in Figure 8. About x4.

Figure 10. Dorsal surface of the smallest individual: a young holaspid; note genal spine diverging laterally. Hypotype GSC 18042. x5¼.



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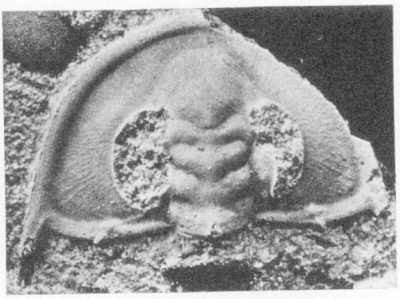

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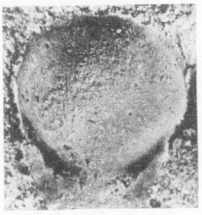

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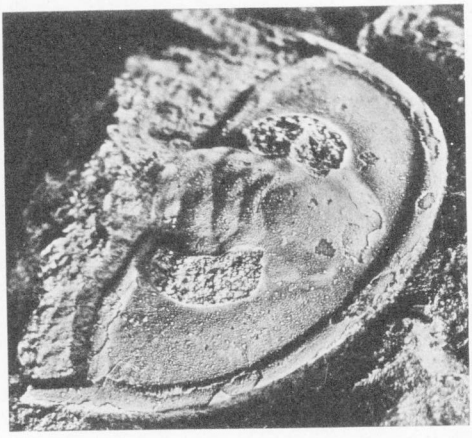

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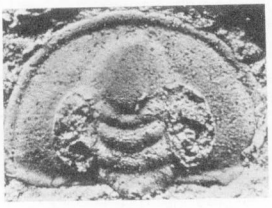

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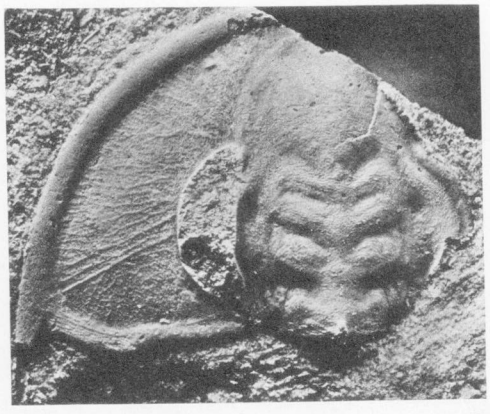

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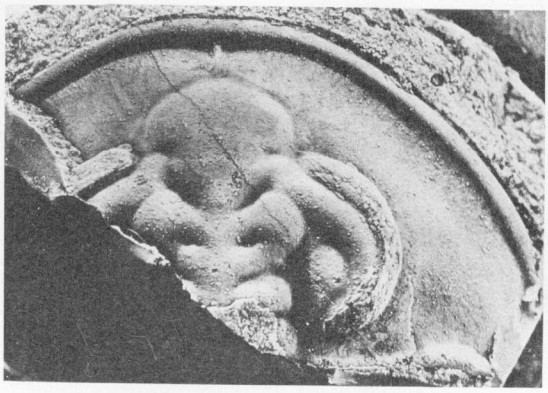

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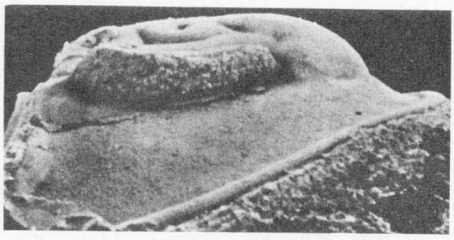

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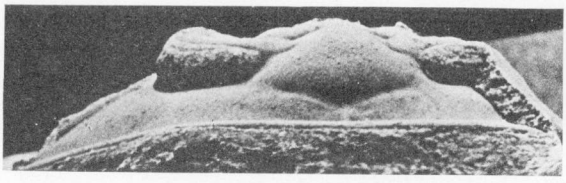

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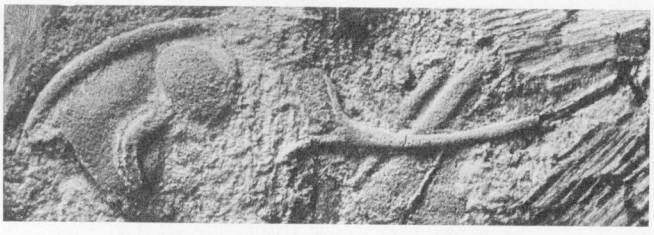

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Plate II

Paedeumias turmalis n. sp. (Page 16)

GSC locality 47287, basal 10 feet of Police Post Formation.

