MEMOIR 316

TRIASSIC STRATIGRAPHY AND FAUNAS, QUEEN ELIZABETH ISLANDS, ARCTIC ARCHIPELAGO

E. T. Tozer

1961

Plate I. Raanes Peninsula, Ellesmere Island, view looking west towards Eureka Sound and Axel Heiberg Island. The valley in the foreground lies at the head of Blind Fiord. The type section of the Blind Fiord formation is west of the prominent cliffs composed of Permian limestone, chert, etc. The cliffs in the middle distance are composed of shale, and, at the top, calcareous siltstone (Blaa Mountain formation). D marks the position of the *Daonella frami* bed; N, the *Nathorstites* bed. *(RCAF photo T476L176)*

GEOLOGICAL SURVEY
OF CANADA

MEMOIR 316

TRIASSIC STRATIGRAPHY AND FAUNAS, QUEEN ELIZABETH ISLANDS, ARCTIC ARCHIPELAGO

By

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DEPARTMENT OF
MINES AND TECHNICAL SURVEYS
CANADA

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PREFACE

For the past ten years the Geological Survey has been investigating the Queen Elizabeth Islands in the Canadian Arctic. This work has shown that the geological record in these islands is much more complete than was formerly supposed. Although Triassic rocks were discovered there many years ago, until recently very little was known of their extent and faunas. This report describes the Triassic rock and faunal succession and shows that a thick section, representing much of Triassic time, is present.

Hitherto, our knowledge of Canadian Triassic faunas was derived mainly from occurrences in British Columbia, particularly those from the northeastern part of that province. The faunas from the Queen Elizabeth Islands include some assemblages in common with British Columbia and some which are not known there at present. The converse is also true, and the assemblages from the north and the west complement each other in the elucidation of Canadian Triassic faunas.

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

OTTAWA, November 17, 1959

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Abstract

The Triassic rocks of the Queen Elizabeth Islands were deposited in the Sverdrup Basin. Exposures occur on Ellesmere, Axel Heiberg, Melville, Prince Patrick, Cornwall, Borden, Cameron, Brock, Table, and Exmouth Islands.

The section in the axial part of the basin is up to 17,000 feet thick; sections on the south and east margins are thinner. The sediment was probably derived from the south and east.

The ascending sequence of formations in the axial part of the basin is: (1) Blind Fiord (marine siltstone and shale); (2) Blaa Mountain (marine shale and calcareous siltstone); (3) Heiberg (non-marine and marine sandstone, shale and coal). On the margins the sequence is: (1) Bjorne (mainly non-marine (?) sandstone); (2) Schei Point (calcareous siltstone and shale); (3) Heiberg (as within the basin). Thus a thick sequence, mainly shale, characterizes the basin proper and a relatively thin, arenaceous, near-shore sequence occurs in the margins. The near-shore sequence is exposed on Central Ellesmere Island and extends west to Table, Cameron, Melville, Prince Patrick, and Borden Islands. The shale sequence of the basin proper is exposed on western and northwestern Ellesmere Island and on Axel Heiberg Island.

The sequence of marine faunas is as follows: (As no single section contains all the faunas, the sequence is partly hypothetical.)

(1) *Otoceras boreale,* (2) *Ophiceras commune,* (3) *Proptychites strigatus* n. sp., (4) *Proptychites candidus* n. sp., (5) *Prionolobus plicatus* n. sp., (6) *Meekoceras, Arctoceras, Euflemingites, Pseudosageceras,* etc., (7) *Wasatchites tardus,* (8) *Olenikites canadensis* n. sp., (9) *Ptychites* cf. *P. trochlaeformis,* (10) *Daonella frami,* etc., (11) *Nathorstites,* (12) several Karnian faunules with *Sirenites, Arctosirenites* n. gen., *Tropites, Jovites* and *Rhacophyllites,* (13) *Meleagrinella antiqua* n. sp. and *Oxytoma kiparisovae* n. sp., (14) *Monotis ochotica.*

Faunas (1-8) are confined to the Blind Fiord formation and are of Lower Triassic (Scythian) age. Faunas (9-12) occur in the Blaa Mountain and Schei Point formations. Fauna (9) is Anisian; (10) Anisian or Ladinian; (11) Ladinian. The Karnian faunules are probably mainly Lower Karnian. Faunas (13) and (14) occur in the lower part of the Heiberg formation; (13) is Karnian or Norian; (14) is Norian. The upper Heiberg beds are non-marine and are probably of Rhaetian age.

Fauna (6) suggests a correlation between the *Arctoceras* fauna (Spitsbergen) and the *Meekoceras* fauna (Idaho), formerly considered of different ages. In several sections *Nathorstites* occurs below *Halobia* and *Sirenites,* supporting the Ladinian dating suggested by McLearn, Popow and Tuchkov rather than the classical Karnian position.

One new genus (*Arctosirenites*) and fourteen new species of ammonoids, and three new pelecypods are described.

Résumé

Les roches triasiques des îles Reine-Élisabeth se sont déposées dans le bassin Sverdrup. On en a découvert des affleurements sur les îles Ellesmere, Axel Heiberg, Melville, Prince-Patrick, Cornwall, Borden, Cameron, Brock, Table et Exmouth.

La section dans la partie axiale du bassin atteint une épaisseur de 17,000 pieds. Les sections sur les bords sud et est sont plus minces. Il est probable que les sédiments sont provenus du sud et de l'est.

La succession ascendante des formations dans la partie axiale du bassin comprend: (1) Fiord Blind (siltstone et schiste argileux d'origine marine); (2) Mont Blaa (schiste argileux et siltstone calcaire d'origine marine); et (3) la formation Heiberg (grès marin et continental, schiste argileux et houille). Sur les bords du bassin, la succession comprend: (1) la formation Bjorne (grès en grande partie continental (?)); (2) la formation Pointe Schei (siltstone calcaire et schiste argileux); et (3) la formation Heiberg (comme à l'intérieur du bassin). Ainsi une succession épaisse, formée principalement de schistes argileux, caractérise le bassin lui-même, tandis qu'une succession relativement mince, arénacée, de dépôts ordinairement situés à proximité du rivage, se trouve sur les bords. La succession à proximité des bords affleure au centre de l'île Ellesmere et s'étend vers l'ouest jusqu'aux îles Table, Cameron, Melville, Prince-Patrick et Borden. La succession des schistes argileux du bassin proprement dit affleure à l'ouest et au nord de l'île Ellesmere, ainsi que sur l'île Axel Heiberg.

La succession des faunes marines s'établit comme suit (étant donné qu'aucune section donnée ne contient toutes les faunes, la série est partiellement hypothétique):

(1) *Otoceras boreale,* (2) *Ophiceras commune,* (3) *Proptychites strigatus* n. esp., (4) *Proptychites candidus* n. esp., (5) *Prionolobus plicatus* n. esp., (6) *Meekoceras, Arctoceras, Euflemingites, Pseudosageceras, etc.,* (7) *Wasatchites tardus,* (8) *Olenikites canadensis* n. esp., (9) *Ptychites* savoir *P. trochlaeformis,* (10) *Daonella frami,* etc., (11) *Nathorstites,* (12) plusieurs faunules carniennes accompagnées de *Sirenites,* d'*Arctosirenites* n. gen., de *Tropites,* de *Jovites* et de *Rhacophyllites,* (13) *Meleagrinella antiqua* n. esp. et *Oxytoma kiparisovae* n. esp. et (14) *Monotis ochotica.*

Les faunes (1-8) se confinent à la formation Fiord Blind et remontent au Trias inférieur (Scythien). Les faunes (9-12) se trouvent dans les formations Mont Blaa et Pointe Schei. La faune (9) est anisienne; la faune (10) anisienne ou ladinienne; la faune (11) ladinienne. Les faunules carniennes appartiennent probablement en grande partie au Carnien inférieur. Les faunes (13) et (14) se trouvent dans la partie inférieure de la formation Heiberg. La faune (13) est carnienne ou norienne, et la faune (14), norienne. Les couches supérieures de la formation Heiberg ne sont pas marines et remontent probablement au Rhétien.

La faune (6) laisse croire à une corrélation entre la faune *Arctoceras* (Spitsberg) et la faune *Meekoceras* (Idaho), autrefois considérées comme appartenant à des âges différents. Dans plusieurs sections, le *Nathorstites* se retrouve sous l'*Halobia* et le *Sirenites,* ce qui semble confirmer l'hypothèse ladinienne soutenue par McLearn, Popow et Tuchkow, de préférence à la position carnienne classique.

On décrit un nouveau genre (*Arctosirenites*) et quatorze nouvelles espèces d'ammonoïdes et trois nouveaux pélécypodes.

INTRODUCTION

Recent work by the Geological Survey has shown that Triassic rocks are widely distributed in the Queen Elizabeth Islands. The section is thick and apparently records sedimentation throughout much, and perhaps all, of Triassic time. Until 1955 very little was known concerning the Triassic stratigraphy and palæontology of these islands. In the years 1955-58 new field information was gathered and many fossils were obtained. In a report treating such a comprehensive subject it seems hardly necessary to say that scope remains for much more work. However, it is probably true to say that the salient features of the rock and faunal succession have now been established. In this memoir the rock succession is described, the leading fossil faunas are described and illustrated, and their affinities and palæogeographic significance are discussed.

Field Work and Acknowledgments

The field data and fossil collections described in this report have been obtained by various officers of the Geological Survey. Most of the material was obtained by R. Thorsteinsson and the writer. J. G. Souther was the first to study the important section at Buchanan Lake, Axel Heiberg Island. Y. O. Fortier, B. F. Glenister, D. J. McLaren and N. J. McMillan also collected material which is treated in this report. Unpublished field data obtained from these members of the Geological Survey are acknowledged in appropriate parts of this report. Where no such acknowledgment is given the information was obtained by the writer, who is also responsible for all fossil and age determinations and for the stratigraphic correlation and synthesis.

For permission to examine collections, for the loan of types and for the donation of plaster replicas, the writer is indebted to: Dr. G. Arthur Cooper (U.S. National Museum, Washington, D.C.), Dr. Bernhard Kummel (Museum of Comparative Zoology, Cambridge, Mass.), Dr. H. Küpper (Director, Geologisches Bundesanstalt, Vienna), Dr. S. W. Muller (Stanford University, California), Drs. Størmer and Henningsmoen (Palaeontologisk Museum, Oslo), Dr. E. I. White (British Museum (Natural History) London). Dr. Hans Frebold, of the Geological Survey of Canada, kindly made available his private collection of Triassic fossils from Spitsbergen and East Greenland. Through the kindness of Dr. Kummel, the writer has had the opportunity to examine many of the figured Triassic specimens from Spitsbergen which, at the time of writing, were on loan to Dr. Kummel from the Riksmuseum, Stockholm. Dr. Norman J. Silberling of the U.S. Geological Survey has kindly kept the writer informed on the results of his research on the Triassic faunas of the Western United States. Finally the writer wishes to record his gratitude to Dr. F. H. McLearn, formerly of the Geological Survey who though now officially retired is still active, and has, in many discussions, freely shared his great knowledge of Triassic faunas.

Historical Review

Sir Edward Belcher (1855a, b) was the first to collect Triassic fossils from the Canadian Arctic islands. Belcher, who was in charge of a British Admiralty Expedition searching for Sir John Franklin and his men, discovered reptile bones in 1852 on Exmouth Island, an islet north of Grinnell Peninsula, Devon Island. Sir Richard Owen (1855) who described the bones, recognized that they were of Mesozoic age, but their Triassic provenance was not apparent until the writer visited Exmouth Island in 1957.

Per Schei (1903) geologist of the Second Norwegian Expedition in the *Fram,* led by Captain Otto Sverdrup, should be credited with the first discovery of recognizable Triassic fossils within this area. Schei's fossils were described by Ernst Kittl (1907) who recognized that Karnian, and possibly also Ladinian, faunas were represented. Schei's exploratory work established that Triassic sandstone and shale, together with some limestone, is widely distributed on the western shores of Ellesmere Island, from Bjorne Peninsula to Blaa Mountain, and on the islands at the mouth of Bay Fiord.

Members of the Danish Thule and Ellesmere Land Expedition, 1939-41, were the next to study Triassic rocks in the Archipelago. Gudmundur Thorlaksson, botanist of the Expedition, collected Triassic fossils near Blind Fiord and on the coast of Raanes Peninsula. Thorlaksson's collections were briefly described by J. C. Troelsen (1950), geologist of the same expedition, who himself made observations on the Triassic stratigraphy of western Ellesmere Island. Troelsen named two Mesozoic formations: the Blaa Mountain and Cape With formations. In the Blaa Mountain formation he placed the fossiliferous beds of Eureka Sound. The section at Blaa Mountain was designated the type, but Troelsen did not observe, or at any rate did not describe, the upper and lower boundaries of the formation. The Cape With formation was named for exposures in Canyon Fiord. Troelsen recognized that the Cape With formation rested with an abrupt but conformable contact upon Permian rocks. From this formation Troelsen collected specimens of *Gryphaea.* These he determined as Mesozoic but he was unable to decide whether they were Triassic or Jurassic. The failure of the distinctive, relatively fossiliferous Triassic beds of Eureka Sound (Blaa Mountain formation) to appear above the Permian in Canyon Fiord evidently, and quite understandably, puzzled Troelsen, both in 1940 and after a second visit to the area 12 years later (Troelsen, 1952).

Previous Stratigraphic Nomenclature

As already noted, Troelsen (1950) named the Blaa Mountain and Cape With formations. The Blaa Mountain formation was loosely defined, as Troelsen simply designated a type section without defining the upper and lower boundaries. This formation has now been more precisely defined (*see* p. 18) and as such is in use by the Geological Survey. The writer's study of the Cape With formation has shown that these beds are of Triassic age and time equivalents of lithologically different strata in Eureka Sound. Furthermore, the Cape With formation includes two distinct lithological units, which have been named the Bjorne and Schei Point formations (GSC Prel. Map 21-1959). The stratigraphic name "Cape With" designates a composite unit and consequently the name is not in current use by the Geological Survey of Canada.

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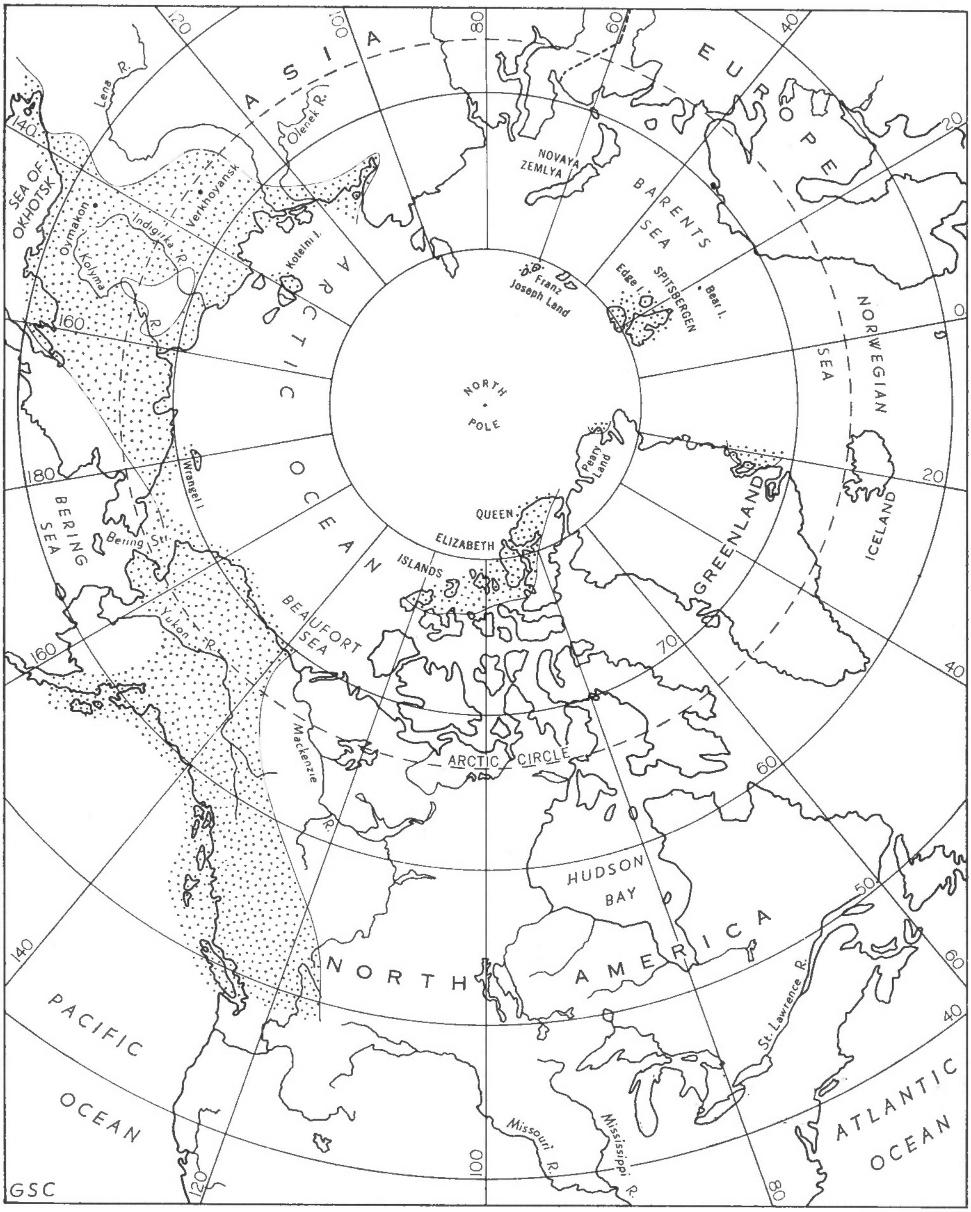


Figure 1. *Map showing known and probable extent of marine Triassic sedimentation (stipple), Queen Elizabeth Islands and other Arctic regions. The discovery of marine Triassic (Karnian) rocks on Wilczek Island (Franz Joseph Archipelago) has recently been recorded by Popow (1958b).*

STRATIGRAPHY

Summary of Stratigraphy and Nomenclature

The Triassic rocks of the Canadian Arctic islands occur in the Sverdrup Basin. Exposures occur on Ellesmere, Axel Heiberg, Cornwall, Table, Exmouth, Cameron, Melville, Prince Patrick, Brock, and Borden Islands. They also occur on the small islands in Eureka Sound, between Ellesmere and Axel Heiberg Islands. The southern and eastern limits of Triassic rocks are shown by the heavy line on Figure 1. Triassic exposures are widely distributed in the area north and west of this line. Except where removed by erosion, Triassic rocks probably occur throughout this area, e.g., beneath the Ringnes Islands, etc.

The south and east limits of Triassic rocks define, approximately, the limits of the Sverdrup Basin. The sections near these east and south limits are relatively thin. Traced towards east-central Axel Heiberg Island they thicken considerably. It seems reasonable to regard the thin sections in the southern and eastern areas as having been deposited on the margins of the basin (the margin being defined as the area where the rate of sedimentation was relatively slow), and to regard the thick sections as the sediments of the axis of the Basin.

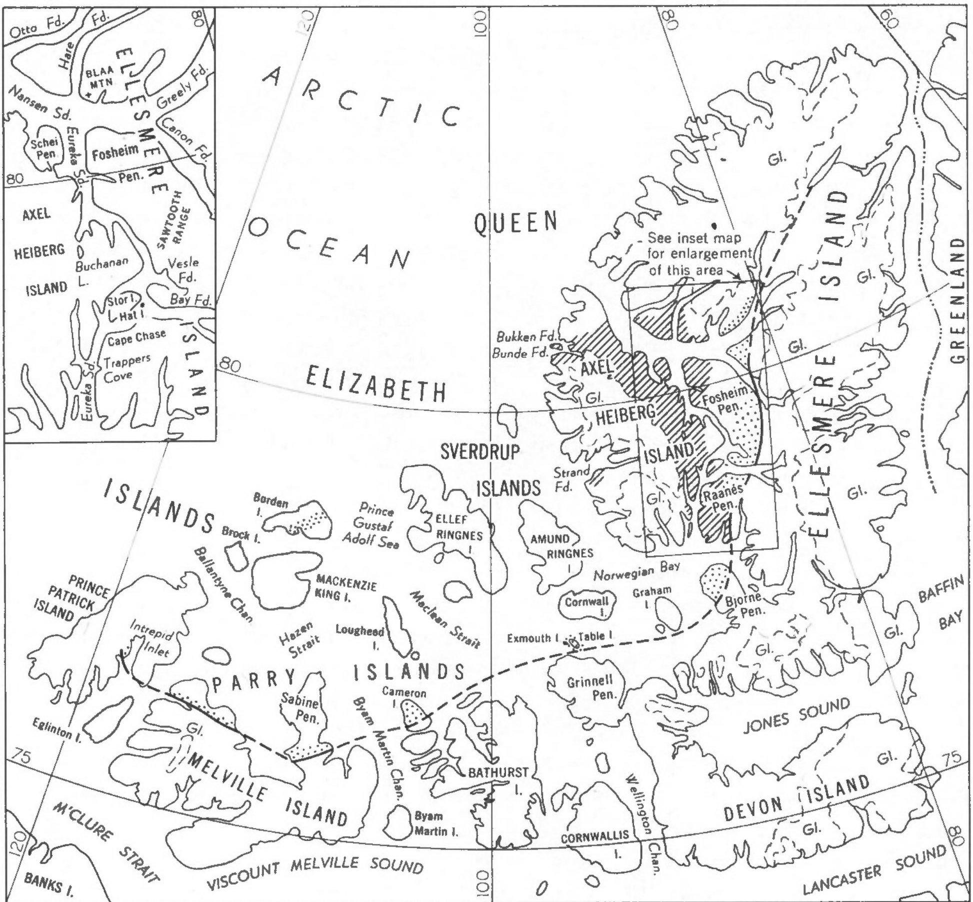
The Triassic sections on the southern and eastern margins of the basin differ from those of the axis, not only in thickness, but also in lithology. The scheme of formation names adopted for the margins therefore differs from that used in the axial part.

Most of the rock on the margins consists of sandstones and calcareous siltstone, with some shale and limestone (Bjorne and Schei Point formations). The bulk of the rock in the axial part of the basin is shale and siltstone (Blind Fiord and Blaa Mountain formations). The youngest Triassic formation (Heiberg) consists mainly of non-marine sandstone, with some marine bands in the lower part. This formation, unlike the underlying Triassic beds, is essentially uniform in lithology throughout both the margins and the axis of the Sverdrup Basin.

The scheme of nomenclature adopted is shown in the following table.

<table>
<tr><th rowspan="2">Series</th><th rowspan="2">Stage</th><th>Axis of Sverdrup Basin</th><th>Margins of Sverdrup Basin</th></tr>
<tr><td colspan="2">Overlying beds: Jurassic. Commonly Toarcian, Sinemurian present in some sections</td></tr>
<tr><td rowspan="3">Upper Triassic</td><td>Rhaetian and lowermost Jurassic (?)</td><td colspan="2" rowspan="3">HEIBERG FORMATION
Mainly non-marine sandstone and shale; some coal in upper part; marine bands in lower part. Up to 4,700 feet thick</td></tr>
<tr><td>Norian</td></tr>
<tr><td>Karnian or Norian</td></tr>
<tr><td rowspan="3">Middle Triassic</td><td>Karnian</td><td rowspan="3">BLAA MOUNTAIN FORMATION
Grey and black shale and siltstone with members of calcareous siltstone and shale in some sections. Up to 8,255 feet thick (marine)</td><td rowspan="3">SCHEI POINT FORMATION
Grey calcareous siltstone and sandstone. Some shale near base and, in some sections, near top. Up to 1,500 feet thick (marine)</td></tr>
<tr><td>Ladinian</td></tr>
<tr><td>Anisian</td></tr>
<tr><td>Lower Triassic</td><td>Scythian</td><td>BLIND FIORD FORMATION
Green and grey siltstone and shale. Up to 4,000 feet thick (marine)</td><td>BJORNE FORMATION
Mainly sandstone, some conglomerate; commonly red weathering. Possibly as much as 3,000 feet thick in some sections but commonly less. (Partly marine, but much of the formation may be non-marine)</td></tr>
<tr><td colspan="4">Underlying beds: in most sections, Permian</td></tr>
</table>

The Schei Point and Bjorne formations, composed of relatively coarse clastic material, represent near-shore deposits. The Blaa Mountain and Blind Fiord formations represent sediments laid down at a greater distance from the shoreline. The distribution of the facies belts is shown by Figure 2. It is apparent that the near-shore facies occurs at, and adjacent to, the present-day south and east limits of Triassic exposures. It is therefore probable that the present-day limit coincides approximately with the Triassic shoreline. It is generally held that the Arctic Ocean of Mesozoic time was much like the ocean of today. The Triassic rocks of the Canadian Arctic islands evidently represent deposits laid down in seas that transgressed from this long-lived ocean.



LEGEND

Sandstone-calcareous siltstone facies (Bjorne and Schei Point formations)

Shale-siltstone facies (Blind Fiord and Blaa Mountain formations)

Note: Boundaries between facies belts concealed on Fosheim Peninsula, by younger formations

South and east limits of Triassic rocks (defined and approximate) . . . .

Glacier . . . . Gl.

Miles

150 0 150

GSC

Figure 2. ***Map of Queen Elizabeth Islands showing distribution of Triassic lithofacies belts.***

The Triassic section within the Sverdrup Basin apparently lacks internal unconformities. Marine faunas represent every stage except the Rhaetian, and non-marine Rhaetian sediments are probably present. On the margins of the basin the situation is somewhat different. Lower Triassic fossils are rare. Well-preserved, diagnostic, Lower Triassic faunas are unknown. Consequently it is impossible to state how much of Lower Triassic time is represented in the Bjorne formation. In some sections the Schei Point formation contains Anisian, Ladinian and Karnian faunas and, like the Blaa Mountain formation, probably records essentially continuous sedimentation. Examples are the sections exposed on Bjorne Peninsula, Exmouth Island and Table Island. In other areas the Schei Point formation apparently records a shorter interval of time. One such locality is Intrepid Inlet, Prince Patrick Island, where the Schei Point beds are transgressive and rest directly upon Devonian rocks. In this section the Schei Point beds are of Ladinian or Karnian age, probably the latter. Anisian rocks are apparently absent. The Schei Point sequence of Cameron Island (p. 17) is probably also incomplete, compared with the section to the east.

A prominent line of division occurs within the Triassic sequence, both within the basin and on the margins. Within the basin this division occurs at the Blind Fiord-Blaa Mountain contact; on the margin it occurs at the Bjorne-Schei Point contact. Both contacts mark an abrupt change in lithology in most, and probably all, sections. Anisian fossils are the first to appear above these contacts, in both the Schei Point and Blaa Mountain formations. Upper Scythian fossils occur beneath this contact in the Blind Fiord formation. It follows that this line of division may mark the boundary between the Lower and Middle Triassic. It is perhaps significant that on the margin of the Sverdrup Basin the Bjorne-Schei Point boundary represents about the same time horizon, and marks a change in sedimentary environment, analogous to the boundary between the Bunter and Muschelkalk of northwestern Europe. In both areas the change is from essentially non-marine to marine deposition. The Muschelkalk was probably deposited in a transgression from the Tethys, where the classic marine sequences are preserved. The appearance of the marine, Anisian, Schei Point beds above the mainly non-marine Bjorne formation may indicate that this transgression was a widespread event.

Within the Sverdrup Basin, the Blaa Mountain-Heiberg boundary is the complete antithesis of the Blind Fiord-Blaa Mountain boundary. The upper boundary of the Blaa Mountain formation (with the Heiberg) is completely transitional and the evidence suggests continuous sedimentation with a gradual change to non-marine conditions of deposition. The Schei Point-Heiberg boundary, on the margin of the basin, may be more abrupt, but good exposures have not yet been found.

The Permo-Triassic Boundary

The Permo-Triassic boundary is not marked by angular unconformity in the Sverdrup Basin. In all sections where the Triassic rests upon the Permian, the rocks of each system appear to be structurally conformable. However, an abrupt change in lithology occurs at this boundary and it is probably paraconformable, i.e., it probably marks an interval of non-deposition and marine regression. The oldest Triassic fauna in the Arctic islands is the oldest known anywhere in the world (*Otoceras* fauna). Despite this, there is no evidence whatsoever to suggest that sedimentation was continuous from the Permian to the Triassic.

The nature of the Permian rocks immediately beneath the Triassic beds varies considerably. In some sections (e.g., Buchanan Lake, Axel Heiberg Island) these Permian rocks are dark shales and siltstones, with fusulinids. In others (e.g., Bjorne Peninsula and Blind Fiord, Ellesmere Island) fossiliferous Permian chert and limestone underlie the basal Triassic rocks. At Trold Fiord and on Melville Island, green, glauconitic Permian strata (Assistance formation) underlie the Triassic beds. These variations in the sub-Triassic surface are partly a function of changes in facies in Permian time. However, it is probable that the basal Triassic beds rest, in different sections, on different parts of the Permian sequence, i.e., the sub-Triassic Permian rocks probably differ in age from one section to another. From a regional standpoint the Permo-Triassic boundary is probably a gently undulating unconformity.

Bjorne Formation

The Bjorne formation was named by the writer (*see* GSC Prel. Map. 21-1959, *in* Fortier, *et al., in press*) to include the quartz sandstone that lies between the Permian and Schei Point formations. The type section is on the southwest limb of the Goose Point anticline, Bjorne Peninsula, Ellesmere Island.

This formation consists essentially of sandstone, commonly crossbedded and with thin seams of conglomerate. The sandstones are generally light coloured but frequently weather red or brown.

The Bjorne formation represents the "unfossiliferous yellow, reddish-weathering sandstone" at the base of the Cape With formation (Troelsen, 1950, p. 74).

The Bjorne formation is now known at the following localities:

1. North side Greely Fiord, between Borup and Tanquary Fiords (Troelsen, 1950, p. 76; also seen by the writer from the air in 1957).
2. East Cape, Canyon Fiord (Troelsen, 1950, p. 76; Thorsteinsson and Tozer, unpublished).
3. Cape With, Canyon Fiord (Troelsen, 1950, p. 75; Thorsteinsson and Tozer, unpublished).
4. Along foothills of "Sawtooth Range", Fosheim Peninsula, from Cape With to Vesle Fiord (Thorsteinsson and Tozer, unpublished).
5. North side Bay Fiord, on one fault block opposite Gretha Islands and on another opposite Hat Island (Thorsteinsson and Tozer, unpublished).
6. Prominent cliffs on south side of Bay Fiord, opposite Hat Island.
7. Head of Trold Fiord. ("Permian and (or) Triassic sandstone" of Tozer, *in* Fortier, *et al., in press;* GSC Prel. Map 21-1959).

8. Bjorne Peninsula (type section). (Tozer, *in* Fortier, *et al., in press;* GSC Prel. Map 21-1959).

9. Table Island

10. Exmouth Island

11. Cameron Island ("Permian and (or) Triassic sandstone" of Tozer, *in* Fortier, *et al., in press;* GSC Map 18-1959).

12. Melville Island (Thorsteinsson and Tozer, 1959).

The thickness ranges from 1,700 feet (on Bjorne Peninsula) to perhaps as much as 3,000 feet (in the Sawtooth Range).

From the foregoing list it may be seen that the Bjorne occurrences form a reversed "L", following the east and south margins of the Sverdrup Basin.

The Bjorne formation is generally unfossiliferous. The prevalent cross-bedding and the paucity of fossils suggest that much of the formation was deposited above sea-level. A few pelecypods and the impression of an ammonite were collected from a thin bed about 100 feet from the top of the type section, on Bjorne Peninsula. The pelecypods include shells that may represent *Anodontophora* (common in Lower Triassic rocks); the ammonite is a smooth form, as are many Lower Triassic ammonoids. *Myalina* sp. indet., another pelecypod common in the Lower Triassic of Greenland and Spitsbergen, occurs north of the Gretha Islands. These fossils are compatible with a Lower Triassic dating but they are too poorly preserved for a precise age determination.

As the fossils do not assist in dating these rocks, it is necessary to consider other data that might assist in determining the age of the Bjorne formation.

The following points are relevant:

1. In most sections the Bjorne beds rest on Permian strata, and the contact, although apparently conformable, is abrupt. It follows that the Bjorne formation is not older than Permian and is probably younger.

2. Anisian fossils occur near the base of the Schei Point formation, which overlies the Bjorne beds. These fossils have been collected at two localities: north side of Bay Fiord, opposite the Gretha Islands; and Exmouth Island. In the type section *Daonella frami* (Anisian or Ladinian) occurs above the Bjorne beds. The Bjorne formation is therefore not younger than Middle Triassic.

3. The Bjorne formation lies between Permian and Middle Triassic rocks on the margin of the Sverdrup Basin. Within the basin, the Blind Fiord formation, with Lower Triassic fossils, occupies this same interval. A correlation between the Blind Fiord and Bjorne formations is therefore suggested on the grounds of their analogous stratigraphic position.

4. North of Vesle Fiord and at the mouth of Bay Fiord, thin beds of green, fine-grained sandstone and siltstone (of Blind Fiord lithology) are interbedded with the typical red weathering Bjorne sandstone. In these areas the Bjorne and Blind Fiord formations apparently interfinger.

All these points suggest that the Bjorne formation is the same age as the Blind Fiord formation, which contains several Lower Triassic faunas, ranging in age from lowest to highest Scythian.

Blind Fiord Formation

The Blind Fiord formation was named by the writer (*in* Fortier, *et al., in press;* GSC Prel. Map 21-1959). In the type section northwest of Blind Fiord, Ellesmere Island, this formation comprises about 3,700 feet of green and grey, partly micaceous, siltstone (*see* Pl. I). Exposures are intermittent and considerable shale may be interbedded with the siltstone. These beds rest on Permian strata and are overlain by the Blaa Mountain formation. The Permo-Triassic boundary is structurally conformable but it marks a very abrupt change in lithology and is almost certainly paraconformable. Ripple-marks and fine cross-bedding are common in the Blind Fiord beds of this section.

The Blind Fiord formation is also known at Buchanan Lake, Blaa Mountain, and on the coast of Nansen Sound, between Hare and Otto Fiords. In the Bunde Fiord area, northern Axel Heiberg Island, R. Thorsteinsson found some particularly fossiliferous sections of great interest.

From the brief lithological description the reader might be led to assume that the Blind Fiord formation is essentially the same as the overlying Blaa Mountain formation. However, the Blind Fiord siltstones are very distinctive. They are grey and green, medium to thin bedded, commonly micaceous, weakly calcareous to non-calcareous and they weather green or reddish brown. In some sections considerable grey shale is interbedded with these siltstones. Where the beds are well exposed, the Blind Fiord-Blaa Mountain contact is seen to be very sharp. This contact is well shown on the face of Blaa Mountain (*see* Pl. III B); it is also conspicuous in the section 6 miles northwest of the entrance to Hare Fiord (*see* Pl. II A). In the type section (which was studied early in the present investigation) no exposures were found to define this contact precisely. However, future work may show that a sharp contact characterizes the upper boundary in the type section.

Thicknesses of the Blind Fiord formation are as follows:

Section	Thickness (feet)
Blind Fiord (E. T. Tozer)	ca 3,700
Buchanan Lake (J. G. Souther)	4,000
Blaa Mountain (Thorsteinsson and Tozer)	3,000+ (incomplete)
Four miles northwest of entrance to Hare Fiord (Thorsteinsson and Tozer)	2,800
South side Otto Fiord, near mouth (Thorsteinsson)	1,800
South side Bunde Fiord (Thorsteinsson)	1,100

The Blind Fiord formation is mainly unfossiliferous, but thin beds at several localities contain ammonoid faunas. All the faunas are of Scythian age. No section

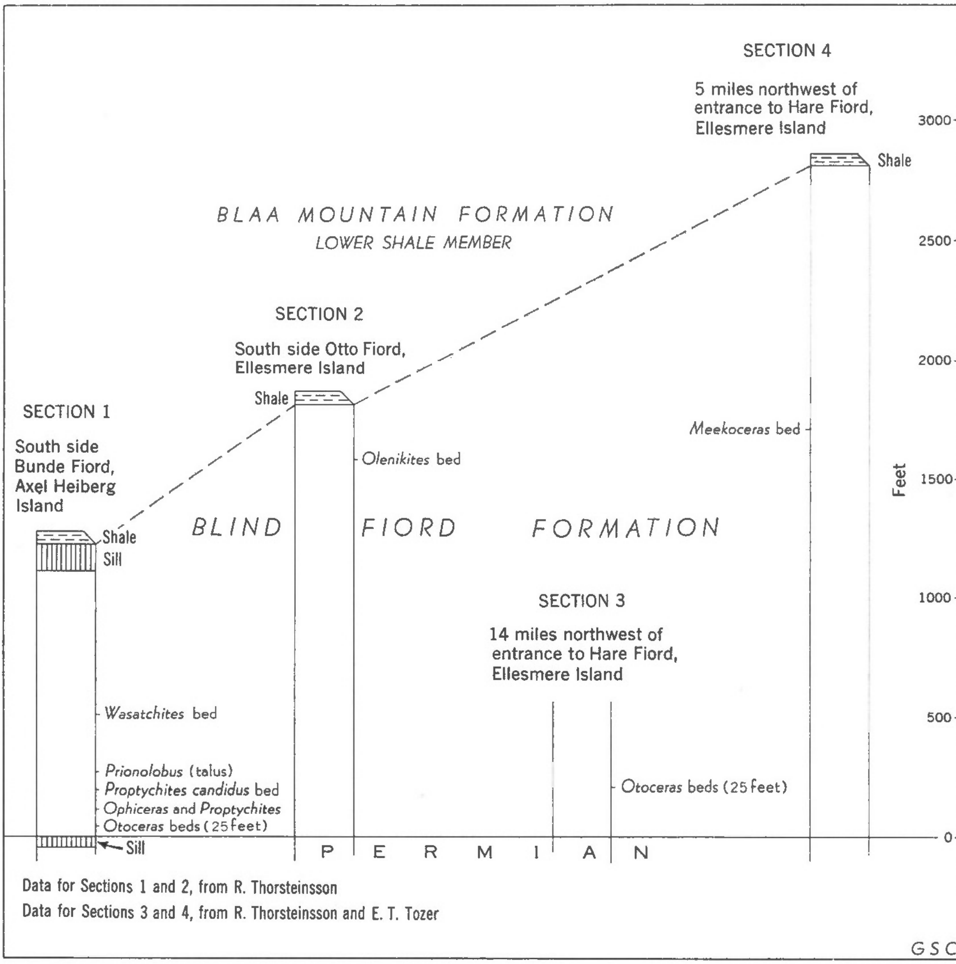


Figure 3. ***Columnar sections showing positions of fossiliferous beds with Lower Triassic faunas, in the Blind Fiord formation.***

in the Archipelago contains all the faunas, consequently the local sequence cannot be stated as a fact but is in part hypothetical. The faunas in the following list are represented. They are arranged in what is believed to be their correct stratigraphic sequence, but it should be noted that the fauna with *Meekoceras* may be the same age as the fauna with *Wasatchites* (*see* p. 31). The extent to which this faunal sequence is based on observations within the Archipelago, as opposed to comparison with other parts of the world, may be seen by comparing the list of faunas with Figure 3. In this figure the relative position of these faunas is shown. Their correlation and affinities are discussed in the following chapter.

Fauna	Distribution
	Upper Scythian
Olenikites canadensis n. sp. *Posidonia aranea* n. sp.	Otto Fiord, Ellesmere Island
Xenoceltites subevolutus Spath *Wasatchites tardus* (McLearn) *Pseudomonotis occidentalis* (Whiteaves)	S. side Bunde Fiord, Axel Heiberg Island
Pseudosageceras multilobatum Noetling *Euflemingites romunduri* n. sp. *Flemingites* ? sp. indet. *Juvenites canadensis* n. sp. *Juvenites crassus* n. sp. *Prosphingites spathi* Frebold *Anakashmirites borealis* n. sp. *Meekoceras gracilitatis* White *Arctoceras oebergi* (Mojsisovics) *Posidonia mimer* Oeberg *Pseudomonotis boreas* (Oeberg)	5 miles northwest of entrance to Hare Fiord, Ellesmere Island
	Lower Scythian
Prionolobus plicatus n. sp.	S. side Bunde Fiord, Axel Heiberg Island
Proptychites candidus n. sp.	S. side Bunde Fiord, Axel Heiberg Island
Proptychites strigatus n. sp.	S. side Bunde Fiord, Axel Heiberg Island
Ophiceras commune Spath	1. S. side Bunde Fiord, Axel Heiberg Island 2. S. side of island between Bunde and Bukken Fiords
Otoceras boreale Spath	1. S. side Bunde Fiord, Axel Heiberg Island 2. S. side of island between Bunde and Bukken Fiords 3. Between Otto and Hare Fiords, Ellesmere Island

Schei Point Formation

The Schei Point formation was named by the writer (*in* Fortier, *et al., in press*) to include the beds, mainly calcareous siltstone, that rest upon the Bjorne formation. The type section is on the southwest limb of the Goose Point anticline, Bjorne Peninsula, Ellesmere Island (*see* GSC Prel. Map 21-1959).

The calcareous siltstones of the Schei Point formation are hard, homogeneous, brown weathering rocks. In the field, these rocks look like limestones, however insoluble residues reveal that they are very quartzose.

The best known, and most fossiliferous, sections are those of Bjorne Peninsula, Table and Exmouth Islands. The formation is also known in Canyon Fiord, on Fosheim Peninsula; around the mouth of Bay Fiord; and on Cameron, Borden and Prince Patrick Islands. In order to relate these sections to one another, the Bjorne Peninsula, Table and Exmouth Islands sections are described first. These sections provide a good lithological and faunal sequence that may be regarded as the standard for the formation. Descriptions of the remaining sections follow, with a discussion of the probable correlations with the better-known sections.

Bjorne Peninsula

The beds in this, the type section, comprise about 800 feet of very calcareous siltstone that locally grades into bioclastic, crinoidal, silty and sandy limestone. They are overlain by the Heiberg formation, but the actual contact is concealed. Light grey phosphatic nodules occur in the lower part and some grey shale occurs near the base of the formation.

Two ammonoid faunas were collected in situ in this section and a third fauna was obtained from talus. These faunas are as follows, in descending order:

3. In situ near top of formation (Karnian)
   Halobia zitteli Lindstrom
   Sirenites sp. indet.
   Arctosirenites sp. indet.

2. From talus (Ladinian)
   Nathorstites mcconnelli (Whiteaves)

1. In situ, from bed about 400 feet above base (Anisian or Ladinian)
   Daonella frami Kittl
   Longobardites sp. indet.
   Protrachyceras sp. indet.
   Ptychites nanuk n. sp.

This section is of interest in that it represents the only known locality where ammonoids have been found in the widely distributed *Daonella frami* bed.

Table and Exmouth Islands

Good exposures of the Schei Point formation occur on Table and Exmouth Islands (*see* Pls. III A, IV A). The top of the formation is not preserved on these islands, but, from comparison with the type section, it would appear that the Table Island section is nearly complete. Several partial sections are known. The lithology and faunal sequence of these various sections is shown by Figure 4. These partial sections occur within a radius of about 10 miles. It seems reasonable to combine the data from the partial sections; by doing so the following generalized section has been constructed.

Top of Section	Approx. Thickness (feet)
5. Calcareous siltstone, grey, weathers brown. Several Karnian faunules have been collected. The combined fauna is *Halobia zitteli* Lindstrom, *Sirenites senticosus* (Dittmar), *Jovites borealis* n. sp.	60
4. Sandstone, calcareous, with some black chert grains and granules. Interval is partly covered. *Pentacrinus* columnals, *Lima* sp., *Myophoria* sp. and other pelecypods	210
3. Calcareous siltstone, medium to thin bedded with light grey phosphatic nodules. This unit contains three faunas: Top (c) *Nathorstites mcconnelli* (Whiteaves), Ladinian, about 200 feet above base (b) *Daonella frami* Kittl, Anisian or Ladinian, about 120 feet above base (a) *Frechites* sp., *Ptychites* cf. *P. trochlaeformis*, and *Halilucites* sp., of Anisian age, near base of unit	220
2. Grey and brown, thin-bedded shale with small grey and white phosphatic nodules; ichthyosaur vertebrae and *Acrodus* teeth; *Daonella* sp. indet. in calcareous concretions (about 15 feet above base;) *Pearylandites* sp., *Parapopanoceras* sp. indet. and indeterminable hungaritids near base	50
1. Sandstone, grey calcareous; poorly preserved ammonoids observed in a talus block....	15
Underlying beds: Bjorne formation	

The sections on Table and Exmouth Islands and on Bjorne Peninsula reveal that the Schei Point formation of these areas is a relatively thin deposit recording sedimentation in Anisian, Ladinian, and Karnian times.

Canyon Fiord, Fosheim Peninsula and Bay Fiord

The Schei Point formation is known northwest of East Cape, in Canyon Fiord (*see* Pl. IV B), at Cape With, also in Canyon Fiord; along the northwest side of the Sawtooth Range, which extends from Cape With to Vesle Fiord (*see* Pl. V B); and at various points, including Hat Island, around the mouth of Bay Fiord.

Most sections are discontinuously exposed. However, several partial sections are known in the Bay Fiord-Vesle Fiord area and by piecing these together some idea of the complete Schei Point sequence can be obtained.

These partial sections are illustrated, in columnar form, by Figure 5. A generalized section for the Bay Fiord-Vesle Fiord area is as follows: (This section, although based essentially upon the Vesle Fiord sequence incorporates faunal data from the other sections.)