Figure 1. Holotype, latex impression from internal surface of part of dorsal test of cephalon; note median ridge crossing preglabellar field, and eye furrow. GSC 18046. x3.

Figure 2. Side view of same specimen as figure 1. x4.

Figure 3. Front view of same specimen as figure 1; note definite, marked furrow at anterior end of glabella. x3.

Fremontia sp. (Page 17)

Both specimens from GSC locality 51569, Scoresby Bay Formation, frost-sheltered outcrop about 350 feet above the base.

Figure 4. Fragmentary dorsal surface of cephalon associated with long curved spine (note cephalon of ptychoparioid gen. and sp. indet.). Hypotypes GSC 18047, and GSC 18048. x1.

Figure 5. Enlarged view of part of figure 4. x3.

olenellid gen. and sp. indet. 1. (Page 19)

GSC locality 47287, basal 10 feet of Police Post Formation.

Figure 6. Fragmentary dorsal surface of glabella. Hypotype GSC 18049. x2.

olenellid gen. and sp. indet. 2. (Page 19)

GSC locality 51572, Kane Basin Formation, 245 feet below the top.

Figure 7. Incomplete dorsal shield showing cephalon and thorax. Hypotypes GSC 18050. x1.

olenellid gen. and sp. indet. 3. (Page 20)

GSC locality 51570, Kane Basin Formation, 240 feet below the top.

Figure 8. A fragment, probably of a cheek. Hypotype GSC 18051. x9.

PLATE III

Bonniopsis sp. (Page 20)

All specimens from GSC locality 47287, basal 10 feet of Police Post Formation.

Figure 1. Incomplete dorsal surface of cranidium. Hypotype GSC 18055. x5½.

Figure 2. Line drawing from figure 1. x5½.

Figure 3. Internal mould of dorsal fragment of pygidium. Hypotype GSC 18056. x5¼.

Figure 4. Internal mould of dorsal test of pygidium. Hypotype GSC 18057. x5.

Figure 5. Latex impression of fragment of external mould of dorsal test of pygidium and part of ventral surface of dorsal test. Hypotype 18054. x6.

ptychoparioid gen. and sp. indet. (Page 21)

All specimens from GSC locality 51569, Scoresby Bay Formation, frost-shattered outcrop about 350 feet above the base. Faint overall pitting due to arenaceous character of the limestone and not to corrosion.

Figure 6. Cranidium; note median furrow. Hypotype GSC 18063. x5.

Figure 7. Cranidium showing tumid anterior border, node on occipital ring and "ghost" eye-ridge. Hypotype GSC 18061. x5.

Figure 8. Cranidium; note truncated glabella. Hypotype GSC 18062. x5½.

Figure 9. Side view of same specimen as figure 8. x5½.

Hyolithes sp. indet. 1. (Page 23)

GSC locality 47287, basal 10 feet of Police Post Formation.

Figure 10. Fragmentary test. Hypotype GSC 18064. x3.

Hyolithes sp. indet. 2. (Page 23)

GSC locality 51569, Scoresby Bay Formation, frost-shattered outcrop about 350 feet above its base.

Figure 11. Fragmentary test. Hypotype GSC 18065. x1½.

Circotheca sp. (Page 24)

GSC locality 47287, basal 10 feet of Police Post Formation.

Figure 12. Fragmentary test. Hypotype GSC 18066. x4.