Top of Section	Approx. Thickness (feet)
6. "*Gryphaea* bed". Grey, brown weathering, calcareous sandstone with numerous shells of *Gryphaea* cf. *G. arcuatiformis* Kiparisova, *Oxytoma* sp., group of *O. inequivalve* Sowerby	45
5. Shale, mainly dark grey, but in part dusky red, with bands of pelecypod coquina and calcareous siltstone	365
4. Calcareous siltstone and sandstone, grey, brown weathering, medium to thick bedded. Some beds carry abundant *Pentacrinus* columnals, and pelecypods (particularly *Lima (Plagiostoma)* sp.). Some grey chert. In the section north of Vesle Fiord this unit is capped by about 20 feet of grey calcareous sandstone with fragmentary pelecypods. In the cliffs north of Hat Island a coarse-grained calcareous sandstone with *Lima haakoni* Kittl occurs near the base. On the east side of Hat Island, cherty beds with *Sirenites nanseni* n. sp., *Cardinia* (?) *ovula* Kittl and *Leda (Phaenodesmia) regia* Kittl (Karnian) probably represent this unit	360
3. Calcareous siltstone, medium to thin bedded, with grey phosphatic nodules; *Nathorstites mcconnelli* (Whiteaves) (Ladinian) about 180 feet above base	420
2. Shale, light grey, very thinly bedded, with small, grey phosphatic nodules and ichthyosaur vertebrae. North of the Gretha Islands this unit contains poorly preserved specimens of *Gymnotoceras* sp. *G. helle* McLearn (Anisian)	280
1. Sandstone, grey, calcareous, with poorly preserved pelecypods	20
Underlying beds: Bjorne formation	

From the foregoing section it would appear that the lower part of this sequence has much in common, both faunally and lithologically, with the sections of Bjorne Peninsula, Table Island and Exmouth Island. The shale with Anisian fossils and ichthyosaur vertebrae (unit 2, above), the calcareous siltstone with *Nathorstites* (unit 3) and the coarser grained beds of unit 4 occur in all the sections described above. However, the shale near the top of the section north of Vesle Fiord (unit 5) has no known parallel in the sections on Bjorne Peninsula, etc. This shale evidently represents a tongue of Blaa Mountain facies interfingering with typical Schei Point beds. The *Gryphaea* bed (unit 6) is also known at Cape With (Troelsen, 1950, p. 74). This bed probably marks the top of the Schei Point formation along the whole length of Sawtooth Range.

Borden Island

The Schei Point beds of Borden Island include at least 100 feet of sand, calcareous sandstone and coquina beds (Thorsteinsson and Tozer, 1959). They represent the oldest exposures on the island, consequently it is not known what lies beneath. Lower Jurassic (Sinemurian) rocks overlie the Schei Point formation.

Several faunules have been collected. On Oyster River pelecypods were collected from a 100-foot interval, immediately below the Sinemurian beds. They include:

Oxytoma sp. (group of *O. inequivalve* Sowerby)
Plicatula cf. *P. hekiensis* Nakazawa
Lima (*Plagiostoma*) sp.
Lima cf. *L. naumanni* Kobayashi and Ichikawa
Gryphaea cf. *G. arcuatiformis* Kiparisova
Myophoria sp.
Halobia zitteli Lindstrom (not in situ)

Fourteen miles south of Cape Malloch, 14 feet of sand and calcareous siltstone is exposed. Fossils occur at two levels in this section. From a bed near the top *Proclydonautilus spirolobus* (Dittmar) and *Sirenites* cf. *S. nanseni* n. sp. were collected. Eleven feet lower in the section *Sirenites senticosus* (Dittmar) was collected. These faunas are of Karnian age and they indicate an approximate correlation with the *Halobia* beds of Cameron and Table Islands. The relationship between the pelecypod beds of Oyster River and the *Sirenites* beds is uncertain. The *Sirenites* beds probably underlie the *Gryphaea*-bearing strata.

Cameron Island

The Schei Point formation is exposed in northwestern Cameron Island (Bathurst group), south of Lyall Point (*see* GSC Prel. Map 18-1959). The beds rest upon an unfossiliferous sandstone, presumably the Bjorne formation. Exposures are poor and the thickness of the section cannot be measured accurately. In the creek south of Lyall Point the sequence of beds is as follows:

Top of Section	
3. Grey bioclastic limestone with *Halobia zitteli* Lindstrom and other pelecypods; *Tropites* cf. *T. morani* Smith, *Jovites richardsi* n. sp., *Proclydonautilus spirolobus* (Dittmar), *Germanonautilus* sp. (Karnian)	about 5 feet exposed
2. Calcareous sandstone with abundant pelecypods: *Anomia* ? sp., *Lima* (*Plagiostoma*) cf. *L. swenanderi* Boehm, *Mytilus* sp., *Myophoria* cf. *M. laevigata* Ziethen, *M.* cf. *M. ovata* Goldfuss	
1. Calcareous siltstone, poorly exposed, no fossils seen.	
Underlying beds: Bjorne formation	

The thickness of the individual units, and the total thickness cannot be determined. The total is probably not more than 150 feet.

The Karnian limestone in this section, with *Tropites* and *Jovites,* is an approximate correlative of the *Halobia-Sirenites* beds of Table Island and Bjorne Peninsula. However, as noted on page 39, the Karnian faunas from these three localities may not be exactly the same age; possibly the Cameron Island fauna is the youngest.

The sandstone with *Lima* and *Myophoria* cf. *M. laevigata* resembles the calcareous sandstone unit 4, p. 15) of Table Island. Both sandstones are overlain by *Halobia* beds and both are probably approximate time correlatives.

No Middle Triassic ammonoid faunas were found in this section. Such faunas might occur in the poorly exposed beds beneath the calcareous sandstone with *Lima*, etc. Alternatively it is possible that the section on Cameron Island is like that of Prince Patrick Island, where Middle Triassic rocks are not merely unknown but almost certainly absent.

Prince Patrick Island

The Schei Point formation is exposed on the west side of Intrepid Inlet, 4 miles north of Salmon Point (Thorsteinsson and Tozer, 1959). The beds there comprise about 15 feet of brown weathering, quartzose, fragmental limestone lying between Devonian and Jurassic rocks. The total stratigraphic interval between the Devonian and the Jurassic amounts to about 50 feet, so the exposed thickness of Schei Point beds cannot exceed that figure.

Pelecypods and brachiopods are abundant. The following have been identified:

Oxytoma sp. (group of *O. inequivalve*)
Plicatula cf. *P. hekiensis* Nakazawa
Lima (*Plagiostoma*) sp.
Gryphaea cf. *G. arcuatiformis* Kiparisova
"*Myophoria*" sp.
Terebratuloid and spiriferid brachiopods indet.

These beds resemble closely, in fauna and lithology, the Schei Point strata of Oyster River, Borden Island (p. 17).

The Bjorne formation is absent in this section, and the equivalents of the lower Schei Point beds (e.g., units 1 to 3 of Table Island) are also apparently lacking. This occurrence is therefore of palæogeographic interest in showing that the Schei Point beds are locally transgressive.

The exact age of these rocks cannot be determined from the fauna found on Prince Patrick Island. However, these beds are probably the same age as the *Gryphaea* beds of Borden Island, which are probably Karnian (p. 17).

Blaa Mountain Formation

The Blaa Mountain formation was named by Troelsen (1950, p. 74) to include the Triassic shales, siltstones, limestones and sandstones of the Eureka Sound area. As already mentioned, these rocks were discovered and first described by Per Schei (1903). Troelsen designated the section at Blaa Mountain, on the north side of Greely Fiord, Ellesmere Island, as the type, but he did not define the upper and lower contacts of the formation.

In recent years J. G. Souther, R. Thorsteinsson and the writer have studied the Triassic rocks of western Ellesmere Island and eastern Axel Heiberg Island. This work has led to a more precise definition of the Blaa Mountain formation. The formation may now be defined as the essentially argillaceous rocks that lie between the Blind Fiord formation (below) and the Heiberg formation (above). At Blaa Mountain, and in most other sections, the lower contact is quite abrupt and is readily recognized (*see* Pls. II A, III B). The upper contact, with the Heiberg formation, is transitional.

The Blaa Mountain formation is very thick. Exposures of the complete sequence within a small area have only been found where steep dips affect the whole section. Such sections are rare. Complete sections have been studied at two localities. One, at Buchanan Lake, Axel Heiberg Island, has been studied by Souther (*in* Fortier, *et al., in press*) and the writer. The other section, studied by Thorsteinsson and the writer, is on the west coast of Ellesmere Island, adjacent to Nansen Sound. There is also a third area, Raanes Peninsula, where the main features of the complete section are known. The sections in each of these three areas differ considerably in that they contain varying amounts of calcareous siltstone of Schei Point facies. For present purposes these sections are designated as the "Buchanan Lake sequence", the "Nansen Sound sequence", and the "Raanes Peninsula sequence" respectively.

Black and grey shale are the most common rocks of the Blaa Mountain formation. Pyritic and calcareous concretions are common in the shale. The Nansen Sound and Raanes Peninsula sequences contain thick, discrete, members of brown weathering calcareous siltstone and shale. These calcareous members evidently represent tongues of Schei Point facies interfingering with the Blaa Mountain shales. In the Buchanan Lake sequence there are thin beds of this lithology but no distinct members.

Throughout the Eureka Sound area the Blaa Mountain beds have been intruded by sills of gabbro up to 300 feet thick. These hard sills produce prominent topographical features. Around Eureka Sound thick sills are virtually confined to the Blaa Mountain and lower Heiberg beds. The Triassic rocks, fortified by these sills, form prominent sea cliffs and ridges in the Eureka Sound area. Examples are Blaa Mountain itself; Black Top Ridge, east of Eureka; and the prominent range on eastern Axel Heiberg Island that extends from Stolz Peninsula to Buchanan Lake.

Brief descriptions of the three types of sequence are as follows.

1. *Buchanan Lake Sequence*

This section is exposed on the southeast side of Buchanan Lake, near the head of Mökka Fiord, Axel Heiberg Island. It was studied by J. G. Souther (*in* Fortier, *et al., in press,* GSC Prel. Map 36-1959) in 1955, and also by the writer in 1956. The measurement and lithological description are mainly the work of Souther.

The section includes about 8,255 feet of sedimentary rock intruded by gabbro sills, 1,875 feet in aggregate thickness. The Blaa Mountain beds consist mainly of dark grey and black shale with dusky red calcareous and pyritic concretions. Thin beds of siltstones, calcareous siltstone and argillaceous limestone are interbedded. In the upper 1,000 feet thin beds of fine-grained sandstone appear and they illustrate the transitional nature of the Blaa Mountain-Heiberg boundary. A gabbro sill lies at the contact between the Blind Fiord and Blaa Mountain formations.

Poorly preserved fossils are common at several levels. Well-preserved ammonites and pelecypods were collected only from an interval of about 300 feet, about 7,000 feet above the base. Several faunules were collected and all are of Karnian age. No recognizable Middle Triassic fossils have been obtained from this section, but Anisian and Ladinian strata are probably present in the unfossiliferous lower part. The highest faunule with determinable fossils contains *Jovites borealis* n. sp. and *Halobia* sp. About 300 feet below the *Jovites* bed, *Arctosirenites canadensis* n. gen., n. sp., occurs in calcareous and pyritic nodules. *Sirenites costatus* n. sp. occurs in another line of nodules, at approximately the same horizon as *Arctosirenites canadensis.*

2. *Nansen Sound Sequence*

A complete section illustrating the Nansen Sound sequence is exposed on the west coast of Ellesmere Island on the cliffs overlooking Nansen Sound, 6 to 9 miles northwest of the entrance to Hare Fiord. This section was studied by R. Thorsteinsson and the writer in 1956. In this section the Blaa Mountain formation may be divided into five members, as follows: (The total thickness is about 5,250 feet.)

Top of Section	Approx. thickness (feet)
Overlying beds: Heiberg formation	
5. *Upper Shale member.* Shale, dark grey, non-calcareous; no fossils seen	450
4. *Upper Calcareous member.* Siltstone, grey, calcareous, interbedded with grey calcareous shale. Unit weathers brown. *Sirenites* sp. indet., *Halobia* sp.	300
These two upper members are best exposed in a small ravine near the east edge of the small cove 9 miles northeast of the entrance to Hare Fiord. The Upper Calcareous member is also exposed on the coast, southeast of the cove	
3. *Middle Shale member.* Grey shale with some interbedded siltstone and sandstone. This unit includes about 3,000 feet of sedimentary rock. The upper 2,000 feet are intruded by gabbro sills, at least 500 feet in aggregate thickness. *Sirenites nanseni* and *Halobia* sp. are common in dusky red concretions in the lower 1,000 feet	3,000
2. *Lower Calcareous member.* Calcareous siltstone and sandstone, mainly thin bedded, with some interbedded shale. The calcareous beds weather light brown and contain *Oxytoma* sp. and other poorly preserved pelecypods	500
1. *Lower Shale member.* Shale, dark grey to black, some hard, yellow weathering calcareous bands up to about 1 foot thick. This member is about 1,000 feet thick and is intruded by gabbro sills. At the southeast end of the outcrop there are two sills, each about 175 feet thick (*see* Pl. II A). Towards the northeast end these sills coalesce to form one. Poorly preserved ammonites occur in the lower part of the shale, below the lower sill. *Daonella frami* occurs about 150 feet above the upper sill	1,000
Underlying beds: Blind Fiord formation	

The contact between the Lower Shale member and the Blind Fiord formation is abrupt (*see* Pl. II A).

The five members distinguished in this section probably represent units that can be recognized over a fairly extensive area.

The section at Blaa Mountain, some 20 miles to the southeast, is known to show the lower four members and probably shows all five (*see* Pl. III B). This section has not been studied in detail and the thickness of the various members has not yet been determined. The cliff known as Blaa Mountain is a faulted anticline. Much of the Blind Fiord formation is exposed in the core and a complete, or nearly complete, section of Blaa Mountain beds is exposed on the northwest limb. The Lower Shale member, with *Daonella frami* (type locality of this species) is overlain by brown weathering calcareous siltstones (Lower Calcareous member). This Lower Calcareous member is followed by grey shales with siltstone bands and gabbro sills. The Upper Calcareous member, with *Halobia* sp., has also been recognized.

Another section illustrating this sequence is exposed 15 miles northwest of the entrance to Hare Fiord. In this section *Nathorstites mcconnelli* (Whiteaves) and *Procladiscites* cf. *P. martini* (Smith) occur in the Lower Shale member, about 100 feet above a bed with *Daonella frami*. This is the only section of the Nansen Sound sequence where Ladinian fossils (*Nathorstites*) are known.

In 1955, N. J. McMillan collected fragmentary specimens of *Ptychites* from black shale, presumably the Lower Shale member as here defined. McMillan collected these fossils from northern Axel Heiberg Island, between Stang Bay and Bunde Fiord. These fossils are of Anisian age, and by analogy with the sections of the Schei Point formation, they are assumed to be older than *Daonella frami*.

The Upper Calcareous and Upper Shale members occur on Black Top Ridge, east of Eureka, and on the ridge that meets the mouth of Slidre Fiord. Nine miles northwest of Eureka weather station R. Thorsteinsson collected a single ammonite, *Rhacophyllites zitteli* Mojsisovics, from the Upper Shale.

By assembling all the faunal data, it would appear that the following faunas occur in the Nansen Sound sequence.

Member	Fauna	Age
Upper Shale	*Rhacophyllites zitteli* Mojsisovics	
Upper Calcareous	*Sirenites* sp. indet. *Halobia* sp.	
Middle Shale	*Sirenites nanseni* n. sp. *Halobia* sp.	Karnian
Lower Calcareous	No distinctive fauna known	?
Lower Shale	*Nathorstites mcconnelli* (Whiteaves) *Procladiscites* cf. *P. martini* (Smith)	Ladinian
	Daonella frami Kittl	Ladinian or Anisian
	Ptychites cf. *P. trochlaeformis* (Lindstrom)	Anisian

3. *Raanes Peninsula Sequence*

The available evidence suggests that the Blaa Mountain formation of Raanes Peninsula can be divided into three members. However, the individual sections that lead to this conclusion are incomplete and scattered.

The basal 1,500 feet of Blaa Mountain beds are well exposed 8 miles northwest of Blind Fiord (Tozer, *in* Fortier, *et al., in press*). They consist of dark grey, mainly calcareous, shale (Lower member, about 800 feet) grading up into hard, brown weathering calcareous siltstone (Middle member). *Daonella frami* (Anisian or Ladinian) occurs in shale, about 500 feet above the base of this section and *Nathorstites* cf. *N. gibbosus* Stolley was collected from the Middle member, about 950 feet above the base of the formation.

The remaining part of the Blaa Mountain formation has been briefly examined on the west coast of Raanes Peninsula. The Blaa Mountain beds are exposed between "Trappers Cove", opposite the mouth of Skaare Fiord, and "Cape Chase", south of Stor Island. At Cape Chase brown weathering calcareous siltstone and shale, with minor grey limestone and calcite veins, at least 500 feet thick (the base was not seen), is overlain by black and grey, earthy, very thin bedded shale with calcareous concretions and poorly preserved specimens of *Halobia*. Poorly preserved trachyceratid ammonites and a ribbed species of *Lima* were seen in the calcareous siltstone.

Between Cape Chase and Trappers Cove the steep cliff exposes black and grey shale intruded by many sills of gabbro. Poorly preserved ammonites and *Halobia* were seen by the writer at several points on this coast. Immediately south of Trappers Cove the Blaa Mountain beds are overlain by the Heiberg formation. It is difficult to make a reliable estimate of the thickness of beds exposed between Cape Chase and Trappers Cove as the beds are disturbed by several folds. However, the combined thickness of the shale and the gabbro sills exceeds 5,000 feet.

It is probable that the calcareous beds at Cape Chase represent the same unit ("Middle member") as occurs above the *Daonella frami* bed at Blind Fiord.

To summarize, it would appear that the Raanes Peninsula sequence is as follows:

Top of Section

Overlying beds: Heiberg formation

Blaa Mountain formation

3. *Upper Member*. Mainly grey and black shale, many gabbro sills. *Halobia* (Karnian) and poorly preserved ammonites occur. Thickness uncertain, but at least 3,000 feet.
2. *Middle Member*. Mainly brown weathering, grey, calcareous siltstone; some calcareous shale and limestone. *Nathorstites* cf. *N. gibbosus* (Ladinian) in lower part. About 1,000 feet thick.
1. *Lower Member*. Grey shale with calcareous bands. *Daonella frami* (Anisian or Ladinian) about 500 feet above base. About 800 feet thick.

Underlying beds: Blind Fiord formation

Relationship Between Blaa Mountain and Schei Point Formations

The essential lithological and faunal characters of the Blaa Mountain and Schei Point formations are given above. It has already been stated that these formations are considered to be contemporary deposits of different lithological facies. The evidence for this conclusion is now given, and is both faunal and lithological.

The faunal evidence is as follows:

1. Anisian fossils (*Ptychites, Gymnotoceras, Frechites*) occur near the base of both formations.

2. A bed with *Daonella frami* Kittl (Anisian or Ladinian), occurs in several sections of both formations. In each section this species seems to be confined to one thin bed, a foot or two feet thick. The *Daonella frami* bed apparently marks a time-stratigraphic horizon throughout the Sverdrup Basin, in both the Schei Point and Blaa Mountain formations.

3. *Nathorstites mcconnelli* (Whiteaves), of Ladinian age, occurs in both formations.

4. *Sirenites nanseni* n. sp., of Karnian age, occurs in both formations. *Jovites borealis,* also of Karnian age, but probably younger than *Sirenites nanseni,* is also known from both formations.

The lithological evidence for the correlation of the Blaa Mountain and Schei Point formations rests on intertonguing relationships. The Nansen Sound and Raanes Peninsula sequences of the Blaa Mountain formation contain tongues of Schei Point lithology. In the Nansen Sound sequence there are two such tongues: the Lower and Upper Calcareous members. In the Raanes Peninsula sequence there is only one; the Middle Member. The section of the Schei Point formation near Vesle Fiord has a thin unit of dark shale (Blaa Mountain lithology) near the top. This intertonguing relationship, and the position of the various faunas, is illustrated diagrammatically by the fence diagram, Figure 6, p. 24.

Heiberg Formation

The Heiberg formation, which is mainly sandstone, was named following studies by several members of the Geological Survey in 1955. The best section was that studied by J. G. Souther, at the southwest end of Buchanan Lake, Axel Heiberg Island, and this section has been chosen as the type (*see* GSC Prel. Map 36-1959). The Heiberg beds consist of sandstone and shale, with some coal in the upper part. The lower boundary, with the Blaa Mountain formation, is drawn at the level where an appreciable amount of quartz sandstone appears in the section. In this section, and also in others, this boundary is transitional. The Blaa Mountain-Heiberg boundary is probably not a good time-stratigraphic plane. The upper boundary with the Savik shale (Jurassic) is abrupt. The nature of this upper boundary is not entirely understood; it is discussed below.

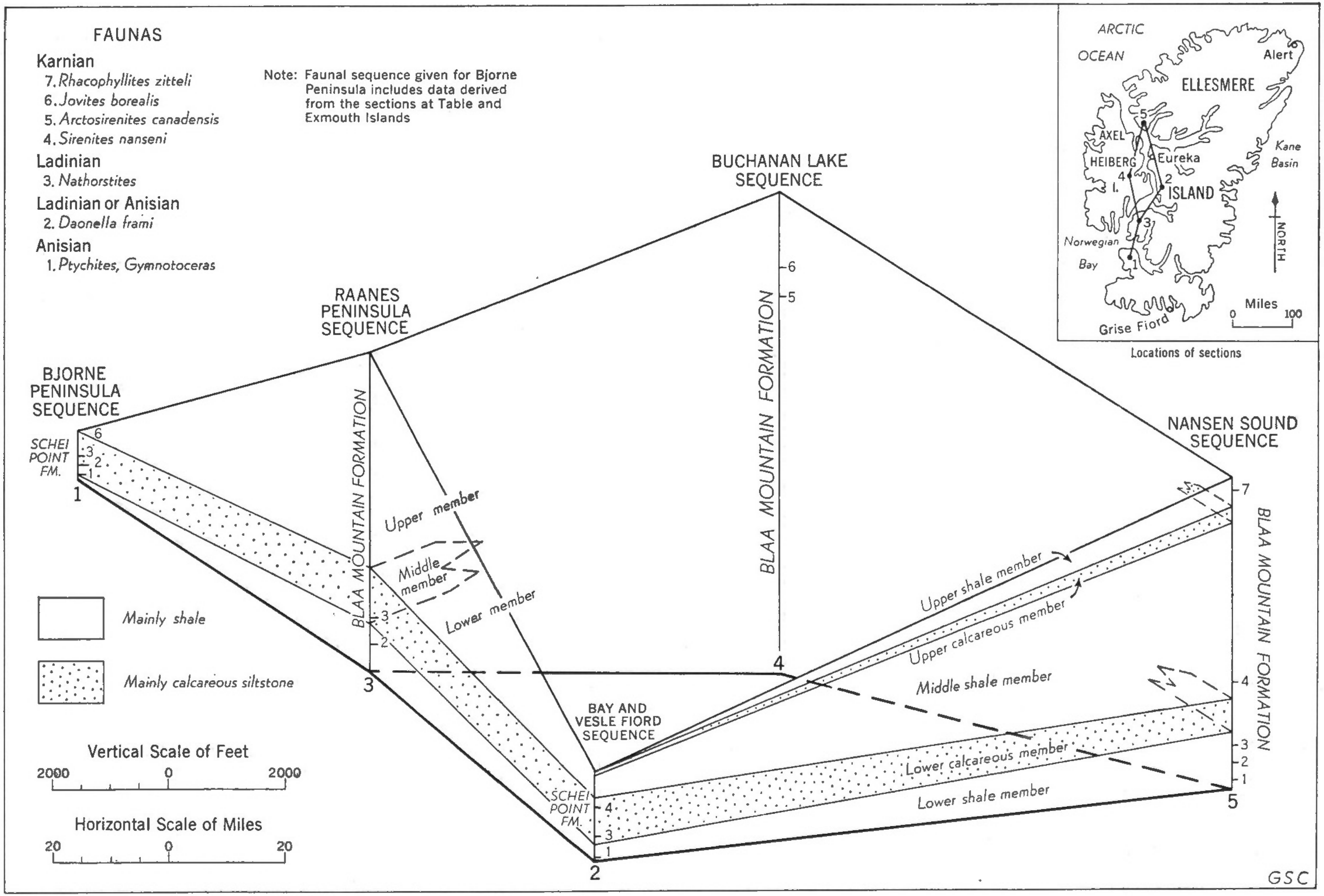


Figure 6. Fence diagram showing relationship between Schei Point and Blaa Mountain formations, Ellesmere and Axel Heiberg Islands.

Two rather distinct members were distinguished in the type section by Souther, and these divisions characterize the formation throughout a wide area.

The lower member consists of thin-bedded, grey and yellow sandstone with grey siltstone and shale interbed. The sandstone is commonly mottled with dusky red patches, and dusky red ironstone nodules also occur. Thin beds with marine fossils occur in the lower member.

In the upper member sandstone forms thick units, commonly with cross-bedding. Plant fragments are common and bedding planes are usually covered with carbonaceous debris. Coal seams occur at several localities.

These divisions have been recognized in the sections at Buchanan Lake (J. G. Souther); Wolf Fiord (B. F. Glenister); west coast of Raanes Peninsula, between Trappers Cove and Bear Corner; Eureka area (R. Thorsteinsson and E. T. Tozer); and Cornwall Island (D. J. McLaren and H. Greiner). The lower member occurs on Brock Island (Thorsteinsson and Tozer, 1959). A thin, non-marine sequence on Cameron Island also represents the Heiberg formation.

The thickness of complete Heiberg sections ranges from 3,300 feet (including about 175 feet of gabbro sills) near Eureka, to 5,300 feet (including about 635 feet of gabbro) at Buchanan Lake. A complete section occurs near the mouth of Strand Fiord, western Axel Heiberg Island. This section has not been examined in detail but it is probably thinner than the sections to the east.

Marine fossils occur in thin beds in the lower member of the Heiberg formation. Some sections have two fossiliferous beds, others one. It is probable that these fossil beds represent marine bands in an otherwise non-marine sequence. If so, they may be good time-stratigraphic marker horizons.

Meleagrinella antiqua n. sp. and *Oxytoma kiparisovae* n. sp. occur in a bed about 250 feet above the base, 6½ miles northwest of Eureka, Ellesmere Island. *M. antiqua* also occurs at several other localities (p. 105). *Halobia* sp. occurs about 250 feet above the base in the section on the east side of Black Top Ridge, east of Eureka.

At three localities (Buchanan Lake, Wolf Fiord, and the west coast of Raanes Peninsula), the cosmopolitan Norian species, *Monotis ochotica* (Keyserling) occurs above the *Meleagrinella antiqua* bed. About 1,000 feet of beds separate the two fossil horizons at Buchanan Lake and the interval on Raanes Peninsula is of the same order. The *Monotis* fauna also occurs on Cornwall and Brock Islands.

Fossil plants from the upper member have been studied by Wayne L. Fry. Fry considers that the flora from the Heiberg formation is not sufficiently varied to permit a precise age determination but that there is a distinct resemblance to the flora of the "Rhaeto-Liassic" beds of Scoresby Sound, East Greenland.

In the Eureka area and on the north side of Gibs Fiord (about 12 miles west of Eureka), about 200 feet of soft, yellow and grey sand, with exceptionally hard, red, ferruginous bands, lie between the non-marine upper Heiberg beds and the succeeding Toarcian (late Lower Jurassic) deposits. This sand with hard red bands contains poorly preserved pelecypods. The fossils are too poorly preserved to date these rocks, but they reveal that the beds represent a marine deposit. At first sight these beds appear to belong to the Heiberg formation, but in fact they may represent a thin, distinct formation, of Sinemurian age (early Lower Jurassic) as mentioned below.

The Triassic-Jurassic Boundary

In the Arctic Archipelago, non-marine deposits (Upper Heiberg) occur above the youngest marine Triassic beds, which contain *Monotis ochotica,* of Norian age. The next known marine beds are of Lower, but not lowermost, Jurassic age. Locating the position of the Jurassic-Triassic boundary will depend upon determining the age of the non-marine upper Heiberg beds.

As already noted, the fossil plants of the upper Heiberg beds do not permit a precise age determination. However, some indication of their age may be obtained by considering the age of the marine beds above and below. After the Norian, the next widespread, or at any rate widely recognized, marine event in the Archipelago was the Toarcian transgression. This transgression is recorded by the basal beds of the Wilkie Point, Jaeger and Savik formations. Toarcian fossils have been collected from beds above the Heiberg at two localities: (1) at the mouth of Strand Fiord, Axel Heiberg Island (Tozer, *in* Fortier, *et al., in press,* GSC Prel. Map 36-1959; Frebold, 1958a, p. 3); (2) east of Black Top Ridge, Fosheim Peninsula (Thorsteinsson and Tozer, unpublished; Frebold, 1958b, p. 32). It follows therefore that the Heiberg formation is not younger than Toarcian.

It is probable that the upper limit of the Heiberg formation can be set even lower. In 1958, R. Thorsteinsson and the writer collected marine Sinemurian fossils from Melville and Borden Islands. Sinemurian deposits are therefore present within the Sverdrup Basin. No recognizable Sinemurian fossils have been collected from Ellesmere and Axel Heiberg Islands, where the Heiberg beds are best known. However, near Eureka, and at the mouth of Gibs Fiord (12 miles west of Eureka), the typical non-marine upper Heiberg beds are overlain by about 200 feet of sand and hard red ferruginous sandstone, with poorly preserved marine pelecypods, including a pernid, a pteriid and *Pleuromya.* Unfortunately these fossils are too poorly preserved to provide an age determination, but they certainly indicate that a marine deposit was laid down in the interval between the Norian and the Toarcian. In lithology these beds resemble closely the Sinemurian beds of Melville and Borden Islands. It seems probable that these beds represent the same formation as the Sinemurian beds of the islands to the west. If this is so, it follows that the upper Heiberg beds are not younger than Sinemurian.

Possibly the nature of the Triassic-Jurassic boundary in the Arctic Archipelago may resemble that of East Greenland. There, on the north side of Scoresby Sound, the Triassic-Jurassic boundary lies within the non-marine Kap Stewart formation, in which T. M. Harris (*see* Donovan, 1957, p. 26 for summary) has distinguished floras of Rhaetian and Hettangian (lowermost Jurassic) age.

CORRELATION AND AFFINITIES OF FAUNAS

In the preceding section the rock and faunal succession has been described. Under this heading the correlation and affinities of the faunas mentioned above are discussed.

Correlation of the Scythian Ammonoid Faunas of the Blind Fiord Formation

Age (Spath, 1934)		Zone	Faunas in the Blind Fiord Formation
Upper Scythian	Prohungaritan	*Olenikites*[1]	*Olenikites canadensis* n. sp.
	Columbitan	*Subcolumbites*[1] *Columbites*[2] *Tirolites harti*[3]	None known
	Owenitan	*Owenites*[4]	*Wasatchites tardus* (McLearn) *Meekoceras gracilitatis* White
Lower Scythian	Flemingitan	*Flemingites*[5]	*Prionolobus plicatus* n. sp.[8] *Proptychites candidus* n. sp.[8] *Proptychites strigatus* n. sp.
	Gyronitan	*Gyronites*[6]	
	Otoceratan	*Otoceras*[7]	*Ophiceras commune* Spath *Otoceras boreale* Spath

[1]The *Prohungarites middlemissi* zone of Kummel (1957, p. 124) is evidently equivalent to both these zones. Whether or not the *Olenikites* and *Subcolumbites* zones are truly distinct is not certainly known. Both zones are provisionally retained, following Spath (1934). The *Tirolites cassianus* fauna of the Campil beds (Austria) is a possible representative of the *Subcolumbites* zone.

[2]Kiparisova and Popow (1956) regard the *Columbites* zone as essentially the same age as the *Subcolumbites* and *Olenikites* zones and accordingly they suppress the "Prohungaritan age" of Spath. However, it has been shown by Kummel (1954, p. 187) that the *Columbites* beds lie well below the top of the Scythian.

[3]Silberling (1959a, p. 2189) has presented evidence to suggest that this zone (known from Idaho) is older than the *Tirolites cassianus* zone of Austria. The *Tirolites harti* zone may be merely a local zone.

[4]As used here the *Owenites* zone includes the *Meekoceras gracilitatis* and *Anasibirites multiformis* zones of Kummel (1957, p. 124). According to Smith (1932, p. 9), *Meekoceras gracilitatis, Owenites* spp. and *Anasibirites* spp. occur together in California, accordingly only one zone is recognized.

[5]Includes the *Koninckites volutus* and *Flemingites flemingianus* zones of the Salt Range (Noetling, 1905b, p. 165). *Flemingites* occurs in both these zones, which are probably only of local importance.

[6]Kummel (1957, p. 124) recognized four zones for this interval. The lower two (*Vishnuites decipiens* and *Proptychites rosenkrantzi*) are defined in Greenland; the upper two (*Prionolobus rotundatus* and *Xenodiscoides fallax*) from the Salt Range.

[7]Kummel (1957, p. 124) recognized two zones in this interval, the *Otoceras woodwardi* zone below, and the *Ophiceras commune* zone above. In Greenland, *Otoceras boreale* ranges up to the *Ophiceras commune* beds (Spath, 1935, p. 104). Accordingly a single zone, characterized by *Otoceras*, is recognized here.

[8]These species represent the *Gyronites* zone or the *Flemingites* zone but their exact correlation is not known.

Lower Triassic (Scythian)

Before discussing the correlation of the Lower Triassic (Scythian) faunas from the Arctic islands it is necessary to consider the subdivisions and zonation of this series. Our knowledge of the succession of Scythian faunas is based on the study of many incomplete sections, as stressed by Spath (1934, p. 25). Spath divided the Scythian into two parts, the Lower Eo-trias and the Upper Eo-trias. In a recent paper Kiparisova and Popow (1956) treat these parts as stages, the Induan (= Lower Eo-trias) and the Olenekian (= Upper Eo-trias). In this report the terms "Lower Scythian" and "Upper Scythian" will be used for these divisions. Spath (op. cit.) divided the Scythian into six "ages", as shown in the correlation table. For present purposes, eight zones are recognized within the Scythian, and their relationship to the six ages is shown in the table. This zonation scheme incorporates most of the late Dr. Spath's suggestions and conclusions. It may also be regarded as a simplified, and slightly modified version of the zonal scheme presented by Kummel (1957, p. 124). It is therefore not suggested that the present arrangement is particularly original, nor is it necessarily final.

The correlation and affinities of the various Blind Fiord faunas are discussed in what is believed to be their sequence in time. This sequence is partly hypothetical; the observed data on the sequence are given on page 12.

1. *Otoceras* beds, Bunde Fiord and Nansen Sound

Otoceras boreale Spath occurs throughout the basal 25 feet of the Blind Fiord formation on the south side of Bunde Fiord, Axel Heiberg Island. Fifteen miles northwest of the entrance to Hare Fiord, on the west coast of Ellesmere Island, the same species is found throughout an interval of about 25 feet, from 200 to 225 feet above the base. These occurrences indicate a correlation with the *Otoceras* zone, the oldest known Triassic zone. *Otoceras* itself is now known from the Himalayas (Griesbach, 1880; Diener, 1912, etc.), East Greenland (Spath, 1930, 1935), Northern Alaska (Kummel, *in* Reeside *et al.*, 1957), northeastern Siberia (Popow, 1958a) and probably also in the Spray River formation of Alberta (Warren, 1945).

2. *Ophiceras commune* beds, Bunde Fiord

At Bunde Fiord, R. Thorsteinsson collected *Ophiceras commune* Spath, *Proptychites strigatus* n. sp. and *Claraia stachei* Bittner from a 25-foot interval separated from the underlying *Otoceras* beds by a 4-foot gabbro sill. In the Himalayas and in East Greenland, *Ophiceras* occurs in association with *Otoceras*. In these areas *Proptychites* appears at a higher level, in the *Gyronites* zone. Consequently it is assumed that *Ophiceras commune* and *Proptychites strigatus* are derived from different beds and represent distinct faunas within this 25-foot interval. Thorsteinsson also collected *Ophiceras commune* on the island between Bunde and Bukken Fiords. At this locality no specimens of *Proptychites strigatus* were obtained, which supports the assumption that these two ammonoids represent distinct faunas.

Ophiceras commune, like the underlying *Otoceras boreale,* suggests a correlation with the *Otoceras* zone. In both the Himalayas and East Greenland *Ophiceras* appears in the same beds as *Otoceras,* consequently there seems to be no justification for recognizing distinct zones of *Otoceras* and *Ophiceras.* According to Diener (1912, p. 24) "*Ophiceras tibeticum* Griesbach probably ranges from the *Otoceras* stage into the *Meekoceras* beds". The "*Meekoceras*" beds referred to by Diener are now considered to be of Gyronitan age. If Diener is correct, *Ophiceras* must be regarded as relatively long-ranging, extending from the Otoceratan to the Gyronitan age. However, the failure of true *Ophiceras* to appear in the best known Gyronitan sections (e.g., the Salt Range) favours the argument that it characterizes only the *Otoceras* zone.

3. *Proptychites strigatus* beds, Bunde Fiord

As already noted, this species is believed to occur above the *Ophiceras commune* beds. *Proptychites strigatus* is close to *P. markhami* Diener, from the "*Meekoceras* beds" of the Himalayas, which Spath (1934, p. 169) places in the Gyronitan age. *P. strigatus* is probably the same age.

4. *Proptychites candidus* bed, Bunde Fiord

Proptychites candidus occurs above *P. strigatus.* It is a new species and does not resemble any described forms closely. It is probably of Gyronitan or Flemingitan age.

In Greenland, *Proptychites rosenkrantzi* Spath, etc., overlie beds with *Otoceras* and *Ophiceras.* Spath (1935) dates the *P. rosenkrantzi* beds as Gyronitan. *P. rosenkrantzi* has not been found in the Arctic Archipelago and the precise relationship between the *Proptychites*-bearing beds of Greenland and those of Canada cannot be determined at present.

5. *Prionolobus plicatus* fauna, Bunde Fiord

This species has not been found in situ and is known only from talus derived from beds above the *P. candidus* horizon. According to Spath (1934, p. 96) *Prionolobus* occurs in the Gyronitan and Flemingitan.

The beds with *Proptychites strigatus, Proptychites candidus* and *Prionolobus plicatus* cannot be dated precisely. There is no evidence to suggest that they are as young as the zone characterized by the distinctive *Flemingites.* All three Canadian species may be of Gyronitan age, in which case approximate correlatives occur in the Salt Range, (Lower Ceratite limestone, Lower and Middle Ceratite marls) (Waagen, 1895); East Greenland, (*Proptychites rosenkrantzi* beds) (Spath, 1935); Dinwoody formation of Montana, (beds with *Prionolobus, Kymatites,* and *Xenodiscoides*) (Kummel, 1954, p. 184); and southwestern Nevada (*Proptychites* fauna of the Candelaria formation) (Muller and Ferguson, 1939).

6. *Meekoceras* bed, Nansen Sound, northwestern Ellesmere Island

The fauna from the *Meekoceras* bed of Nansen Sound is well preserved and diverse. This fauna occurs in a bed about 2 feet thick and the fossils therein clearly represent one contemporary assemblage. It is closely related to two others, namely the *Meekoceras* fauna of the western United States and the *Arctoceras* fauna of Spitsbergen. The *Meekoceras* fauna of Idaho and adjacent areas occurs in the lower part of the Thaynes formation (Kummel, 1954) and the *Arctoceras* fauna is in the Spitsbergen "Fish beds".

This affinity is shown in tabular form as follows:

Meekoceras fauna of Nansen Sound	*Meekoceras* fauna of Thaynes formation		*Arctoceras* fauna of Spitsbergen	
	Same species	Same genus	Same species	Same genus
Pseudosageceras multilobatum Noetling	x	x		
Flemingites ? sp.		?		
Euflemingites romunduri n. sp.		x	?	x
Juvenites canadensis n. sp.		x		
Juvenites crassus n. sp.		x		
Prosphingites spathi Frebold		x	x	x
Anakashmirites borealis n. sp.		?		
Meekoceras gracilitatis White	x	x		
Arctoceras oebergi (Mojsisovics)	?	x	x	x
Posidonia mimer Oeberg			x	x
Pseudomonotis boreas (Oeberg)			x	x

It would appear that the fauna from Nansen Sound links the *Meekoceras* fauna of Idaho with the *Arctoceras* fauna of Spitsbergen. This correlation differs from that adopted by most authorities. In order to discuss this correlation it is necessary to consider the succession of Scythian faunas in Spitsbergen and their relationship to those of the Canadian Arctic, and the Western United States and Siberia.

The Scythian ammonoids of Spitsbergen have been studied by many workers, particularly Lindstrom (1865), Oeberg (1877), Mojsisovics (1886), Stolley (1911), Boehm (1913), Spath (1921, 1934, 1951) and Frebold (1929a, b, 1930). A concise summary of the Scythian sequence has more recently been prepared by Frebold (1951). Ammonoids have been described from two formations, the Fish beds (or *Posidonomya* limestone) below, and the *Grippia* bed, above. In Frebold's most recent summary the *Grippia* bed is placed in the Anisian, but in earlier works he (Frebold, 1930, p. 33) regards this bed as highest Scythian or lowest Anisian, a view which must be reconsidered here (p. 32).

Most of the Scythian ammonoids from Spitsbergen have been collected by geologists engaged in reconnaissance, or, incidentally, by vertebrate palæontologists. Virtually no detailed stratigraphic sections have been published by collectors that show the position of the various ammonoid faunas. The only exception is a paper by Frebold (1931) which gives several sections showing the position of ammonoid beds.

The ammonoid faunas of the Fish beds have considerable bearing on the correlation of the *Meekoceras* bed. The following genera have been described or mentioned: *Euflemingites, Xenoceltites, Prosphingites, Tellerites, Arctoceras, Hemiprionites, Gurleyites, Arctoprionites* and *Wasatchites*. Spath (1930, p. 82) and Frebold (1930, p. 33) recognize two faunal zones within the Fish beds. They place

Hemiprionites, Arctoprionites, Gurleyites and *Wasatchites* in the lower fauna; *Arctoceras* and *Prosphingites* in the upper fauna. Both faunas were placed near the top of the Scythian, and the *Arctoceras* fauna was dated as Prohungaritan. The writer would suggest that these faunas are very similar to the *Meekoceras* and *Wasatchites* faunas (both Owenitan) of the Western United States and that they are quite unrelated to the *Olenikites* fauna from Siberia of Prohungaritan age. As noted elsewhere (p. 67), *"Meekoceras" tuberculatum* Smith, from Nevada, of Owenitan age, is referable to *Arctoceras*. The writer therefore rejects Spath's view (1934, p. 258) that "the apparent restriction of *Arctoceras* to Spitsbergen may be explained by the fact that deposits of Prohungaritan age are so far known only from a few localities, and those of dates slightly different from that of the Spitsbergen beds".

In the Western United States *Wasatchites,* etc., occur above the *Meekoceras-Arctoceras* fauna in several sections (Mathews, 1929, 1931; Kummel, 1954). As already noted, Spath and Frebold believed that *Arctoceras* lies above *Wasatchites* in Spitsbergen. However Spath, in his first Spitsbergen paper (Spath, 1921), recorded *Wasatchites* (at that time he called it *Keyserlingites*) from the same bed as *Arctoceras*. In both the Western United States and Spitsbergen *Arctoceras* and *Wasatchites* are not widely separated in time. In Spitsbergen there is even some evidence to suggest that these genera were contemporaries. Both genera occur in the Queen Elizabeth Islands, but in different sections, consequently their relative position in the Archipelago cannot be determined at present.

The writer concludes that the beds with *Arctoceras* in the Canadian Arctic, Spitsbergen and the Western United States are essentially contemporáneous and of Owenitan age. The *Wasatchites* beds of these three areas are also correlated (*see below*). From the evidence of the Utah succession (Mathews, 1929) *Wasatchites* may be younger than *Arctoceras,* but the Spitsbergen data suggest that the ranges of these genera overlap. Both faunas (whether or not they are truly heterochronous in all areas) are older than the *Olenikites* fauna of Siberia and the *Columbites* fauna of Idaho.

Owenites, the distinctive ammonoid which provides the name for the Owenitan age (or zone) is said to occur with *Meekoceras gracilitatis* in California (Smith, 1932, p. 9). *Owenites* is not known in the Canadian Arctic. It occurs in Timor (Welter, 1922), the Caucasus (Kiparisova, *et al.,* 1947, p. 139), New Zealand (Kummel, 1959) and China (Chao, 1959). In view of the association with *Meekoceras* in California, we may conclude that the *Owenites* beds of these areas are essentially the same age as the *Meekoceras* bed of Nansen Sound.

7. *Wasatchites* bed, Bunde Fiord

The *Wasatchites* fauna of Bunde Fiord was collected by Thorsteinsson from a thin bed 514 feet above the base of the Blind Fiord formation. The following species occur.

Wasatchites tardus (McLearn)
Xenoceltites subevolutus Spath
Pseudomonotis occidentalis (Whiteaves)

This fauna permits a correlation with the *Wasatchites-Anasibirites* assemblages of Utah (Mathews, 1929), Spitsbergen (Frebold, 1930; Spath, 1934), Timor (Welter, 1922; Spath, 1934), northeastern British Columbia (McLearn, 1945), Japan (Yehara, 1928), and the Upper Ceratite limestone of the Salt Range, Pakistan (Waagen, 1895).

All these faunas represent the so-called "*Anasibirites multiformis* zone", of Owenitan age. The independent status of this zone within the Owenitan age seems doubtful (p. 27). As already mentioned above, the relationship of the *Wasatchites* and *Meekoceras* beds has not been determined in the Arctic Archipelago, but they are probably essentially the same age.

8. *Olenikites* bed, Otto Fiord

The *Olenikites* bed of Otto Fiord contains *Olenikites canadensis* n. sp. and *Posidonia aranea* n. sp. It is a meagre fauna but the presence of the rare, distinctive *Olenikites* permits a correlation with the fauna from the Olenek River, Siberia. This fauna, made known by Mojsisovics' monographs (1886, 1888), is characterized by the following ammonoids (the generic nomenclature given is essentially that of Spath, 1934): *Olenikites, Sibirites, Keyserlingites, Svalbardiceras*[1], and *Czekanowskites*. After 70 years comparable faunas are still very rare and none so rich in variety are known. Kummel (1954, p. 187) has recognized several genera from the Olenek River fauna (*Keyserlingites* and *Svalbardiceras,* and possibly *Olenikites* and *Czekanowskites*) in the upper part of the Thaynes formation, Idaho, associated with *Prohungarites*. *Olenikites* may also occur in the uppermost beds of the Upper Ceratite limestone (Waagen, 1895, p. 25; Spath, 1934, p. 360). The writer believes that this fauna can be recognized in the *Grippia* beds of Spitsbergen, which overlie the "Fish beds". Frebold (1931, p. 32) described some interesting sections at Botneheia, in the Ice Fiord area, in which the *Grippia* beds, with *Svalbardiceras* and *Keyserlingites,* overlie the *Arctoceras* beds. The *Grippia* beds, not the underlying *Arctoceras* strata, presumably represent the uppermost Scythian *Olenek* fauna. In an earlier work, based on collections made by Swedish Expeditions, Frebold (1930) describes *Svalbardiceras* from the "Lower Reptile beds", with the Anisian *Beyrichites affinis*. Dr. Frebold informed the writer (personal communication) that he was never completely satisfied that *Svalbardiceras* occurs with *Beyrichites affinis*. In the sections that he examined (Frebold, 1931) no such association was apparent.

Kiparisova and Popow (1956) correlate the *Olenikites* beds with the *Subcolumbites* beds of Primorye, Albania and Chios Island and with the *Columbites* beds of Idaho. However, the three faunas characterized respectively by *Olenikites, Columbites* and *Subcolumbites* have very little in common and the writer prefers Spath's verdict that they are heterochronous.

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[1] *Svalbardiceras schmidti* (Mojsisovics), 1886, p. 77, pl. XI, figs. 8-11. Waagen (1895, p. 297) separated one specimen (fig. 11) as "*Gyronites*" *mojsisovicsi*. The writer prefers to accept Mojsisovics' broad interpretation of "*Xenodiscus*" *schmidti*.

Middle Triassic

At least three Middle Triassic faunas occur in the Arctic Archipelago. They are as follows:

Fauna	Age	Distribution
3. *Nathorstites*	Ladinian	Schei Point and Blaa Mountain formations
2. *Daonella frami*	Anisian or Ladinian	"
1. *Ptychites* cf. *P. trochlaeformis*, etc.	Anisian	"

1. Anisian faunules

In the Arctic Archipelago Anisian fossils are rare and generally poorly preserved. The following ammonoids occur:

	Locality	
	Schei Point fm.	Blaa Mountain fm.
Pearylandites sp.	Exmouth Island	
Frechites sp.	Exmouth Island	
Gymnotoceras cf. *G. helle* McLearn	North of Gretha Islands	
Halilucites sp.	Exmouth Island	
Parapopanoceras sp.	Exmouth Island	
Ptychites cf. *P. trochlaeformis* (Lindstrom)	Exmouth Island	Lower Shale member, northern Axel Heiberg Island

These fossils clearly indicate that deposits of Anisian age occur in the Schei Point and Blaa Mountain formations. More than one zone may be present, but the collections are too meagre to establish any local zonation or to correlate with Anisian zones of other areas. The existence of Anisian rocks in the Arctic Archipelago is not surprising for rocks of this age are known in several areas bordering the Arctic Ocean, e.g., Spitsbergen (*see* Frebold, 1935, 1951 for summary), northeastern Siberia (Kiparisova, *et al.*, 1947, p. 9), Pearyland, at the north end of Greenland (Kummel, 1953b), and northern Alaska (Kummel, *in* Reeside, *et al.*, 1957, p. 1501). Anisian deposits also occur in the Toad formation of northeastern British Columbia (McLearn, 1946-1951), and in the Spray River beds of the Alberta Rocky Mountains (Warren, 1945; McLearn, 1953a, p. 1222), and they are widely distributed in the Western United States (Smith, 1914; Muller and Ferguson, 1939, etc.).

2. *Daonella frami* fauna

As noted previously (p. 23), *Daonella frami* is widely distributed in the Sverdrup Basin, in both the Schei Point and Blaa Mountain formations. In each section it is confined to a thin bed which we are probably justified in correlating from one section to another. This species occurs in the Schei Point formation of

Bjorne Peninsula, Table and Exmouth Islands. It occurs in the Blaa Mountain formation (Lower member) near Blind Fiord, and in the Lower Shale member of the Nansen Sound sequence. It has not yet been found in the Buchanan Lake section. In all sections but one, *Daonella frami* is the only species in this bed. The one exception is the Schei Point section on Bjorne Peninsula, where the following ammonoids also occur:

Longobardites sp. indet.
Protrachyceras sp. indet.
Ptychites nanuk n. sp.

The only well-preserved ammonoid is *Ptychites nanuk,* at present known only in the Canadian Arctic Archipelago and not closely related to any other species. The genus *Ptychites* is particularly abundant in the Anisian, but some Ptychitidae (e.g., *Flexoptychites* Spath) range up to the Ladinian. *Protrachyceras* and *Longobardites* also range from the Anisian into the Ladinian. The age of the *Daonella frami* bed therefore cannot be determined precisely.

3. *Nathorstites* fauna

The *Nathorstites* fauna occurs in the Schei Point formation of Table Island, Bjorne Peninsula (talus) and in several sections near the mouth of Bay Fiord. In the Blaa Mountain formation it is known at Blind Fiord (Middle member), and between Hare and Otto Fiords (Lower Shale member). In each section it has been collected only from one bed. It follows that the *Nathorstites* zone in the Sverdrup Basin is probably very thin.

At Blind Fiord the specimens probably represent *Nathorstites gibbosus* Stolley. The remainder apparently represent *Nathorstites mcconnelli* (Whiteaves). In the section between Hare and Otto Fiords, *Procladiscites* cf. *P. martini* (Smith) occurs with *Nathorstites.* In the other sections no other ammonoids occur. In at least two sections (Table Island, and between Hare and Otto Fiords) *Nathorstites* occurs above *Daonella frami* and below Karnian beds with *Sirenites* and *Halobia zitteli* Lindstrom.

In other parts of the world *Nathorstites* occurs at the following localities: Liard formation, "Grey beds" and "Dark Siltstones", northeastern British Columbia (McLearn, 1947b); Bear Island (Boehm, 1903); Kotelnyi Island, in the New Siberian Archipelago (Diener, 1916a); Spitsbergen (Stolley, 1911; Frebold, 1929a, b); and near Oymyakon, northeastern Siberia (Popow, 1946). Smith (1927, p. 67) described *"Nathorstites alaskanus",* based on a small specimen, about 9 mm in diameter, from the Nation River area (Central Alaska). This species may represent *Nathorstites,* but it is too small to be certain.

These *Nathorstites*-bearing beds are presumably approximately all of the same age. *Nathorstites* has not yet been found in the Mediterranean region, where the classical Triassic sections are found. Consequently the age of the genus, in terms of the classical sequence, cannot be directly established.

Boehm (1903) dated the *Nathorstites* beds of Bear Island as Karnian. He identified species of "*Clionites*" (now *Clionitites*) and *Trachyceras,* typical Karnian genera, from Bear Island which led him to make this correlation. The figures of these ammonoids show that they are poorly preserved and scarcely determinable. Nevertheless, the Karnian dating suggested by Boehm was generally accepted, for example by Diener (1916a, b, 1925) and Frebold (1929a, b). Diener (1916a) described several Upper Triassic ammonoids (*Anatomites, Pinacoceras,* etc.) from Kotelnyi Island, in the same paper as the one in which he records *Nathorstites.* However, Diener points out that the specimens of *Nathorstites* were not found in association with these Karnian ammonoids.

Over the past 30 years F. H. McLearn has published many papers concerning the age of the *Nathorstites* beds of northeastern British Columbia. In 1937 he (McLearn, 1937a) first expressed doubts concerning the generally accepted Karnian dating of the *Nathorstites* fauna. In several papers he revealed that many other genera of ammonoids occur in the *Nathorstites* fauna of the Peace River foothills, including *Paratrachyceras, Protrachyceras, Thanamites, Asklepioceras, Silenticeras, Sagenites* and *Lobites.* Also present in other parts of northeastern British Columbia are *Daxatina* (= *Dawsonites*) and *Anolcites,* recently collected by B. R. Pelletier. McLearn has also described two species of *Daonella* from the *Nathorstites* beds of British Columbia. One of these, *Daonella nitanae,* as recognized by McLearn, resembles closely *Daonella lommeli* Wissmann from the Wengen beds (*Protrachyceras archelaus* zone, Upper Ladinian) of Austria. McLearn (1947b) concluded that the evidence from northeastern British Columbia favours a Ladinian age for the *Nathorstites* fauna but that the possibility of a Lower Karnian age could not be excluded.

In recent years new occurrences of *Nathorstites* have been recorded in northeastern Siberia (Popow, 1946; Tuchkov, 1957, 1958). In Siberia the *Nathorstites* beds occur beneath strata with *Sirenites* and *Halobia.* These *Sirenites* beds are considered Lower Karnian by the Siberian geologists, and the *Nathorstites* beds, below, are placed in the Ladinian. Popow (1946) recorded *Nathorstites,* together with two genera probably identical with *Nathorstites* (*Indigirites* and *Paraindigirites, see* p. 90), *Mojsvarites* and *Daonella* from the Oymyakon area, near the headwaters of the Indigirka River. Previous records of *Mojsvarites* are from Upper Triassic deposits, but Popow considered that the Siberian species (*Mojsvarites oimekonensis* Popow) has a more primitive suture line than the Upper Triassic forms.

In the Arctic Archipelago *Nathorstites* occurs below beds with *Sirenites nanseni* n. sp. and *Halobia zitteli* Lindstrom. These beds with *Sirenites* and *Halobia* are certainly Karnian, and probably Lower Karnian. Thus the position of *Nathorstites* in the Arctic Archipelago appears to be essentially the same as in Siberia.

The evidence derived from stratigraphic position, in both the Arctic Archipelago and Siberia, suggests that *Nathorstites* is older than beds containing Lower Karnian faunas. One must therefore look for correlatives in the Ladinian. The

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ammonoids associated with *Nathorstites* in the Peace River valley are quite compatible with a Ladinian correlation, but, as McLearn pointed out, they cannot confirm such a correlation because most of these genera occur in both Ladinian and Lower Karnian faunas. The occurrence of *Daonella,* is, however, very suggestive of a Middle Triassic age, and the recent discovery of *Anolcites* in the *Nathorstites* beds of the Tetsa River area also points to this age determination.

The *Nathorstites* beds are presumably either the same age as the upper Ladinian *Protrachyceras archelaus* zone or slightly younger. If younger, they evidently represent a new zone, because they seem to be older than the Lower Karnian *Trachyceras* zone. If they truly represent a distinct zone, between the *Protrachyceras archelaus* and *Trachyceras* zones, it is a matter of choice whether they be placed in the Ladinian, or the Karnian, or a new stage. At present it seems appropriate to treat the *Nathorstites* beds as Ladinian, because they appear to predate the Lower Karnian.

Upper Triassic

At least three successive Upper Triassic faunas have been recognized in the Queen Elizabeth Islands. They are as follows:

Fauna	Age	Distribution
3. *Monotis ochotica* (Keyserling)	Norian	Heiberg formation
2. *Meleagrinella antiqua* n. sp. *Oxytoma kiparisovae* n. sp.	Karnian or Norian	Heiberg formation
1. Several faunules with *Sirenites, Arctosirenites, Jovites, Tropites, Rhacophyllites, Halobia zitteli* Lindstrom, etc.	Karnian	Blaa Mountain and Schei Point formations

1. Karnian faunules

Karnian ammonoids are the most abundant in the Queen Elizabeth Islands. Despite this, their interpretation from a stratigraphic standpoint is more difficult than for most of the ammonoids from other levels. This is mainly because the faunas of individual Karnian ammonite beds are very meagre. Most beds contain only one species. A wide interpretation has been adopted for most of these assemblages and some workers might recognize several species where the writer has named only one. However, there would be general agreement that only one genus is present in, for example, a typical sample of *Sirenites nanseni* n. sp., so that these faunules are truly lacking in variety compared with most Karnian assemblages from southern latitudes. Furthermore, well-preserved fossils are rare except in isolated beds and in no section is there an established sequence of Karnian beds with well-preserved ammonoids. It also appears that the rate of sedimentation was more rapid in Karnian time than in the Lower and Middle Triassic. In the Nansen Sound sequence of the Blaa Mountain formation, *Sirenites* ranges through more than 3,000 feet of beds. More than one species is probably represented but as the specimens from the upper part of the sequence are relatively poorly preserved this cannot be established. The high sirenitids are, however, of *"senticosi"* type and are certainly not younger than Karnian. This long range for *Sirenites* may be contrasted with the range of *Daonella frami* and *Nathorstites,* both of which appear to be confined to a foot or two feet of beds. Thus the great thickness of the Karnian deposits and the great variation in thickness from one section to another mean that it is probably unwise to assume that *Jovites borealis* (at a level about 7,000 feet above the Blind Fiord formation at Buchanan Lake) is much younger than *Sirenites nanseni* (about 1,500 feet above the same datum in the Nansen Sound sequence).

These factors make it difficult to assess, from the local evidence, the time-stratigraphic significance of differences in the Karnian faunas of the various localities.

The following Karnian cephalopods have been identified from the Queen Elizabeth Islands.

Karnian Cephalopods of the Blaa Mountain and Schei Point Formations

	Blaa Mountain formation	Schei Point formation
Sirenites senticosus (Dittmar)**		x
Sirenites nanseni n. sp.	x	x
Sirenites costatus n. sp.	x	
Arctosirenites canadensis n. gen., n. sp.	x	
Arctosirenites spp. indet.	x	x
Tropites cf. *T. morani* Smith*		x
Jovites borealis n. sp.**	x	x
Jovites richardsi n. sp.*		x
Rhacophyllites zitteli Mojsisovics	x	
Germanonautilus sp.		x
Proclydonautilus spirolobus (Dittmar)*	x	x

*These species occur together on Cameron Island.
**These species probably occur together on Table Island.
No other associations have been definitely established.

Before considering possible zonation in the Karnian of the Queen Elizabeth Islands we may treat the cephalopods in the foregoing list as members of one essentially synchronous fauna and examine the affinities on this assumption.

All the old genera in this list are known in Karnian strata. *Sirenites, Jovites* and *Tropites,* if we ignore doubtful records, are known only in the Karnian. *Rhacophyllites* and *Proclydonautilus* range up into the Norian. With the exception of the long-ranging *Germanonautilus,* none of these genera is known in the Middle Triassic.

The Canadian specimens referred to *Sirenites senticosus* are apparently identical with a species in the Lower Karnian *Trachyceras* zone of the Hallstatt limestone, Austria. *Sirenites nanseni* is very close to a number of species in this zone. Species of *Sirenites* close to, or perhaps identical with the Canadian forms are known from Alaska (*Sirenites hayesi* Smith, 1927) and from northeastern Siberia (Kiparisova 1937a,b; Tuchkov, 1957, 1958). Comparable species of *Sirenites* are known from no other level in the classical Triassic sections. These *Sirenites* occurrences are taken to be essentially the same age and synchronous with the Lower Karnian of Austria. Palæontologists in the Soviet Union (Kiparisova, Tuchkov) have already adopted this correlation.

There are several anomalies of distribution that must be mentioned. The Lower Karnian beds of Austria, besides *Sirenites,* contain many ammonoid genera (e.g., *Trachyceras, Joannites, Lobites, Hoplotropites,* etc.). These genera have never been found in the Queen Elizabeth Islands. The *Sirenites nanseni* beds of the Blaa Mountain formation yield abundant, well-preserved specimens but they have not provided a single ammonoid other than *Sirenites.* Undoubted Lower Karnian ammonoids have been recorded from only one locality in North America, namely New Pass, Nevada (Johnston, 1941). This fauna contains the true *Trachyceras* and other characteristic Lower Karnian genera but there are no representatives of *Sirenites* in this fauna. These faunal differences may indicate that distinct faunal provinces existed in Karnian time.

As already mentioned, it has not been possible to detect any zonation of Karnian ammonoids within one section. However, in such thick Karnian sections the fossils must differ in age. The problem is to determine what faunal changes, if any, took place during this part of Karnian time.

Sirenites nanseni is the first undoubted Karnian ammonoid to appear in the Blaa Mountain formation. The *Arctosirenites* bed, and the *Jovites borealis* bed, of Buchanan Lake, occur high in the formation and are probably younger than the *Sirenites nanseni* beds.

Near Cape Ursula, Table Island, *Jovites borealis* occurs in disintegrated outcrops with the Lower Karnian *Sirenites senticosus.* This suggests, but does not necessarily establish, that these species were contemporaries, and that *Jovites borealis* is also Lower Karnian. *Arctosirenites canadensis* lies below *Jovites borealis* at Buchanan Lake, so this species would also be Lower Karnian. On Borden Island, poorly preserved specimens of *Sirenites,* with many rows of lateral tubercles, like *S. nanseni,* occur 11 feet above *Sirenites senticosus.* It would seem that there is no evidence to suggest a date younger than Lower Karnian for any of the Karnian ammonoids considered in the preceding paragraphs.

The Schei Point fauna from Cameron Island may be younger than the other Karnian faunas because *Tropites* cf. *T. morani* may be identical with an Upper Karnian species from California. However the associated species cannot confirm this. *Jovites richardsi* is a new and distinctly isolated form and cannot be used for correlation at present. The range of *Proclydonautilus spirolobus,* combined with that of its close ally *P. goniatites* (Hauer), is from Lower Karnian to Norian.

The sequence of Karnian faunas in the Queen Elizabeth Islands is interpreted as follows:

(Youngest)

4. *Tropites* cf. *T. morani,* etc., Schei Point formation of Cameron Island.
3. *Jovites borealis,* Schei Point formation of Table Island, Blaa Mountain formation of Buchanan Lake.
2. *Arctosirenites canadensis,* Blaa Mountain formation of Buchanan Lake.
1. *Sirenites nanseni,* Blaa Mountain formation of Nansen Sound, Schei Point formation of Hat Island.

It should be stressed that this sequence is hypothetical and tentative and that it has not been established objectively by superposition.

2. *Meleagrinella antiqua–Oxytoma kiparisovae* fauna

Most of the lower part of the Heiberg formation is unfossiliferous but in many sections there are thin beds of sandstone with abundant pelecypods. Although abundant in numbers the variety is poor. The most abundant and widely distributed species is *Meleagrinella antiqua* n. sp., which occurs on Bjorne Peninsula, Raanes Peninsula, on Eastern Axel Heiberg Island, Fosheim Peninsula and on the north side of Greely Fiord. Near Eureka, *Oxytoma kiparisovae* n. sp. occurs with *M. antiqua.* In several sections poor specimens of *Halobia* occur at about the same horizon as the two species named above. *Palaeopharus scheii* Kittl was probably collected from beds that should be placed in the Heiberg formation but it has not been found by the writer and the exact position is not known.

Oxytoma kiparisovae belongs to the group of *O. mojsisovicsi* Teller. Members of this group occur in the Upper Triassic of Siberia (Teller, 1886; Kiparisova, 1937a; Kiparisova, *et al.,* 1947, p. 94; Tuchkov, 1958) and Japan (Yehara, 1927; Kobayashi and Ichikawa, 1950; Ichikawa, 1956).

The Japanese occurrences are dated as "Sakawan" (i.e., approximately Karnian) by Ichikawa. The published data on the Siberian occurrences would suggest a range from the Karnian to the Rhaetian for *O. mojsisovicsi* (Tuchkov, 1956, 1958), but in Siberia this species seems to be particularly common and widely distributed beneath the Norian *Monotis ochotica* beds. *Meleagrinella antiqua* is not very helpful. Related forms have been recorded, as "*Pseudomonotis* aff. *spitsbergensis*" from beds in Japan (Kobayashi and Ichikawa, 1949, p. 247). These Japanese forms occur with shells identified as *Oxytoma zitteli* (Teller), which is closely related to *Oxytoma kiparisovae.* This Japanese faunule would appear to be related to the assemblage in the Lower Heiberg beds. In both Japan and the Queen Elizabeth Islands these faunules are overlain by beds with *Monotis ochotica.*

The exact age of the *Meleagrinella antiqua-Oxytoma kiparisovae* fauna is not known. The fauna is certainly younger than the Karnian faunas of the Blaa Mountain formation and older than the Norian *Monotis ochotica.* It is probably Upper Karnian or Lower Norian. Broadly speaking, a correlation with the *Oxytoma* *mojsisovicsi* beds of Japan and Siberia may be suggested. In Japan and Siberia, as in the Queen Elizabeth Islands, no ammonoids have been described from these *Oxytoma*-bearing beds.

3. *Monotis ochotica* fauna

The record of *Monotis ochotica* Keyserling from the Heiberg formation adds one more locality to the range of this widespread species. In the Queen Elizabeth Islands *Monotis ochotica* is known from Buchanan Lake, Wolf Fiord, Raanes Peninsula, Cornwall Island, and Brock Island. It is not known on Fosheim and Bjorne Peninsulas, where the Heiberg beds carry only the lower fauna, with *Meleagrinella antiqua*. It would seem that the marine band with *M. antiqua* extends farther to the east than the overlying band with *Monotis ochotica*.

The *Monotis ochotica* fauna of the Queen Elizabeth Islands is a meagre one. At Wolf Fiord a species of *Myophoria* (probably *Cardita* ? *Ursina* Kittl, 1907, p. 33, pl. 2, fig. 5 and erroneously described in the text and on the plate description as fig. 15) and some fragmentary ammonoids were collected. At other localities *Monotis ochotica* occurs alone.

Monotis ochotica, or its close allies *M. richmondiana* Zittel, *M. salinaria* Bronn, *M. subcircularis* Gabb, etc., are found throughout the "Tethys", from Austria to the Himalayas; on the lands bordering the Pacific Ocean (New Zealand, Japan, Primorye, Kamchatka Peninsula, southeastern Alaska, British Columbia, California, Nevada and Peru); and near the shores of the Arctic Ocean (northeastern Siberia, Wrangell Island, Kotelnyi Island, northern Alaska, possibly Spitsbergen[1], and now also the Canadian Arctic Archipelago.

The *Monotis ochotica* fauna is generally treated as Norian. Cephalopods are not usually found in association with *Monotis,* but those that have been collected, e.g., *Rhabdoceras* and *Halorites* which occur with *M. subcircularis* in California (Smith, 1927, p. 8) and Yukon Territory (Tozer, 1958a) indicate a Norian age. Arthaber (1905, pp. 344-345), Muller and Ferguson (1939, p. 1608) and McLearn (1947a) have described sections and advanced further arguments in support of a Norian dating for *Monotis salinaria* and *M. subcircularis.* In 1908, Diener (1908, p. 130) had some misgivings about accepting *M. salinaria* as a distinctive Norian index for he claimed that this species had been collected from Karnian beds at Spizza. Marwick (1953, p. 17), on the basis of Diener's assertion, revived this feeling of doubt concerning the age of the *Monotis* fauna. However, in 1923, Diener himself, in the "Catalogue of Triassic Pelecypods" (Diener, 1923, p. 45) gave the age of *M. salinaria* as Norian, without reservations. So there seems to be no good reason to doubt that typical large *Monotis* species, such as *M. ochotica, M. salinaria* and *M. subcircularis* are confined to rocks of Norian age.

McLearn's work has shown that in northeastern British Columbia *Monotis* first appears in the *Himavatites* zone, which is approximately equivalent to the *Cyrtopleurites bicrenatus* zone at the top of the lower Norian of the Hallstatt limestone. It follows that *Monotis* is not only Norian, but mainly late Norian.

[1] Boehm, 1913, p. 6, pl. I, fig. 9, "*Pseudomonotis ochotica* v. Keyserling var. *densestriata* Teller". From the figure the specimen is small and does not show the characteristic *Monotis* outline. This cannot be considered a satisfactory record.

PALAEOGEOGRAPHY

The Triassic Palæogeography of Arctic regions has been discussed by Diener (1916b) and Frebold (1929a). The essential picture that emerges from their reconstructions is that of a permanent sea on the site of the present-day Arctic Ocean. The marine Triassic rocks of Arctic lands were deposited during transgressions of the sea from the north. The connection with the Pacific, and thence to the Tethys, evidently lay in the region of Bering Strait.

The Arctic areas affected by marine Triassic sedimentation are shown on Figure 1. This map does not differ radically from those prepared by Diener and Frebold. Frebold produced maps for each Triassic stage. His maps suggest that the Karnian and Norian transgressions were more widespread than those of Lower and Middle Triassic time. Discoveries since 1930, mainly in northeastern Siberia and northern Alaska, and now also the Queen Elizabeth Islands, have shown that Lower and Middle Triassic rocks are more widely distributed than formerly believed. As our knowledge increases it appears that Triassic sections in most Arctic areas record more or less continuous sedimentation throughout the period. However, there are some areas where Middle or Upper Triassic strata rest directly upon pre-Triassic rocks. Examples are: southern Spitsbergen and Bear Island, where the *Nathorstites* beds (evidently Ladinian) rest directly upon Permian or older formations (Frebold, 1951, p. 77); Intrepid Inlet, Prince Patrick Island, where Middle or Upper Triassic (probably Karnian) beds rest on the Devonian; and Kamchatka Peninsula, where Norian beds rest on crystalline rocks of unknown age (Kiparisova, 1937b, p. 33).

As already mentioned, in the Queen Elizabeth Islands the Triassic rocks near the south and east margins of the Sverdrup Basin evidently represent near-shore deposits. It follows that the outline of the Triassic embayment shown on Figure 1 probably gives a fairly accurate picture of the palæogeography of this area. The Triassic sediments, which are essentially either quartzose or argillaceous and without rocks of greywacke facies, were presumably derived from the south and east. Much of the quartz sand may have been derived from terrain composed of the Devonian sandstones like those that make up much of the Parry Island belt today.

Most of the Triassic sediments were laid down in shallow, marine waters (Blind Fiord, Schei Point and Blaa Mountain formations). Some of the sediment was probably (Bjorne formation) and some certainly (most of the Heiberg formation) deposited above strand line. Most of the Sverdrup Basin experienced marine conditions from the lowest Scythian until the Karnian. Non-marine conditions prevailed in late-Triassic time. The youngest marine fauna (*Monotis ochotica,* of Norian age) is intercalated with non-marine sediments; above *Monotis* are non-marine sandstones and shales with coal seams. They evidently provide local testimony of the world-wide Rhaetian regression.

SYSTEMATIC PALAEONTOLOGY

Ammonoidea

Taxonomic approach. In naming Triassic ammonoids from the Queen Elizabeth Islands an attempt has been made to treat the various assemblages as populations, rather than to adopt a purely typological approach. The typological approach, according to which each species is defined by rigid morphological criteria, has some advantages but tends to produce a multiplicity of "species". In the classical monographs on Triassic ammonoids by Mojsisovics, Waagen, Diener, Arthaber and James Perrin Smith, the typological method is generally used. Although many contemporary palæontologists would criticize the approach of these pioneers, it must be admitted that their method has one advantage, namely, that it is the most objective way in which to treat the material. This method is particularly useful when dealing with small collections (one or two specimens) from scattered localities. Under such circumstances it is often impossible to estimate whether morphological differences observed between specimens from different localities indicate a different stage of evolution, or whether the differences reflect phenotypic variation within a single variable species. By naming such specimens typologically, differences are objectively characterized, and theories regarding affinities do not affect taxonomy at the specific level. With most of the specimens under consideration, this difficulty does not apply. Ammonoids are rare in the Triassic sections and most specimens were obtained from thin beds in a thick, essentially unfossiliferous sequence. Consequently it is possible to say that all the specimens of, for example, *Arctosirenites canadensis* n. gen., n. sp., are essentially the same age. In dealing with the fossils from thin beds of this sort, for example also the *Meekoceras* bed, morphological varieties that may be linked together to form a series are treated as members of one species.

In this connection it should be mentioned that an attempt has been made to avoid creating names for immature individuals. It would seem that complete specimens of adult ammonoids are relatively rare. Kummel (1948, p. 61) pointed out that among hundreds of specimens of the Lower Cretaceous *Engonoceras* from Texas, only a "mere half dozen are complete and mature specimens including the living chamber". Thanks to the industry of F. H. McLearn, the Geological Survey of Canada possesses large collections (several hundred specimens) of *Nathorstites* and *Longobardites* from northeastern British Columbia. The largest known specimen of *Nathorstites mcconnelli* (Whiteaves) (*see* p. 91) is 74 mm in diameter with nearly a full whorl of living chamber. Most are much smaller and display great variation in proportional width. Large specimens are rare and it is not known whether they display comparable variation; probably they do not. The young of

Longobardites nevadanus (Hyatt and Smith) are also very variable (McLearn, 1951). Of the many, mainly small, *Longobardites* from northeastern British Columbia there is only one specimen that attains a diameter of 82 mm. This specimen has a broken venter at the aperture and was originally about 90 mm in diameter. It has half a whorl of body chamber, a contracted aperture, an enlarged umbilicus, and is presumably adult. Ideally our species should be founded on such specimens rather than on phragmocones and immature individuals (cf. Smith, 1914, pl. XXX, figs. 3, 4.) It seems reasonable to regard *Nathorstites mcconnelli* and *Longobardites nevadanus* as species with variable young. The lesson learned from the study of such species, of which there is abundant material, has guided the writer in naming the various specimens of *Otoceras boreale* (p. 45), and *Proptychites strigatus* n. sp. (p. 55).

In naming trachyceratidae (e.g., *Sirenites* and *Arctosirenites*) in which the strength and type of sculpture is very variable, the writer has followed the approach advocated by Silberling (1956, p. 1148), who refers variable, intergrading, associated forms to a single species instead of using many specific names as was commonly done in the past.

These remarks must not be construed as a total rejection of "typology" in the study of ammonoids. It is obvious that the naming of ammonoids cannot be suspended until we are certain that we have adults of all our species. The writer offers no apology for naming *Jovites richardsi* n. sp. on three specimens (two of which are fragmentary phragmocones), or *Juvenites canadensis* n. sp. (on one specimen). It is clearly desirable to give distinctive ammonoids unambiguous names, but it is also desirable to avoid naming what appear to be morphological variants within an inter-breeding population.

Regarding the taxonomic significance of size in ammonoids there is still little agreement. This may be illustrated by referring to two recent works on Jurassic ammonoids. Howarth (1958, p. xviii) stated that complete adults of *Amaltheus wertheri* (Lange) vary in size between 10.7 and 31.7 mm. Callomon (1957, p. 61), on the other hand, considered that adults of one species are commonly the same size. The writer has little to add to this problem; the few adults of *Jovites borealis* n. sp. (an excentrumbilicate species, like Callomon's Jurassic forms) are about the same size. Many of the Triassic ammonoids described here lack distinctive adult characters, and frequently it has been impossible to recognize mature forms. However, wherever possible, an attempt has been made.

The suture line terminology of Arkell ("Treatise on Invertebrate Palaeontology", part L, Mollusca 4, 1957, p. 97) has been used. In the arrangement of ammonoid families, the work of Kummel (in the same Treatise) has been followed. All measurements are given in mm.

The measurements are given in the conventional manner; diameter (D), whorl height (H); whorl width (W) and umbilical width (U) in that order, with the proportions of H, W, and U expressed as a decimal fraction of D. The diameter given is not necessarily the maximum. Commonly H, W, and U cannot be determined at the maximum diameter, owing to imperfections of the specimens. On such specimens the diameter given is one at which other dimensions can be measured. In some specimens the whorl width has been calculated from the width of one side of the shell.

Family Sageceratidae

Genus *Pseudosageceras* Diener 1895

Pseudosageceras multilobatum Noetling

Plate XIII, numbers 8, 9a, b

Pseudosageceras multilobatum Noetling, 1905, p. 181, pls. XIX-XXVII; Smith, 1932, p. 87, pl. 4, figs. 1-3; pl. 5, figs. 1-6; pl. 25, figs. 7-16; pl. 60, fig. 32; pl. 63, figs. 1-6; Spath, 1934, p. 54, fig. 6a.
Pseudosageceras intermontanum Hyatt and Smith, 1905, p. 99, pl. IV, figs. 1-3; pl. V, figs. 1-6; pl. LXIII, figs. 1, 2.

In addition to the figured specimens (Nos. 14173 and 14174), which are about 54 mm in diameter, there is a fragmentary specimen (not figured, GSC No. 14175) about 127 mm in diameter and still septate. GSC No. 14173 preserves part of the shell and shows a slightly sulcate venter with two narrow keels. The large phragmocone (GSC No. 14175) is mainly steinkern. The venter of the steinkern appears to be acute but small pieces of shell reveal a narrow, slightly sulcate periphery.

Occurrence and Age. This species is apparently long-ranging. It was originally described from the Salt Range (Pakistan) where it ranges through much of the Lower (but not lowermost) Scythian (Lower Ceratite limestone to the Ceratite marls). It has also been recorded from the Lower Scythian of the Himalayas, Timor and Madagascar.

In the Western United States, *P. multilobatum* has been recorded from the *Meekoceras* and *Columbites* zones, both of which are generally considered Upper Scythian. Smith (1932, p. 88) considered that the Asiatic and North American specimens were the same age. Spath (1934), on the other hand, considered the American forms younger than the Asiatic because the associated faunas are different. Spath's view is generally accepted today.

In the Queen Elizabeth Islands, *Pseudosageceras multilobatum* occurs in talus derived from the *Meekoceras* bed, 1,700 feet above the base of the Blind Fiord formation, northwestern Ellesmere Island, 5 miles northwest of the entrance to Hare Fiord (GSC locality 28681, R. Thorsteinsson and E. T. Tozer, 1956; GSC locality 32371, R. Thorsteinsson, 1957).

It has also been collected in talus, from an unknown level, on the south side of Bunde Fiord, Axel Heiberg Island (GSC locality 32367, R. Thorsteinsson, 1957).

Family Otoceratidae

Genus *Otoceras* Griesbach 1880

Type species: *Otoceras woodwardi* Griesbach

Otoceras boreale Spath

Plate VI, numbers 1a to 3; Plate VII, numbers 1 to 3b;
Plate VIII, numbers 1 to 4b

Otoceras aff. *fissisellatum* Diener; Spath, 1930, p. 10, pl. I, figs. 1a-d.
Otoceras boreale Spath 1935, p. 9, pl. I, figs. 1a, 1b, 6; pl. II, figs. 1-3; pl. IV, fig. 1; pl. V, fig. 1; pl. VI, fig. 8; Popow, 1958, p. 107, text-figs. 1, 2.

Figure 7. *Otoceras boreale Spath.*
Complete suture (x1) of hypotype 14026.

Diagnosis. Large *Otoceras,* probably reaching a diameter of more than 300 mm. Venter tricarinate on most of phragmocone, acute on body chamber. Sculpture and proportional width of phragmocone rather variable. Phragmocone varies from compressed (width 26% of diameter) to inflated (width 50% of diameter). The type of sculpture is related to the degree of inflation. Compressed individuals are smooth with a low umbilical rim. Inflated individuals have radial plications and an elevated umbilical rim bordered ventrally by a narrow vertical platform. Suture ceratitic, with adventitious lobe in second lateral saddle.

Types and Dimensions

Specimen	Locality	D	H		W		U	
14014 hypotype	28441	24.5	13.0	0.53	13.8	0.56	4.0	0.16
14015 hypotype	28440	40	22	0.55	20*	0.50	5	0.13
14016 hypotype	28440	47	25	0.53	22*	0.47	9	0.19
14017 hypotype	28441	60	ca. 33	0.55	18*	0.30		
14018 hypotype	28448	78	43	0.55	24	0.31	7	0.09
14019 hypotype	28440	ca. 81	44	0.54	40*	0.50	11	0.13
14020 hypotype	28441	81	45	0.55	30	0.37		
14021 hypotype	28440	ca. 82	44	0.53	20	0.24		
14022 hypotype	28441	83	47	0.57	32*	0.38	10	0.12
14023 hypotype	28440	ca. 83	49	0.59	18*	0.22		
14024 hypotype	28440	88	49	0.55	26*	0.29	9	0.11
14025 hypotype	28440	ca. 91	46	0.50	49*	0.54		
14026 hypotype	32215	93	52	0.56	43	0.46	15	0.16
14020 hypotype	28441	100	53	0.53	ca. 42	0.42	14	0.14
14027 hypotype	28440	125	70	0.56	60	0.48	17	0.14
14028 hypotype	34001	189	108	0.57	88*	0.47	20	0.11
14029 hypotype	34001	217	118	0.54	88	0.41	21	0.10

*Calculated from width of one side.

The collection includes about fourteen specimens that are sufficiently well preserved to provide measurements. Several of these have almost exact counterparts in the material described by Spath from East Greenland. For example, specimen No. 14020 (Pl. VIII, No. 1) agrees very closely with the one figured by Spath (1935, Pl. I, fig. 1). The largest well-preserved Canadian specimen (GSC No. 14029, Pl. VI, No. 3; Pl. VII, No. 2) is still septate at a diameter of 233 mm. The septa are distinctly crowded near the aperture and it is probable that this specimen represents the phragmocone of an adult. This specimen shows a faintly tricarinate venter at the beginning of the last whorl, but near the aperture it is simply acute. It is more inflated than the partly reconstructed large specimen figured by Spath (1935, Pl. III, figs. 1a, 1b). One Canadian example (GSC No. 14027, not figured) has an acute venter at 125 mm; at smaller diameters they are generally tricarinate. Additional spiral ridges, less prominent than the ventral keels, are present on the whorl sides of some specimens (e.g., GSC No. 14020, Pl. VIII, No. 1).

Most of the Canadian specimens are less than 100 mm in diameter. Most are phragmocones, but at least three show body chamber. Large individuals (up to at least 200 diameter) occur at each *Otoceras* locality and consequently it seems reasonable to conclude that the small specimens are immature. The small specimens are remarkably variable in proportions and sculpture. The table of dimensions illustrates the variation in proportions. As noted in the diagnosis, there is apparently a relationship between degree of inflation and the type of sculpture.

Compressed individuals (e.g., GSC No. 14023, Pl. VII, No. 1; GSC No. 14018, Pl. VII, Nos. 3a, b) have a very feebly defined umbilical rim and a poorly defined spiral shelf below the umbilical rim. These compressed forms nevertheless retain the prominent ventral keels. Specimens of intermediate inflation, for example GSC No. 14020, Plate VIII, number 1, have a well-defined umbilical rim. Beneath this rim there is a prominent spiral ridge, which defines a vertical shelf below the umbilical rim. The remainder of the whorl side carries about three spiral ridges of low relief and faint radial plications. The most inflated form (GSC No. 14025, Pl. VIII, No. 3) has a strongly projected umbilical rim and prominent radial plications.

Every Canadian example showing the septal sutures possesses an adventitious lobe on the inner principal saddle.

Most of the specimens are preserved as internal moulds and do not show the growth lines. Specimen 14028 (Pl. VI, Nos. 1a, b) preserves sigmoidal growth lines on the internal mould of the body chamber. The body chamber of this specimen is distinctly asymmetrical, probably through growth, not distortion. The ventro-lateral keel on the left side is much closer to the periphery than that on the right. Plate VI, number 1a, illustrates the right side.

Occurrence. *Otoceras boreale* was originally described from East Greenland. It has recently been reported from Canning River, northern Alaska (Kummel, *in* Reeside *et al.*, 1957, p. 1501), and from northeastern Siberia (Popow, 1958a).

In the Queen Elizabeth Islands, *Otoceras boreale* occurs in the Blind Fiord formation at the following localities:

1. About 200 feet above base, west coast of Ellesmere Island, between Hare and Otto Fiords, about 14 miles northwest of the entrance to Hare Fiord (GSC locality 28440, R. Thorsteinsson and E. T. Tozer, 1956).
2. About 225 feet above base, west coast of Ellesmere Island between Hare and Otto Fiords, about 14 miles northwest of the entrance to Hare Fiord (GSC locality 28440, R. Thorsteinsson and E. T. Tozer, 1956).
3. Talus collection, west coast of Ellesmere Island, between Hare and Otto Fiords, about 14 miles northwest of the entrance to Hare Fiord (GSC locality 28441, R. Thorsteinsson and E. T. Tozer, 1956).
4. About 25 feet above base, south side of Bunde Fiord, Axel Heiberg Island (GSC locality 32215, R. Thorsteinsson, 1957).
5. Near base, unnamed island between Bunde and Bukken Fiords, Axel Heiberg Island (GSC locality 34001, R. Thorsteinsson, 1957).

Age. The genus *Otoceras* characterizes the lowest zone of the Triassic system (*see* p. 28).

Family OPHICERATIDAE

Genus *Ophiceras* Griesbach 1880

Type species: *Ophiceras tibeticum* Griesbach

Ophiceras commune Spath

Plate IX, numbers 1a, b, 2a, b

Ophiceras commune Spath, 1930, p. 24, pl. II, figs. 9a-d, 13, 14; pl. III, figs. 3a, 3b; pl. IV, figs. 3a, 3b, 11a, 11b. Spath, 1935, p. 16, pl. IV, figs. 3a, 3b; pl. XIII, fig. 13; pl. XV, figs. 1a, 1b, 4a, 4b, 9; pl. XIX, fig. 8.
Ophiceras greenlandicum Spath (in part); Spath, 1930, pl. I, figs. 2a, 2b; pl. IV, figs. 1a, 1b, 8a, 8b.
Ophiceras chamunda Diener; Spath, 1930, p. 20, pl. IV, figs. 1a, 1b, 8a, 8b.
Ophiceras (*Lytophiceras*) aff. *evolutum* Frech and Noetling; Spath, 1930, p. 22, pl. III, figs. 1, 4a, 4b.

Types and Dimensions

Specimen	Locality	D	H		W		U	
14030 hypotype	32364	74	24	0.32	17	0.23	29	0.39
14031 hypotype	32364	84	30	0.36	20	0.24	33	0.39
14032 hypotype	32364	89	36	0.40	24	0.27	30	0.34
Spath, 1930, pl. I, fig. 2	East Greenland	69		0.37		0.24		0.37
Spath, 1930, pl. III, fig. 1	East Greenland	96		0.38		0.23		0.36

The only well-preserved specimens of *Ophiceras* from the Queen Elizabeth Islands seem to be identical with this East Greenland species. The smaller Canadian specimen (GSC No. 14030, Pl. IX, Nos. 1a, b) has a distinct umbilical shoulder at a diameter of 73 mm. This specimen also shows faint radial swellings, just below the umbilical shoulder, as in *Ophiceras tibeticum* Griesbach. The larger specimen (GSC No. 14032, Pl. IX, Nos. 2a, b) has an umbilical shoulder on the phragmocone, but on the body whorl the umbilical shoulder is less clearly defined.

Spath pointed out that *Ophiceras commune* is very close to *O. sakuntala* Diener, from the *Otoceras* beds of the Himalayas. *O. connectens* Schindewolf, recently described from the base of the Triassic section of the Salt Range (Pakistan), is another closely related species.

Spath (1930) placed this species in his subgenus *Lytophiceras,* which is said to be more compressed and to have a less prominent umbilical shoulder than *Ophiceras* in the strict sense.

Occurrence. Originally described from the Lower Triassic (*Ophiceras* beds) of East Greenland.

In the Queen Elizabeth Islands *O. commune* occurs in the Blind Fiord formation at the following localities:

1. South coast of island between Bunde and Bukken Fiords, Axel Heiberg Island (GSC locality 32364, R. Thorsteinsson, 1957).
2. From 25-foot interval, lying above the basal Blind Fiord beds with *Otoceras,* south side of Bunde Fiord, Axel Heiberg Island. A 4-foot basic sill separates the *Otoceras* beds and the beds with *Ophiceras* (GSC locality 32373, R. Thorsteinsson, 1957).

Age. In East Greenland *Ophiceras commune* occurs with *Otoceras boreale* and is dated as Lower Scythian. As noted above, in the Queen Elizabeth Islands *O. commune* occurs at a slightly higher level than *O. boreale* (*see* p. 28).

Family GYRONITIDAE

Genus *Prionolobus* Waagen 1895

Type species: *Prionolobus atavus* Waagen

Prionolobus includes moderately involute, fairly thin and high whorled ammonoids with a narrow, tabulate periphery. The umbilical wall is narrow and commonly perpendicular, or nearly so. The sutures are ceratitic with a prominent, saw-like, auxiliary series.

Until 1934 most authors (Diener, for example) considered *Prionolobus* a synonym of *Meekoceras.* Spath (1934) considered that *Prionolobus* is an older genus than *Meekoceras.* Spath implicitly attributed any resemblances between the two genera to homeomorphy for he resurrected *Prionolobus.* To justify this purely on morphology is not easy. However, *Meekoceras* (*see* p. 65) has an excentric umbilicus, unlike the regularly increasing spiral shown by the umbilical seam of *Prionolobus.* Adult specimens of *Meekoceras gracilitatis* (the type species of *Meekoceras*), from the Queen Elizabeth Islands, acquire slightly rounded ventrolateral shoulders at maturity, unlike *Prionolobus* which probably had a tabulate periphery throughout life.

Prionolobus occurs only in the upper part of the Lower Scythian (Gyronitan and Flemingitan ages). It was originally described from the Salt Range (Pakistan) and has been reported from the Himalayas, Timor, Nevada, Montana and possibly also Madagascar. A new species has now been found in the Queen Elizabeth Islands.

Prionolobus plicatus n. sp.

Plate XX, numbers 4a-c, 5a-c

Diagnosis. Fairly high and thin whorled, moderately involute *Prionolobus* with perpendicular umbilical wall, angular umbilical shoulder, slightly convex whorl sides and a narrow, tabulate (on inner whorls slightly sulcate) periphery. Sculpture consists of weak sinuous radial pleats, which are most prominent just below the umbilical shoulder.