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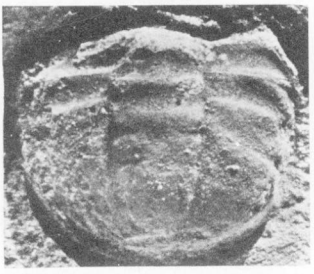

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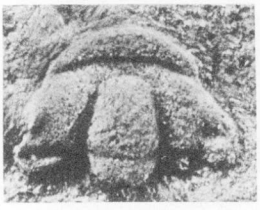

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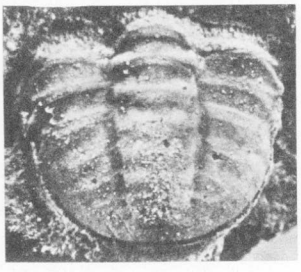

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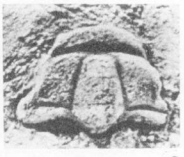

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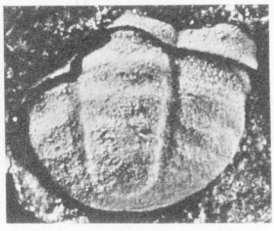

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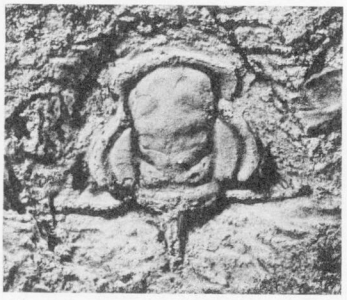

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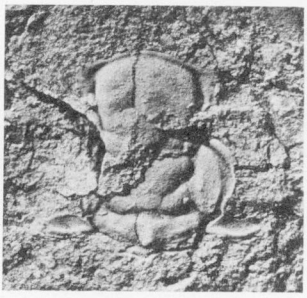

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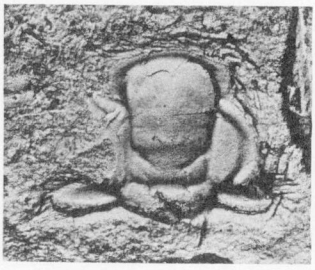

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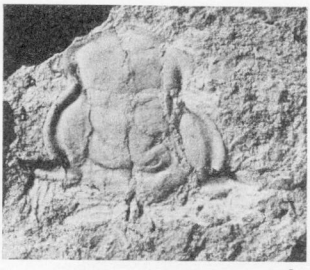

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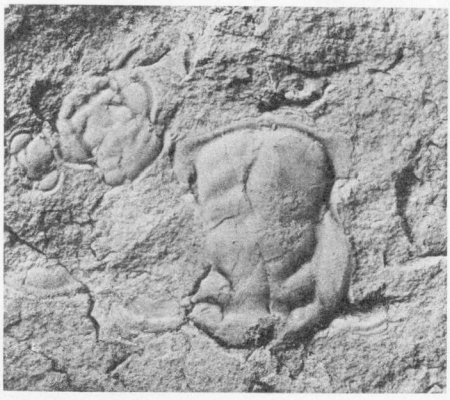

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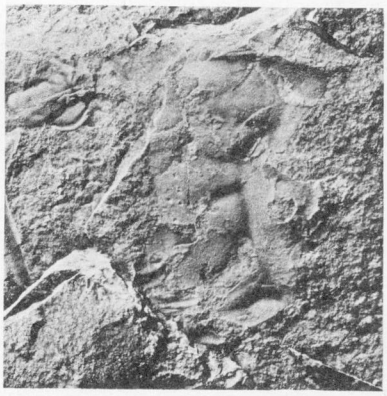

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PLATE IV

Fieldaspis? *nahanniensis* n. sp. (Page 34)

Figures 1, 3, 4, 6, 10. Cranidia (holotype 19893, paratypes 19894, 19892, 19891, 19890, and 19889) from locality 58467, all twice natural size; 19889 (upper left of fig. 10) best shows the lateral glabellar furrows, figures 1 and 3 best show the occipital spine.

Figure 2. Cranidium of figure 4, natural size.

Figure 5. Pygidium (paratype 19896) from same locality, twice natural size.

Figure 7. Ventral surface of a free cheek (paratype 19895) that probably belongs to the species, same locality, twice natural size.

Figure 8. Incomplete thorax and attached pygidium (cast of paratype 19898), same locality, twice natural size.

Fieldaspis cf. *F. superba* Rasetti (Page 35)

Figure 9. Free cheek (hypotype 19897) that may belong to the species, locality 58467, twice natural size.

Figure 11. Fragmentary cranidium (hypotype 19899) from same locality, twice natural size.