Types and Dimensions

Specimen	Locality	D	H		W		U	
14047 holotype	32366	103	49	0.48	21	0.20	22	0.21
14048 paratype	32366	34	15	0.44	7.5	0.22	8.2	0.24

The holotype is preserved mainly as internal mould, with some fragments of shell adhering. It is entirely septate. There are two specimens in the collection that show the change from phragmocone to body chamber; on one specimen (the outer whorl, not figured, of paratype, GSC No. 14048) this takes place at a whorl height of 36 mm, on the other at about 38 mm.

The suture line shows the well-rounded saddles and numerous auxiliaries that characterize *Prionolobus.*

Comparisons. *Prionolobus plicatus* resembles most closely *"Meekoceras" magnumbilicatum* Waagen (1895, p. 251, pl. 33, figs. 3a, b) from the Ceratite sandstone of the Salt Range (Pakistan). *"Meekoceras" magnumbilicatum* is described by Waagen as having a flat periphery, a high, distinct, umbilical wall and low undulations on the inner whorls. These features are believed to indicate affinity with *Prionolobus* rather than with *Meekoceras,* as Spath (1934, p. 98) apparently suggested. *Prionolobus plicatus* differs from Waagen's species in retaining radial undulations at a larger diameter and in having a proportionately wider umbilicus.

Occurrence. Blind Fiord formation, talus from beds about 180 feet above base of formation, about 20 feet above bed with *Proptychites candidus* n. sp., south side of Bunde Fiord, Axel Heiberg Island (GSC locality 32366, R. Thorsteinsson, 1957).

Age. Upper part of Lower Scythian (*see* p. 29).

Family FLEMINGITIDAE

Genus ***Flemingites*** Waagen 1892

Type species: *Ceratites flemingianus* de Koninck

Flemingites ? sp. indet.

Plate XII, numbers 1a-c

Two fragmentary specimens (GSC Nos. 14176, 14177) from the *Meekoceras* bed of the Blind Fiord formation may be referable to *Flemingites.* The larger specimen shows the compressed whorls and radially plicated whorl sides of *Flemingites.* These specimens do not retain well-preserved shell material, consequently it is impossible to ascertain whether the fine spiral sculpture of *Flemingites* is present. The septal sutures have swollen lobes and a well-incised external lobe. These are flemingitid characters.

Occurrence. Blind Fiord formation, *Meekoceras* bed, 1,700 feet above base of formation, west coast of Ellesmere Island, 5 miles northwest of entrance to Hare Fiord (GSC localities 28680, 28681 (talus), R. Thorsteinsson and E. T. Tozer, 1956).

Age. Presumably Upper Scythian (*see* pp. 29-31).

Genus *Euflemingites* Spath 1934

Type species: *Flemingites guyerdetiformis* Welter

Euflemingites romunduri n. sp.

Plate XII, numbers 2a to 5b; Figure 8

Figure 8. *Euflemingites romunduri n. sp.*
External suture of paratype 14192 at a whorl height of about 50 mm (x1). The second lateral lobe and the auxiliary lobes are somewhat weathered.

Diagnosis. Fairly high-whorled, fairly thick-whorled, moderately involute *Euflemingites,* of large size, probably reaching 270 mm in diameter. Umbilical wall steep, umbilical shoulder rounded, whorl sides almost flat, periphery semicircular in outline. Sculpture consists of prominent spiral ridges; at diameters below 15 mm there may be weak, irregular, radial folds as well.

Types and Dimensions

Specimen	Locality	D	H		W		U	
14049 paratype	28680	19	7.5	0.39	8.7	0.46	6.5	0.34
14050 paratype	28681	40	18.5	0.46	15	0.37	11	0.28
14051 holotype	28680	144	62	0.43	57	0.40	44	0.31
14051 holotype	28680	187	75	0.40	70	0.38	59	0.32

Other fragmentary paratypes, GSC Nos. 14191, 14192, 14193, 14194, all from locality 28681.

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The holotype is septate at a diameter of 118 mm and the last half whorl is body chamber. The maximum whorl height shown by the phragmocone in this specimen is 49 mm. There are, however, fragments of larger specimens in the collection and the holotype is presumably not adult. The maximum whorl height shown by a septate fragment (GSC No. 14194) is 60 mm, equivalent to a diameter of about 140 mm. The largest body chamber fragment (GSC No. 14193) is at least 90 mm wide. If the proportions shown at a diameter of 187 mm are maintained in larger specimens, GSC No. 14193 would represent the remains of an individual about 270 mm in diameter.

The whorl section of this species is best illustrated by specimen No. 14050 (Pl. XII, No. 2c). The umbilical wall is flat near the umbilical seam. The whorl sides are almost flat and an evenly rounded umbilical shoulder separates the sides from the umbilical wall. The periphery forms an even curve, almost semicircular in outline. This whorl section apparently characterizes the larger whorls of *E. romunduri,* but as most of the larger specimens are somewhat crushed this feature cannot be illustrated.

Paratype 14049 (Pl. XII, Nos. 4a, b) shows that at a diameter of 15 mm there are faint, radial, irregular folds, somewhat reminiscent of those shown by *Flemingites* s.s. The innermost whorls have not been seen, but one broken specimen reveals that at a diameter of 3 mm the whorl section is essentially as described above.

As a rule the spiral striae are more closely spaced at the ventro-lateral shoulder than on the whorl sides and the periphery. The spacing of the striae at different stages of growth is as follows:

Dimensions	Interval between striae (mm)	
	On whorl side	On periphery
D 19 (No. 14049)	0.5	0.7
D 33 (No. 14050)	1.0	1.0
D 40 (No. 14050)	1.5	1.5
D 66 (No. 14052)	2.5–3.0	3.0
D 144 (No. 14051)	5.0–7.0	6.0– 8.0
D 187 (No. 14051)	6.0–7.0	6.0–10.0
W ca. 90 (No. 14054)		10.0–12.0

The suture (Pl. XII, No. 3, and Figure 8) has a moderately incised external lobe, and two "splayed out" lateral lobes, as in most flemingitids. The first lateral lobe is situated on the ventro-lateral shoulder.

Comparisons. Euflemingites romunduri resembles *E. cirratus* (White) from the *Meekoceras* beds of Idaho. *E. cirratus* is not based on very well preserved specimens. The best specimen figured by Smith (1932, pl. 26, figs. 2, 3) is about 210 mm in diameter. It is more compressed than *E. romunduri* at the same diameter (width of *E. cirratus* is 32% of diameter, of *E. romunduri* 38% of diameter). A comparison of a replica of the specimen figured by Smith (op. cit.) on Plate 26, figure 1, with the holotype of *E. romunduri* suggests that this difference is maintained, or even increased, at greater diameters. The umbilical wall of *E. romunduri* is apparently considerably wider than that of *E. cirratus* and this, in ammonoids with such flat whorl sides, accounts for the differences in degree of compression. The sculpture of the two species is different, the spiral ridges of *E. cirratus* are more closely spaced than those of *E. romunduri.*

Fragments of a large *Euflemingites* from the *Arctoceras* beds of Spitsbergen have been described by Spath (1951, p. 5). In 1958 the writer examined these specimens in the British Museum (Natural History). They are too fragmentary for specific determination but probably represent either *E. cirratus* or *E. romunduri.*

This species is named for Dr. Raymond (Hromundur) Thorsteinsson, who discovered the type locality.

Occurrence. Blind Fiord formation, *Meekoceras* bed, 1,700 feet above the base, west coast of Ellesmere Island, between Hare and Otto Fiords, 5 miles northwest of entrance to Hare Fiord (GSC localities 28680, 28681 (talus), R. Thorsteinsson and E. T. Tozer, 1956; GSC locality 32371, R. Thorsteinsson, 1957).

Age. Upper Scythian (Owenitan) (*see* pp. 29-31).

Family XENOCELTITIDAE

Genus *Xenoceltites* Spath 1930

Type species: *Xenoceltites subevolutus* Spath

Xenoceltites subevolutus Spath

Plate XVI, numbers 1a, b

Xenodiscus cf. *comptoni* Diener; Frebold, 1930, p. 14, pl. III, figs. 1, 2, 2a, 3.
Lecanites cf. *ophioneus* Waagen; Frebold, 1930, p. 12, pl. III, figs. 4, 4a, 5.
Xenoceltites subevolutus Spath, 1930, p. 12; Spath, 1934, p. 130, pl. II, fig. 2; pl. VIII, fig. 2; pl. IX, fig. 4; pl. XI, fig. 2.

Types and Dimensions

Specimen	Locality	D	H		W		U	
Holotype Frebold, 1930, pl. III, fig. 1	Vikingberg, Spitsbergen	27.0	9.5	0.35	5.5	0.20	10.5	0.39
Spath, 1934, pl. IX, fig. 4	Sassendal, Spitsbergen	28.0		0.40		0.20		0.32
14183 hypotype	32365	30.0	11.5	0.38	6.5	0.22	11.0	0.37

The collection includes only one specimen, which is almost completely exfoliated. The last quarter whorl is body chamber. It seems to be weakly sculptured for this species but agrees well in dimensions.

Occurrence. Originally described from the "Fish beds" (with *Arctoceras*) of the Ice Fiord area, Spitsbergen.

Wasatchites bed, about 514 feet above base of the Blind Fiord formation, south side of Bunde Fiord, Axel Heiberg Island (GSC locality 32365, R. Thorsteinsson, 1957).

Age. Upper Scythian (Owenitan) (*see* p. 31).

Family PROPTYCHITIDAE

Genus *Proptychites* Waagen 1892

Type species: *Ceratites lawrencianus* de Koninck

Diagnosis. Moderately involute ammonoids; whorls with rounded venter and umbilical shoulders, rather inflated, particularly at the umbilical margin in some species. Shell surface smooth or delicately sculptured, but not plicate or ribbed. Suture line ceratitic, with rather deeply incised lobes. Lateral lobes and saddles narrow, no well differentiated auxiliary lobes.

Spath (1930, p. 40; 1934, p. 136) considered that inflation of the whorls, particularly at the umbilical margin, is one of the principal distinguishing characters of *Proptychites*. This type of inflation results in a somewhat trigonal whorl section. This feature is certainly well shown by some of the species classed as *Proptychites* by Spath, e.g., *Proptychites markhami* Diener, and also *P. strigatus* n. sp. The whorl section of the type species *P. lawrencianus* is elliptical rather than trigonal. A second new species from the Canadian Arctic, *P. candidus,* has such a whorl section. However, *P. candidus* is not a typical species for it has an unusually wide umbilicus and a feebly incised external lobe.

Proptychites ranges throughout the upper part of the Lower Scythian; it is not known from the lowermost Scythian beds with *Otoceras*. In the Himalayas and in East Greenland (and now also in the Canadian Arctic) *Proptychites* occurs in beds immediately above those with *Otoceras*. In the Salt Range (Pakistan) the genus ranges from the Lower Ceratite limestone to the Ceratite sandstone ("Gyronitan" and "Flemingitan" ages of Spath), above beds with *Ophiceras connectens* Schindewolf, of lowermost Scythian age.

Proptychites has also been recorded from Primorye, Madagascar and Nevada. *"Proptychites" walcotti* Hyatt and Smith, a younger species from the *Meekoceras* zone of California, has recently been made type species of a new genus, *Discoproptychites* Kiparisova (1956, p. 77).

Proptychites strigatus n. sp.

Plate IX, number 3; Plate X, numbers 1a, b, 2a, b;
Plate XI, numbers 2a to 4c

Diagnosis. Large, moderately involute *Proptychites,* probably reaching a diameter of about 200 mm. Whorls fairly high and thick, distinctly trigonal in section, with greatest width at the umbilical margin. Whorl sides are flat or slightly concave. Umbilical wall folded ventrally, meeting the whorl side to form a rounded, acute angle. Surface commonly with strigate sculpture which is more marked at the periphery than on the whorl sides. Suture with numerous incisions between the second lateral saddle and the umbilical seam, but no defined auxiliary lobes.

Types and Dimensions

Specimen	Locality	D	H		W		U	
14033 paratype	32373	30	15	0.5	12	0.4	6.4	0.21
14034 paratype	32367	41	22	0.54	20	0.49	7	0.17
14034 paratype	32367	53	29	0.55	25	0.47	7.5	0.14
14035 paratype	32373	45	26	0.58	23	0.51	6	0.13
14036 paratype	32373	63	34	0.54	23	0.37	11	0.17
14037 paratype	32373	67	32	0.48	25	0.37	15	0.22
14038 paratype	32373	71	31	0 44	25	0.35		
14039 paratype	32367		40		40			
14040 paratype	32373	84	41	0.49	27	0.32		
14041 paratype	32373	93	46	0.49	36	0.39		
14042 holotype	32373	95	45	0.47	39	0.41	20	0.21
14043 paratype	32373	184	87	0.47	70	0.38	41	0.22

The holotype (No. 14042, Pl. X, Nos. 2a, b) is septate to a diameter of at least 91 mm. It is partly exfoliated but much of the shell still remains. The strigate sculpture is best seen on the sides and periphery of the initial part of the last whorl. The largest known specimen (GSC No. 14043, Pl. X, Nos. 1a, b) is septate at a whorl height of 65 mm; this is approximately equivalent to a diameter of 130 mm. The last septa are approximated and this specimen was therefore probably an adult. The last septum is followed by half a whorl of body chamber. The full diameter of this specimen was probably at least 200 mm.

The external suture is well preserved on a number of specimens. The relative width of the elements varies somewhat, depending upon the degree of inflation. However, all the sutures agree in lacking well-defined adventitious lobes. In this respect they agree with the sutures of *P. lawrencianus* (de Koninck) and *P. markhami* Diener. The internal suture apparently agrees in essentials with that of typical representatives of *Proptychites.* No complete suture has been prepared, but the apertural view of specimen 14037 (Pl. XI, No. 2a) reveals most of a septal surface. On this specimen the saddle bordering the internal lobe has considerable relief with respect to the auxiliaries. At a diameter of 65 mm the summit of this saddle is about 2.5 mm adorad to the level of the auxiliaries bordering it. There are eleven specimens in the collection that are sufficiently well preserved to provide measurements. Most of these represent different growth stages so that little can be said concerning the variability of this species. Among the small specimens there is evidently considerable variation in degree of inflation, as in *Otoceras boreale*. The most inflated example (an incomplete, unfigured paratype, No. 14039) has, at a diameter of about 80 mm, whorls of approximately equal width and height.

Proptychites markhami Diener, from the Himalayas, is probably closer to this species than any other. There is a close resemblance in whorl section, and in the nature of the umbilicus. Furthermore, according to von Krafft (1909, p. 23), *P. markhami* occasionally bears faint concentric striae. However, *P. strigatus* is evidently consistently wider than *P. markhami*. At a diameter of 163 mm the width of the Canadian species is 40 per cent of the diameter, and for the most compressed Canadian specimen this figure is 32 per cent. At a diameter of 163 mm, the width of *P. markhami* is 28 per cent of the diameter.

According to Diener's original description (1897, p. 77), *P. markhami* has a distinct auxiliary lobe (unlike *P. strigatus*). This lobe is not shown in von Krafft's figure of *P. markhami* (*in* von Krafft and Diener, 1909, pls. XI-XIII), nor is it described in the text of this work. The suture of *P. strigatus* thus resembles that of the specimens of *P. markhami* described by von Krafft.

There is superficial resemblance between *Proptychites strigatus* and *P. otoceratoides* Diener (1895, p. 36, pl. II, fig. 8; pl. III, figs. 2a, 2b) from Primorye. Diener (1916c) subsequently made this species the type of *Pachyproptychites*. This resemblance is evidently merely superficial for *P. otoceratoides* has projections on the umbilical margin (rather like *Otoceras*), and a funnel-shaped umbilicus, both of which distinguish it from *P. strigatus*.

Occurrence. Known from the Blind Fiord formation at the following localities:

1. From 25-foot interval lying above the basal Blind Fiord beds with *Otoceras*, south side of Bunde Fiord, Axel Heiberg Island (GSC locality 32373, R. Thorsteinsson, 1957). At this locality a 4-foot sill separates the beds with *Otoceras* from those with *Proptychites*. *Proptychites strigatus* and *Ophiceras commune* both occur in this 25-foot interval. It has not been established that *Ophiceras commune* and *P. strigatus* occur in precisely the same bed. *P. strigatus* probably occurs at a slightly higher level than *Ophiceras commune* (*see* p. 28).
2. Talus, south side of Bunde Fiord, Axel Heiberg Island (GSC locality 32367, R. Thorsteinsson, 1957).
3. Talus, from beds above *Otoceras boreale* zone, section between Hare and Otto Fiords, 14 miles northwest of mouth of Hare Fiord (GSC locality 28663, E.T. Tozer, 1956).

Age. Lower Scythian (*see* p. 29).

Proptychites candidus n. sp.

Plate XI, numbers 1a-c

Diagnosis. Ammonoids with unusually wide umbilicus (for *Proptychites*); whorls fairly high, apparently of rather variable width. Whorl section elliptical. Umbilical wall steep, umbilical shoulders rounded, whorls sides nearly flat with their greatest width just below the umbilical shoulder. Surface apparently smooth. External suture anomalous (for *Proptychites*) in having external lobe with only one incision.

Types and Dimensions

Specimen	Locality	D	H		W		U	
14044 holotype	32368	61	28	0.46	22	0.36	15	0.25
		ca. 125	54	0.43	35	0.28	30	0.24
14045 paratype			58		42			

The holotype is not complete and is preserved mainly as internal mould. The last quarter whorl is body chamber. This specimen shows approximation of septa at a whorl height of 43 mm; another specimen (unfigured paratype, No. 14046) shows a similar crowding at 49 mm. These figures probably indicate the approximate maximum whorl height for the phragmocone. No specimens retain well-preserved shell material. The shell fragments that remain seem to be perfectly smooth. The internal mould of the phragmocone is smooth. Internal moulds of the body chamber show obscure growth lines but no other sculpture.

The external suture is well displayed by the holotype (Pl. XI, No. 1b). The external lobe has only one incision. The lateral lobes have sharp incisions and a "sawtooth" auxiliary series resembling that of typical *Proptychites*. Judging from the appearance of the surface of the septa, the internal suture resembles that figured by Spath (1934, p. 141, fig. 39b) for *Proptychites markhami*.

This remarkably generalized ammonoid is not closely comparable to any described species, indeed the assignment of *Proptychites candidus* to a genus, or even family, is not easy. The sharply serrated auxiliary series and the moderately deeply incised lobes exclude this species from the Ophiceratidae. The Paranoritidae (particularly *Paranorites* Waagen) present some superficial similarities to the present species. However, *Paranorites* has a narrowly rounded or tabulate periphery, unlike the broadly arched venter of *P. candidus*. Spath (1934, p. 140) considered that the Paranoritidae are characterized by a tendency towards individualization of the auxiliary lobes. This feature is not found in *P. candidus,* nor indeed in *Paranorites ambiensis* Waagen, the type species of *Paranorites*. The Paranoritidae excluded, there remains only one possible family for this new species, namely the Proptychitidae. In common with *Proptychites* the new species has thick whorls; deeply incised lateral lobes and negligible individualization of the auxiliary lobes. It cannot be considered a typical representative of *Proptychites,* however, for it is more widely umbilicate than any described species of that genus. Furthermore, the Proptychitidae (like the Paranoritidae) have incised external lobes, unlike the relatively simple lobe of *P. candidus.* It is this last feature, which is reminiscent of the Ophiceratidae, that reveals the isolated position of *Proptychites candidus.*

Morphologically this species seems to lie between the Ophiceratidae (generally regarded as the ancestral group of Lower Triassic ammonoids), and the younger derivatives, Proptychitidae and Paranoritidae. However, *P. candidus* cannot be considered a simple intermediate form for it occurs at a higher level than *Proptychites strigatus. Proptychites* may have been polyphyletic, and possibly *P. candidus* is ancestral to relatively thin-whorled *Proptychites* (such as *P. lawrencianus*), rather than species with trigonal whorls, such as *P. markhami* and *P. strigatus.*

Occurrence. Blind Fiord formation, 160 feet above base, south side of Bunde Fiord, Axel Heiberg Island (GSC locality 32368, R. Thorsteinsson, 1957).

Age. Upper part of Lower Scythian (*see* p. 29).

Family PARANANNITIDAE

Genus *Prosphingites* Mojsisovics 1886

Type species: *Prosphingites czekanowskii* Mojsisovics

Prosphingites spathi Frebold

Plate XIII, numbers 1a-c, 2a-e

Prosphingites ? sp. nov., Spath, 1921, pp. 298, 301.
Prosphingites spathi Frebold, 1930, p. 20, pl. IV, figs. 2, 3, 3a; Spath, 1934, p. 195, pl. XIII, figs. 1a-e, 2.

Types and Dimensions

Specimen	Locality	D	H		W		U	
14085	28680	20.5	10.0	0.49	12.0	0.58	5.0	0.24
14086	28680	22.0	9.5	0.43	14.2	0.64	6.0	0.27
BM C 27092	Spitsbergen	23.0	10.0	0.43	12.2	0.53	6.8	0.30
Lectotype*	Spitsbergen	23.0	10.0	0.44	15.5	0.67		
Lectotype*	Spitsbergen	27.0	11.0	0.41	16.5	0.60	8.0	0.30

*Frebold, 1930, pl. IV, figs. 3, 3a.

In degree of compression this is a very variable species, as noted by Spath. The best preserved Canadian specimens are small, mainly phragmocone, and do not exceed 22 mm in diameter. There are, however, some poorly preserved examples that reach a diameter of about 32 mm, which is the size of the largest individual recorded by Spath.

Frebold was unable to describe the details of the suture from his type material. Spath (1934, pl. XIII, fig. 1e) figured the suture of a specimen from Spitsbergen. In 1958, the writer examined the collections studied by Spath, which are preserved in the British Museum (Natural History). The writer's study of these specimens shows that Spath's drawing is not representative; in fact no specimen could be found to match it. Spath's figure shows a rounded auxiliary lobe on the umbilical shoulder. The writer examined three specimens that show the umbilical wall (BM Nos. C 27107, C 27090 and C 27092). These specimens have three pointed auxiliary lobes on the umbilical wall. Only one Canadian specimen shows the suture on the umbilical wall (No. 14086, Pl. XIII, No. 1c). This specimen has two prominent auxiliary lobes on the umbilical wall, near the umbilical seam, and smaller incisions on the umbilical shoulder. The Canadian specimen is therefore not identical with the three Spitsbergen specimens, but in essentials the sutures of the Canadian and Spitsbergen specimens are moderately close.

Occurrence. Originally described from the *Posidonomya* limestone (Fish beds) of Sassendal, at the head of Ice Fiord, Spitsbergen.

In the Canadian Arctic, *Prosphingites spathi* is known only from the *Meekoceras* bed, 1,700 feet above the base of the Blind Fiord formation, west coast of Ellesmere Island, between Hare and Otto Fiords, 5 miles northwest of entrance to Hare Fiord (GSC localities 28680, 28681, R. Thorsteinsson and E. T. Tozer, 1956; GSC locality 32371, R. Thorsteinsson, 1957).

Age. Upper Scythian (Owenitan) (*see* pp. 29-31).

Genus *Juvenites* Smith 1927

(=*Thermalites* Smith 1927)

Type species: *Juvenites kraffti* Smith

Juvenites, in the sense of Spath (1934, p. 193), includes globose paranannitids, with or without constrictions, with entire (goniatitic) or ceratitic suture lines, two external lateral lobes and one internal lateral lobe.

Spath included *Thermalites* Smith in *Juvenites.* Smith had separated *Thermalites* because its type species, *Thermalites thermarum,* has ceratitic lobes, unlike the type of *Juvenites,* in which the lobes are entire.

Kummel (1954, p. 185) compiled a list of the *Meekoceras* fauna of Idaho in which the treatment of these forms conforms with Spath's system of nomenclature. However, more recently, Kummel (1957, p. L 139) placed both *Juvenites* and *Thermalites* in synonymy with *Arnautoceltites* Diener. *Arnautoceltites* (type species, *Celtites arnauticus* Arthaber, from the Upper Scythian of Albania) has pronounced constrictions with a distinct adorad curvature at the periphery. *Juvenites* and *Thermalites* do not possess oblique constrictions of this sort. In the writer's opinion, *Arnautoceltites* and *Juvenites* may be retained as distinct genera in order to characterize this difference.

Juvenites canadensis n. sp.

Plate XIII, numbers 3a-d

Diagnosis. *Juvenites* with rather wide umbilicus. Whorl section depressed, umbilical shoulder prominent, outer part of whorl almost semicircular in section. No well-defined constrictions. Suture ceratitic with rather sharp incisions. Ventral lobe incised, first lateral saddle rather large.

Types and Dimensions

Specimen	Locality	D	H		W		U	
14079 holotype......................	28681	24.3	9.0	0.37	15.4	0.63	11.2	0.46

This species is based on a single specimen, preserved mainly as the internal mould of the phragmocone. The most adorad part (the matrix-filled part visible on Pl. XIII, No. 3a) is filled with shell debris and probably represents the start of the body chamber. There is a weak constriction on the last whorl of this specimen. This constriction and the obscure growth lines, pursue an almost radial course, without pronounced adorad bending. The external suture is well preserved. The nature of the internal suture may be interpreted from the surface of the septum (Pl. XIII, No. 3c). There is apparently one internal lateral lobe. Apparently there are no "sawtooth" auxiliary lobes, as in *Prosphingites.*

In dimensions and shell form, *J. canadensis* resembles closely *J. kraffti* Smith from the *Meekoceras* zone of Idaho. *J. kraffti* differs in having entire, unincised lobes.

"Thermalites" thermarum Smith, also from the *Meekoceras* zone of Idaho, has an external suture comparable with that of *J. canadensis.* According to Smith's description (1932, p. 111), the internal suture of his species has "a divided antisiphonal and two laterals"; compared with this *J. canadensis* has only one internal lateral lobe. *"Thermalites" thermarum* has a very narrow umbilicus compared with *J. canadensis.*

Occurrence. Talus from the *Meekoceras* bed, 1,700 feet above base of Blind Fiord formation, west coast of Ellesmere Island, between Hare and Otto Fiords, 5 miles northwest of entrance to Hare Fiord (GSC locality 28681, R. Thorsteinsson and E. T. Tozer, 1956).

Age. Upper Scythian (Owenitan) (*see* pp. 29-31).

Juvenites crassus n. sp.

Plate XIII, numbers 4a to 7c

Diagnosis. *Juvenites* at least 22 mm in diameter, with very thick whorls and a kidney-shaped whorl section. Periphery, whorl sides and umbilical wall all rounded with a very obscure shoulder at, or just below, the point of maximum whorl width. Whorl surface without constrictions, marked only by growth lines with slight adorad bending on the periphery. Suture line ceratitic, with two incised external lobes; internal suture with one lateral lobe.

Types and Dimensions

Specimen	Locality	D	H		W		U	
14080 paratype	28681	13.0	7.0	0.54	13.0	1.0		
14081 holotype	28681	16.5	8.0	0.49	15.0	0.91	2.8	0.17
14082 paratype	32371	18.0			15.5	0.86		
14083 paratype	28681	20.0	11.0	0.55	16.0	0.80		
14084 paratype	28681	20.8	11.0	0.54	17.5	0.84		

The holotype is septate to within about half a whorl of the aperture. The last few septa are approximated so that this specimen may represent a fragmentary adult. Paratype 14080 is septate, with comparable septal approximation, to a diameter of 12.5 mm. The phragmocone of this specimen is about the same diameter as that of the holotype, and that of paratype 14084 is also about the same diameter. Paratype 14084 seems to show a full whorl of body chamber; this specimen may, therefore, be adult and essentially complete. No specimens (or fragments) are known to exceed the diameter of paratype 14084.

Most of the external suture is well displayed on the holotype and on paratype 14080 (Pl. XIII, Nos. 6d, 7c). The second lateral lobe has been seen only on the holotype; it is not very well preserved and cannot be drawn accurately. This lobe, however, is certainly low, wide, and incised in the manner of the first lateral lobe. The characters of the internal suture have been determined from the well-preserved septum of paratype 14084, which shows that the suture is as described in the diagnosis. There are apparently no adventitious elements at the umbilical seam.

"Prenkites" depressus Smith (1932, p. 110, pl. 31, figs. 16-18) is the only described species that bears any resemblance to *Juvenites crassus*. It seems to share the very narrow umbilicus. The external sutures are also similar. Smith's drawings of the suture of *"Prenkites" depressus* show a smooth second lateral lobe. The writer has examined this specimen (USNM, No. 74961). The second lateral saddle is not very clearly exposed but seems to be slightly serrated, not smooth as shown in Smith's drawing. If this is so, the external sutures of *"Prenkites" depressus* and *J. crassus* are similar in essentials. However *"Prenkites" depressus* is proportionately less wide than *J. crassus*.

J. crassus and *"Prenkites" depressus* are almost certainly congeneric. They are also essentially the same age, for both occur in the *Meekoceras* zone. These species should not be placed in *Prenkites* Arthaber (type species *Prenkites malsorensis* Arthaber, from the Upper Scythian of Albania), which has umbilical tubercles on the inner whorls and an excentric umbilical seam. It must also be admitted that the reference of these species to *Juvenites* is not particularly satisfactory. The type species of *Juvenites* (*J. kraffti*) is widely umbilicate compared with *J. crassus,* but *J. dieneri* Smith approaches *J. crassus* in shape of conch.

Occurrence. Blind Fiord formation, *Meekoceras* bed, 1,700 feet above base of formation, west coast of Ellesmere Island, between Hare and Otto Fiords, 5 miles northwest of entrance to Hare Fiord (GSC locality 28681 (talus), R. Thorsteinsson and E. T. Tozer, 1956; GSC locality 32371, R. Thorsteinsson, 1957).

Age. Upper Scythian (Owenitan) (*see* pp. 29-31).

Family KASHMIRITIDAE

Genus *Anakashmirites* Spath 1930

Type species: *Danubites nivalis* Diener

Loosely coiled ammonoids, with simple ribs, more or less rounded venters and simple, ceratitic suture lines are represented in nearly all Triassic faunas, from the oldest to the youngest. The grouping of these forms into genera is exceedingly difficult, for all represent variations upon a very simple, monotonous, morphological theme. Until the late Dr. Spath started revising the classification of Triassic ammonoids in 1930, most authorities placed Lower Triassic ammonoids of this habit in *Xenodiscus* (the type of which is Permian), or *Danubites* (typically Middle Triassic). Spath was convinced that most of these ammonoids are not closely related, and proceeded (Spath, 1930, 1934) to place the Scythian *Xenodiscus*-like ammonoids in four genera; and these genera he assigned to four different families, as follows:

1. *Glyptophiceras* (Ophiceratidae) of "Otoceratan" (lowermost Scythian) age
2. *Xenodiscoides* (Flemingitidae) of "Flemingitan" (Lower Scythian) age
3. *Xenoceltites* (Xenoceltitidae) of "Owenitan" (Upper Scythian) age
4. *Anakashmirites* (Kashmiritidae) of "Owenitan" and "Flemingitan" age.

The types of these genera are fairly easily distinguished, but it is by no means easy to assign all the *Xenodiscus*-like forms to one or another of Spath's genera. The new species described below (*Anakashmirites borealis*) is referred to *Anakashmirites,* for it is closer to the type of that genus than to any other. *A. borealis* also resembles *Glyptophiceras pascoei* Spath, of Otoceratan age, much older than the new species. Furthermore, several species of *Xenoceltites,* such as *X. spitsbergensis* Spath and *X. robertsoni* McLearn, both of Owenitan age, have much in common with *A. borealis. A. borealis* does not particularly resemble the type species of *Glyptophiceras* and *Xenoceltites.*

The classification of these forms, at the generic and family level, is clearly in an unsatisfactory state. However, until some better alternative is available the writer has attempted to follow Spath's scheme of classification. This scheme has been adopted in the recently published "Treatise on Invertebrate Palaeontology".

Spath (1934, p. 236) gave the age and range of *Anakashmirites* as "Flemingitan and Owenitan; Himalayas, Timor". As far as the writer can determine from the literature, the Himalayan and Timor occurrences are of Flemingitan, not Owenitan age. According to Diener (1912, p. 19) *"Danubites" nivalis* occurs in the *Hedenstroemia* beds of the Himalayas, associated with true *Flemingites* and not with any genera characteristic of Owenitan time. Furthermore, in Timor, Welter (1922, p. 84) recorded *Xenodiscus brouweri* Welter (*Anakashmirites* according to Spath) from the *"Meekoceras* kalke", but the *"Meekoceras"* of this limestone are placed in *Prionolobus* by Spath himself and dated as Gyronitan or Flemingitan (i.e., Lower Scythian). The Timor records of *Anakashmirites nivalis* (Diener), *A. lidacensis* (Welter), *A. lidacensis involutior* (Welter) and *A. molengraffi* (Welter) are in the "kalke mit *Ophiceras crassecostatum*". The assemblage from this limestone is also placed in the Flemingitan by Spath. It would thus appear that the Himalayan and Timor occurrences are all Flemingitan rather than Owenitan.

As noted above, some species placed in *Xenoceltites* closely resemble *Anakashmirites*. These species, which occur in Spitsbergen, Utah and British Columbia, are all of Owenitan age. An Owenitan age is also assigned to the new species, *A. borealis*.

From the foregoing it may be seen that closely similar *Xenodiscus*-like ammonoids range from the earliest Triassic (*Glyptophiceras*), through the Flemingitan age to the Owenitan. Whether these forms be considered successive homeomorphs or a conservative stock seems an open question, and one that is not likely to be resolved.

Anakashmirites borealis n. sp.

Plate XIV, numbers 1a to 6c

Diagnosis. Moderately evolute *Anakashmirites,* with subrectangular to subcircular whorl section, reaching a diameter of at least 55 mm. Inner whorls with very prominent, widely spaced ribs on whorl sides and a smooth periphery. Body whorl with more closely spaced and finer ribs that cross the periphery.

Types and Dimensions

Specimen	Locality	D	H		W		U	
14072 paratype	28680	22.5	7.0	0.31	6.0	0.27	11.5	0.51
14073 paratype	28680	28.0	8.3	0.30	7.0	0.25	15.0	0.54
14074 paratype	28681	28.2	7.0	0.25	10.0	0.35	16.7	0.59
14075 paratype	28681	37.5	10.9	0.29	12.5	0.30	20.0	0.53
14076 paratype	28681	46.5	13.0	0.28	12.0	0.26	24.5	0.53
14074 paratype	28681	48.5	14.0	0.29	14.0	0.29	25.0	0.51
14077 holotype	28681	55.5	16.0	0.29	13.3	0.24	31.0	0.56

The holotype is partly exfoliated and preserves slightly more than half a whorl of body chamber.

The inner whorls of this species have a very distinctive sculpture, best shown by paratype 14072 (Pl. XIV, figs. 2a, b). On this specimen, at a diameter of 22 mm, the whorls are almost square in section. The whorl sides bear rather strong bulge-like, almost perfectly radial, slightly curved, ribs, which disappear at the ventro-lateral shoulder. At the periphery a prominent growth line marks the position of the peristome at the time of the formation of the rib. This growth line is slightly curved adorad. The adorad curvature of the peristome on the periphery is retained as long as the sculpture of prominent ribs is present, i.e., to a diameter of about 45 mm. On the body whorl of the holotype the distantly spaced, strong ribs are replaced by slightly prorsiradiate, rounded ribs. A slight adorad curvature is retained at the periphery, but on some ribs this is almost negligible.

The denticulations of the lobes are rather fine and are easily eroded away. In the sutures figured there are no visible incisions in the ventral lobe; however, the sutures on the last whorl of the holotype reveal a single small incision in this lobe.

A glance at the table of dimensions will show that *Anakashmirites borealis* varies considerably in proportional width. The body chamber of the holotype is higher than wide; but on paratype 14075 this relationship is reversed.

The sculpture seems the most consistent feature in this species. If this be accepted as a good specific character, *Anakashmirites borealis* differs from *A. nivalis* (Diener) and *A. lidacensis* (Welter) (from the Himalayas and Timor respectively), in having more widely spaced ribs on the inner whorls. At a diameter of 30 to 35 mm, *A. borealis* has four to five prominent ribs per half whorl; *A. nivalis* has six to seven and *A. lidacensis* about nine. *A. borealis* also differs from these species in being more widely umbilicate (53-56% in *A. borealis;* 50% in both *A. nivalis* and *A. lidacensis*).

Xenoceltites spitsbergensis Spath (from Spitsbergen); *X. hannai* (Mathews) (from Utah) and *X. robertsoni* McLearn (from British Columbia) may be congeneric with *A. borealis.* These three *"Xenoceltites"* are certainly as close to the type of *Anakashmirites* as to that of *Xenoceltites.* In both *X. spitsbergensis* and *X. hannai* the ribs are much closer together than on *A. borealis.* The same applies to *X. robertsoni,* which also differs from the new species in that the heavy costae are replaced by finer ones at a diameter of 33 mm.

Occurrence. Blind Fiord formation, *Meekoceras* bed, 1,700 feet above base of formation, west coast of Ellesmere Island, between Hare and Otto Fiords, 5 miles northwest of entrance to Hare Fiord (GSC localities 28680, 28681 (talus), R. Thorsteinsson and E. T. Tozer, 1956).

Age. Upper Scythian (Owenitan) (*see* pp. 29-31).

Family Meekoceratidae

Genus *Meekoceras* Hyatt 1879

Type species: *Meekoceras gracilitatis* White

Diagnosis. Discoidal ammonoids, with wide excentric umbilicus. Periphery tabulate on most of phragmocone, ventro-lateral shoulders somewhat rounded on body whorl. Surface smooth, striate or slightly corrugated. Suture line ceratitic, with broad saddles, generally with few denticulations in lobes, no individualized auxiliary lobes.

Superficially *Meekoceras* resembles *Prionolobus* Waagen, an older Scythian genus, but *Prionolobus* lacks an excentric umbilicus.

Meekoceras was named at an early stage in the study of Triassic ammonoids and in the past many species, of from early to latest Scythian age, have been referred to it. However, in the restricted sense of Spath (1934, p. 246) the genus is known only from the *Meekoceras* zone of Idaho, Utah, Nevada and California, to which may now be added the occurrence described below. Spath (loc. cit.) and Kummel (1957, p. L 142) cite Timor as a locality for *Meekoceras,* but this is probably a mistake, for Spath (1934, pp. 98-100) placed the Timor *"Meekoceras"* species in *Prionolobus.*

Meekoceras gracilitatis White

Plate XV, number 6; Plate XVII, numbers 1a to 3;
Plate XVIII, numbers 4 to 6

Meekoceras gracilitatis White; Smith, 1932, p. 57 (with many illustrations and full synonymy); Spath, 1934, p. 248, fig. 83.

Diagnosis. *Meekoceras* with fairly high and thin whorls, umbilicus excentric, ranging from 0.1 of the diameter on inner whorls to 0.24 on the body whorl. Umbilical wall usually sloping, with obtusely angular umbilical shoulder but the wall and shoulder may be rounded on some individuals. Whorl sides moderately convex. On most of phragmocone the periphery is tabulate, or even slightly sulcate, with very pronounced ventro-lateral shoulders. On body whorl the ventro-lateral shoulders become less prominent and the periphery almost assumes a rounded aspect. Surface smooth or striate.

The collection from the Canadian Arctic includes about ten specimens that provide reliable measurements. In dimensions some Canadian specimens have almost exact counterparts in material described from the Western United States. For example, USNM 75303 (Smith, 1932, pl. 70, figs. 4, 5), from Idaho, is almost identical with GSC No. 14058 (Pl. XVII, figs. 1a, b). The Idaho specimen has a slightly narrower umbilicus and a wider and more denticulate second lateral lobe, otherwise the specimens are very similar.

Types and Dimensions

Specimen	Locality	D	H		W		U	
GSC 14052 hypotype	32371	50	27	0.54	14	0.28	7	0.14
BM C 21856	Idaho	52		0.52		0.26		0.15
USNM 74977[1]	Idaho	55	27	0.49	14	0.25	10	0.18
BM C 21855	Idaho	60		0.51		0.25		0.13
GSC 14053	32371	66	31	0.47	16.5	0.25	14.5	0.22
GSC 14054 hypotype	32371	66	33	0.50	15	0.24	12	0.18
USNM 75303[2]	Idaho	72	38	0.53	18	0.25	8	0.11
USNM 74870[3]	Idaho	73	37	0.51	15	0.20	15.5	0.21
GSC 14055 hypotype	28682	74	32	0.43	15	0.20	18	0.24
GSC 14056 hypotype	28682	75	32	0.43	16.5	0.22	16	0.21
GSC 14057 hypotype	28680	76	39	0.51	19	0.25	10	0.13
GSC 14058 hypotype	32371	77	38	0.49	20	0.26	12	0.16
GSC 14059 hypotype	Montello, Nevada	78	38	0.49			12	0.15
USNM 74972[4]	Idaho	84	38	0.45	19	0.23	24	0.29
GSC 14060 hypotype	28682	106	49	0.46			21.5	0.20
Spath, 1934, p. 248	Idaho	122		0.44		0.20?		0.22
GSC 14061 hypotype	32371	143	60	0.42	31	0.22	34	0.24

[1] Smith, 1932, pl. 38, figs. 2-3.
[2] Smith, 1932, pl. 70, figs. 4-5.
[3] Smith, 1932, pl. 33, figs. 1-3 (holotype, *Meekoceras sylvanum* Smith).
[4] Smith, 1932, pl. 33, fig. 4 (paratype, *Meekoceras sylvanum* Smith).

All the Canadian specimens have a narrow second lateral lobe (*see* Pl. XVIII). The Idaho specimens placed in *Meekoceras gracilitatis* by Smith are more variable in this respect. Some (for example those figured by Smith (1932) on pl. 37, figs. 1, 2, and pl. 38, fig. 2) have a narrow, second lateral lobe, with few teeth, apparently identical with that of the specimens from Ellesmere Island. On the other hand, some well-preserved specimens from Montello, Nevada, kindly donated by Dr. Bernhard Kummel, have a wide second lateral lobe, even wider than that shown by USNM 75303, referred to above.

The Canadian specimens vary considerably in proportions, particularly in the proportional width of the umbilicus. They generally show an abrupt widening of the umbilicus starting at a diameter of from 75 to 80 mm. The precise diameter at which this change takes place varies, and specimens of roughly the same diameters (for example GSC Nos. 14055 and 14057) may show very different umbilical proportions (*see* table of dimensions).

The features mentioned above do not conflict with the identification adopted, for concerning the Idaho and California specimens Hyatt and Smith (1905, p. 144) stated: "The relative width of the umbilicus . . . seems to be variable, also the abruptness or roundness of the umbilical shoulders".

The largest Canadian specimen (GSC No. 14061, Pl. XVIII, No. 4; Pl. XV, No. 6) is 143 mm in diameter. This specimen includes only just over a quarter whorl of body chamber, so that it is probably not complete. On the last whorl of this specimen the ventro-lateral shoulders are distinctly rounded, unlike the angular shoulders that characterize the inner whorls. This feature has not been described for the Idaho material. However, this may be because large specimens of *Meekoceras* have not been discovered in the Western United States. The largest *Meekoceras gracilitatis* figured by Smith (1932, pl. 37, fig. 1) is only 100 mm in diameter. The largest specimen recorded by Spath (1934, p. 248) is 122 mm in diameter; this has not been described or figured.

Occurrence. Originally described from beds now placed in the Thaynes formation, Idaho; also reported from Utah, Nevada, and California.

Blind Fiord formation, *Meekoceras* bed, 1,700 feet above base of formation, west coast of Ellesmere Island, between Hare and Otto Fiords, 5 miles northwest of entrance to Hare Fiord (GSC localities 28680, 28681 (talus), 28682, 28463, R. Thorsteinsson and E. T. Tozer, 1956; GSC locality 32371, R. Thorsteinsson, 1957).

Age. Upper Scythian (Owenitan) (*see* pp. 29-31).

Genus *Arctoceras* Hyatt 1900
(= *Submeekoceras* Spath 1934)

Type species: *Ceratites polaris* Mojsisovics

Diagnosis. Involute to moderately involute, discoidal ammonoids, with steep-sided umbilical wall, abruptly rounded or angular umbilical shoulder, mildly convex whorl sides and a rounded periphery. Sculpture variable; inner whorls commonly smooth, or nearly so, outer whorls with radial folds and commonly small tubercles on the umbilical shoulder. Suture line ceratitic, with narrow second lateral lobe, and slight individualization of the auxiliary series.

It was unfortunate that Hyatt chose *Ceratites polaris* as the type of *Arctoceras*. The type of *Arctoceras polaris* is relatively small and is probably an immature representative of the associated large, sculptured forms such as *Arctoceras costatum* (Oeberg) and *A. oebergi* (Mojsisovics). The generic diagnosis given above is based essentially upon these larger forms.

Spath (1934, p. 255) named *Submeekoceras* (type, *Meekoceras mushbachanum* White) for *Arctoceras*-like shells from the *Meekoceras* zone of Idaho. *Submeekoceras* was stated to differ from *Arctoceras* by having more slender saddles. Spath believed, mistakenly in the writer's opinion, that *Submeekoceras* is an older genus than *Arctoceras,* and this belief probably influenced his judgment in separating the two genera. The differences in the saddles, are, in the writer's view, of no more than specific significance. Some species, placed by Spath in *Submeekoceras* (e.g., *"Meekoceras" tuberculatum* Smith, 1932, p. 62, pl. 50, figs. 1-4) should certainly be placed in *Arctoceras.* J. Perrin Smith recognized the affinities of *"Meekoceras" tuberculatum* for he compared it with *Arctoceras oebergi.*

Arctoceras bears a superficial resemblance to the Lower Scythian genus *Koninckites* Waagen, and this resemblance led Perrin Smith to place *"Meekoceras" mushbachanum* and its allies in *Koninckites* (as a subgenus). There are differences,

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however, and there seems to be little doubt that Spath is correct in treating *Koninckites*, and the Arctoceratinae (which include *Submeekoceras*) as belonging to completely different stocks. *Koninckites* lacks sculpture and has the numerous saw-tooth auxiliary lobes that characterize so many Lower Scythian genera and which are quite unlike the relatively well-differentiated auxiliaries of *Arctoceras*.

The age of *Arctoceras* has for long been uncertain. Mojsisovics (1886) placed the typical species of *Arctoceras*, from Ice Fiord, Spitsbergen, in the Anisian. Stolley (1911) suggested that some of the *Arctoceras* species might be of Scythian age. Spath (1921, 1934) and Frebold (1930) have shown that *Arctoceras* is confined to the Scythian. Spath believed that *Arctoceras* lived in the "Prohungaritan" age; the latest Scythian "age" that he recognized. The genera associated with *Arctoceras* on Ellesmere Island (*see* p. 30) suggest that the Canadian *Arctoceras* bed is essentially the same age as the *Meekoceras* beds of the Western United States, which lie well below the top of the Scythian stage.

The writer concludes that *Arctoceras* is of early Upper Scythian age (Owenitan age of Spath) and is known from the following localities: Spitsbergen, Ellesmere Island, Western United States (*Arctoceras tuberculatum* (Smith)), and probably also Timor (*Arctoceras malayicum* (Welter)).

Arctoceras oebergi (Mojsisovics)

Plate XV, numbers 1 to 5b; Plate XVI, numbers 2 to 4

Ceratites costatus Oeberg, 1877, p. 13, pl. IV, fig. 4 (only).
Ceratites blomstrandi Lindstrom; Oeberg, 1877, p. 11, pl. III, figs. 1, 2 (only).
Ceratites Öbergi Mojsisovics, 1886, p. 33, pl. VII, figs. 5, 6; pl. VIII, figs. 1, 3.
Arctoceras oebergi (Mojsisovics); Diener, 1915, p. 52; Spath, 1934, p. 261.

Diagnosis. Moderately involute *Arctoceras*, probably reaching a diameter of about 175 mm. Umbilical wall vertical, umbilical shoulder angular. Inner whorls (to about 40 mm) with sculpture of growth lines only; outer whorls with low, radial, rather irregular, prorsiradiate folds. These folds may be somewhat emphasized near the periphery, but the periphery itself is smooth. Tubercles, variably spaced, occur on umbilical shoulder. The shell surface may also show fine strigate sculpture.

Types and Dimensions

Specimen	Locality	D	H		W		U	
14067 hypotype	28680	53.5	27	0.51	14	0.26	10.8	0.20
14068 hypotype	28680	76	37	0.49	20	0.26	18	0.24
14069 hypotype	32371	82	38	0.46	25	0.30	18	0.22
14070 hypotype	28681	99	44	0.44			23	0.23
14071 hypotype	28681		78					
Lectotype (Mojsisovics, 1886, pl. VII, figs. 6a, 6b)	Ice Fiord, Spitsbergen	71	33	0.46	17	0.24	17.5	0.25

The dimensions of the Canadian specimens are very close to those of Spath's lectotype, as shown in the preceding table. There is considerable variation in the development and spacing of the umbilical tubercles, as shown by the figured specimens (Pl. XV, Nos. 4, 5a). A precisely similar type of variation was noted in the original description by Mojsisovics. The strigate sculpture mentioned in Mojsisovics' description is also shown by some Canadian specimens, for example, on the periphery of GSC No. 14069. The combination of the strigate sculpture and the fine growth lines may produce a finely punctate appearance.

Mojsisovics considered that four teeth on the first lateral lobe characterized this species. Some of the Canadian specimens show this number; others have six (*see* Pl. XV, Nos. 1-3). The original of Mojsisovics' plate VII, figure 6 (chosen as lectotype by Spath, 1934, p. 261), has five teeth, not the four divisions illustrated. Such minor variations do not seem useful as a specific character, as Spath has pointed out. Indeed, according to Spath (1934, p. 262), the number of teeth in the lobes may differ on each side of one specimen.

The Canadian collection includes some large poorly preserved fragments, apparently without septa, that presumably represent body chambers, for example GSC No. 14071, Plate XVI, number 2, with a whorl height of 78 mm. This specimen has umbilical tubercles, from which radiate low, prorsiradiate folds and it resembles closely a large fragment from Spitsbergen named *"Ceratites costatus"* by Oeberg (1877, pl. IV, fig. 4). Mojsisovics (1886, p. 36) suggested that Oeberg's body chamber fragment is probably referable to *"Ceratites" oebergi* and the association of these large Canadian fragments supports such an interpretation. If the proportions shown at a diameter of 99 mm are maintained, these large body chambers would represent the remains of individuals about 175 mm in diameter.

Occurrence. Originally described from the *Posidonomya* limestone of Ice Fiord, Spitsbergen. This stratigraphic unit is also known as the Fish beds.

Blind Fiord formation, *Meekoceras* bed, 1,700 feet above the base of formation, west coast of Ellesmere Island, between Hare and Otto Fiords, 5 miles northwest of entrance to Hare Fiord (GSC localities 28680, 28681 (talus), 28682, 28463, R. Thorsteinsson and E. T. Tozer, 1956; GSC locality 32371, R. Thorsteinsson, 1957).

Age. Upper Scythian (Owenitan) (*see* pp. 29-31).

Family PRIONITIDAE

In the Upper (but not uppermost) Scythian of many parts of the world (notably Spitsbergen, the Canadian Arctic, northeastern British Columbia, Utah, Timor, the Himalayas, Salt Range, Japan) there occurs a distinctive stock of sculptured ammonoids characterized by tabulate or subtabulate peripheries. Seven genera have been named to accommodate these forms. They are: *Prionites* Waagen, *Hemiprionites* Spath, *Gurleyites* Mathews, *Arctoprionites* Spath, *Anasibirites* Mojsisovics, *Wasatchites* Mathews and *Anawasatchites* McLearn.

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Spath (1934) and Kummel (1957) placed the first four genera listed in the Prionitidae and the remaining three in the Sibiritidae. Despite this arrangement, Spath evidently recognized that these forms are closely allied for he has described a specimen[1] intermediate between *Arctoprionites* ("Prionitidae") and *Wasatchites* ("Sibiritidae"). In order to emphasize the homogeneity of this group of ammonoids, all of which are more or less contemporary, the writer places them all in the Prionitidae.

It may be added that *Sibirites* Mojsisovics, around which the Sibiritidae must be grouped, is younger than *Prionites* and allied forms. Furthermore, *Sibirites,* according to Mojsisovics' illustrations, has chevron sculpture on the periphery, a feature unknown in the genera mentioned above.

Many of the Prionitidae seem to be remarkably variable, and consequently the taxonomy of the group is very difficult. Various authors have attempted to solve these problems in rather different ways. This is illustrated by the fact that Welter (1922) placed the Timor *Anasibirites* in two species (one based on 111 specimens, the other on one). In contrast, Mathews (1929) placed a comparable assemblage from Utah in no less than thirty-three species.

Genus *Wasatchites* Mathews 1929
(= *Anawasatchites* McLearn 1945)

Type species: *Wasatchites perrini* Mathews

Wasatchites includes ribbed Prionitidae with, at maturity, prominent bullae near the umbilical shoulder. Each bulla gives rise to two or three strong ribs, which cross the periphery. The periphery is distinctly tabulate but the ventrolateral shoulders are rounded. The ribs may show a slight swelling at the ventrolateral shoulder, but there are no spines in this position, as in *Keyserlingites.* The suture line is ceratitic with a simple, or only slightly incised ventral lobe.

Anawasatchites McLearn (1945) was defined to include forms in which the acquisition of bullae is deferred until a diameter of about 50 mm is reached. However, the young of typical *Wasatchites* also lack prominent sculpture to a diameter of about 15 mm. *Wasatchites tridentinus* Spath, from Spitsbergen, lacks prominent sculpture to a diameter of about 25 mm. It thus appears that the *Wasatchites* and *Anawasatchites* (contemporaneous genera) are linked by transitions. To distinguish these genera would be tantamount to using shell size as a generic character. The writer, therefore, prefers to treat *Anawasatchites* as a synonym of *Wasatchites.*

Arctoprionites Spath, a contemporary of *Wasatchites,* is a close ally. The type species, *A. nodosus* (Frebold) has a smooth periphery, but "*Goniodiscus* sp. nov. aff. *nodosus*" of Frebold (1930, p. 11, pl. II, figs. 1, 1a), regarded as a new species of *Arctoprionites* by Spath (1934, p. 340), has distinct ribs crossing the

[1] *Arctoprionites* sp. nov. ?, Spath, 1934, p. 341, pl. XIV, fig. 4; pl. XVIII, fig. 1.

venter, much like *Wasatchites merrilli* (McLearn). The lateral bullae of *Arctoprionites* are more ventrally situated than those of *Wasatchites,* as McLearn (1945, p. 6) pointed out, and this permits the separation of these genera.

Spath (1934, pp. 33, 353) stressed the similarities between *Wasatchites* and *Keyserlingites* of the Olenek fauna (Siberia), of uppermost Scythian age. The writer believes that these similarities are superficial, that they do not indicate a close relationship and consequently have little or no significance for purposes of correlation. Spath himself pointed out that the sutures of the two genera are different. *Keyserlingites* has a more serrated external lobe. What seems more important, however, is that *Keyserlingites* has pronounced ventro-lateral spines. *Wasatchites,* and some other prionitids, show a thickening of this part of the shell, but none shows anything that approaches the form of *Keyserlingites subrobustus* (Mojsisovics), which may be only a prominently sculptured variety of the superficially *Wasatchites*-like *Keyserlingites middendorfi* (Keyserling).

Wasatchites occurs in Upper Scythian beds in Timor, Utah, northeastern British Columbia, Spitsbergen, Ellesmere Island and Axel Heiberg Island. In Utah it occurs above beds with *Meekoceras gracilitatis* White (Mathews, 1931, p. 13).

Wasatchites tardus (McLearn)

Plate XIX, numbers 1a to 3c

Anawasatchites tardus McLearn, 1945, p. 5, appendix sheet 1, pl. II, figs. 1, 2.

Diagnosis. *Wasatchites* at least 107 mm in diameter. The periphery and whorl sides are without sculpture up to a diameter of about 40 mm. Succeeding whorls have bullae near the umbilical shoulder from which branch two or three ribs that cross the periphery.

Types and Dimensions

Specimen	Locality	D	H		W		U	
14087 hypotype	32365	44	21	0.48	16	0.36	10	0.23
holotype	Liard River	70	29	0.41	22	0.31	17	0.24
14088 hypotype	32365	72	31	0.43	25	0.35	17	0.24
14089 hypotype	32365	107	44	0.41	40	0.37	38	0.36

Specimens of *Wasatchites* from the Arctic islands are not particularly well preserved and the collection is relatively small. The best specimen (Pl. XIX, Nos. 3a-c) is almost identical with the type of "*Anawasatchites*" *tardus.* A large specimen, 107 mm in diameter, with half a whorl of living chamber and probably adult, evidently represents the same species (Pl. XIX, Nos. 1a, b).

The collection also contains some smaller specimens which for the time being are not named. One of these (Pl. XX, Nos. 2a, b) has prominent bullae, weak ribs and a nearly smooth, subtabulate periphery. This specimen resembles *"Prionites* sp. indet." from Spitsbergen (Frebold, 1930, pl. III, fig. 7). Spath (1934, p. 340) considered that this Spitsbergen specimen represents an *Arctoprionites*.

Another specimen from the *Wasatchites* bed (Pl. XX, Nos. 3a, b) has a truly tabulate periphery and weak radial bullae originating from the umbilical shoulder. This *Hemiprionites*-like specimen has a close counterpart in the *Wasatchites* bed of Liard River, British Columbia (Pl. XX, Nos. 1a, b)[1]. The specimens described above may represent aberrant, immature individuals of *Wasatchites tardus*. Alternatively they may represent other species of other genera. Whatever the exact affinities of these specimens, they serve to illustrate the close faunal similarities between Spitsbergen, the Arctic islands, British Columbia and Utah.

Occurrence. Originally described from the *Wasatchites* bed of the Toad formation, Liard River, British Columbia (McLearn, 1945).

Wasatchites bed, 514 feet above base of the Blind Fiord formation, south side of Bunde Fiord, Axel Heiberg Island (GSC locality 32365, R. Thorsteinsson, 1957).

Age. Upper Scythian (Owenitan) (*see* p. 31).

Family Sibiritidae (?)

Genus *Olenikites* Hyatt 1900

Type species: *Dinarites spiniplicatus* Mojsisovics 1886

Olenikites includes small, moderately involute ammonoids with arched or subtabulate venters. The inner whorls have prominent, thorn-like umbilical tubercles. On the body whorl the tubercles become bullate, or form ribs, or degenerate entirely. The septal sutures are goniatitic, rarely ceratitic, with two (occasionally one) lateral lobes.

This genus is believed to occur only in strata of latest Scythian age. This is the age assigned to the Olenek River fauna, from which the genus was first described. It may occur also in the "Highest beds of the Ceratite limestone" in the Salt Range, Pakistan (Waagen, 1895, p. 25; Spath, 1934, p. 360). Kummel (1954, p. 187) has tentatively identified *Olenikites* from the upper part of the Thaynes formation of Idaho. It is now recorded from Ellesmere Island.

[1] *Hemiprionites* Spath (*Goniodiscus* Waagen, *non* Mueller and Troschel) is probably a spurious genus. The type species (*H. typus* (Waagen), from the Salt Range) is small and not particularly well preserved. Some "species" (e.g., *H. timorensis* Spath) are linked by continuous contemporary transitional forms, with *Anasibirites*. Some of the Utah *Hemiprionites* described by Mathews (1929) may represent the young of *Gurleyites*. It is possible that all *Hemiprionites* are either the young of other, distinctively sculptured Prionitidae, or conservative, atavistic, variants, revealing the characters of the ancestral Meekoceratidae.

Olenikites canadensis n. sp.

Plate XVIII, numbers 1a to 3b; Figure 9

Diagnosis. Olenikites with rounded umbilical and ventral shoulders on the early whorls; living chamber with prominent umbilical shoulders and a subtabulate venter. Early whorls have umbilical bullae which change to rib sculpture on the body whorl. Ribs are straight, slightly prorsiradiate, and are most prominent at the umbilical shoulder, less prominent below. Sculpture of both early and later whorls apparently varies greatly in prominence. Septal sutures goniatitic with two external lateral saddles and a deep external lobe.

Types and Dimensions

Specimen	Locality	D	H		W		U	
14093 paratype	32363	8.0	2.8	0.35	3.0	0.38	2.8	0.35
14094 holotype	32363	15.0	7.0	0.47	4.8	0.32	4.0	0.27
14095 paratype	32363	23.0	10.0	0.44	8.0	0.35	6.5	0.28

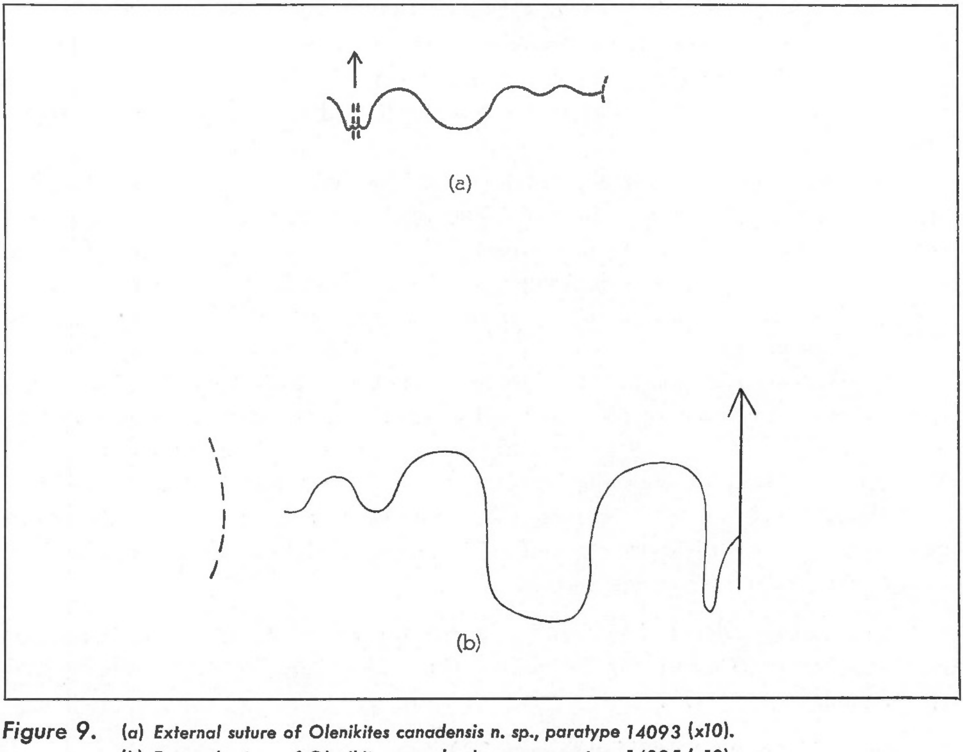

Figure 9. (a) External suture of *Olenikites canadensis* n. sp., paratype 14093 (x10).
(b) External suture of *Olenikites canadensis* n. sp., paratype 14095 (x10).

The holotype (Pl. XVIII, Nos. 1a, b) has at least four and probably about five whorls in all. The sides of the last whorl are slightly convex, with their greatest width near the umbilical margin. The umbilical margin is rounded except on the last one quarter whorl where a moderately prominent shoulder appears. At the beginning of the last whorl the venter is well rounded, but towards the aperture the venter becomes subtabulate. At a diameter of 10 mm the whorl carries ten umbilical bullae. Of these, the first five are simple, thorn-like tubercles, the remainder are drawn out towards the periphery and so become increasingly bullate. The last two bullae are replaced by ribs. Immediately behind the aperture the whorl sides are devoid of sculpture. The umbilical suture lies on the bullae; two whorls can be seen to show umbilical sculpture. The septal sutures are not well preserved on this specimen, but the edges of some septa are visible. There are two lateral lobes, both perfectly smooth. The first lateral lobe is below the bullae and the second is upon them.

The large paratype (Pl. XVIII, Nos. 3a, b) is septate except for the last half whorl. This specimen is weakly sculptured compared with the holotype. It has faint bullae on the umbilical shoulder of the penultimate whorl and it seems reasonable to treat this specimen as a weakly sculptured variety of *O. canadensis*. The last whorl has distinct umbilical shoulders and a subtabulate venter. This whorl has straight, prorsiradiate ribs, all of which, except the last one adjacent to the aperture, are very faint. These ribs are most prominent at the umbilical shoulder and fade away below. The external suture is well displayed (Fig. 9). There are two lateral lobes, both perfectly smooth, and an unusually deep external lobe.

The smaller paratype (Pl. XVIII, No. 2) represents the inner whorls of a large, fragmentary individual. At a diameter of 4 mm the venter of this specimen is rounded, with poorly defined ventro-lateral shoulders. At a diameter of 8 mm the venter is subtabulate and the bullae are drawn out to form ribs. This specimen has acquired a subtabulate periphery and rib sculpture at an earlier stage than the other figured specimens.

This species is probably very closely related to *Olenikites spiniplicatus* and its allies, from northeastern Siberia. The Canadian specimens differ from *O. spiniplicatus* as follows: (1) they have a subtabulate venter on the later whorls, unlike the round periphery of *O. spiniplicatus;* (2) the lateral bullae of *O. canadensis* are replaced by ribs before a diameter of 13 mm; *O. spiniplicatus* commonly retains them to a diameter of about 20 mm; (3) the external lobe of *O. canadensis* is deeper than that of *O. spiniplicatus.*

Occurrence. About 235 feet below the top of the Blind Fiord formation, south side of Otto Fiord, near the mouth, Ellesmere Island (GSC locality 32363, R. Thorsteinsson, 1957).

Age. Uppermost Scythian (*see* p. 32).

Family TRACHYCERATIDAE

Genus *Protrachyceras* Mojsisovics 1893

Protrachyceras is represented in the collection by one fragmentary specimen from the *Daonella frami* bed of Bjorne Peninsula. This specimen (No. 14190, Pl. XXI, Nos. 1a, b, from locality 26110) is a fragment of a moderately evolute form, with five or six rows of tubercles between the umbilical shoulder and the ventral furrow. It cannot be determined specifically and consequently does not assist materially in determining the age of the *Daonella frami* fauna.

Kittl (1907, p. 38, pl. 3, figs. 7-11) has figured some specimens from Bjorne Peninsula which he referred to *Protrachyceras*. The writer has examined these specimens, which occur with *Halobia zitteli* Lindstrom and are of Karnian age. The ammonites are preserved as flattened impressions and cannot be determined satisfactorily. They are probably not *Protrachyceras* but may be *Sirenites* or *Arctosirenites*.

Genus *Sirenites* Mojsisovics 1893

Type species: *Ammonites senticosus* Dittmar

Sirenites includes trachyceratids in which the number of tubercles is greater than the number of ribs at the ventro-lateral shoulder. This increase in the number of ventral tubercles takes place by adorad rib-splitting near the venter. Spath (1951, p. 44) has stressed that "the Sirenitids . . . are not derived from just one branch, say the genus *Protrachyceras*". This conclusion is born out by *Sirenites costatus* n. sp., an unusual species from the Arctic Archipelago which lacks lateral tubercles and is probably a descendant of *Paratrachyceras*.

The type species is from the Lower Karnian of Austria. Species that are closely related to *S. senticosus* are only known from relatively few areas. Such occurrences include *Sirenites hayesi* from Alaska, *S.* aff. *S. hayesi,* etc., from northeastern Siberia, and two species (*S. senticosus* and *S. nanseni* n. sp.) now recorded from the Canadian Arctic islands. It seems reasonable to conclude that all these species are of Lower Karnian age. *Sirenites* has also been recognized in the Upper Karnian and Norian of many parts of the world, i.e., from a higher level than the typical sirenitids. Most of these younger species (e.g., *Sirenites pamphagus* (Dittmar)) bear little resemblance to the Lower Karnian species. Many of these young sirenitids might be placed in other genera, as are some Norian species (the *"argonautae"* of Mojsisovics), which have already been separated as *Pseudosirenites* Arthaber (Spath, 1951, p. 45).

Sirenites senticosus (Dittmar)

Plate XXIV, numbers 7, 8, 9a, b

Ammonites senticosus Dittmar, 1866, p. 375, pl. 17, figs. 9, 10.
Sirenites senticosus (Dittmar); Mojsisovics, 1893, p. 727, pl. CLXI, figs. 8-12, 14, 15.

Typical representatives of this species have five spiral rows of tubercles; one on the umbilical shoulder, two on the whorl side, one on the ventro-lateral shoulder, and one bordering the ventral furrow. The ventral tubercles are aligned obliquely to the plane of coiling. Through the kindness of Dr. H. Küpper, Director of the Geologisches Bundesanstalt, Vienna, the writer had the opportunity to examine some of the specimens illustrated by Mojsisovics. The Canadian specimens resemble particularly the specimen figured by Mojsisovics on plate CLXI, as figure 8. This resemblance may be shown by comparing the details of the sculpture and the dimensions.

Specimen	Locality	D	H	W	U	No. of tubercles per $\frac{1}{2}$ whorl		
						at umbilical shoulder	at ventro-lateral shoulder	at ventral furrow
14149 hypotype	30369	26	12.5 0.48	6 0.23	5 0.19	9	25	34
Mojsisovics, pl. clxi, fig. 8	Austria	at 26	12 0.46	6 0.23	5.5 0.21	11	23	37

The ribs on Mojsisovics' specimen appear to be more elevated than those on the Canadian ones. Mojsisovics' specimen preserves the shell, whereas the Canadian specimens are internal moulds. Consequently it is difficult to assess the significance of this apparent difference. It is probably unimportant.

Mojsisovics (1893, p. 728) stated that the suture line is imperfectly known, but he also said that the suture is ceratitic, with wholly rounded saddles. Of three specimens from Austria seen by the writer (Mojsisovics, pl. CLXI, figs. 8, 9, 15), none shows the septal sutures clearly. The writer examined the original of figure 8 under a liquid film. At a diameter of 26 mm this specimen shows part of the first lateral saddle, which is weakly serrated, and apparently like the first lateral saddle of GSC No. 14149 (Pl. XXIV, No. 7). The first lateral saddle of Nos. 14148 and 14149 have a distinct notch on the outer side. These specimens thus show an incipient adventitious saddle and they presage the Norian *Pseudosirenites,* which has well-developed adventitious saddles.

The largest Canadian specimen is an external mould, about 35 mm in diameter (Pl. XXIV, No. 8).

Occurrence. Originally described from the Lower Karnian part of the Hallstatt limestone, Austria.

Schei Point formation, from disintegrated outcrops on the summit of the cliffs at Cape Ursula, Table Island (GSC locality 30369, E. T. Tozer, 1957). Schei Point formation, 14 miles south of Cape Malloch, Borden Island (GSC locality 37218, R. Thorsteinsson, 1958).

Closely related, and perhaps identical, species occur in Alaska (*Sirenites hayesi* Smith, 1927, p. 82, pl. CIII, figs. 7, 8) and northeastern Siberia (*Sirenites* aff. *S. hayesi* Smith; Kiparisova, 1937a, p. 180, pl. V, figs. 6-8).

Age. Karnian, probably Lower Karnian (*see* pp. 36-39).

Sirenites nanseni n. sp.

Plate XXIII, numbers 1a to 8b; Plate XXIV, numbers 12a to 16b

Diagnosis. *Sirenites* with many (up to fourteen) rows of spirally arranged tubercles. The inner whorls have elevated ribs that branch prominently. On the outer whorls the ribs are of low relief and the tubercles alone constitute the principal sculpture. Ventral tubercles form simple spines, aligned in the spiral plane, on the inner whorls; on the outer whorls they are obliquely placed, resulting in a "braided keel". Septal sutures ammonitic, with high, narrow saddles. The first lateral saddle lacks adventitious elements.

The whorls of this species have mildly convex sides. The maximum width is just below the umbilical shoulder. The umbilical wall is vertical and the umbilical shoulder is rounded. The nature of the sculpture changes in the course of development. It is more pronounced on the inner than on the outer whorls. Specimens up to a diameter of about 30 mm (e.g., paratypes 14151, 14153 and 14154, Pl. XXIII, Nos. 2a, b; Pl. XXIV, Nos. 12a, b, 16a, b) commonly have elevated ribs that branch near the middle of the whorl side. At diameters above 30 mm the ribs are normally of low relief and they branch less conspicuously. The outer whorl of paratype 14158 (Pl. XXIII, Nos. 3a, b) shows this change in sculpture. Some individuals (e.g., paratype 14159, Pl. XXIII, Nos. 7a, b) retain the coarse branching ribs to a diameter of about 40 mm. This seems to be unusual. The ventral sculpture also changes with development. As the size increases the ventral tubercles become increasingly oblique to the spiral plane. Some specimens (e.g., the holotype 14161) show a suggestion of bispinose ventral tubercles, as in *Sirenites* (*Diplosirenites*) *starhembergi* Mojsisovics; however, this specimen is an internal mould and the presence of two spines cannot be definitely established. The early whorls of this species certainly lack double spines. Large fragments, such as paratype 14163 (Pl. XXIV, Nos. 15a, b), suggest that *Sirenites nanseni* reaches a diameter of at least 80 mm. This specimen has crude, rather irregular sculpture and is probably adult. Specimens that show the septal sutures, e.g., No. 14165 (Pl. XXIII, No. 5), show that the high first lateral saddle lacks the adventitious elements that characterize the Norian genus *Pseudosirenites.*

Sirenites nanseni resembles a number of species from the Lower Karnian zones of the Hallstatt limestone, Austria. Mojsisovics described many *Sirenites* species from these zones, most of them based on a single specimen. *Sirenites plutarchi* Mojsisovics resembles *S. nanseni* in possessing spiral spines (*"senticosi*-sculpture") on periphery of the inner whorls and a braided keel (*"striatofalcati*-sculpture") near the aperture. However, *S. plutarchi* has reduced lateral tuberculation near the aperture, unlike *S. nanseni. Sirenites dionysii, S. junonis, S. cornelii, S. theresiae, S. vestalinae* and *S. sophiae* (all Mojsisovics' species) and *S. betulinus* Dittmar resemble the inner whorls of *S. nanseni* but they lack the braided keel of the adult. *Sirenites* (*Diplosirenites*) *starhembergi* Mojsisovics,

Types and Dimensions

Specimen	Locality	D	H		W		U		No. of rows of tubercles at aperture (including ventral)	No. of tubercles per ¼ whorl		
										at umbilical shoulder	at ventro-lateral shoulder	at venter
14151 paratype	28427	18.5	8.5	0.46	6.0	0.32	4.0	0.22	6	5	9	11
14152 paratype	28569	24.0	11.2	0.47	7.5	0.31	6.2	0.26	8	7	11	12
14153 paratype	28427	27.0	13.0	0.48	8.8	0.33	6.0	0.22	9	7	11	16
14154 paratype	28439	28	13.5	0.48	8.0	0.29	6.5	0.23	8	5	9	15
14155 paratype	28439	30	14	0.47	9.5	0.32	9.0	0.30	9	8	15	22
14156 paratype	32220	34	17.5	0.51	11.0	0.32	7.0	0.21	10	8	16	ca. 20
14157 paratype	32369	34	18	0.53			7.0	0.21	9	8	17	18
14158 paratype	28439	35	16.5	0.47	11.5	0.33	9.0	0.26	12	7	12	19
14159 paratype	28439	ca. 40	18.5		13.0		10		10	6	12	18
14160 paratype	28439		32				11		14	7	19	32
14161 holotype	28439	68	36	0.53			13	0.19	12	ca. 9	17	31
14162 paratype	28439		37						13	ca. 5	25	39
14163 paratype	28439		47						9	ca. 7		33

Other paratypes: 14164 (locality 28439); 14165 (locality 28439); 14166 (locality 30359).

founded on a single specimen 77 mm in diameter also resembles *S. nanseni*. *S. starhembergi* has double spines on the ventral tubercles, a feature not well developed, if at all, by *S. nanseni*. The type specimen of *S. starhembergi* has more prominent ribs than any specimen of *S. nanseni* at the same diameter. This specimen is not as well preserved as suggested by Mojsisovics' illustration. *Sirenites praxedis* Mojsisovics has ventral sculpture close to that of *S. nanseni* but differs in having slightly clavate lateral tubercles.

All the Hallstatt species mentioned above share the following characters with *S. nanseni*: many rows of lateral tubercles; a relatively open umbilicus; a moderately rounded umbilical shoulder; and the absence of differentiated sculpture at the umbilical shoulder. All the Hallstatt species are Lower Karnian. These characters are not found in Upper Karnian *Sirenites*, such as *Sirenites nabeschi* McLearn, and *Sirenites pamphagus* (Dittmar). It seems reasonable to conclude that *Sirenites nanseni,* like the closely similar species from Hallstatt, is also of Lower Karnian age. It should be mentioned that most of the Hallstatt species are based on one specimen and many are founded on small, probably immature, individuals. If the Hallstatt collection were studied by a contemporary taxonomist, many of the "species" would probably be grouped as synonyms.

Occurrence. *Sirenites nanseni* is abundant in the lower part of the Middle Shale member, Blaa Mountain formation. In this member it has been collected at the following localities:

1. East limb of Blaa Mountain anticline, north side Greely Fiord, Ellesmere Island (GSC locality 28469, E. T. Tozer, 1956).
2. Northwest coast Ellesmere Island, 7 miles northwest of entrance to Hare Fiord, about 250 feet above base of Middle Shale member (GSC locality 28427, R. Thorsteinsson and E. T. Tozer, 1956).
3. Northwest coast Ellesmere Island, 7 miles northwest of entrance to Hare Fiord, about 650 feet above base of Middle Shale member (GSC locality 28569, R. Thorsteinsson and E. T. Tozer, 1956).
4. Northwest coast Ellesmere Island, 15 miles northwest of entrance to Hare Fiord (type locality). (GSC locality 28439, R. Thorsteinsson and E. T. Tozer, 1956).
5. Northwest coast Ellesmere Island, about 22 miles northwest of entrance to Hare Fiord (GSC locality 32369, R. Thorsteinsson and E. T. Tozer, 1957).
6. Southeast side of Otto Fiord, 2 miles from mouth of fiord (GSC locality 32220, R. Thorsteinsson, 1957).

Schei Point formation, Hat Island at the mouth of Bay Fiord, section on the east side of the island (GSC locality 30359, E. T. Tozer, 1957).

Age. Karnian, probably Lower Karnian (*see* pp. 36-39).

Sirenites costatus n. sp.

Plate XXIV, numbers 10, 11a, b

Diagnosis. Moderately evolute ammonoids with the ventral sculpture of *Sirenites* on the outer whorl and elevated, branching, non-tuberculate ribs which are strongly projected towards the aperture on the periphery.

Types and Dimensions. These specimens are slightly distorted and the measurements are approximate.

Specimen	Locality	D	H	W	U
14144 paratype	28454	31	12 0.38	9.5 0.31	9.5 0.31
14143 holotype	28454	ca. 44	18 0.41	11.0 0.25	11.5 0.26

Other paratypes: Nos. 14145, 14146, 14147, 14148; all from locality 28454.

The holotype, on a quarter of the last whorl shows about seven ribs at the umbilical margin and fifteen at the ventro-lateral shoulder. Most ribs branch at the middle of the whorl side. The number of ventral tubercles is approximately double the number of ventro-lateral ribs, but some ribs fail to split on the venter. The ribs show no real tubercles. A very slight radial swelling is present on the umbilical shoulder and some ribs show a slight elevation on the ventro-lateral shoulder, at the point where they bend forwards. Again, these swellings can hardly be described as tubercles. The holotype shows no septa.

Paratypes 14144 and 14147 show that at diameters up to 12 mm rib-splitting at the venter is the exception rather than the rule. These shells thus have the characters of *Paratrachyceras*. Paratype 14145 shows the inner whorls down to a diameter of about 5 mm. These whorls show no sign of tuberculation.

The septal sutures are not well preserved. Paratype 14146, shows weakly incised saddles at a whorl height of 8 mm.

Sirenites costatus is not close to typical representatives of *Sirenites*. The sculpture of the new species resembles that of several *Paratrachyceras* species, e.g., *P. richtofeni* (Mojsisovics), *P. caurinum* McLearn, and *P. meginae* (McLearn). These Ladinian *Paratrachyceras* species share with *Sirenites costatus* elevated, non-tuberculate ribs, strongly projected on the venter. They differ from *S. costatus* by lacking the ventral rib-splitting. *Paratrachyceras meginae,* as noted by McLearn (1937b, p. 128; 1953b, p. 3), shows what might be described as incipient *Sirenites* ventral sculpture, with the number of ventral tubercles slightly exceeding the number of ventro-lateral ribs. Of the *Paratrachyceras* species mentioned, those that show the septal sutures (namely *P. meginae* and *P. caurinum*) have ceratitic sutures. The suture of *S. costatus,* as already mentioned, is apparently weakly ammonitic, as is that of the type species of *Paratrachyceras* (*P. hofmanni* Boekch). *Sirenites costatus* probably represents a derivative of *Paratrachyceras* that has acquired the ventral sculpture of *Sirenites*.

At first sight it might be supposed that *Sirenites costatus* is the same as *"Protrachyceras" sverdrupi* Kittl (1907, p. 38, pl. 3, figs. 5, 7, 8) from Bjorne Peninsula, Ellesmere Island. The steinkerns of Kittl's species show smooth ribs, like those of *S. costatus,* but the outer surface of the shell is tuberculate.

Occurrence. Blaa Mountain formation, about 6,700 feet above base. Cliff on the southeast side of Buchanan Lake, 5 miles from the outlet, Axel Heiberg Island (GSC locality 28454, E. T. Tozer, 1956).

Age. Karnian (*see* pp. 36-39).

Genus *Arctosirenites,* new

Type species: *Arctosirenites canadensis* n. sp.

Diagnosis. Trachyceratidae with tuberculate ribs and variable ventral sculpture. The number of ventral tubercles may be less than the number of ribs at the ventro-lateral shoulder, or there may be more, or the number may be the same. Septal sutures ammonitic.

The ventral sculpture of *Arctosirenites* shows considerable variation in its relationship to the rib sculpture. This, in itself, may be considered one of the distinguishing characters of *Arctosirenites,* for in most members of the Trachyceratidae the ventral tubercles on the outer whorls bear a constant relationship to the number of ribs at the ventro-lateral shoulder. Not only is the sculpture of *Arctosirenites* variable, but some varieties show sculpture unlike that of any described genus. This novel type of sculpture results from the presence of more ventro-lateral than ventral tubercles. In a sense this sculpture is the reverse of that shown by *Sirenites.* It also differs from that of *Protrachyceras,* in which the ventral tubercles match the ribs at the shoulder. In the discussion that follows, the distinctive ventral ornament of *Arctosirenites* is referred to as "reversed" sculpture. Reversed sculpture is not common to all the specimens placed in the type species of *Arctosirenites* (*A. canadensis*). Some have *Sirenites*-like sculpture and others resemble *Protrachyceras.* This range of variation is known only in the group of shells placed in the type species. From a strictly typological point of view it might be suggested that three genera (and therefore at least three species) are represented in *A. canadensis,* as here defined. There seems to be no evidence to support this argument for there appears to be a continuous gradation from coarsely sculptured forms (commonly with *Sirenites* or *Protrachyceras* ventral sculpture) to delicately ornamented forms (with reversed sculpture). However, the appearance of reversed sculpture within this variable series of shells represents the evolution, probably from a *Protrachyceras* ancestor, of a new morphological character in the Trachyceratidae. The appearance of this character excludes these shells from *Sirenites* and

Protrachyceras. It is not suggested that the variable ventral sculpture of *Arctosirenites canadensis* indicates that the details of tuberculation are not a reliable character in the classification of other Trachyceratidae. Large collections of *Sirenites* (e.g., *Sirenites nanseni* n. sp.) and *Protrachyceras* (*P. sikanianum* McLearn) have been examined by the writer. As noted by McLearn (1943, p. 55), the ribs of *P. sikanianum* vary in density and relief, but the ventral clavi always match the ribs, and *Sirenites nanseni* consistently shows ventral sculpture characteristic of *Sirenites.*

Arctosirenites canadensis n. sp.

Plate XXIV, numbers 1a to 5c; Plate XXV, numbers 1a to 11b

Diagnosis. Moderately evolute *Arctosirenites,* with six or seven spiral rows of tubercles on the mature whorl sides. The rows (commonly three on the mature shell) near the umbilical shoulder and the row on the ventro-lateral shoulder are more prominent than the others. The ventral tubercles are simple or slightly clavate. The sculpture varies in prominence. Individuals with prominent sculpture commonly have more ventral than ventro-lateral tubercles. Those with faint sculpture have this relationship reversed. All intermediates appear to be present.

The holotype (GSC No. 14136, Pl. XXV, Nos. 8a, b) is an incomplete internal mould, septate to the beginning of the last whorl. When complete it was about 45 mm in diameter. Near the aperture there is a rather coarse constriction, which suggests that this specimen is adult. Paratype 14126 (Pl. XXV, Nos. 3a-c), 33 mm in diameter, has diminished sculpture near the aperture. Paratype 14128 (Pl. XXIV, Nos. 4a, b), of about the same size, also shows diminished sculpture. These specimens may also be adult. If so, adults in this species have a minimum size range of 33 to 45 mm.

Most of the specimens are internal moulds. However, some show the shell material and reveal that the internal mould faithfully reproduces the details of the surface ribbing and tuberculation.

The shells included in this species show a great range of variation in strength and type of sculpture. Paratypes 14133 and 14130 (Pl. XXV, Nos. 4a, b, 5) show the mature whorls of the most coarsely sculptured varieties. The ribs are widely spaced and of strong relief. They branch once, just above the middle of the whorl side. There are six spiral rows of tubercles on the ribs and those near the umbilical shoulder are more prominent than the others. The ventral sculpture is of *Sirenites*-type, with more ventral than ventro-lateral tubercles.

The holotype illustrates the character of the moderately sculptured varieties, and paratypes 14125 and 14129 (Pl. XXV, Nos. 2a, b, 6a, b) are intermediate in sculpture between the holotype and the coarsely ornamented forms. The ribs of the holotype are of low relief and they branch once, less commonly twice, on the whorl sides. They carry six rows of tubercles, three prominent rows near the umbilical shoulder, two fainter ones below, and one moderately prominent row near the ventro-lateral shoulder. The ventral sculpture is of "reversed" type.

Types and Dimensions

Specimen	D	H	W	U	Number of tubercles per ¼ whorl: whorl height	ventral tubercles	ventro-lateral tubercles	Number of ribs at umbilical shoulder per ¼ whorl
14119 paratype	4	1.5 0.37	2.0 0.5	1.5 0.37	1.5	none	none	
14120 paratype	ca. 5	2.0	3.0		2.0	none	none	
14121 paratype	9.0	3.0 0.33	3.6 0.4	3.0 0.33				
14122 paratype	ca. 16				6.0	12	12	
14123 paratype	21	8.5 0.40	6.5 0.31	6.0 0.29	8.5	19	20	
14124 paratype	22	9.0 0.40	7.0 0.32	7.0 0.32	9.0	11	9	4
14125 paratype	27.5	ca. 11.0	8.5 0.31		ca. 11	13	14	
14126 paratype	32	14.0 0.44	10.0 0.31	10.0 0.31	14	28	33	11
14127 paratype					12	12	12	7
14128 paratype					13	22	33	
14129 paratype	ca. 34				13	20	18	10
14130 paratype	37	13.5 0.36	11.0 0.30	13.0 0.35	13.5	16	12	
14131 paratype					14	23	23	
14132 paratype	39	14.0 0.36	10.0 0.26	13.0 0.33	14		20	6
14133 paratype		15.0	13.0		15	20	15	8
14134 paratype					15		22	12
14135 paratype					17	23	21	
14136 holotype	at 41	16.0 0.39	11.5 0.28	14.5 0.35	17	23	32	ca. 14
14137 paratype					16	21	18	7
14138 paratype					16	23	32	ca. 11
14139 paratype	(weakly sculptured variety)							
14140 paratype	(shows suture at H=2)							

All specimens are from Buchanan Lake, Axel Heiberg Island (GSC locality 28436).

Paratypes 14138 and 14139 (Pl. XXV, Nos. 9a, b, 10a, b) illustrate the most delicately sculptured variety. Paratype 14138 has dense, low, ribs that branch at least twice.

On all varieties the rows of tubercles near the umbilical shoulder are more prominent than those below. This uniform character supports the conclusion that all these shells, among which no two individuals are exactly alike, represent members of one interbreeding population.

Paratypes 14119, 14120 and 14121 (Pl. XXIV, Nos. 1-3) show some of the ontogenetic changes. No. 14119 at 4 mm has whorls that are round in section and about as wide as high. The venter lacks a furrow and there are no tubercles. The whorl sides bear simple ribs, also without tubercles. No. 14120 at 5 mm has a ventral furrow but still lacks tubercles. No. 14121 at 9 mm has added ventral tubercles. At a diameter of 22 mm, No. 14123 (Pl. XXIV, Nos. 5a-c) shows essentially adult characters. The young stages of *Arctosirenites* resemble those of *Protrachyceras sikanianum,* described by McLearn (1943).

The septal sutures are not well preserved. A small paratype (No. 14140) shows that the saddles are incised at a whorl height of 2 mm. Paratype 14123 shows the external suture, with incised saddles at a diameter of 13 mm. The degree of incision is weak.

Occurrence. Blaa Mountain formation, about 6,700 feet above base. Cliffs on the southeast side of Buchanan Lake, 5 miles from the outlet, Axel Heiberg Island (GSC locality 28436, E. T. Tozer, 1956).

Age. Karnian (see pp. 36-39).

Arctosirenites spp. indet.

Plate XXIV, numbers 6a, b

Specimens from two localities reveal the distinctive ventral sculpture of the type specimen of *Arctosirenites canadensis.* The best specimen (Pl. XXIV, Nos. 6a, b; GSC No. 14141, from the Blaa Mountain formation of Buchanan Lake, GSC locality 26167) is from about the same stratigraphic horizon as *A. canadensis.* This specimen has twenty-four ventro-lateral tubercles and twenty ventral tubercles on the last quarter whorl. There is one spiral row of tubercles on the umbilical shoulder and one on the whorl side. The approximate dimensions (in mm) are: D 25; H 12 (0.48); W 6 (0.24); U 4 (0.16). The proportions of the shell and the details of lateral sculpture are quite unlike those of *A. canadensis.*

Some specimens from the Schei Point formation of Bjorne Peninsula (e.g., GSC No. 14142, from GSC locality 26124) show ventral sculpture similar to that of the specimen described in the preceding paragraph.

These specimens are too poor to merit a name. They do show, however, that "reversed" sculpture is not confined to *Arctosirenites canadensis.*

Family TROPITIDAE

Genus *Tropites* Mojsisovics 1875

Type species: *Ammonites subbullatus* Hauer

Tropites cf. *T. morani* Smith

Plate XXVII, numbers 3 to 5

Compare: *Tropites morani* Smith, 1927, p. 36, pl. LXXIII, figs. 7-18; Silberling, 1959b, p. 47.

Types and Dimensions

Specimen	Locality	D	H		W		U	
Holotype (Smith, pl. LXXIII, figs. 7-9)	California	79	36	0.45	35	0.44	16	0.20
14179	35611	78	37	0.47	ca. 34	0.44	16	0.20

Figured specimens: GSC Nos. 14180, 14181, 14182, all from GSC locality 35611.