PLATE V

Fieldaspis cf. *F. superba* Rasetti (Page 35)

Figures 1, 3. Pygidium (hypotype 19901, largely peeled) from locality 58467, twice natural size. Figure 3 shows the specimen immersed in water to better reveal outline. A ridge marks the impression of the edge of the doublure.

Figure 2. Fragmentary cranidium (hypotype 19900) from same locality, twice natural size.

Inglefieldia sp. (Page 36)

Figure 4. Two incomplete shields (hypotypes 19903 upper right, 19904 lower left) from locality 58467, twice natural size.

Figure 6. Shields of figure 4, natural size.

Figure 7. Cranidium (hypotype 19906) from same locality, twice natural size.

Figure 8. Almost complete shield (cast of hypotype 19902) from same locality, twice natural size.

Kochiella mackenziensis n. sp. (Page 36)

Figures 5, 9. Incomplete thoraxes (paratypes 19915 and 19914) from locality 58467, twice natural size. A fragment of free cheek can be seen on figure 9; ornament of sparse tubercles is shown by figure 5.

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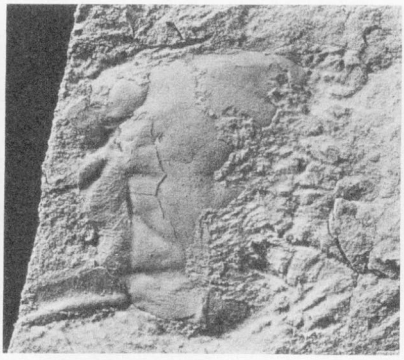

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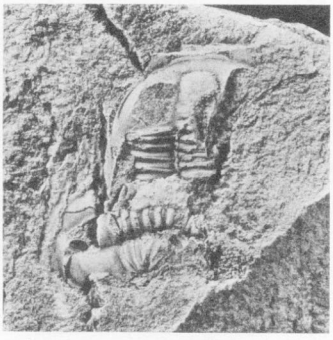

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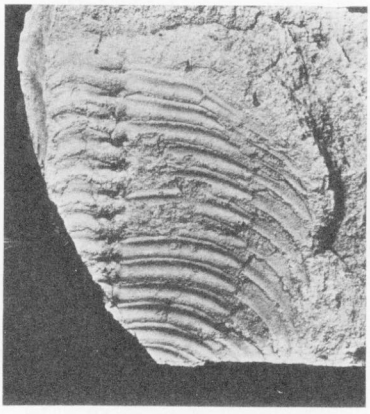

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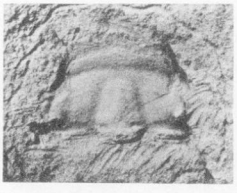

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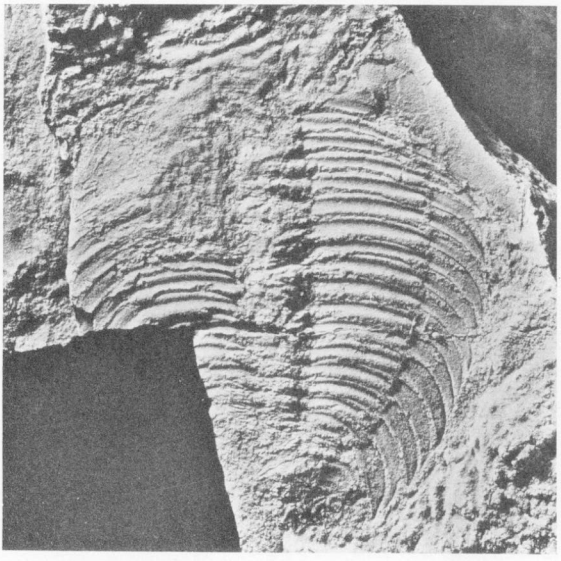

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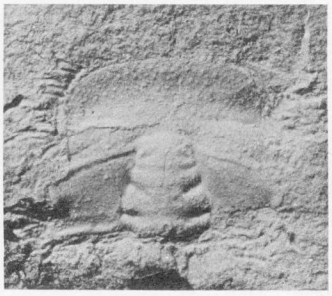

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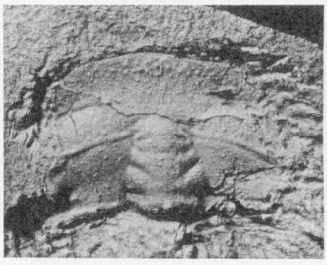