The collection from Cameron Island includes some rather poorly preserved specimens which may be identical with *Tropites morani*. Most of the Cameron Island specimens are about 40 to 50 mm in diameter. These specimens cannot be measured accurately but their degree of involution seems to compare with that of small specimens of *T. morani*. There are no umbilical tubercles and the ribs branch on the whorl sides and on the ventral side. The Canadian specimens reveal no sign of spiral sculpture. According to Silberling (1959b) the spiral striae of *T. morani* are weak. The largest Canadian specimen (No. 14179) unfortunately has the surface features almost completely obliterated. The phragmocone of this specimen is replaced by crystalline calcite and the last whorl is filled with matrix. It is probably an adult with one whorl of body chamber. This specimen has been sectioned and it shows that in degree of involution it compares closely with the holotype of *T. morani*.

Silberling (1959b) included most of the members of Smith's (1927, p. 27) "Group of *Tropites morani*" within one species. According to Silberling's interpretation, specimens of *Tropites morani* vary considerably in proportional width. None of the Canadian specimens approach the thick-whorled varieties of *T. morani* (in Silberling's sense), i.e., they do not resemble the specimens named *T. arthaberi* and *T. stearnsi* by Smith.

Occurrence. *Tropites morani* was originally described from the Upper Karnian of Shasta county, California.

84003-3—7½

Schei Point formation, *Halobia* bed, 1 mile south of Lyall Point, Cameron Island (GSC locality 35611, E. T. Tozer, 1958).

Age. Typically an Upper Karnian species. The fauna from Cameron Island is also Karnian but it is too meagre to confirm, positively, an Upper Karnian date (*see* pp. 36-39).

Family HALORITIDAE

Genus *Jovites* Mojsisovics 1893

Type species: *Tropites dacus* Mojsisovics

Typical representatives of *Jovites* are excentrically umbilicate sphaerocones, with a wide phragmocone, a contracted body chamber, and rib sculpture that is commonly reduced on the body whorl. Spiral sculpture may also be developed but it is not prominent. The ribs cross the periphery, which usually has a faint siphonal ridge. The septal sutures are ammonitic with two principal lateral saddles.

Two other haloritid genera bear some resemblance to *Jovites*: *Halorites* Mojsisovics and *Parajuvavites* Mojsisovics. Mojsisovics recognized that these genera differ from *Jovites* in having three principal lateral saddles. *Parajuvavites* and *Halorites* also lack the siphonal ridge of *Jovites.*

The type species of *Jovites, J. dacus,* is from the Upper Karnian *Tropites subbullatus* zone of Austria. *Parajuvavites* and *Halorites* are younger genera, of Norian age. In some works (e.g., Kummel, 1957, p. 174) *Jovites* is said to occur in the Norian. The record of *Jovites* from the Norian is based on *J. mercedis* Mojsisovics, from the *Sagenites giebeli* zone of Austria. *Jovites mercedis* is not a typical *Jovites,* as Mojsisovics (1901, p. 20) recognized, for it lacks the distinctive septal sutures and siphonal ridge of *J. dacus. Jovites mercedis* is best excluded from *Jovites*; then all known species of *Jovites* are of Karnian age. It occurs in both the Upper and the Lower Karnian, and is known from Austria, Sicily, Greece, the Himalayas and Timor. A typical species, *J. borealis* n. sp., is now recorded from the Queen Elizabeth Islands. It appears to be the only true *Jovites* known from North America, for "*Jovites*" *pacificus* Smith, from the Upper Karnian of California, has a narrow umbilicus and is probably an inflated *Juvavites.* Another species from the Arctic Archipelago, *J. richardsi* n. sp. is provisionally placed in this genus, but, as noted below, it is not close to the type species and may represent a new haloritid genus.

Jovites borealis n. sp.

Plate XXVI, numbers 2a to 7

Diagnosis. *Jovites* about 50 mm in diameter and 19 mm wide. Body whorl abruptly contracted and weakly sculptured. Peristome U-shaped.

Types and Dimensions

Specimen	Locality	D	H (at aperture)		Max. W		W (at aperture)		U	
14107 paratype	28435	12.0	7.0	0.58	10.0	0.83	10.0	0.83	2.0	0.17
14108 paratype	28435	20.0	12.5	0.62	14.5	0.73	14.5	0.73		
14109 paratype	28435	27.5	15.5	0.56	19.0	0.69	19.0	0.69		
14110 paratype	26168	37.0	20.0	0.54	19.0	0.51	16.0	0.43	6.0	0.22
14111 paratype	28435	38.0	16.0	0.42	17.5	0.46	16.5	0.43	6.0	0.16
14112 holotype	28435	ca. 48	17.0	0.35	19.5	0.41	17.5	0.36	13.0	0.27
14113 paratype	26168									
14114 paratype	26168									
14115 paratype	30369									

The holotype (Pl. XXVI, Nos. 4a-c) is an internal mould. Although not quite complete, the original diameter is estimated to have been about 48 mm. This specimen has a contraction immediately behind the aperture. It is therefore probably an adult preserving the entire body chamber. There is only one other specimen of comparable size (paratype, 14114, Pl. XXVI, No. 6). It is crushed and cannot be measured accurately. Like the holotype, it is about 48 mm in diameter and probably indicates the adult diameter.

Specimens of the phragmocone show that the narrowly umbilicate stage persists to a diameter of about 27 mm; there are no specimens with narrow umbilici that exceed this diameter. The collection includes fifteen specimens that are more than 27 mm in diameter. All show an excentric umbilical seam.

The phragmocone has a very narrow umbilicus, a well-rounded periphery and a nearly semicircular whorl section. The body chamber is contracted and at the aperture the whorl sides are nearly vertical and the whorl section is U-shaped, with faint ventro-lateral shoulders. As a result of this contraction the maximum width is at the beginning of the last whorl, i.e., approximately at the last septum. The surface of the phragmocone bears anteriorly projected ribs which branch on the whorl side. These ribs become less prominent on the body whorl. The last half whorl of paratype 14114 (which retains the shell) is virtually devoid of rib-sculpture.

The siphonal ridge is moderately prominent on the holotype (an internal mould). Specimens that retain the shell material commonly do not show this ridge clearly. On some it cannot be seen at all. The prominence and relief of the siphonal ridge never exceeds that of the lateral ribs. Obscure spiral lines have been seen on the surface of some phragmocones (e.g., No. 14110).

The external suture line (Pl. XXVI, Nos. 3a, b) has two large, moderately incised saddles like that of the type species of *Jovites, J. dacus* (Mojsisovics).

Jovites borealis has a more compressed aperture than species from Austria, Sicily and the Himalayas.

Occurrence. Blaa Mountain formation, about 7,000 feet above base, southeast side of Buchanan Lake 5 miles from outlet, Axel Heiberg Island (GSC locality 26168, J. G. Souther, 1955; GSC localities 28435, 28438, E. T. Tozer, 1956).

Schei Point formation, from outcrops disintegrated by frost action, about 550 feet above base, Cape Ursula, Table Island (GSC locality 30369, E. T. Tozer, 1957).

Age. Karnian, probably Lower Karnian (*see* pp. 36-39).

Jovites richardsi n.sp.

Plate XXVII, numbers 6a to 8c

Diagnosis. Sphaerocones with thick whorls, an excentric umbilicus and a siphonal ridge. Inner whorls weakly sculptured; body whorl not compressed, sculptured with strongly projected branching ribs. External suture with two principal saddles.

Types and Dimensions

Specimen	Locality	D	H	W	U
14116 paratype	35611	31	13.5 0.43	19 0.61	6 0.19
14118 holotype	35611	ca. 54		29	19
		at 46	21 0.46	27 0.59	10.5 0.23
14117 paratype	35611				

Three specimens, all from one locality, are referred to this unusual species. Each specimen represents a different stage of growth but there is sufficient overlap in whorl characters shown by these specimens to justify the assumption that they represent one species. The diagnosis given above is made on this assumption.

The holotype is an internal mould. It is not quite complete for the venter, near the aperture, has been weathered away. The exposed whorl section is semicircular. There are no distinct ventro-lateral shoulders. No septa are visible, consequently the extent of the body chamber cannot be determined. From the degree of excentrumbilication it is probable that this specimen is adult. The ribbing is stronger on the whorl side than at the periphery. Branching takes place at the whorl side and near the periphery. On half a whorl at a diameter of 46 mm there are eleven ribs at the umbilical shoulder and thirty-one at the siphonal ridge. The siphonal ridge is low, and about equal to the ribs in prominence.

The small paratype (No. 14116, Pl. XXVII, Nos. 6a, b) has whorls that are U-shaped rather than semicircular in section. The ventro-lateral shoulders, although not prominent, are distinct. At a diameter of 32 mm the shell surface is well preserved revealing sculpture of projected, branching, growth lines, but no distinct ribs. The last 25 mm of this specimen (measured along the venter) reveal the acquisition of distinct rib sculpture, like that on the outer whorl of the holotype. This specimen shows the external suture at 32 mm. There are two principal lateral saddles, moderately incised, as in typical *Jovites* and most Tropitidae.

The third paratype (No. 14117, Pl. XXVII, No. 7), although poorly preserved, also shows two types of sculpture: growth lines alone on the inner whorls; and the appearance of ribs beyond. It also shows an excentric umbilicus, like that of the holotype, and supports the reference of all three specimens to *Jovites richardsi*.

Jovites richardsi differs from typical representatives of the genus as follows: (1) it has an uncompressed body whorl; (2) the ontogenetic changes in sculpture are the reverse of those shown by typical *Jovites,* which have ribbed inner whorls and a relatively smooth body chamber. *Parajuvavites,* a Norian genus, includes some species with uncompressed, prominently sculptured body whorls. These resemblances are believed to be superficial because *Parajuvavites* has three principal saddles (like *Juvavites* and *Halorites*). *Parajuvavites* also lacks the siphonal ridge of *Jovites richardsi.*

Jovites richardsi probably represents an independent derivative of the Tropitidae, paralleling *Jovites* in some characters, but not in all. If so, *Jovites richardsi* should be placed in a new genus, but the writer believes that this step should be deferred until better material is available to confirm (or contradict) this interpretation.

This species is named for the late Admiral Sir George Richards, RN, who, in 1853, as Commander Richards of HMS *Assistance,* was the first to map the coast of what is now known as Cameron Island.

Occurrence. Schei Point formation, *Halobia* bed, one mile south of Lyall Point, Cameron Island (GSC locality 35611, E. T. Tozer, 1958).

Age. Karnian (*see* pp. 36-39).

Family CLADISCITIDAE

Genus *Procladiscites* Mojsisovics 1882

Type species: *Procladiscites brancoi* Mojsisovics

Procladiscites cf. *P. martini* (Smith)

Plate XXII, numbers 9, 10a, b, c

Compare: *Cladiscites martini* Smith, 1927, p. 70, pl. CII, figs. 17-20.

Dimensions

Specimen	Locality	D		W
14171	28442	16.5	7.0	(0.42)

There are also fragments (e.g., No. 14172, from locality 28442) representing phragmocones about 30 mm in diameter.

Some incomplete specimens from Nansen Sound are referred to the genus *Procladiscites,* which ranges from the Anisian to the Karnian. Comparable forms are "*Cladiscites*" *martini* Smith (referred to *Procladiscites* by Johnston, 1941, p. 479, footnote) and "*Paracladiscites*" cf. *diaturnus* Mojsisovics of Frebold (1929, p. 307, pl. I, figs. 13-15; pl. II, figs. 13-14). These species, and also the Canadian specimens, have a deep external lobe and a large first lateral saddle, unlike the type species of *Procladiscites*. Frebold excluded his specimens from *Procladiscites* on account of this difference. The writer believes that these Arctic cladiscitids are closer to *Procladiscites* than to *Paracladiscites*. *Paracladiscites* lacks spiral sculpture and has deeply incised saddles unlike the monophyllic saddles of these Arctic forms. *Procladiscites martini, P.* cf. *P. martini* and Frebold's specimens all possess spiral sculpture. At a diameter of about 15 mm Frebold's specimens are more compressed and have more pronounced ventro-lateral shoulders than those from Nansen Sound. The holotype of *P. martini* (an incomplete phragmocone about 30 mm in diameter) may be conspecific with Frebold's specimens from Svalbard. According to Spath (1951, p. 137, footnote), the Svalbard specimens attain a diameter of at least 60 mm. Possibly the differences in whorl outline and compression shown at a diameter of 15 mm represent phenotypic variation among immature individuals. *P. martini, P.* cf. *P. martini* and the Svalbard specimens may represent one species.

Occurrence. *Procladiscites* cf. *P. martini* is known only from the Blaa Mountain formation, Lower Shale member, northwest coast of Ellesmere Island, on the coast of Nansen Sound, 15 miles northwest of the entrance to Hare Fiord (GSC locality 28442, R. Thorsteinsson and E. T. Tozer, 1956). It occurs with *Nathorstites mcconnelli* (Whiteaves).

P. martini occurs with *Nathorstites* (?) *alaskananus* Smith, on Yukon River, Alaska. The related specimens from Svalbard (Spitsbergen and Edge Island) are associated with *Nathorstites gibbosus* Stolley. It seems that in Arctic regions *Procladiscites* is a widely distributed companion of *Nathorstites*. However, it must also be mentioned that in the large collections from the *Nathorstites* beds of northeastern British Columbia, there are many ammonoid genera, but not even one specimen of *Procladiscites*. Conversely, the many ammonoids associated with *Nathorstites* in northeastern British Columbia are not known in the Arctic regions. The explanation of these zoogeographic anomalies is not yet known.

Age. Ladinian, (*see* pp. 34-36).

Family NATHORSTITIDAE

Genus *Nathorstites* Boehm 1903

(=*Indigirites* Popow 1946, *Paraindigirites* Popow, 1946)

Type species: *Popanoceras mcconnelli* Whiteaves

Nathorstites includes narrowly umbilicate to imperforate, macrodome oxycones with globose inner whorls and multisellate, ceratitic, septal sutures. The whorl sides are smooth or they may have low radial plications that die out towards the periphery.

Indigirites Popow 1946 (type species *Indigirites krugi* Popow) and *Paraindigirites* Popow 1946 (type species *Paraindigirites vaskovskii* Popow), both from northeastern Siberia, are probably congeneric with *Nathorstites*. *Indigirites* is believed by Popow to differ from *Nathorstites* by having weakly pronounced ribs and a more acute venter. The inner whorls of *Paraindigirites* are said to be more compressed and sub-acute than those of *Nathorstites*. The young of *Nathorstites* vary greatly in compression and strength of ribbing. From Popow's descriptions and illustrations the writer believes that these Siberian forms should be placed in *Nathorstites*. Popow (1946) has identified *Nathorstites* sp. ind. aff. *N. gibbosus* Stolley from the same beds as *Indigirites* and *Paraindigirites*.

The affinities of *Nathorstites* are uncertain. Boehm placed *Nathorstites* in the Arcestidae; Spath (1951, p. 141) suggested affinity with the keeled hungaritids; Kiparisova, *et al.* (1947, p. 131) place it in the "Parapopanoceratidae", i.e., in the Megaphyllitidae of Spath (1951) and Kummel (1957). Tuchkov (1958) evidently regards *Nathorstites* as a keeled derivative of *Parapopanoceras*.

Nathorstites is known from northeastern British Columbia, Bear Island, Svalbard, Kotelnyi Island, northeastern Siberia and possibly also Alaska. The age is evidently Ladinian (pp. 34-36).

Nathorstites mcconnelli (Whiteaves)

Plate XXII, numbers 5a to 8b

Popanoceras mcconnelli Whiteaves, 1889, p. 138, pl. 18, figs. 2a, 2b.
Popanoceras mcconnelli var. *lenticulare* Whiteaves, 1889, p. 140, pl. 18, figs. 3a, 3b.
Nathorstites mcconnelli (Whiteaves); Diener, 1915, p. 209; Kutassy, 1933, p. 299; McLearn, 1947, pl. II, figs. 4, 5; pl. VIII, figs. 7, 8.
Nathorstites lenticularis (Whiteaves); Diener, 1915, p. 208; Kutassy, 1933, p. 599; McLearn, 1947b, pl. II, figs. 1-3; pl. VIII, figs. 4, 5.

Types and Dimensions

Specimen	Locality	D	W	
14167 hypotype	28442	16.8	13.5	0.80
14168 hypotype	28442	24.0	18.5	0.77
14169 hypotype	30353	22.0	10.0	0.45
14170 hypotype	Halfway R., B.C., 4 miles west of Mt. Wright	74	33	0.45

As noted by Whiteaves in his original description, the proportioned width of this species varies greatly. This observation is emphatically confirmed by the large collections made by F. H. McLearn from Peace River. The character of the umbilicus also seems to vary. Wide forms are narrowly, but nevertheless distinctly, umbilicate. Narrow forms have a small or completely sealed umbilicus. The largest specimen known, which is from British Columbia, is figured here (Pl. XXII, No. 8). It shows that *N. mcconnelli* attains a diameter of at least 74 mm. This specimen is a steinkern showing nearly one whorl of body chamber. The internal mould of the initial part of the body chamber shows low spiral ridges.

The best specimens from the Arctic islands are small phragmocones. They vary greatly in width, as shown by the figured specimens. Exact counterparts of these specimens occur in northeastern British Columbia. Number 14169, from Table Island, at a diameter of 22 mm has seven external and five internal lateral lobes. This count agrees well with the suture line figured by Boehm (1903, pl. 7, fig. 7) for a specimen of *Nathorstites "lenticulare"* from Bear Island. Specimens from Peace River have the same number of suture elements at this diameter.

The record from Blind Fiord is based on a fragmentary individual showing low radial, wave-like ribs. This specimen may represent *N. gibbosus* Stolley rather than *N. mcconnelli*.

Occurrence. Originally described from beds now placed in the Liard formation, of Liard River, northeastern British Columbia; also known from the "Dark siltstones" and "Grey beds" of Peace River, British Columbia (McLearn, 1947b).

Schei Point formation, 265 feet above base, 80 feet above *Daonella frami* bed, north coast of Table Island (GSC locality 30353, E. T. Tozer, 1957); southwest limb of Goose Point anticline, Bjorne Peninsula, Ellesmere Island (talus) (GSC locality 26111, E. T. Tozer, 1955); north side of Bay Fiord, opposite Hat Island, talus (GSC locality 28678, E. T. Tozer, 1956); about 480 feet above base, Sawtooth Range, 6 miles north of Vesle Fiord, Ellesmere Island (GSC locality 28665, E. T. Tozer, 1956).

Blaa Mountain formation. Middle member, about 450 feet above *Daonella frami* bed, northwest of Blind Fiord, Ellesmere Island (GSC locality 26167, E. T. Tozer, 1955); Lower Shale member, in association with *Procladiscites* cf. *P. martini* (Smith), about 100 feet above *Daonella frami* bed, northwest coast of Ellesmere Island, 15 miles northwest of entrance to Hare Fiord (GSC locality 28442, R. Thorsteinsson and E. T. Tozer, 1956).

Age. Ladinian (*see* pp. 34-36).

Family PTYCHITIDAE

Genus *Ptychites* Mojsisovics 1875

Type species: *Ammonites eusomus* Beyrich, designated by Diener (1915)[1]

Typical representatives of *Ptychites* have a moderately involute thick whorled shell, a round venter and, commonly, low radial ribs. The septal suture is multisellate and ammonitic, but not deeply incised. The first lateral saddle is much smaller than the other principal saddles. The writer is not aware of any published

[1] Kummel (1957) cites *Ammonites rugifer* Oppel as type species indicating that Spath (1951) had made this designation. Spath (op. cit., p. 147) discussed the question but retained *P. eusomus* as type species. Nobody questions that *P. rugifer* and *P. eusomus* are congeneric so that the characters of *Ptychites* remain clear irrespective of the choice of type species.

figures that show the development of this short, first lateral saddle. In *Ptychites nanuk* n. sp. the second lateral saddle grows more rapidly than the first and in this way the disparity develops. The development of *P. nanuk* seems to contradict Mojsisovics' opinion (1882, p. 246) that this first lateral saddle is an element derived from the "ventral" saddle. *Ptychites,* in the strict sense, includes the *"rugiferi"* and *"opulenti"* of Mojsisovics (1882). Most authors now place the other groups recognized by Mojsisovics in distinct genera, e.g., *Discoptychites* Diener (*"megalodisci"*) and *Flexoptychites* Spath (*"flexuosi"* and *"subflexuosi"*). *Ptychites* in the restricted sense is known only from beds of Anisian age. It has been recorded from the Mediterranean region, Himalayas, Japan, northeastern British Columbia, Alberta, Spitsbergen, possibly Siberia, and now the Canadian Arctic islands (*Ptychites* cf. *P. trochlaeformis* (Lindstrom)). *Ptychites nanuk* has an unusual suture line and is not, therefore, a typical species of the genus. It is certainly a Middle Triassic species but is not necessarily of Anisian age (pp. 33-34).

Ptychites cf. *P. trochlaeformis* (Lindstrom)

Plate XXII, numbers 1a, b, 2a, b

Compare: *Ptychites trochlaeformis* (Lindstrom); Mojsisovics, 1886, p. 89, pl. XII, figs. 1, 2; pl. XIII, fig. 1.

Some fragmentary specimens are probably referable to *P. trochlaeformis* (Lindstrom), from the Anisian of Spitsbergen. All the Canadian specimens are too small or imperfect for specific determination.

Occurrence. Schei Point formation, disintegrated outcrops about 100 feet above base of formation, northern summit of Exmouth Island (GSC locality 30341, E. T. Tozer, 1957).

Blaa Mountain formation, Lower Shale member, west of Stang Bay, northern Axel Heiberg Island (GSC locality 26365, N. J. McMillan, 1955).

Age. Anisian (*see* p. 33).

Ptychites nanuk n. sp.

Plate XXI, numbers 2 to 10;

Figure 10

Diagnosis. Fairly thin whorled *Ptychites,* with pronounced umbilical shoulders, slightly convex whorl sides and an evenly rounded periphery. Adult probably with enlarged umbilicus. Whorl sides carry low, straight, radial ribs, that die out near the periphery. External septal suture moderately incised, with four, bifid, principal saddles, the first of which is smaller than the remainder. Internally there are three principal lateral saddles.

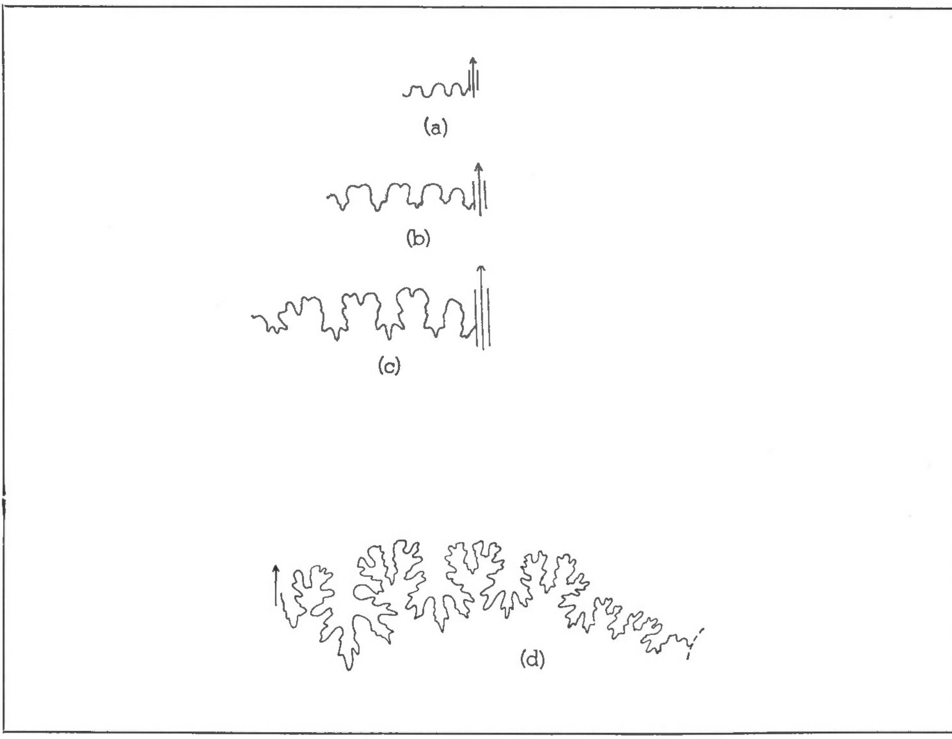

Figure 10. ***External sutures of Ptychites nanuk n. sp.***
(a) At diameter of 3.5 mm (x6), paratype 14102
(b) At diameter of ca 5.0 mm (x6), paratype 14096
(c) At diameter of 7.5 mm (x6), paratype 14103
(d) At whorl height of 16 mm (x3), paratype 14105

Types and Dimensions

Specimen	Locality	D	H		W		U	
14096 paratype	26114	6.3	2.3	0.37	6.3	1.0	1.5	2.4
14106 paratype	26113	10.5	5.0	0.49	8.5	0.81		
14097 paratype	26111	16.2	9.0	0.56	9.4	0.58		
14098 paratype	26111	42	20	0.47	16.5	0.39	8.0	0.19
14099 holotype	26110	ca. 47	23	0.49			ca. 7	0.15
14100 paratype	26110	50	25	0.50	18	0.36		
14101 paratype	26110	ca. 77						
14102 paratype	26112	(specimen showing external suture at 3.5 mm)						
14103 paratype	26111	(specimen showing external suture at 4.0 and 7.5 mm)						
14104 paratype	26111	(specimen showing excentric siphuncle)						
14105 paratype	26110	(specimen showing external suture at whorl height of 16 mm)						

The collection includes about fifteen specimens, in various stages of growth. The holotype (Pl. XXI, Nos. 9a, b) is an internal mould, and is completely septate. It represents the remains of a phragmocone about 48 mm in diameter. It is the largest phragmocone known. The largest specimen known is a poorly preserved external mould (No. 14101) about 77 mm in diameter. This specimen (Pl. XXI, No. 10) seems to show an enlarged umbilicus.

At a diameter of 6.3 mm the shell is globose, with whorls as wide as high, and semicircular in outline. The development of the external septal sutures between 3.5 mm and about 32 mm is shown by Figure 10. At a diameter of 3.5 mm the first lateral saddle is about the same size as the inner ones. As growth proceeds the inner saddles increase in size more rapidly than the first lateral. The first lateral saddle is apparently not an adventitious element.

There seems to be some variation in the nature of the umbilical wall. The holotype, and paratype 14100 (Pl. XXI, Nos. 7a, b) both have a nearly vertical umbilical wall. Paratype 14098 (Pl. XXI, Nos. 6a, b) is rather different for it has an inclined umbilical wall. This specimen, an internal mould, lacks the radial folds of typical specimens. However, in dimensions, and in the characters of the suture line, it agrees with the other specimens.

One internal mould, No. 14104, is unusual in having a displaced siphuncle. The siphuncle of this specimen is closer to the umbilicus than to the periphery (Pl. XXI, Nos. 5a, b). The suture line on the side of the periphery has the normal number of principal elements. The suture on the other side is not completely exposed but the number of elements seems to be considerably reduced. About ten other specimens show the siphuncle. In all these it is at the periphery.

Ptychites nanuk differs from most described species in having a prominent notch in all the external saddles, including the small, first lateral saddle. *P. kolymaensis* Kiparisova (1937), from northeastern Siberia, based on two small specimens, less than 16 mm in diameter, has bifid saddles, but they are less incised than those of *P. nanuk*. The shell of *P. kolymaensis* is proportionally much wider than that of *P. nanuk*.

There is some resemblance between *P. nanuk* and some species of *Flexoptychites* Spath. However, *Flexoptychites,* as the name suggests, has curved, prorsiradiate ribs, unlike the straight ones of *P. nanuk*. *Flexoptychites* also lacks the bifid saddles of *P. nanuk*.

Some species of *Discoptychites,* e.g., *D. barclayi* (Diener) (from Kashmir), *D. amarissicus* (Welter) (from Timor), *D. pauli* (Mojsisovics) (from Austria) and *D. maximus* (Arthaber) (also from Austria) have some of their saddles notched as in *P. nanuk*. It might be suggested that *P. nanuk* should be placed in *Discoptychites* on account of these resemblances. Against this procedure it should be noted that the type of *Discoptychites* (*D. megalodiscus* (Beyrich)) and its close allies have a compressed shell, a narrowly rounded venter and a foliaceous suture with a large first lateral saddle. The lack of these features excludes *P. nanuk* from *Discoptychites*.

Occurrence. Daonella frami bed of Schei Point formation, about 400 feet above base, southwest limb of Goose Point anticline, Bjorne Peninsula, Ellesmere Island (GSC locality 26110; talus blocks from same locality, GSC localities 26111, 26112, 26113, 26114, E. T. Tozer, 1955).

Age. Middle Triassic. Anisian or Ladinian (*see* pp. 33-34).

Family DISCOPHYLLITIDAE

Genus ***Rhacophyllites*** Zittel 1884

Type species: *Ammonites neojurensis* Quenstedt

Rhacophyllites zitteli Mojsisovics

Plate XXVI, numbers 1a-d

Rhacophyllites zitteli Mojsisovics, 1902, p. 318, pl. XVII, figs. 3, 4.
Diphyllites zitteli (Mojsisovics); Spath, 1934, p. 322.

Dimensions

Specimen	Locality	D	H		W		U	
14178 hypotype		37	17	0.46	14	0.38	11	0.30
Mojsisovics 1902, p. 318	Austria	45	20	0.44	15.5	0.34	12.3	0.27
Spath, 1934, p. 323	Austria	38		0.44		0.35		0.30

In dimensions the solitary Canadian specimen is close to the types from Austria. The suture line of the Canadian specimen is somewhat weathered but it agrees in essentials.

Occurrence. Originally described from the *Lobites ellipticus* zone (Lower Karnian) of the Hallstatt limestone, Austria. *R. pumilus* (Mojsisovics) from the Upper Karnian, and *R. debilis* (Hauer) from the Norian, are closely related species. At present these species are of limited stratigraphic use.

Blaa Mountain formation, Upper Shale member, 9 miles northwest of Eureka, Ellesmere Island (GSC locality 37975, R. Thorsteinsson, 1956).

Age. Karnian (*see* pp. 36-39).

Nautiloidea

Genus ***Proclydonautilus*** Mojsisovics 1902

Type species: *Nautilus griesbachi* Mojsisovics

Proclydonautilus spirolobus (Dittmar)

Plate XXVII, numbers 1a, b, 2

Proclydonautilus spirolobus (Dittmar); Kummel, 1953a, p. 82, pl. 7, figs. 10-19 (with full synonymy).

Types. Hypotype, 14148, from locality 37219; hypotype, 14185, from locality 28766.

The Canadian specimens show the globose involute shell of this species. One specimen (No. 14185, Pl. XXVII, No. 2) also shows the deep ventral and lateral lobes of the septal suture. In addition to the figured examples, the collection also includes some poorly preserved specimens with whorls 40 mm high and 54 mm wide. The sculpture of all the Canadian specimens is very prominent and in this respect they resemble the typical representatives from Austria more than the specimens from California, which are less prominently sculptured.

Occurrence and Age. In Austria *Proclydonautilus spirolobus* has been recorded only from beds of Norian age. However, a closely related species, *P. goniatites* (Hauer), occurs in the Lower Karnian, *Trachyceras aonoides* zone. The specimens from California are of Upper Karnian age.

In the Queen Elizabeth Islands it occurs as follows: Blaa Mountain formation, probably Upper Calcareous member, north coast of Schei Peninsula, Axel Heiberg Island (GSC locality 28766, R. Thorsteinsson, 1956).

Schei Point formation, *Halobia* bed, with *Tropites* cf. *T. morani* and *Jovites richardsi* n. sp., northern Cameron Island, 1 mile south of Lyall Point (GSC locality 35611, E. T. Tozer, 1958).

Schei Point formation, 12 miles south of Cape Malloch, Borden Island, in association with *Sirenites* sp. (GSC locality 37219, R. Thorsteinsson, 1958).

The associated ammonoids indicate that the Canadian specimens are of Karnian age.

Pelecypoda

Pelecypods are abundant in the Triassic rocks of the Queen Elizabeth Islands, but well-preserved specimens are very rare. In this account a few stratigraphically important species are described and illustrated. The greater part of the pelecypod fauna is as yet unstudied and, for most of the species, a profitable study should await the discovery of better material.

Genus *Claraia* Bittner 1901

Type species: *Posidonomya clarae* Emmrich

Claraia stachei Bittner

Plate XXVIII, numbers 1, 2

Claraia stachei Bittner; Spath, 1930, p. 46, pl. 9, figs. 1a-d; pl. 10, figs. 5a, 5b; Spath 1935, p. 69, pl. 21, figs. 3-9; Newell, 1955, p. 22, pl. 1, fig. 9.

The specimens from the Queen Elizabeth Islands are poorly preserved but they are identical with those from East Greenland described by Spath. The writer has examined an East Greenland specimen (Pl. XXVIII, No. 1) which shows a distinct anterior auricle on the left valve, hitherto unrecognized in this species. The figured right valve (GSC No. 14195, locality 32373) shows the sculpture characteristic of this species. The outline of this specimen is hard to illustrate owing to the poor preservation. It seems to be the same as the outline of a well-preserved specimen of *Claraia clarai* (Emmrich), from the Spray River group of Alberta, which is figured for comparison (Pl. XXVIII, No. 3).

Occurrence and Age. The name *Claraia stachei* was originally applied to shells from the Scythian of Austria (Bittner, 1901, p. 587), but the specimens have never been figured.

In East Greenland, *Claraia stachei* occurs throughout much of the Lower Scythian sequence, from the *Glyptophiceras* beds to the *Proptychites* beds (Spath, 1935, p. 105).

Blind Fiord formation, from the top of the 25-foot interval with *Proptychites strigatus* n. sp. and *Ophiceras commune* Spath, south side of Bunde Fiord, Axel Heiberg Island (GSC locality 32373, R. Thorsteinsson, 1957).

Related, and perhaps identical species have been reported from the Grayling formation of Liard River (McLearn, 1945), the Spray River group of Alberta (Warren, 1945), the Dinwoody formation of Idaho and Wyoming (Newell and Kummel, 1942) and the Candelaria formation of Nevada (Muller and Ferguson, 1939).

Genus *Pseudomonotis* Beyrich 1862

Type species: *Gryphites speluncaria* Schlotheim (Permian)

This genus has been described and discussed by Newell (1937, pp. 92-94) who tentatively concludes that it became extinct at the end of the Permian. However, there are some Triassic species which bear some resemblance to typical representatives of *Pseudomonotis*. Some of these, e.g., *P. occidentalis* (Whiteaves), may link *Pseudomonotis* with *Meleagrinella,* the type of which is Jurassic. The true position and relationships of these Triassic *Pseudomonotis*-like forms will be difficult to determine until more is known of their hinge characters.

Pseudomonotis occidentalis (Whiteaves)

Plate XXVIII, numbers 7 to 12

Halobia occidentalis Whiteaves, 1889, p. 134, pl. 17, figs. 5, 6.
Monotis ovalis Whiteaves, 1889, p. 132, pl. 17, fig. 4.
Pseudomonotis ovalis (Whiteaves); McLearn, 1945, Appendix, pl. I, fig. 4.
Pseudomonotis ovalis var. *kindli* McLearn, 1945, Appendix, sheet 2, pl. I, figs. 5, 6.

Types and Dimensions

Specimen	Locality	Length	Height	Inflation
4722 holotype, left valve	Liard River	21	25	8
4728 holotype of *Monotis ovalis*, left valve	Liard River	17	20	5
14197 hypotype, left valve	32365	16.5	16.5	6
14198 hypotype, left valve	32365	28	34	10
9598 paratype of *Pseudomonotis ovalis* var. *kindli*, right valve	Liard River	14	15	2

The sculpture of this species is quite variable. The ribs may be wide and flat (as on the holotype of *"Monotis ovalis"*, Pl. XXVIII, No. 9), or narrow and thread-like (as on the types of *"Halobia occidentalis"* and *"Pseudomonotis ovalis* var. *kindli"*). The small figured left valve from Axel Heiberg Island (Pl. XXVIII, No. 7) has ribbing of an intermediate nature.

The left valve is moderately convex and oblique with no trace of auricles. The right valve is known from GSC No. 9598 (paratype of *Pseudomonotis ovalis* var. *kindli*); the hinge line is short and straight and there is a moderately prominent anterior auricle above the byssal notch. It is not possible to say if the byssal sinus is deep (as in *Pseudomonotis speluncaria*) or relatively shallow (as in *Meleagrinnella echinata* (Smith)).

The collection from Liard River is sufficiently large to leave little doubt that *"Halobia occidentalis"* and *"Monotis ovalis"* are the same species. The writer has chosen the trivial name *"occidentalis"* because the combination *"Pseudomonotis ovalis"* has been used for at least two other species (namely *Pseudomonotis ovalis* (Sowerby), Arkell, 1933, p. 198; *Pseudomonotis ovalis* (Netschajew), Branson, 1948, p. 663).

Occurrence and Age. Pseudomonotis occidentalis seems to be widely distributed in Upper Scythian beds, in association with *Wasatchites*. It was originally collected by R. G. McConnell on Liard River. In 1943, E. D. Kindle collected this species in the *Wasatchites* bed of the Toad formation, also on Liard River (*see* McLearn, 1945).

Wasatchites bed, 514 feet above base of Blind Fiord formation, south side of Bunde Fiord, Axel Heiberg Island (GSC locality 32365, R. Thorsteinsson, 1957).

Spath (1934, pl. XV, fig. 2b) has figured a specimen of *Wasatchites tridentinus,* from the "Fish beds" of Spitsbergen, with what appears to be an individual of *P. occidentalis* attached.

Pseudomonotis boreas (Oeberg)

Plate XXVIII, numbers 4, 5

Monotis boreas Oeberg, 1877, p. 17, pl. V, fig. 5; Kittl, 1912, p. 168, pl. X, fig. 11.

The generic affinities of this species are quite unknown. It is certainly not referable to *Monotis*. The sculpture, short hinge line, absence of auricles, and lack of inflation, shown by the Canadian specimens, reveal that they are identical with those from Spitsbergen. The Canadian specimens, judging from the umbonal curvature, are left valves.

Occurrence. Originally described from Ice Fiord, Spitsbergen. Nathorst (1910, p. 354) cited this species from the "Fish beds" with a query. A specimen in Dr. Frebold's private collection, from Mount Congress, North Fiord (near Ice Fiord) is labelled "Fiskeniveau" (i.e., Fish beds).

Meekoceras bed, 1,700 feet above base of Blind Fiord formation, west coast of Ellesmere Island, between Hare and Otto Fiords, 5 miles northwest of entrance to Hare Fiord (GSC localities 28680, 28681, R. Thorsteinsson and E. T. Tozer, 1956).

Age. Upper Scythian (Owenitan) (*see* pp. 29-31).

Genus *Oxytoma* Meek 1864

Type species: *Avicula münsteri* Bronn

Oxytoma kiparisovae n. sp.

Plate XXIX, numbers 10 to 13

Diagnosis. An *Oxytoma* with differentiated ribs on the left valve and dense, uniform ribs on the right valve. The left valve has about fifteen prominent ribs on the main body of the shell, with, near the ventral margin, about nine smaller ribs intercalated. The auricles of the left valve have narrow, undifferentiated ribs only.

Types and Dimensions

Specimen	Locality	Length	Height	Inflation
14215 holotype (left valve)..	28687	35	33	ca. 5

Paratypes: 14216 (left valve) from locality 28686
14217 (left valve) from locality 28686
14214 (right valve) from locality 28687

The right valve (No. 14214) referred to *O. kiparisovae* occurs on the same slab as the holotype. The collection includes about ten left valves and two right valves. No bivalved specimens are known. All the left valves are sculptured like the holotype and both right valves have the ornament of No. 14214. It thus seems reasonable to conclude that No. 14214 is a right valve of *O. kiparisovae.*

Interior moulds of the left valve show that the anterior auricle is sharply demarcated from the body of the shell. The posterior auricle is not limited in this way.

This species is clearly related to *Oxytoma mojsisovicsi* Teller from the Upper Triassic of northeastern Siberia. The left valve of *O. kiparisovae* has more numerous first order ribs than *O. mojsisovicsi,* which has about eight.

The right valve attributed to *O. kiparisovae* is apparently indistinguishable from the specimen named "*Pseudomonotis zitteli*" by Teller. The figure of Teller's specimen shows a prominent anterior auricle above the byssal notch. The anterior auricle of the right valve of *O. kiparisovae* is not well preserved, but what is visible resembles the auricle of "*Pseudomonotis zitteli*".

Oxytoma majsisovicsi and "*Pseudomonotis zitteli*" occur together in Siberia. Teller (1886, p. 128) discussed the possibility that these shells belonged to one species but he rejected this view. Since then, Kobayashi and Ichikawa (1950, p. 220) described a bivalved *Oxytoma* in which the right valve is like "*Pseudomonotis zitteli*" and the left valve has differentiated sculpture, rather like *O. mojsisovicsi*. It would therefore seem that there is evidence to doubt Teller's conclusion. Kobayashi and Ichikawa named their specimen "*Oxytoma zitteli* Teller".

Right valves like "*Pseudomonotis zitteli*" are known from Siberia, Japan, and now also Ellesmere Island. The associated left valves at each locality have differentiated sculpture of *O. mojsisovicsi* type. It seems desirable to recognize several species from the differences shown by the left valves. However, the right valves apparently do not mirror these differences. Accordingly the writer suggests that *Pseudomonotis zitteli*, founded on a right valve, cannot be satisfactorily determined. For this reason, the Canadian specimens are not referred to "*Oxytoma zitteli*". It is recognized, however, that *O. kiparisovae* may be identical with the specimens named "*Pseudomonotis* (*Eumorphotis*) *zitteli* Teller" by Kiparisova (1937b, p. 195, pl. VI, figs. 1-3) and "*Oxytoma zitteli* (Teller)" by Kobayashi and Ichikawa (1950, p. 222, pl. II, figs. 3-6).

This species is named for Madame L. Kiparisova, who, for many years, has studied the Triassic faunas of the U.S.S.R.

Occurrence. Heiberg formation, about 250 feet above the base at the following localities:

1. 6½ miles northwest of Eureka, Ellesmere Island (GSC locality 28686, R. Thorsteinsson, 1956).
2. 14 miles north of Eureka, Ellesmere Island (GSC locality 28687, R. Thorsteinsson, 1956).
3. About 6 miles east of Eureka, Ellesmere Island (GSC locality 30486, E. T. Tozer, 1956).

At locality 30486, *Meleagrinella antiqua* is associated with *Oxytoma kiparisovae*.

Age. Karnian or Norian (*see* pp. 39-40).

Genus ***Posidonia*** Bronn 1828

Type species: *Posidonia becheri* Bronn

Posidonia mimer Oeberg

Plate XXVIII, number 6

Posidonia mimer Oeberg: 1877, p. 15, pl. V, figs. 9-14.

Type and Dimensions

Specimen	Locality	Length	Height	Inflation
14201 hypotype, left valve	28681	23 mm	20 mm	about 1 mm

Occurrence. Originally described from the "Fish beds", of Ice Fiord, Spitsbergen.

Meekoceras bed, 1,700 feet above base of Blind Fiord formation, west coast of Ellesmere Island, between Hare and Otto Fiords, 5 miles northwest of entrance to Hare Fiord (GSC localities 28680, 28681, R. Thorsteinsson and E. T. Tozer, 1956).

Age. Upper Scythian (Owenitan) (*see* pp. 29-31).

Posidonia aranea n. sp.

Plate XXVIII, numbers 13 to 15

Diagnosis. Acline *Posidonia,* without auricles, hinge line apparently straight, less than total length. Outline subovoid. Entire shell sculptured with concentric undulations and radial ribs.

Types

Specimen	Locality
14202 holotype, right valve	32363
14203 paratype, left valve	28450
14204 paratype, left valve	32363

This species, like so many thin-shelled Triassic pelecypods, is based on rather poorly preserved material. The holotype, although incomplete, is not crushed. It is moderately convex, for at a height of 18 mm the inflation is about 3 mm. The earliest growth lines (to a height of about 6 mm) show that the immature shell was slightly produced posteroventrally. Larger specimens (e.g., No. 14203) reveal rounded anterior and posterior margins and a slightly flattened ventral margin. The hinge line, which is about half as long as the whole shell, meets the anterior and posterior margins at an obtuse angle. The characters of the hinge are unknown. The holotype, the only well-preserved right valve, shows no trace of an anterior auricle. Apparently this species, like most adult Posidonias, had no functional byssal sinus.

Posidonia aranea is probably related to *"Daonella" sancta-anae* Smith (1914, p. 145, pl. 50, figs. 12-14) from the Middle Triassic(?)[1] of California. The sculpture of Smith's species resembles that of *P. aranea* closely. However, *"Daonella" sancta-anae* has a distinctly oblique, prosocline outline, unlike *P. aranea.* Smith considered his species to be "transitional from *'Posidonomya'* " (i.e., from *Posidonia*). *P. aranea* also seems to occupy an intermediate position between *Posidonia* and *Daonella. Daonella,* with its long hinge line and radially ribbed shell, is not known below the Middle Triassic; *P. aranea* occurs near the top of the Lower Triassic. It is generally held that *Daonella* was derived from *Posidonia. P. aranea,* with sculpture that resembles that of many *Daonella* species, is probably a member of the stock which gave rise to the younger genus.

[1] According to Silberling, *in* Reeside, *et al.,* 1957, p. 1468, the age of the beds is uncertain.

Occurrence. Olenikites bed, about 235 feet below the top of the Blind Fiord formation, south side of Otto Fiord, near mouth, Ellesmere Island (GSC locality 32363, R. Thorsteinsson, 1957).

Also known (with *Olenikites* sp. indet.) on west coast of Ellesmere Island, between Hare and Otto Fiords, 15 miles northwest of mouth of Hare Fiord (GSC locality 28450, E. T. Tozer, 1956).

Age. Uppermost Scythian (*see* p. 32).

Genus *Daonella* Mojsisovics 1874

Type species: *Halobia lommeli* Wissmann

Daonella frami Kittl

Plate XXIX, numbers 1 to 3

Daonella frami Kittl, 1907, p. 13, pl. I, figs. 5, 6.

Types and Dimensions

Specimen	Locality	Length	Height
14205 topotype, right valve	28473	35	25
Hypotypes, 14206, from locality 26110 14207, from locality 30352			

As noted by Kittl (1907, p. 14) the height of this species reaches at least 42 mm. Complete specimens of this size have not been found.

Occurrence. Blaa Mountain formation, Lower Shale member, at the following localities:

1. Blaa Mountain, Ellesmere Island, west limb of anticline (type locality) (GSC locality 28473, R. Thorsteinsson and E. T. Tozer, 1956).
2. West coast of Ellesmere Island, between Hare and Otto Fiords, 6 miles northwest of entrance to Hare Fiord (GSC locality 28464, R. Thorsteinsson and E. T. Tozer, 1956).

It also occurs in the Raanes Peninsula sequence of the Blaa Mountain formation. In this sequence it occurs about 500 feet above the base, 6 miles northwest of the head of Blind Fiord (GSC locality 26106, E. T. Tozer, 1955).

Schei Point formation, about 400 feet above base, southwest limb of Goose Point anticline, Bjorne Peninsula, Ellesmere Island (GSC locality 26110, E. T. Tozer, 1955) and 185 feet above base, north coast of Table Island (GSC locality 30352, E. T. Tozer, 1957).

Age. Anisian or Ladinian (*see* pp. 33-34).

Genus *Halobia* Bronn 1830

Type species: *Halobia salinaria* Bronn

Halobia zitteli Lindstrom

Plate XXIX, number 4

Halobia zitteli Lindstrom, 1865, p. 6, pl. I, figs. 6-12, pl. II, fig. 11; Mojsisovics, 1874, p. 32, pl. III, figs. 10, 11; Oeberg, 1877, p. 6, pl. V, figs. 3, 4; Kittl, 1907, pl. I, figs. 7-11.

Type. Hypotype, GSC No. 14208, locality 26123 (Schei Point formation, near top, southwest limb of Goose Point anticline, Bjorne Peninsula, Ellesmere Island).

Halobia is the most common fossil in the Upper Triassic of the Queen Elizabeth Islands. Despite its common occurrence, well-preserved specimens are very rare. Nearly all the specimens have wavy ribs, like the figured example. In this report all specimens with such sculpture are referred to *Halobia zitteli,* although it may eventually be possible to recognize several species with this type of sculpture. A very large number of *Halobia* "species" have been named, many based on incomplete specimens. An attempt to sort out these "species" is not within the scope of this report.

Occurrence. In the Arctic islands, *Halobia zitteli* occurs in the following formations and members. The individual localities are too numerous to be listed.

Blaa Mountain formation; Middle Shale member, Upper Calcareous member, and Upper Shale member. It also occurs in the upper part of the Buchanan Lake sequence and in the upper member on Raanes Peninsula.

Halobia zitteli occurs in the upper Schei Point beds of Bjorne Peninsula, Table Island, Cameron Island and Borden Island. It has not yet been found in the Schei Point beds of Sawtooth Range, Fosheim Peninsula.

Fragmentary specimens occur in the lower Heiberg beds of Fosheim Peninsula.

Genus *Meleagrinella* Whitfield 1885

Type species: *Avicula curta* Hall

Meleagrinella antiqua n. sp.

Plate XXIX, numbers 5 to 9b

Diagnosis. *Meleagrinella* of about equal height and length; both valves are sculptured with radial ribs and faint concentric growth lines, without nodes at the intersections.

Types and Dimensions

Specimen	Locality	Length	Height	Inflation
14209 holotype, left valve	26119	10.5	10.5	ca. 3.5
14212 paratype, left valve	26150	10.0	10.0	3.5
14213 paratype, right valve	30362	12.0		

Other paratypes: Nos. 14210 and 14211, from locality 26119

This species seems to be referable to *Meleagrinella* (=*Echinotis* Marwick 1935) which includes small pteriidae with the following characters: left valve inflated; right valve flat; posterior auricles distinct, but not prominent; left valve with poorly defined anterior auricle; right valve with prominent anterior auricle, separated from the body of the valve by a deep, narrow furrow which leads to a small byssal sinus (*see* Cox, 1940, p. 90; Cox, 1941). *Meleagrinella* is typically a Jurassic genus; *M. antiqua* seems to be the oldest known representative.

The holotype, and paratype 14212, show a distinct posterior auricle on the left valve. The growth lines of the holotype seem to show that there is no anterior auricle on the left valve. The paratype right valve, No. 14213, which is an external mould, is almost perfectly flat. The anterior auricle is 3 mm long. The posterior limit of the byssal notch proper cannot be determined, i.e., it is not possible to say to what extent the demarcation of the anterior auricle is due to the groove referred to above, and to what extent to the byssal notch.

The ribs are semicircular in section and the interspaces are wider than the ribs. On the types there is some increase by implantation, but most ribs can be traced to the umbo. On the ventral margin of the types there are about ten ribs in 5 mm.

Meleagrinella antiqua has more prominent and widely spaced ribs than *"Pseudomonotis" spitsbergensis* Boehm (1903, p. 27, pl. 2, figs. 10-13) from the Upper Triassic of Spitsbergen. The right valve of *"P." spitsbergensis* is not known and the holotype is poorly preserved. It is probable that *P. spitsbergensis* should be referred to *Meleagrinella* rather than to *Eumorphotis* Bittner (cf. Ichikawa, 1958, p. 152).

Occurrence. *Meleagrinella antiqua* is the most widely distributed and abundant species in the lower part of the Heiberg formation. It occurs at the following localities:

1. About 900 feet above base, southwest limb of Goose Point anticline, Bjorne Peninsula, Ellesmere Island (GSC locality 26119, E. T. Tozer, 1955).
2. West coast Raanes Peninsula, Ellesmere Island, 8 miles north of Hare Point (GSC locality 30362, E. T. Tozer, 1957).

3. Section 3 miles northeast of head of Wolf Fiord, Axel Heiberg Island (GSC locality 26449, B. F. Glenister, 1955).
4. North side Greely Fiord, between Borup Fiord and Blaa Mountain (GSC locality 28460, E. T. Tozer, 1956).
5. About 250 feet above base, 6 miles east of Eureka, Ellesmere Island (GSC locality 30486, E. T. Tozer, 1956).
6. Buchanan Lake, Axel Heiberg Island (GSC locality 26150, J. G. Souther, 1955).

Age. Karnian or Norian (*see* pp. 39-40).

Genus *Monotis* Bronn 1830

(=*Entomonotis* Marwick 1935)

Type species: *Pectinites salinaria* Schlotheim (Ichikawa, 1958, p. 173)

Monotis ochotica (Keyserling)

Plate XXX, numbers 1 to 10

Avicula ochotica Keyserling, 1848, p. 257, figs. 15-17.
Pseudomonotis ochotica (Keyserling); Teller, 1886, pp. 116-124, pl. XVII, figs. 1-15, pl. XVIII, figs. 1-11; Diener, 1923, p. 36; Kutassy, 1931, p. 275; Kiparisova, 1937b, p. 17, pl. II, fig. 2; Kiparisova, 1938, p. 15, pl. III, figs. 1, 2, 4-6; Kiparisova, *et al.*, 1947, p. 99, pl. XVI, figs. 1-10.

As noted elsewhere (p. 40) this species has numerous relatives, many of which are probably inseparable from *M. ochotica*.

Types and Dimensions

Specimen	Locality	Length	Height	Inflation
14224, hypotype, right valve	25843	30	22	ca. 3
14222, hypotype, left valve	30377	20	16	5
14225, hypotype, left valve	30354	87+		15+
14226, hypotype, right valve	30354	83		65

Other figured specimens:

No. 14218, locality 26450
No. 14219, locality 26450
No. 14220, locality 26450
No. 14221, locality 30377
No. 14223, locality 25843
No. 14227, locality 26385

Teller (1886) in his well-illustrated account of this species, based on specimens from Verkhoyansk, Siberia, named several varieties. Some of these varieties can be recognized in the collection from the Queen Elizabeth Islands. Numbers 14221, 14222, 14223 and 14224 (Pl. XXX, Nos. 4-7) resemble Teller's "var. *densestriata*". Numbers 14225, 14226 and 14227 resemble "var. *eurachis*" Teller. Most of the Canadian specimens are exfoliated to varying degrees and do not show the fine details of the sculpture; however, some external moulds (e.g., No. 14223, Pl. XXX, No. 7) show the regular concentric growth lines that characterize this species.

The specimens from near Wolf Fiord, Axel Heiberg Island, represent a variety which has apparently not been described before. The left valves (e.g., No. 14218, Pl. XXX, No. 1) are densely ribbed. Ribs of three or even four orders are present. The right valve of the Wolf Fiord variety (Nos. 14219, 14220, Pl. XXX, Nos. 2, 3) has a triangular area of dense, relatively prominent ribs adjacent to the posterior part of the hinge line, and delicate sculpture on the greater part of the valve. All the right valves in the Wolf Fiord collection have this distinctive sculpture. Several bivalved specimens occur so there can be no doubt that these right valves belong to a species of *Monotis*. Possibly this character has genotypic rather than phenotypic significance but for the present these shells are treated as a variety of *Monotis ochotica.*

All the representatives of *M. ochotica* from the Queen Elizabeth Islands, including the unnamed variety from Wolf Fiord, are inequivalve, i.e., the left valves are more inflated than the right. The umbo of the left valve is above the hinge line; that of the right valve is below (Pl. XXX, Nos. 4a and 10). A byssal auricle is commonly preserved, e.g., on No. 14226 (Pl. XXX, No. 9), on which it is at least 3 mm long. In all these characters the specimens from the Canadian Arctic are precisely the same as those from Siberia described by Teller. Specimens of *Monotis subcircularis,* from Western North America, are more or less equivalve, with a relatively inflated right valve and a byssal auricle which is presumably very small for it is rarely seen at all. Ichikawa (1958, p. 177) regards these differences as subgeneric; relatively equivalve species (like *M. subcircularis*) he places in *Monotis* sensu stricto; the inequivalve species (like *M. ochotica*) he assigns to *Entomonotis* Marwick. The writer prefers to regard these differences as specific, and, following Muller (1938), to place *Entomonotis* in synonymy with *Monotis.*

Occurrence. Originally described from Siberia. This species and its close relatives have been reported from many parts of the world (p. 40).

In the Queen Elizabeth Islands *Monotis ochotica* occurs in the Heiberg formation at the following localities:

1. Near Mount Nicolay, Cornwall Island (GSC localities 25843, 26385, 30354, D. J. McLaren, W. Tedlie, 1955; E. T. Tozer, 1957).

2. Section 3 miles northeast of head of Wolf Fiord, Axel Heiberg Island, above the beds with *Meleagrinella antiqua* n. sp. (GSC locality 26450, B. F. Glenister, 1955).
3. West coast of Raanes Peninsula, Ellesmere Island, 6 miles north of Hare Point (GSC locality 30377, E. T. Tozer, 1957).
4. Buchanan Lake, Axel Heiberg Island, above the beds with *Meleagrinella antiqua* n. sp. (GSC locality 26149, J. G. Souther, 1955).
5. Brock Island, near southeast corner, 22 miles S65°E of Cape Murray (GSC locality 37201, E. T. Tozer, 1958).

Age. Norian (*see* p. 40).

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PLATES II TO XXX


BLAA MTN. FM.
D
BLIND FIORD FM.


BLIND FIORD FM.
PERMIAN

PLATE II

A. Cliffs on the west coast of Ellesmere Island, about 6 miles northwest of the entrance to Hare Fiord. The light coloured siltstones and shales of the Blind Fiord formation are overlain abruptly by black shale—the Lower Shale member of the Blaa Mountain formation. Gabbro sills form the massive layers on the cliff side. D marks the position of the *Daonella frami* bed. The *Meekoceras* bed of the Blind Fiord formation is exposed just to the right of the photograph. (*Thorsteinsson, 1.4.57*)

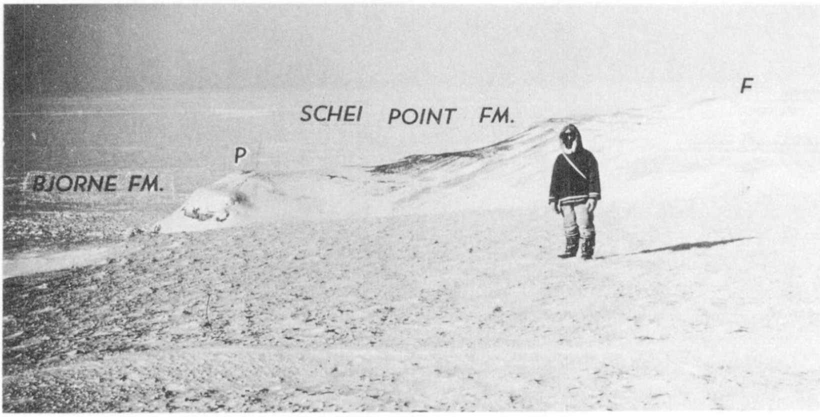
B. Cliffs on the west coast of Ellesmere Island, about 4 miles northwest of the entrance to Hare Fiord. Note the abrupt boundary between the Permian beds and the Blind Fiord formation (Lower Triassic). These cliffs lie a short distance southeast of those illustrated by Plate II A. A complete, and almost continuously exposed, section of the Blind Fiord formation occurs within the area shown by these photographs. (*Thorsteinsson, 1.1.57*)

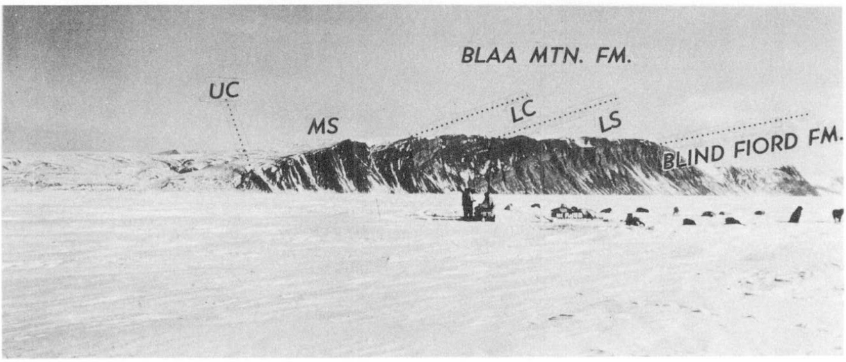
PLATE III

A. Northern summit of Exmouth Island. Exposed are the uppermost, thick-bedded, in part red weathering sandstones of the Bjorne formation overlain by soft shales (dark coloured) and, above, calcareous siltstone (light coloured) of the Schei Point formation. P marks the position of nodules with *Pearylandites* sp. and *Parapopanoceras* sp. F marks the position of the calcareous siltstone with *Ptychites* cf. *P. trochlaeformis* and *Frechites* sp. About 100 feet of Schei Point beds are exposed at this locality (*110789*)

B. Blaa Mountain, on the north side of Greely Fiord, Ellesmere Island. This cliff exposes much of the Blind Fiord formation and a nearly complete section of the Blaa Mountain formation. LS indicates the position of the Lower Shale member; LC, the Lower Calcareous member; MS, the Middle Shale member, with projecting sills of gabbro; UC, the Upper Calcareous member. (*110788*)

C. Cliffs on the southeast side of Buchanan Lake, Axel Heiberg Island. The exposures are grey and black shale with thick sills of gabbro. *Jovites borealis* occurs immediately beneath the sill marked G; *Arctosirenites canadensis* and *Sirenites costatus* occur on the slope below. (*110790*)

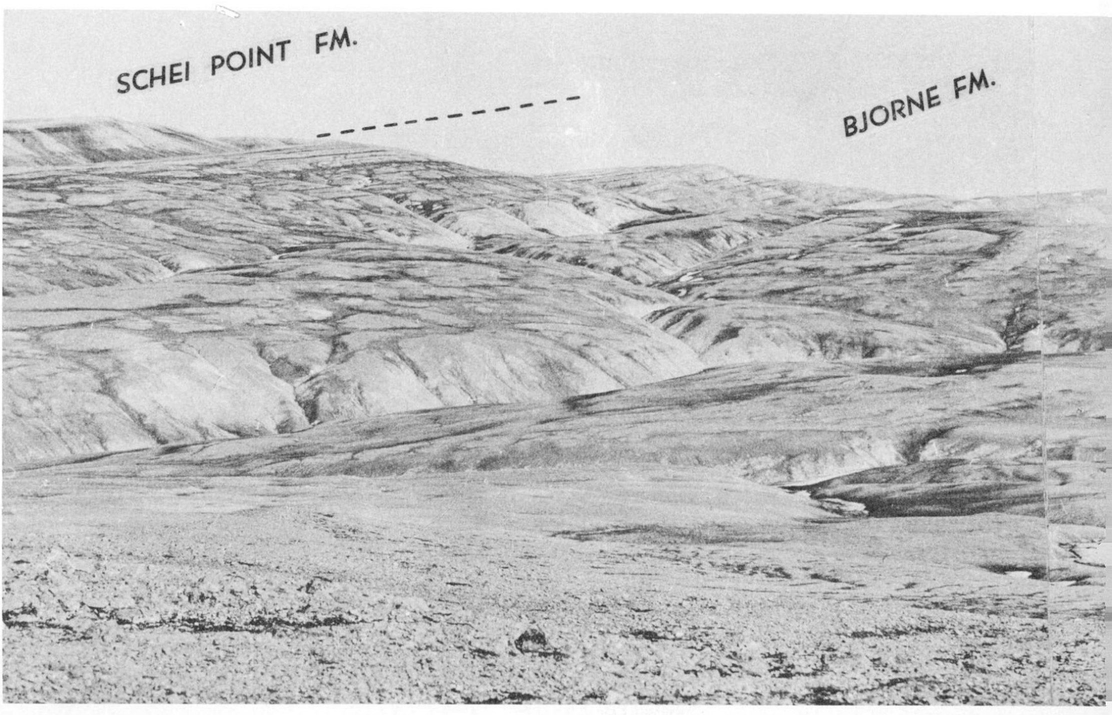

F
SCHEI POINT FM.
P
BJORNE FM.

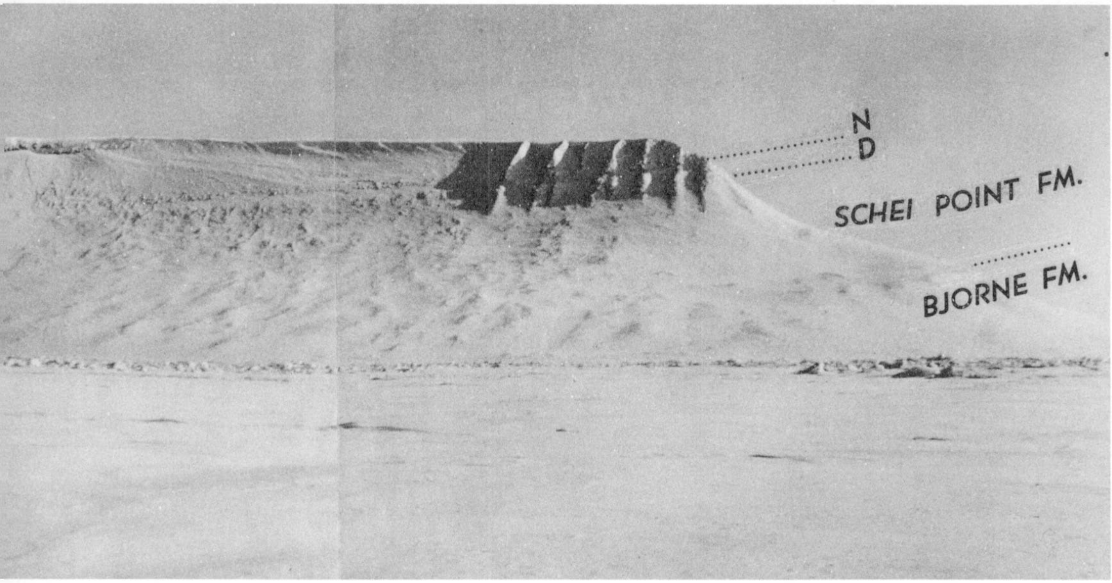

BLAA MTN. FM.
UC
LC
MS
LS
BLIND FIORD FM.


G

A. Panorama of cliffs, about 700 feet high, on the north coast of Table Island. These cliffs expose a nearly complete section of the Schei Point formation and the uppermost beds of the Bjorne formation. D marks the position of the *Daonella frami* bed; N, the *Nathorstites* bed; and H, the *Halobia* beds. Between the *Nathorstites* horizon and the *Halobia* beds are exposures of calcareous sandstone with poorly preserved pelecypods. (*109511*)

P





B. Panorama of hills north of East Cape, Canyon Fiord, Ellesmere Island. This panorama illustrates a complete section of the Bjorne formation, mainly red weathering sandstone, overlain by poorly exposed grey shale and calcareous siltstone of the Schei Point formation.

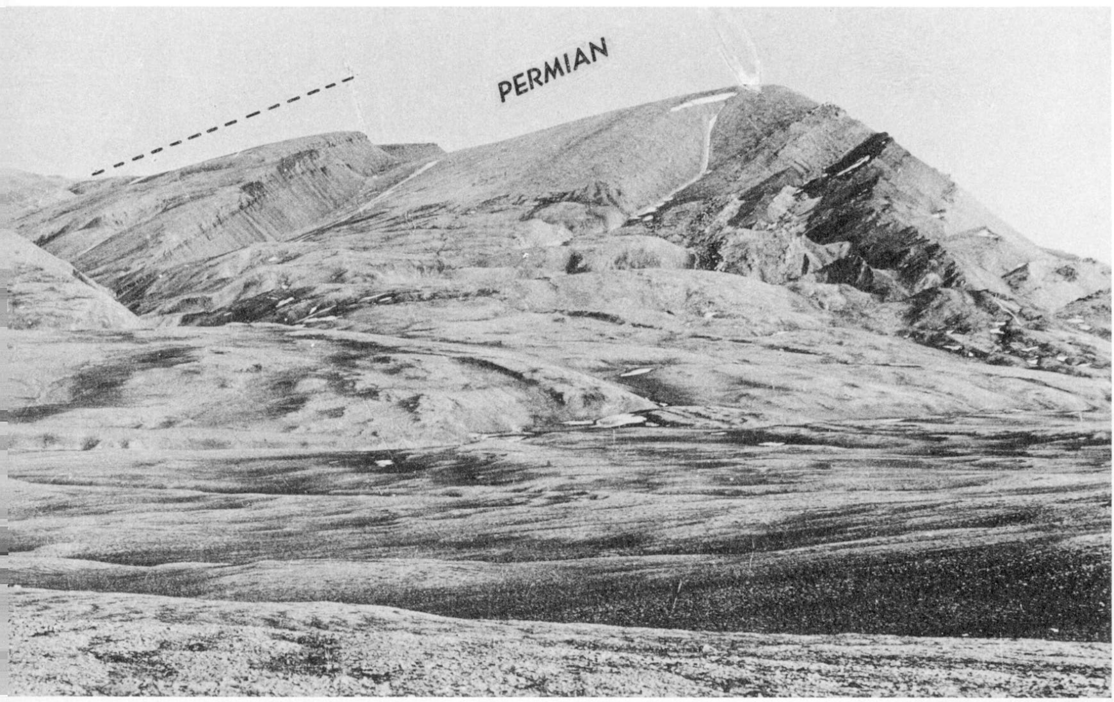


PLATE V

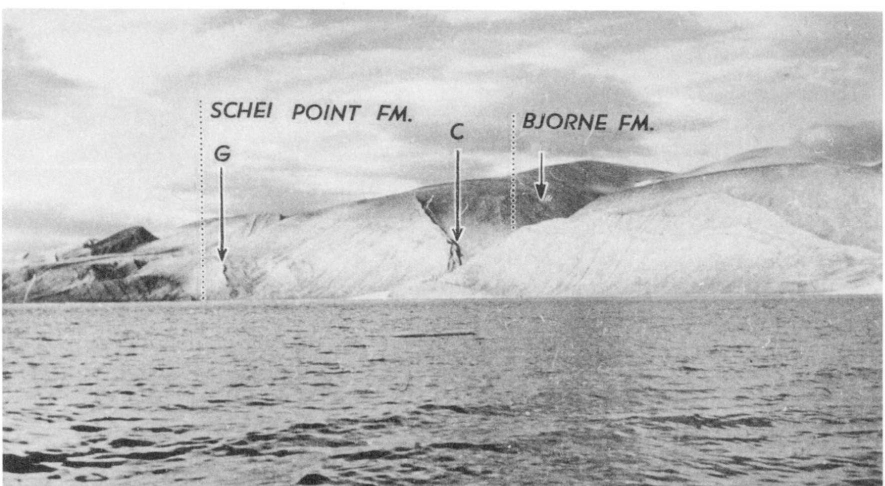


PLATE V

A. Cliffs, about 2,300 feet high, on the west coast of Raanes Peninsula, Ellesmere Island, 6 miles north of Hare Point. The exposures are of Heiberg formation. The prominent light coloured beds are sandstone; the recessive intervals are composed of thinly bedded sandstone and shale. *Monotis ochotica* occurs at M; the beds above represent the non-marine upper part of the formation. (*110791*)

B. Sawtooth Range, north of Vesle Fiord, Ellesmere Island. Eureka Sound is in the foreground. The Schei Point formation is well exposed in this area. G indicates the position of the *Gryphaea* bed, at the top of the Schei Point formation; C, prominent beds of calcareous siltstone in the middle part of the formation, above the *Nathorstites* bed. (*109204*)

Plate VI

Otoceras boreale Spath

(lowermost Scythian)

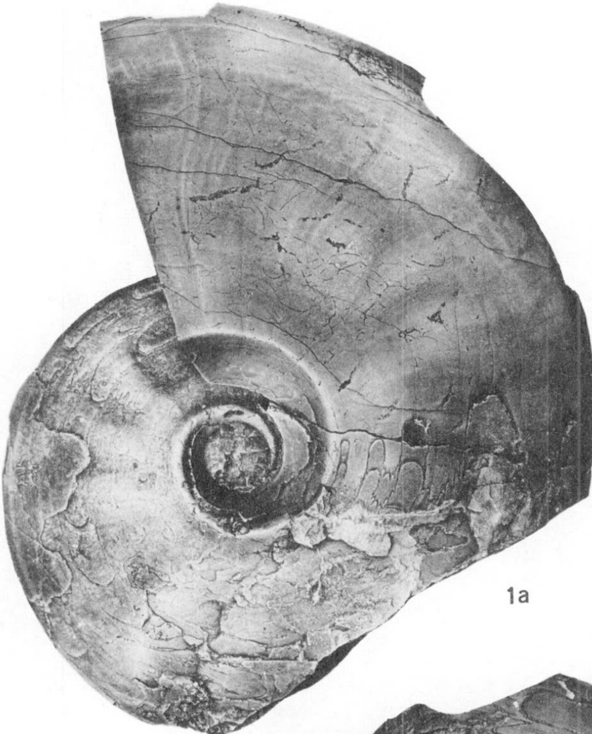
(Page 45)

Numbers 1a, b. A large specimen, one half natural size, hypotype, GSC No. 14028; this specimen has an asymmetrical venter. Blind Fiord formation, near base, island between Bunde and Bukken Fiords.

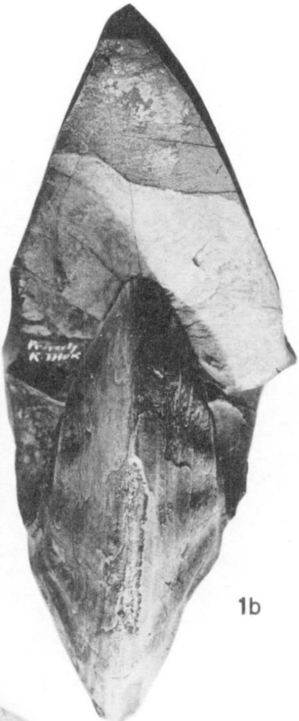
Numbers 2a, b. Hypotype, GSC No. 14015, natural size. Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island.

Number 3. Hypotype, GSC No. 14029, the largest specimen known from the Queen Elizabeth Islands, one half natural size; the periphery of this specimen, which is perfectly acute, without tricarination, is illustrated by number 2, Plate VII. Blind Fiord formation, near base, island between Bunde and Bukken Fiords.

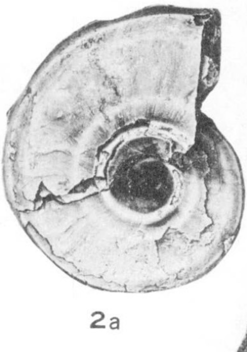
PLATE VI



1a



1b



2a

2b

3

PLATE VII

1

2

3a

3b

Plate VII

(Figures natural size unless otherwise stated)

Otoceras boreale Spath

(lowermost Scythian)

(Page 45)

Number 1. Hypotype, GSC No. 14023, an unusually compressed specimen, lacking an umbilical rim and without lateral ribs. Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island.

Number 2. Hypotype, GSC No. 14029, periphery of the largest specimen known from the Queen Elizabeth Islands, one half natural size, side view is illustrated by Plate VI, number 3. Blind Fiord formation, near base, island between Bunde and Bukken Fiords.

Numbers 3a, b. Hypotype, GSC No. 14018, a moderately compressed individual with a slightly raised umbilical rim. Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island.

Plate VIII

(All figures natural size)

Otoceras boreale Spath

(lowermost Scythian)

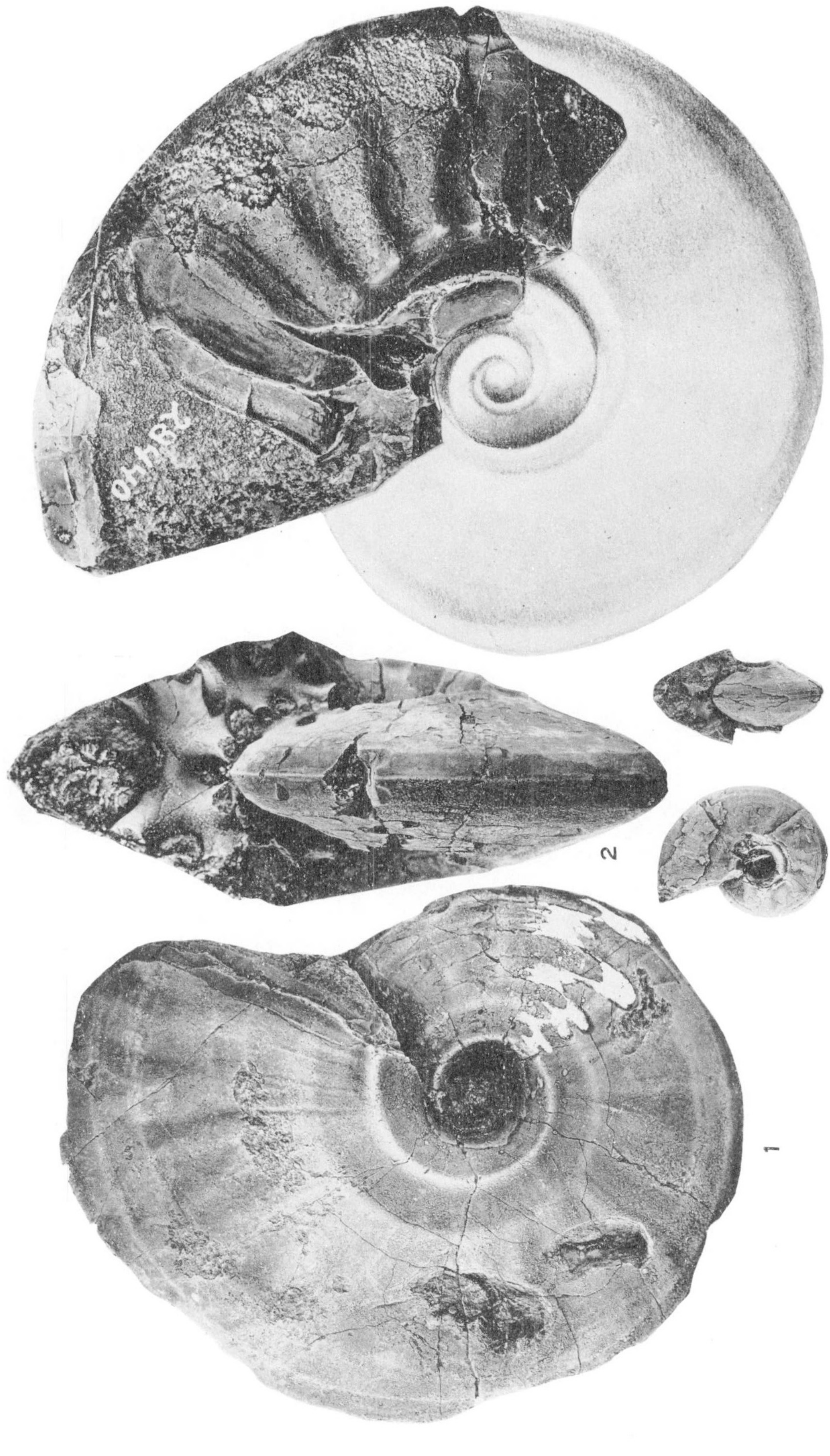
(Page 45)

Number 1. Hypotype, GSC No. 14020. Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island.

Number 2. Hypotype, GSC No. 14026. Blind Fiord formation, basal 25 feet, Bunde Fiord, Axel Heiberg Island.

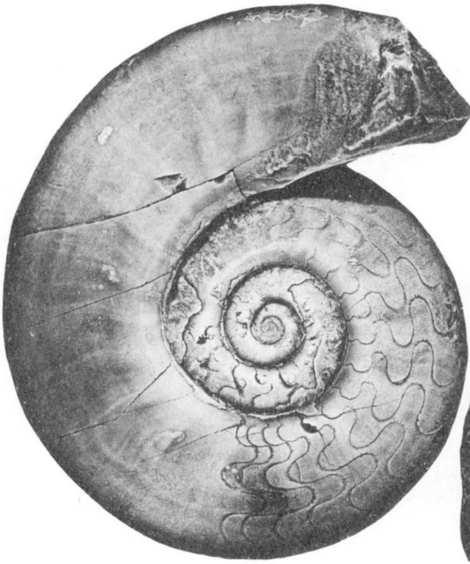
Number 3. Hypotype, GSC No. 14025, unusually wide and prominently sculptured specimen, restored to show probable diameter; the width of this specimen was probably more than half the diameter (54%). Blind Fiord formation, section between Hare and Otto Fiords, Ellesmere Island.

Numbers 4a, b. Hypotype, GSC No. 14014. Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island.



1
2
3
4a
4b

PLATE IX



1a

3

1b

2a

2b

Plate IX

(All figures natural size)

Numbers 1a, b. *Ophiceras commune* Spath. Hypotype, GSC No. 14030, from beds near base of Blind Fiord formation, island between Bunde and Bukken Fiords (Lower Scythian). (Page 48.)

Numbers 2a, b. *Ophiceras commune* Spath. Hypotype, GSC No. 14032, from beds near base of Blind Fiord formation, island between Bunde and Bukken Fiords (Lower Scythian). (Page 48.)

Number 3. *Proptychites strigatus* n. sp. Paratype, GSC No. 14040, from beds about 50 feet above base of Blind Fiord formation, Bunde Fiord, Axel Heiberg Island (Lower Scythian). (Page 55.)

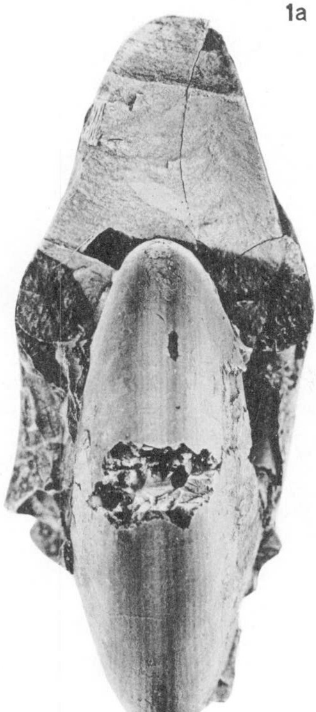
PLATE X

Numbers 1a, b. *Proptychites strigatus* n. sp. Paratype, GSC No. 14043, the largest specimen known, one half natural size. Blind Fiord formation, about 50 feet above base, Bunde Fiord, Axel Heiberg Island (Lower Scythian). (Page 55.)

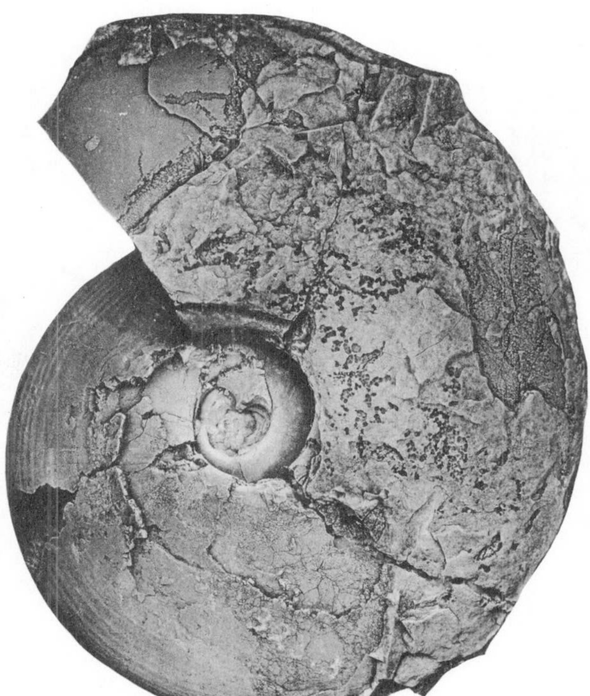
Numbers 2a, b. *Proptychites strigatus* n. sp. Holotype, GSC No. 14042, natural size. Blind Fiord formation, about 50 feet above base, Bunde Fiord, Axel Heiberg Island (Lower Scythian). (Page 55.)

1a

1b

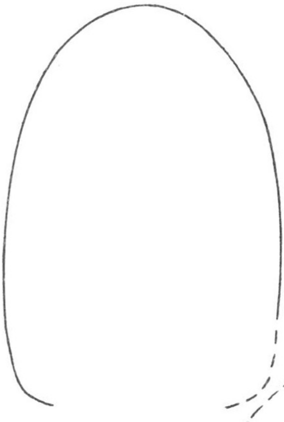


2a



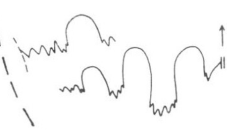
2b

PLATE XI



1c

1a



1b

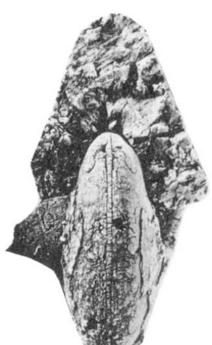
2a

3a

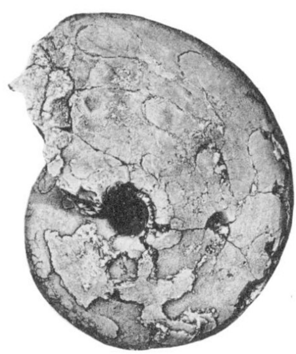
2b

3b

4a



4b



4c

Plate XI

(All figures natural size)

Numbers 1a-c. *Proptychites candidus* n. sp. Holotype, GSC No. 14044; 1b, external suture; 1c, cross-section, partly restored. Blind Fiord formation, 160 feet above base, Bunde Fiord, Axel Heiberg Island (Lower Scythian). (Page 57.)

Numbers 2a, b. *Proptychites strigatus* n. sp. Paratype, GSC No. 14037, showing whorl section and external suture. Blind Fiord formation, about 50 feet above base, Bunde Fiord, Axel Heiberg Island (Lower Scythian). (Page 55.)

Numbers 3a, b. *Proptychites strigatus* n. sp. Paratype, GSC No. 14033, showing compressed inner whorls. Blind Fiord formation, about 50 feet above base, Bunde Fiord, Axel Heiberg Island (Lower Scythian). (Page 55.)

Numbers 4a-c. *Proptychites strigatus* n. sp. Paratype, GSC No. 14035. Blind Fiord formation, about 50 feet above base, Bunde Fiord, Axel Heiberg Island (Lower Scythian). (Page 55.)

PLATE XII

(Figures natural size unless otherwise indicated)

All specimens illustrated on this plate are from the *Meekoceras* bed of the Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island.

Numbers 1a-c. *Flemingites* ? sp. indet. GSC No. 14176. Figure 1c represents the external suture of GSC No. 14177 (Upper Scythian). (Page 50.)

Numbers 2a-c. *Euflemingites romunduri* n. sp. Paratype, GSC No. 14050 (Upper Scythian). (Page 51.)

Number 3. *Euflemingites romunduri* n. sp. External suture of paratype, GSC No. 14191 (Upper Scythian). (Page 51.)

Numbers 4a, b. *Euflemingites romunduri* n. sp. Paratype, GSC No. 14049 (Upper Scythian). (Page 51.)

Numbers 5a, b. *Euflemingites romunduri* n. sp. Holotype, GSC No. 14051, one half natural size; number 5b shows the specimen with the last quarter whorl removed (Upper Scythian). (Page 51.)

2a

1a

1b

1c

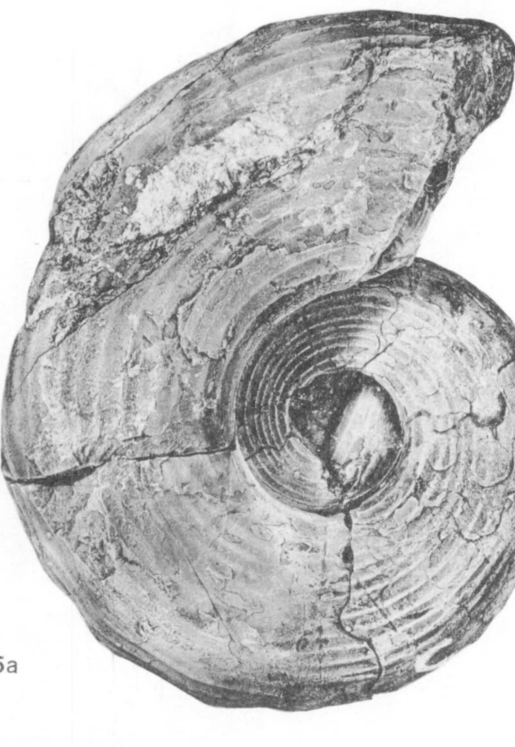
2b

2c

3

4a

4b



5a

5b

PLATE XIII

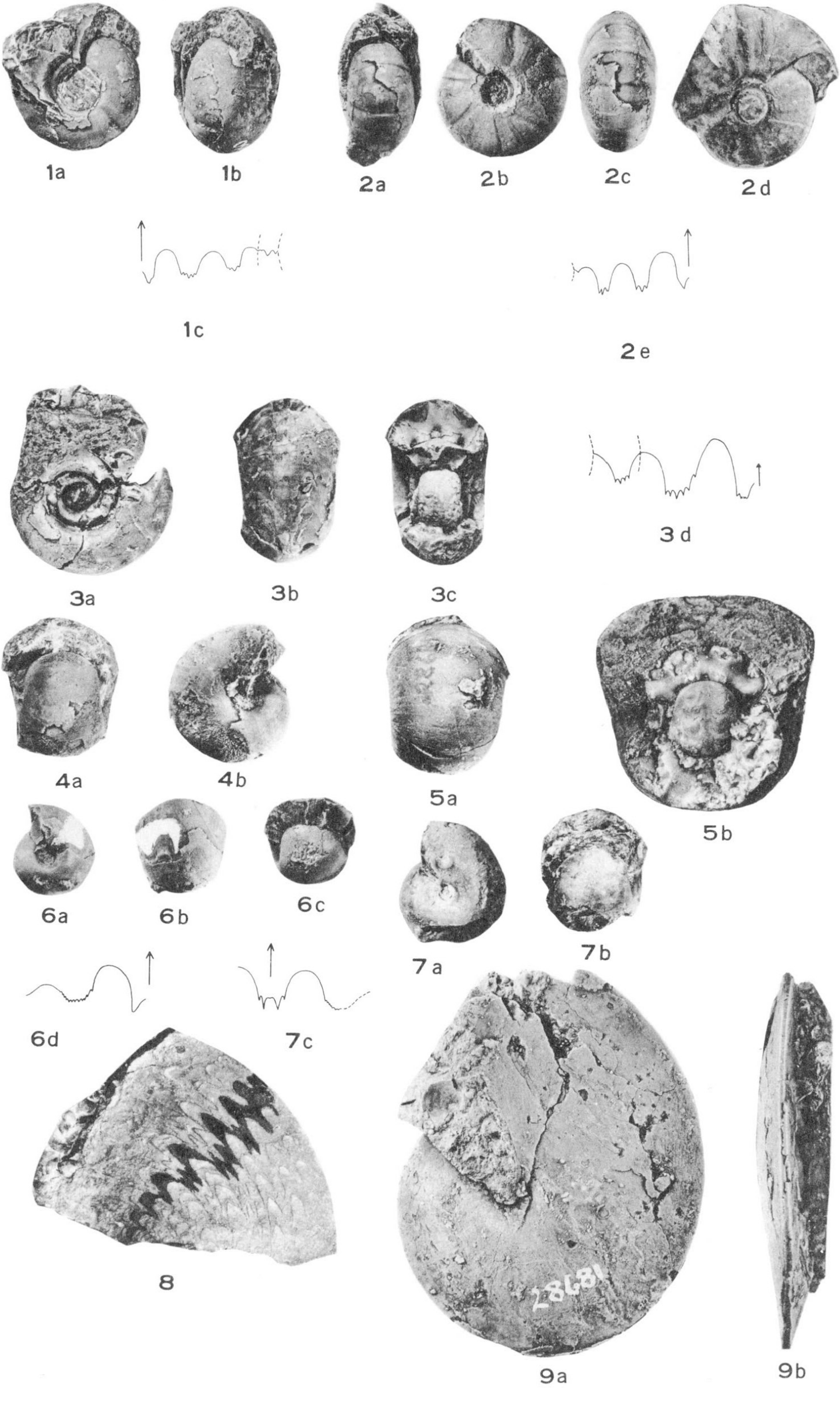

1a
1b
2a
2b
2c
2d
1c
2e
3a
3b
3c
3d
4a
4b
5a
5b
6a
6b
6c
7a
7b
6d
7c
8
28681
9a
9b

Plate XIII

(Figures natural size unless otherwise indicated)

All specimens illustrated on this plate are from the *Meekoceras* bed of the Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island.