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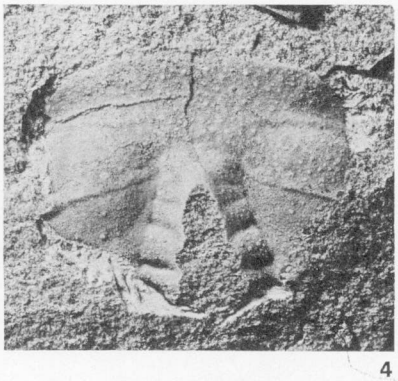

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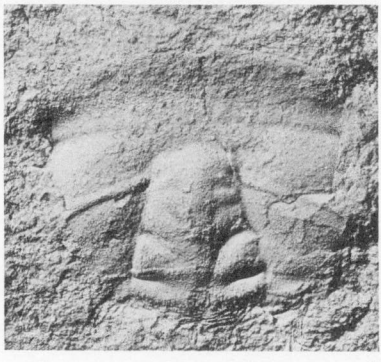

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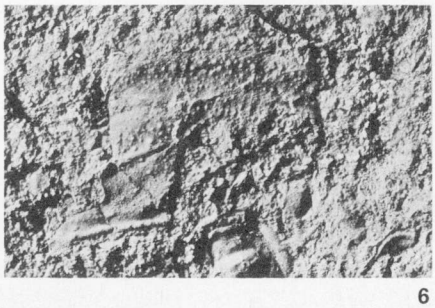

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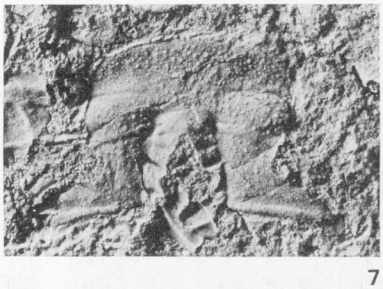

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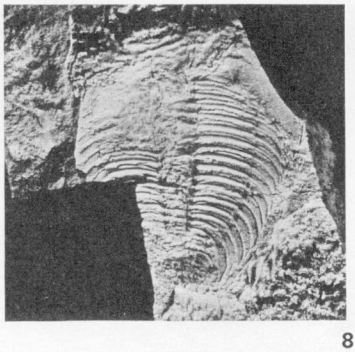

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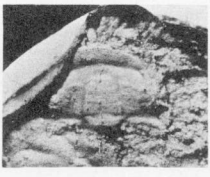

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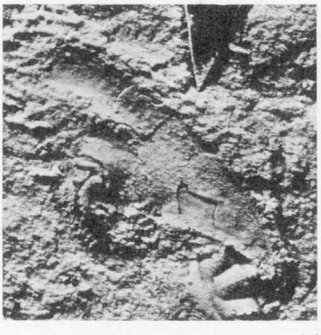

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PLATE VI

Kochiella mackenziensis n. sp. (Page 36)

Figure 1. Holotype cranidium (19908) from locality 58467, twice natural size.

Figure 2. Cranidium of figure 1, natural size.

Figures 3, 4, 5, 6, 7. Paratype cranidia (19911, 19910, 19909, 19913, and 19912) from same locality, twice natural size. Figure 3 shows well the occipital ring and the lateral glabellar furrows; figures 6 and 7 show well the ornament and the posterior part of the fixed cheek.

Figure 8. Incomplete thorax of Plate V, figure 9, natural size.

Figure 11. Incomplete free cheek (cast of ventral surface of paratype 19916a that is mould of 19916) from same locality, twice natural size.

Inglefieldia sp. (Page 36)

Figure 9. Cranidium (cast of hypotype 19905) from locality 58467, twice natural size; the lateral glabellar furrows are well displayed.

Figure 10. Cranidium with one free cheek attached (hypotype 19907) from same locality, twice natural size.

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135 Type lithostrotionid corals from the Mississippian of western Canada, *by* E. W. Bamber, 1966, $1.50 (M42-135)

136 Surficial geology of Dawson, Larsen Creek, and Nash Creek map-areas, Yukon Territory, *by* P. Vernon and O. L. Hughes, 1966, $1.00 (M42-136)

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