Numbers 1a-c. *Prosphingites spathi* Frebold. Two views of hypotype, GSC No. 14086, and external suture (x2) (Upper Scythian). (Page 58.)

Numbers 2a-e. *Prosphingites spathi* Frebold. Hypotype, GSC No. 14085. Numbers 2a-c show the specimen with the fragmentary outer whorl removed; number 2d shows the outer whorl in place; number 2e shows the external suture (x2) (Upper Scythian). (Page 58.)

Numbers 3a-d. *Juvenites canadensis* n. sp. Holotype, GSC No. 14079. Number 3c shows the specimen broken to show the cross-section of the whorls; 3d shows the external suture (x2) (Upper Scythian). (Page 60.)

Numbers 4a, b. *Juvenites crassus* n. sp. Paratype, GSC No. 14083 (Upper Scythian). (Page 60.)

Numbers 5a, b. *Juvenites crassus* n. sp. Paratype, GSC No. 14084; 5b is x2 (Upper Scythian). (Page 60.)

Numbers 6a-d. *Juvenites crassus* n. sp. Paratype, GSC No. 14080; 6d shows external suture x2 (Upper Scythian). (Page 60.)

Numbers 7a-c. *Juvenites crassus* n. sp. Holotype, GSC No. 14081; 7c shows external suture x2 (Upper Scythian). (Page 60.)

Number 8. *Pseudosageceras multilobatum* Noetling. Hypotype, GSC No. 14174 (Upper Scythian). (Page 44.)

Numbers 9a, b. *Pseudosageceras multilobatum* Noetling. Hypotype, GSC No. 14173 (Upper Scythian). (Page 44.)

PLATE XIV

(All figures natural size)

Anakashmirites borealis n. sp.

(Upper Scythian)

(Page 63)

All specimens illustrated on this plate are from the *Meekoceras* bed, Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island.

Numbers 1a-c. Paratype, GSC No. 14073.

Numbers 2a, b. Paratype, GSC No. 14072.

Numbers 3a, b. Paratype, GSC No. 14071.

Numbers 4a-c. Two views and external suture of paratype, GSC No. 14075.

Number 5. External suture of paratype, GSC No. 14074.

Numbers 6a-c. Holotype, GSC No. 14077.

PLATE XIV

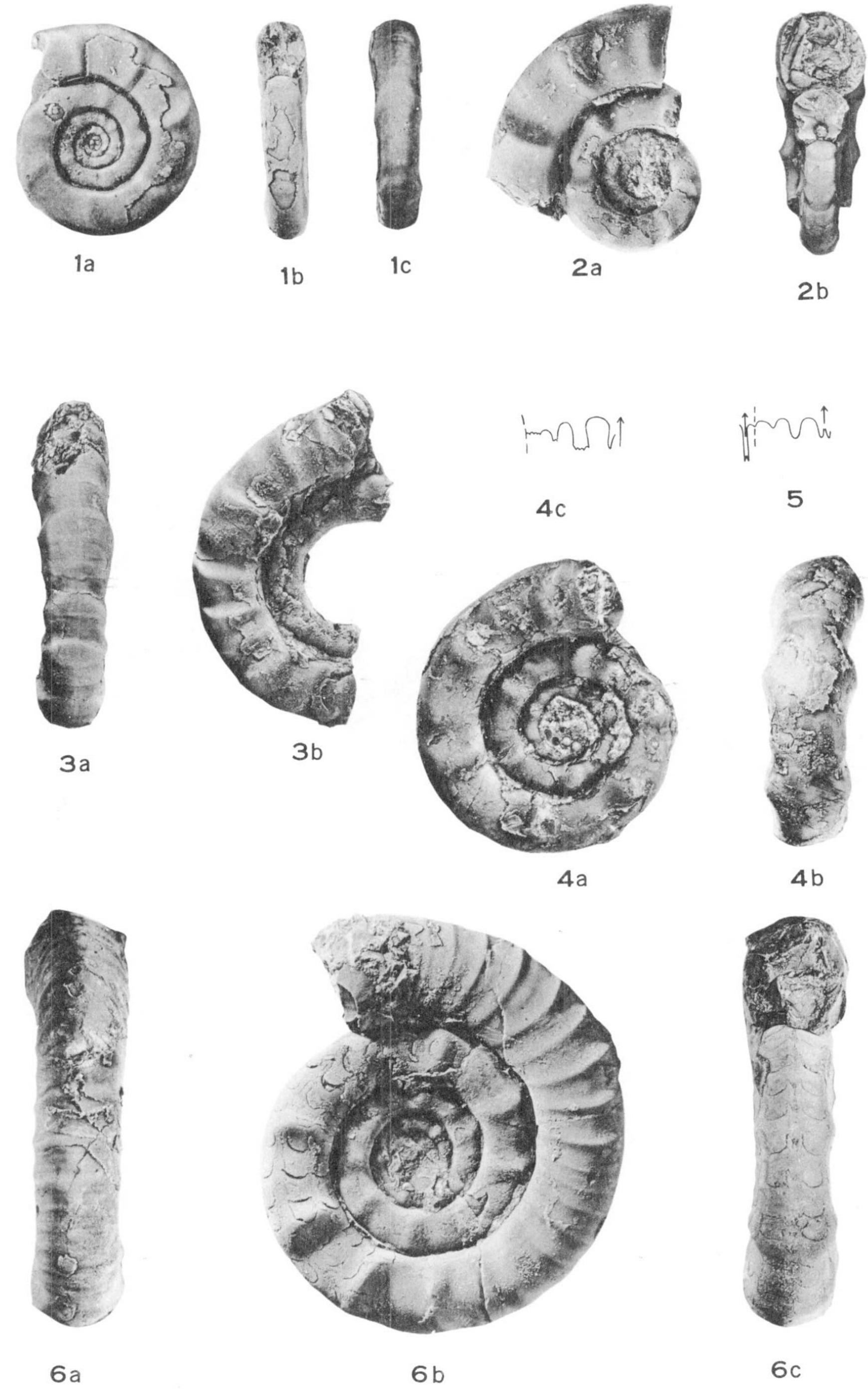


PLATE XV

1

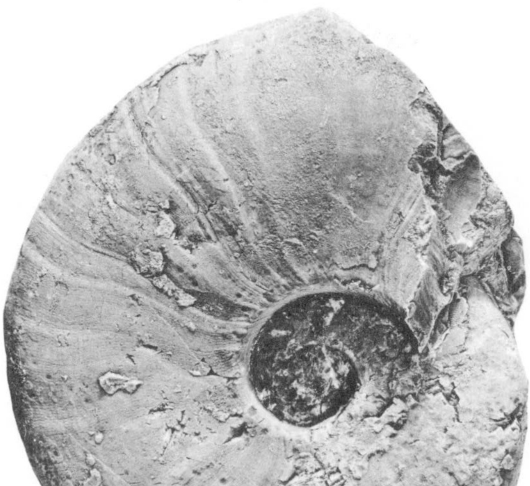
2

3

4

6

5b



5a

Plate XV

(All figures natural size)

All specimens illustrated on this plate are from the *Meekoceras* bed, Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island.

Number 1. *Arctoceras oebergi* (Mojsisovics). External suture of hypotype, GSC No. 14064 (Upper Scythian). (Page 68.)

Number 2. *Arctoceras oebergi* (Mojsisovics). Complete suture of hypotype, GSC No. 14065 (Upper Scythian). (Page 68.)

Number 3. *Arctoceras oebergi* (Mojsisovics). External suture of hypotype, GSC No. 14066 (Upper Scythian). (Page 68.)

Number 4. *Arctoceras oebergi* (Mojsisovics). Hypotype, GSC No. 14068, showing rather widely spaced tubercles on the umbilical shoulder (Upper Scythian). (Page 68.)

Numbers 5a, b. *Arctoceras oebergi* (Mojsisovics). Hypotype, GSC No. 14069; 5b is cross-section, partly restored. This specimen has relatively dense tuberculation at the umbilical shoulder (Upper Scythian). (Page 68.)

Number 6. *Meekoceras gracilitatis* White. Periphery of hypotype, GSC No. 14061; for side view see Plate XVIII, number 4. (Upper Scythian). (Page 65.)

Plate XVI

(All figures natural size)

Numbers 1a, b. *Xenoceltites subevolutus Spath*. Hypotype, GSC No. 14183. *Wasatchites* bed of Blind Fiord formation, Bunde Fiord, Axel Heiberg Island (Upper Scythian). (Page 53.)

Number 2. *Arctoceras oebergi* (Mojsisovics). Hypotype, GSC No. 14071, large fragment of living chamber. *Meekoceras* bed of Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island (Upper Scythian). (Page 68.)

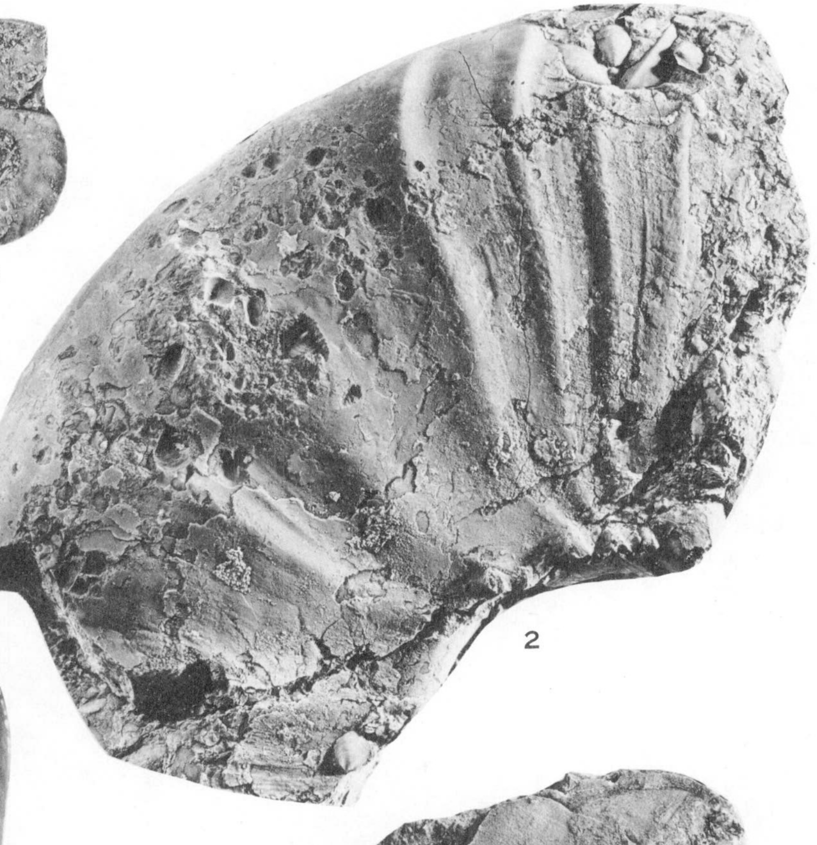
Numbers 3a, b. *Arctoceras oebergi* (Mojsisovics). Hypotype, GSC No. 14067. *Meekoceras* bed of Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island (Upper Scythian). (Page 68.)

Number 4. *Arctoceras oebergi* (Mojsisovics). Hypotype, GSC No. 14070. *Meekoceras* bed of Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island (Upper Scythian). (Page 68.)

PLATE XVI

1a

1b



2

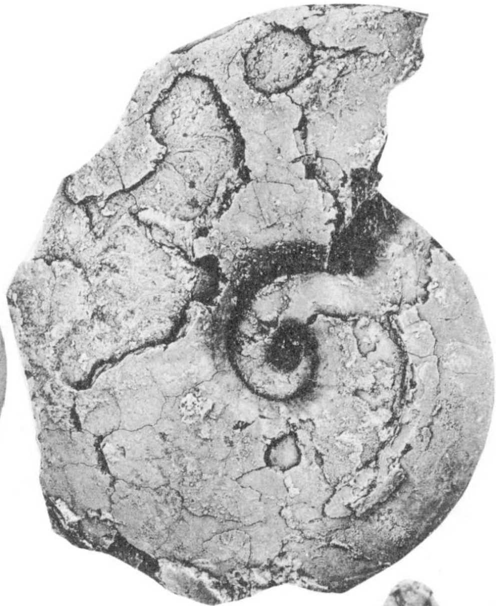
3a

3b

4

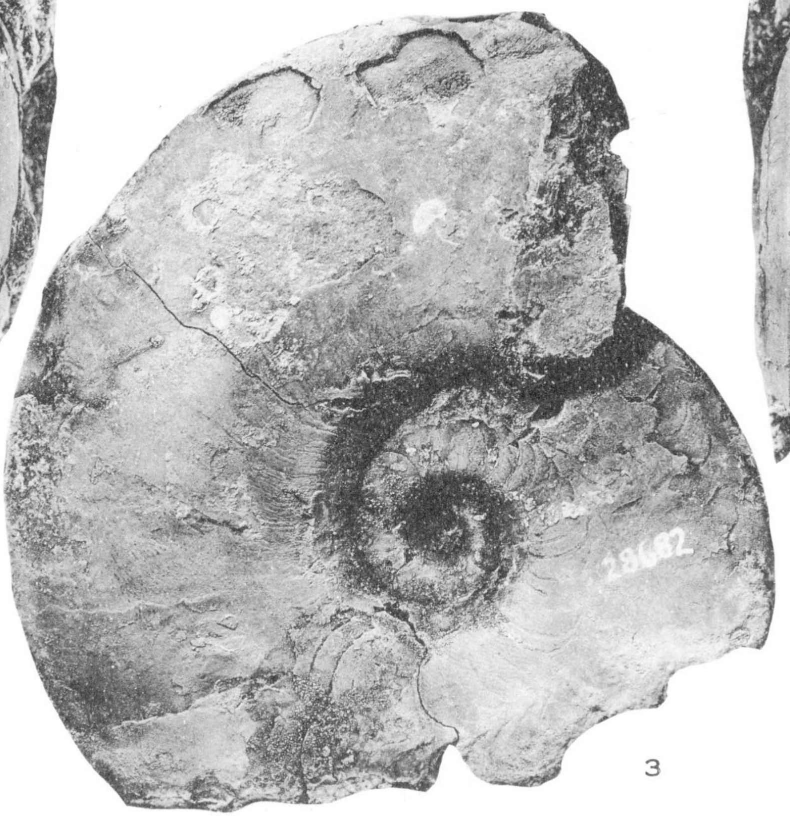
PLATE XVII

1a



2a

1b



3

2b

PLATE XVII

(All figures natural size)

Meekoceras gracilitatis White

(Upper Scythian)

(Page 65)

All specimens illustrated on this plate are from the *Meekoceras* bed of the Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island.

Numbers 1a, b. Narrowly umbilicate phragmocone, hypotype, GSC No. 14058.

Numbers 2a, b. Widely umbilicate phragmocone, hypotype, GSC No. 14056.

Number 3. Hypotype, GSC No. 14060.

Plate XVIII

(All figures natural size unless otherwise stated)

Numbers 1a, b. *Olenikites canadensis* n. sp. Holotype, GSC No. 14094. *Olenikites* bed of Blind Fiord formation, near mouth of Otto Fiord, Ellesmere Island (uppermost Scythian). (Page 73.)

Number 2. *Olenikites canadensis* n. sp. Paratype, GSC No. 14093 (x2). *Olenikites* bed, Blind Fiord formation, near mouth of Otto Fiord, Ellesmere Island (uppermost Scythian). (Page 73.)

Numbers 3a, b. *Olenikites canadensis* n. sp. Paratype, GSC No. 14095. *Olenikites* bed of Blind Fiord formation, near mouth of Otto Fiord, Ellesmere Island (uppermost Scythian). (Page 73.)

Number 4. *Meekoceras gracilitatis* White. Hypotype, GSC No. 14061. The largest known specimen from the *Meekoceras* bed, Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island (for view of periphery *see* Pl. XV, No. 6) (Upper Scythian). (Page 65.)

Number 5. *Meekoceras gracilitatis* White. External suture of hypotype, GSC No. 14062. *Meekoceras* bed of Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island (Upper Scythian). (Page 65.)

Number 6. *Meekoceras gracilitatis* White. External suture of hypotype, GSC No. 14063. *Meekoceras* bed of Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island (Upper Scythian). (Page 65.)

Plate XVIII

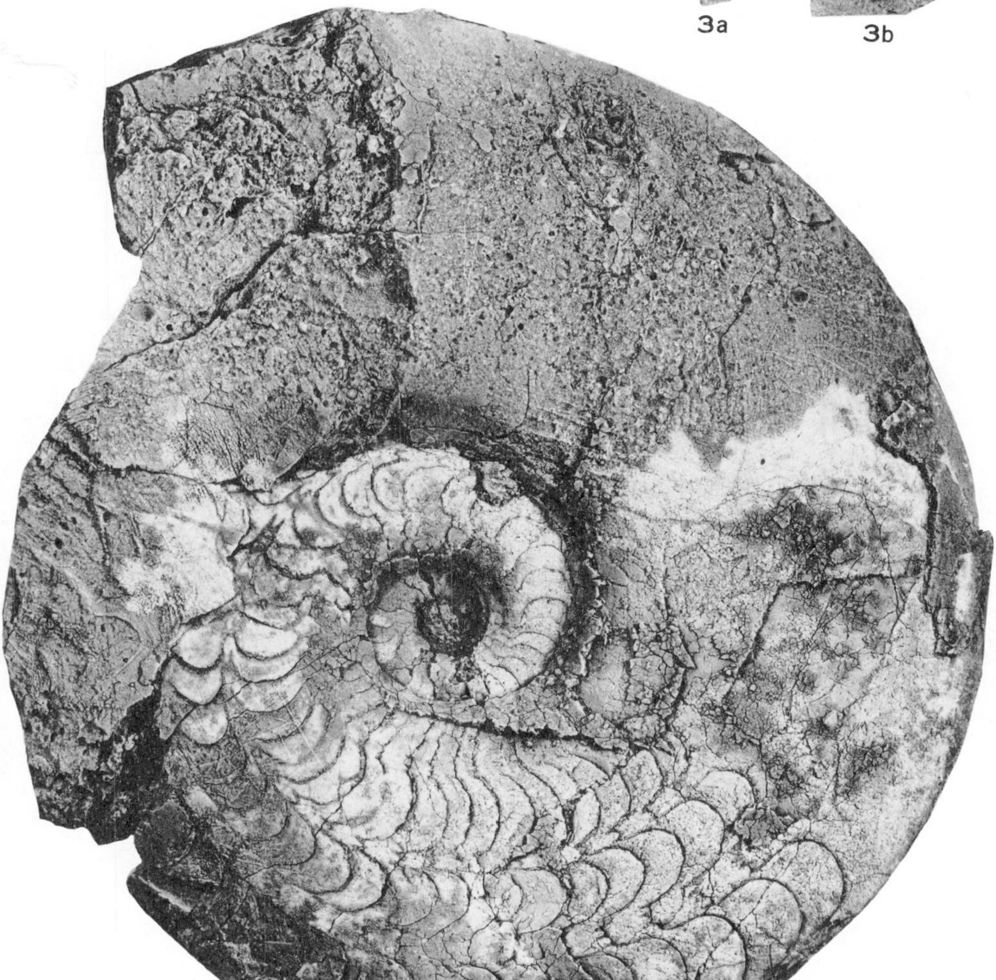

1a


1b


2


3a


3b


4


5


6

PLATE XIX

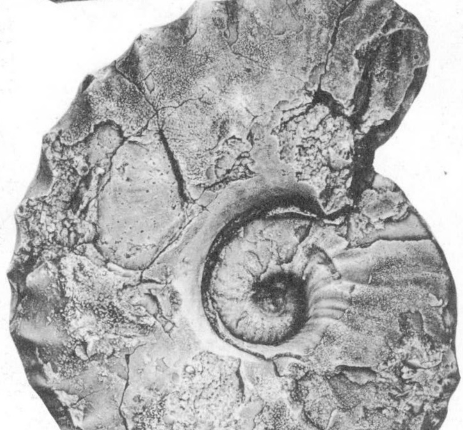
1a

2a

1b

2b

3a



3b

3c

Plate XIX

(All figures natural size)

Wasatchites tardus (McLearn)

(Upper Scythian)

(Page 71)

All specimens illustrated on this plate are from the *Wasatchites* bed of the Blind Fiord formation, Bunde Fiord, Axel Heiberg Island.

Numbers 1a, b. Hypotype, GSC No. 14089. The bullae on the whorl side are rather worn.

Numbers 2a, b. Hypotype, GSC No. 14087, showing the smooth whorl sides and periphery of the inner whorls.

Numbers 3a-c. Hypotype, GSC No. 14088, showing the transition from smooth to ribbed whorls.

Plate XX

(All figures natural size)

Numbers 1a, b. Prionitid indet. GSC No. 14092. *Wasatchites* bed, Toad formation, Liard River, British Columbia (Upper Scythian). (Page 72.)

Numbers 2a, b. Prionitid indet. GSC No. 14090. *Wasatchites* bed, Blind Fiord formation, Bunde Fiord, Axel Heiberg Island (Upper Scythian). (Page 72.)

Numbers 3a, b. Prionitid indet. GSC No. 14091. This specimen is probably conspecific with No. 14092 (numbers 1a, b). No. 14091 is from *Wasatchites* bed, Blind Fiord formation, Bunde Fiord, Axel Heiberg Island (Upper Scythian). (Page 72.)

Numbers 4a-c. *Prionolobus plicatus* n. sp. Paratype, GSC No. 14048. Blind Fiord formation, talus, Bunde Fiord, Axel Heiberg Island (Lower Scythian). (Page 49.)

Numbers 5a-c. *Prionolobus plicatus* n. sp. Holotype, GSC No. 14047. Blind Fiord formation, talus, Bunde Fiord, Axel Heiberg Island (Lower Scythian). (Page 49.)

PLATE XX

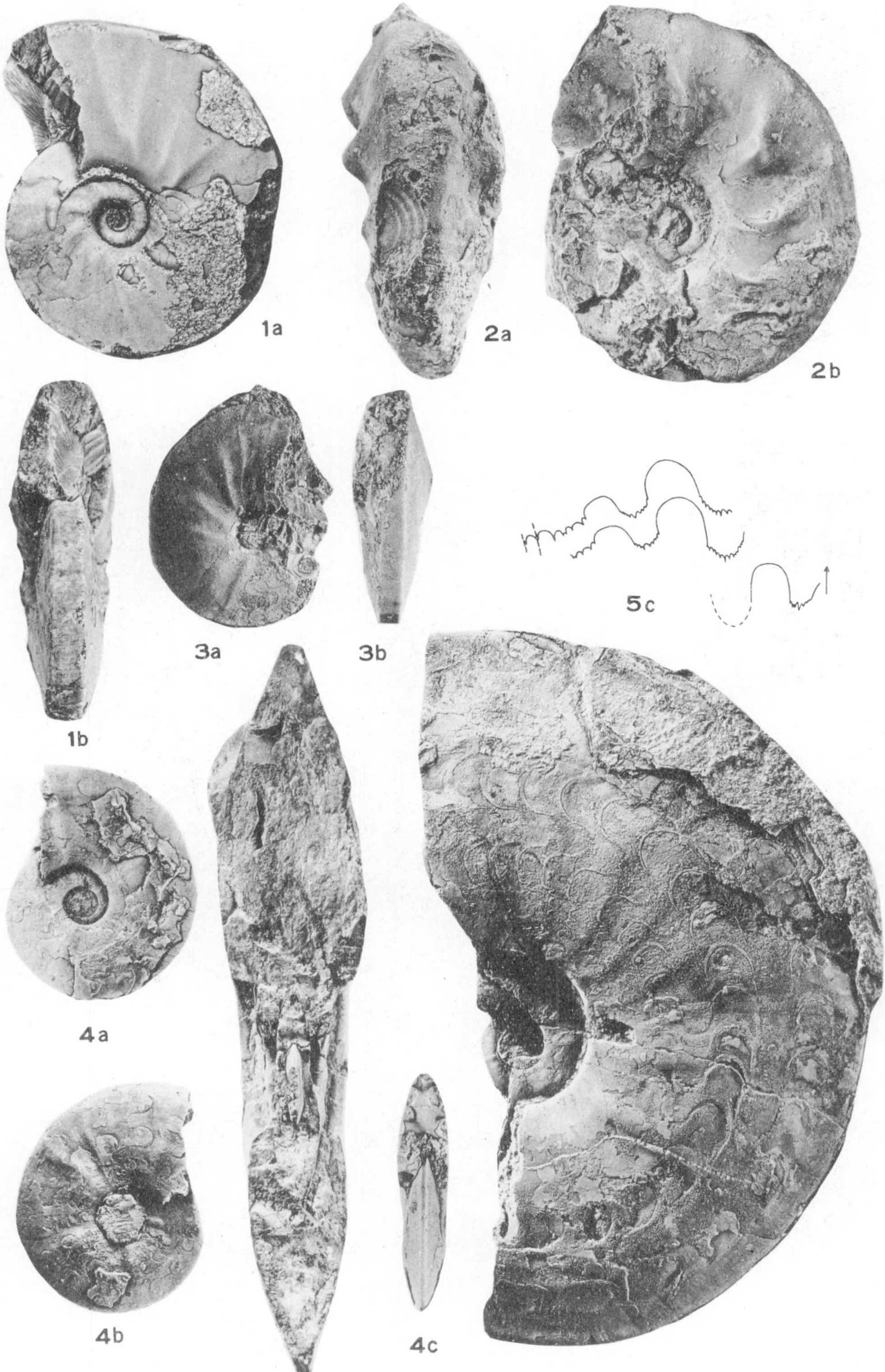


PLATE XXI

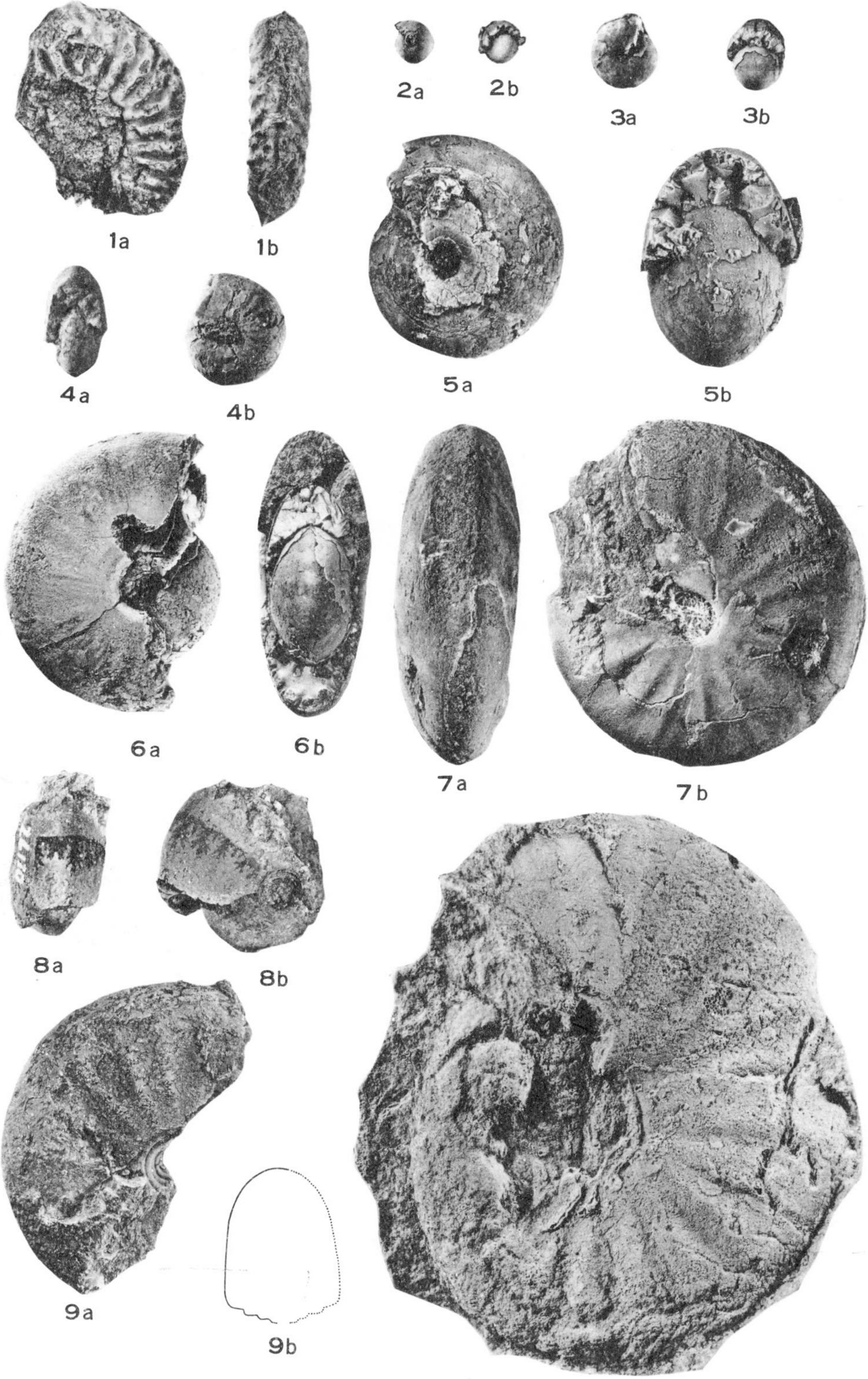


PLATE XXI

(Figures natural size unless otherwise stated)

All specimens illustrated on this plate are from the *Daonella frami* bed, about 400 feet above the base of the Schei Point formation, Bjorne Peninsula, Ellesmere Island.

Numbers 1a, b. *Protrachyceras* sp. indet GSC No. 14190 (Anisian or Ladinian). (Page 75.)

Numbers 2a, b. *Ptychites nanuk* n. sp. Paratype, GSC No. 14096 (Anisian or Ladinian). (Page 93.)

Numbers 3a b. *Ptychites nanuk* n. sp. Paratype, GSC No. 14106 (Anisian or Ladinian). (Page 93.)

Numbers 4a b. *Ptychites nanuk* n. sp. Paratype, GSC No. 14097 (Anisian or Ladinian). (Page 93.)

Numbers 5a b. *Ptychites nanuk* n. sp. Paratype showing displaced siphuncle (x2), GSC No. 14104 (Anisian or Ladinian). (Page 93.)

Numbers 6a b. *Ptychites nanuk* n. sp. Paratype, GSC No. 14098 (Anisian or Ladinian). (Page 93.)

Numbers 7a b. *Ptychites nanuk* n. sp. Paratype, GSC No. 14100 (Anisian or Ladinian). (Page 93.)

Numbers 8a b. *Ptychites nanuk* n. sp. Paratype showing external suture, for details of suture *see* Figure 10, page 94, GSC No. 14105 (Anisian or Ladinian). (Page 93.)

Numbers 9a b. *Ptychites nanuk* n. sp. Holotype, GSC No. 14099 (Anisian or Ladinian). (Page 93.)

Number 10. *Ptychites nanuk* n. sp. Rubber mould taken from natural cast of a large specimen, probably an adult, apparently showing an excentric umbilical seam, paratype, GSC No. 14101 (Anisian or Ladinian). (Page 93.)

Plate XXII

(Figures natural size unless otherwise stated)

Numbers 1a, b. *Ptychites* cf. *P. trochlaeformis* (Lindstrom). GSC No. 14186, about 100 feet above base of Schei Point formation, Exmouth Island (Anisian). (Page 93.)

Numbers 2a, b. *Ptychites* cf. *P. trochlaeformis* (Lindstrom). Side view and external suture (x3) of GSC No. 14187, about 100 feet above base of Schei Point formation, Exmouth Island (Anisian). (Page 93.)

Numbers 3a, b. *Pearylandites* sp. GSC No. 14188, about 20 feet above base of Schei Point formation, Exmouth Island (Anisian). (Page 33.)

Numbers 4a, b. *Frechites* sp. GSC No. 14189, about 100 feet above base of Schei Point formation, Exmouth Island (Anisian). (Page 33.)

Numbers 5a, b. *Nathorstites mcconnelli* (Whiteaves). GSC No. 14167. Blaa Mountain formation, Lower Shale member, Ellesmere Island, between Hare and Otto Fiords (Ladinian). (Page 91.)

Numbers 6a, b. *Nathorstites mcconnelli* (Whiteaves). GSC No. 14168. Blaa Mountain formation, Lower Shale member, Ellesmere Island, between Hare and Otto Fiords (Ladinian). (Page 91.)

Numbers 7a-c. *Nathorstites mcconnelli* (Whiteaves). GSC No. 14169, about 265 feet above base of Schei Point formation, northern Table Island (Ladinian). (Page 91.)

Numbers 8a, b. *Nathorstites mcconnelli* (Whiteaves). GSC No. 14170, the largest specimen known, Halfway River, northeastern British Columbia (Ladinian). (Page 91.)

Number 9. *Procladiscites* cf. *P. martini* (Smith). First lateral saddle (x3) of specimen about 30 mm in diameter, GSC No. 14171. Blaa Mountain formation, Lower Shale member, Ellesmere Island, between Hare and Otto Fiords (Ladinian). (Page 89.)

Numbers 10a-c. *Procladiscites* cf. *P. martini* (Smith). Two views and external suture (x3) of GSC No. 14171. Blaa Mountain formation, Lower Shale member, Ellesmere Island, between Hare and Otto Fiords (Ladinian). (Page 89.)

PLATE XXII

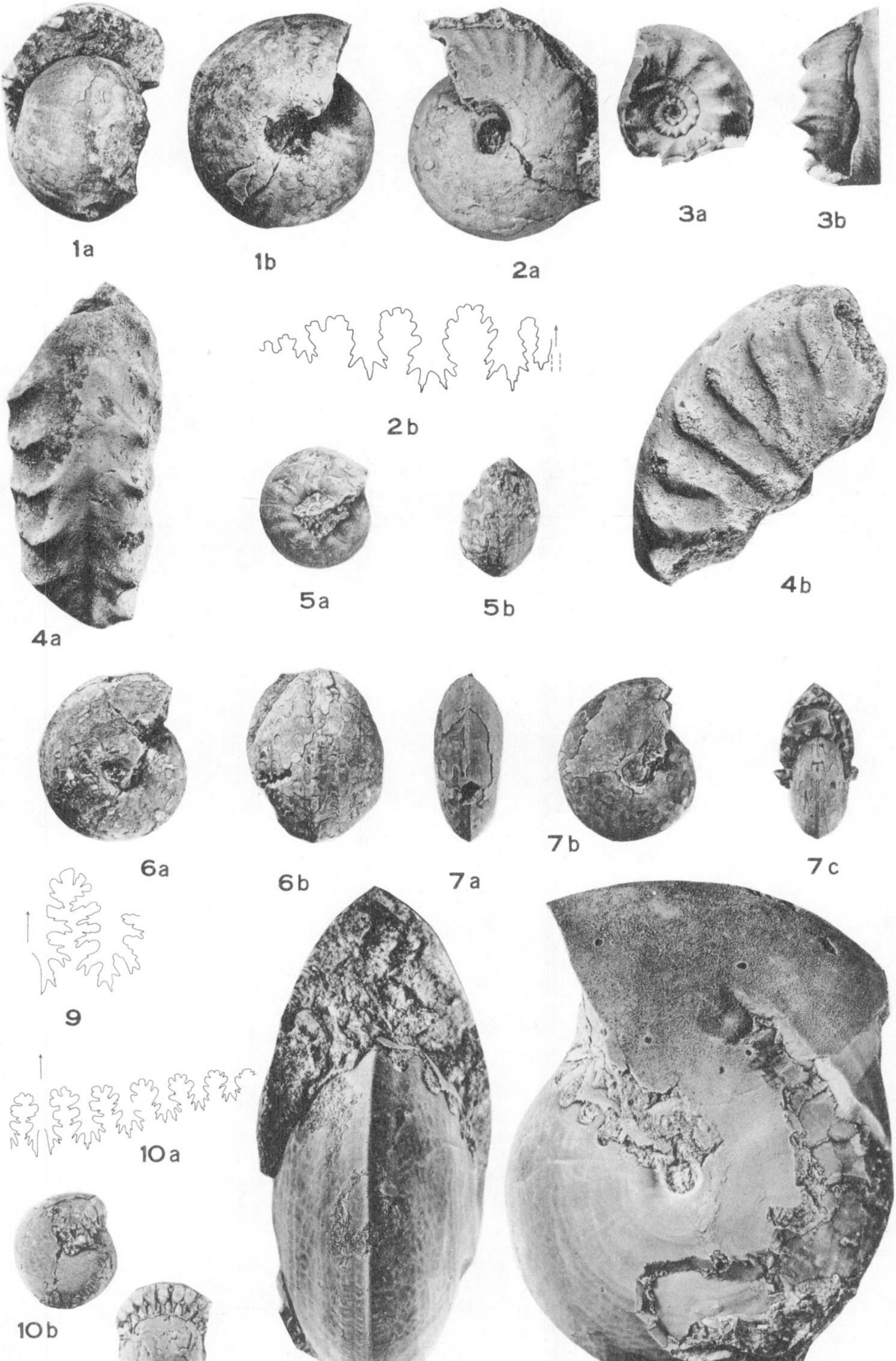


Plate XXIII

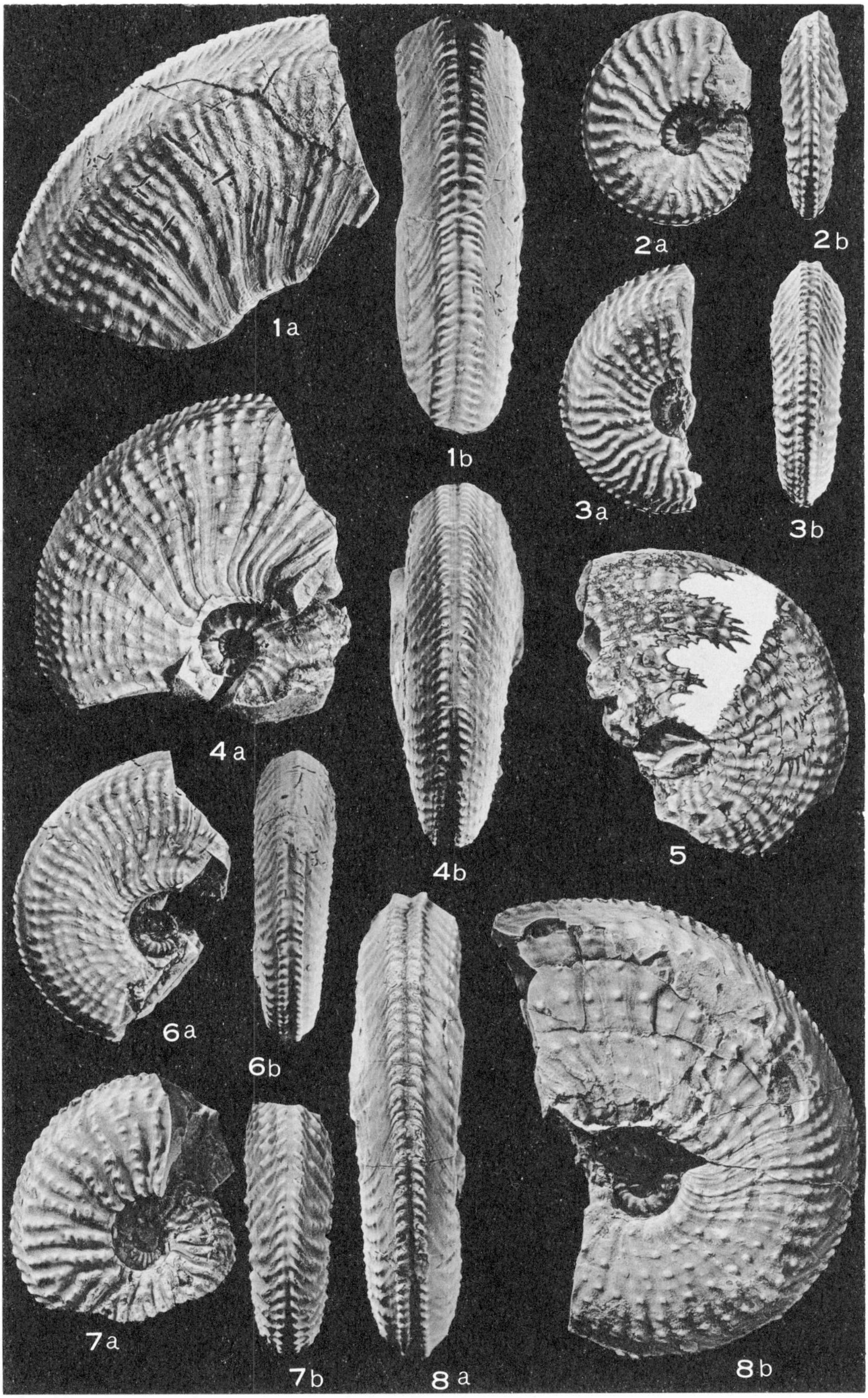


Plate XXIII

(All figures natural size)

Sirenites nanseni n. sp.

(Karnian)

(Page 77)

All specimens illustrated on this plate are from the Middle Shale member, Blaa Mountain formation, between Hare and Otto Fiords, Ellesmere Island.

Numbers 1a, b. Paratype, GSC No. 14162.

Numbers 2a, b. Paratype, GSC No. 14154.

Numbers 3a, b. Paratype, GSC No. 14158.

Numbers 4a, b. Paratype, GSC No. 14160.

Number 5. Paratype, GSC No. 14165.

Numbers 6a, b. Paratype with reduced sculpture near aperture, GSC No. 14164.

Numbers 7a, b. Paratype, GSC No. 14159.

Numbers 8a, b. Holotype, GSC No. 14161.

Plate XXIV

(Figures natural size unless otherwise stated)

Numbers 1a, b. *Arctosirenites canadensis* n. gen., n. sp. Inner whorls (x2), paratype, GSC No. 14119. Blaa Mountain formation, Buchanan Lake, Axel Heiberg Island (Karnian). (Page 82.)

Numbers 2a, b. *Arctosirenites canadensis* n. gen., n. sp. Inner whorls (x2), paratype, GSC No. 14120. Blaa Mountain formation, Buchanan Lake, Axel Heiberg Island (Karnian). (Page 82.)

Numbers 3a, b. *Arctosirenites canadensis* n. gen., n. sp. Inner whorls (x2), paratype, GSC No. 14121. Blaa Mountain formation, Buchanan Lake, Axel Heiberg Island (Karnian). (Page 82.)

Numbers 4a, b. *Arctosirenites canadensis* n. gen., n. sp. Paratype, GSC No. 14128. Blaa Mountain formation, Buchanan Lake, Axel Heiberg Island (Karnian). (Page 82.)

Numbers 5a-c. *Arctosirenites canadensis* n. gen., n. sp. Paratype, GSC No. 14123. Blaa Mountain formation, Buchanan Lake, Axel Heiberg Island (Karnian). (Page 82.)

Numbers 6a, b. *Arctosirenites* sp. indet. GSC No. 14141. Blaa Mountain formation, Buchanan Lake, Axel Heiberg Island (Karnian). (Page 84.)

Number 7. *Sirenites senticosus* (Dittmar). Hypotype, GSC No. 14149. Schei Point formation, Cape Ursula, Table Island (Karnian). (Page 75.)

Number 8. *Sirenites senticosus* (Dittmar). Hypotype, GSC No. 14150. Schei Point formation, Borden Island (Karnian). (Page 75.)

Numbers 9a, b. *Sirenites senticosus* (Dittmar). Holotype, GSC No. 14148. Schei Point formation, Cape Ursula, Table Island (Karnian). (Page 75.)

Number 10. *Sirenites costatus* n. sp. Inner whorls, paratype, GSC No. 14145. Blaa Mountain formation, Buchanan Lake, Axel Heiberg Island (Karnian). (Page 80.)

Numbers 11a, b. *Sirenites costatus* n. sp. Holotype, GSC No. 14143. Blaa Mountain formation, Buchanan Lake, Axel Heiberg Island (Karnian). (Page 80.)

Numbers 12a, b. *Sirenites nanseni* n. sp. Paratype, GSC No. 14153. Middle Shale member, Blaa Mountain formation, between Hare and Otto Fiords, Ellesmere Island (Karnian). (Page 77.)

Numbers 13a, b. *Sirenites nanseni* n. sp. Paratype, GSC No. 14166. Schei Point formation, Hat Island (Karnian). (Page 77.)

Numbers 14a, b. *Sirenites nanseni* n. sp. Paratype, GSC No. 14157. Middle Shale member, Blaa Mountain formation, between Hare and Otto Fiords, Ellesmere Island (Karnian). (Page 77.)

Numbers 15a, b. *Sirenites nanseni* n. sp. Paratype, GSC No. 14163. Middle Shale member, Blaa Mountain formation, between Hare and Otto Fiords, Ellesmere Island (Karnian). (Page 77.)

Numbers 16a, b. *Sirenites nanseni* n. sp. Paratype, GSC No. 14151. Middle Shale member, Blaa Mountain formation, between Hare and Otto Fiords, Ellesmere Island (Karnian). (Page 77.)

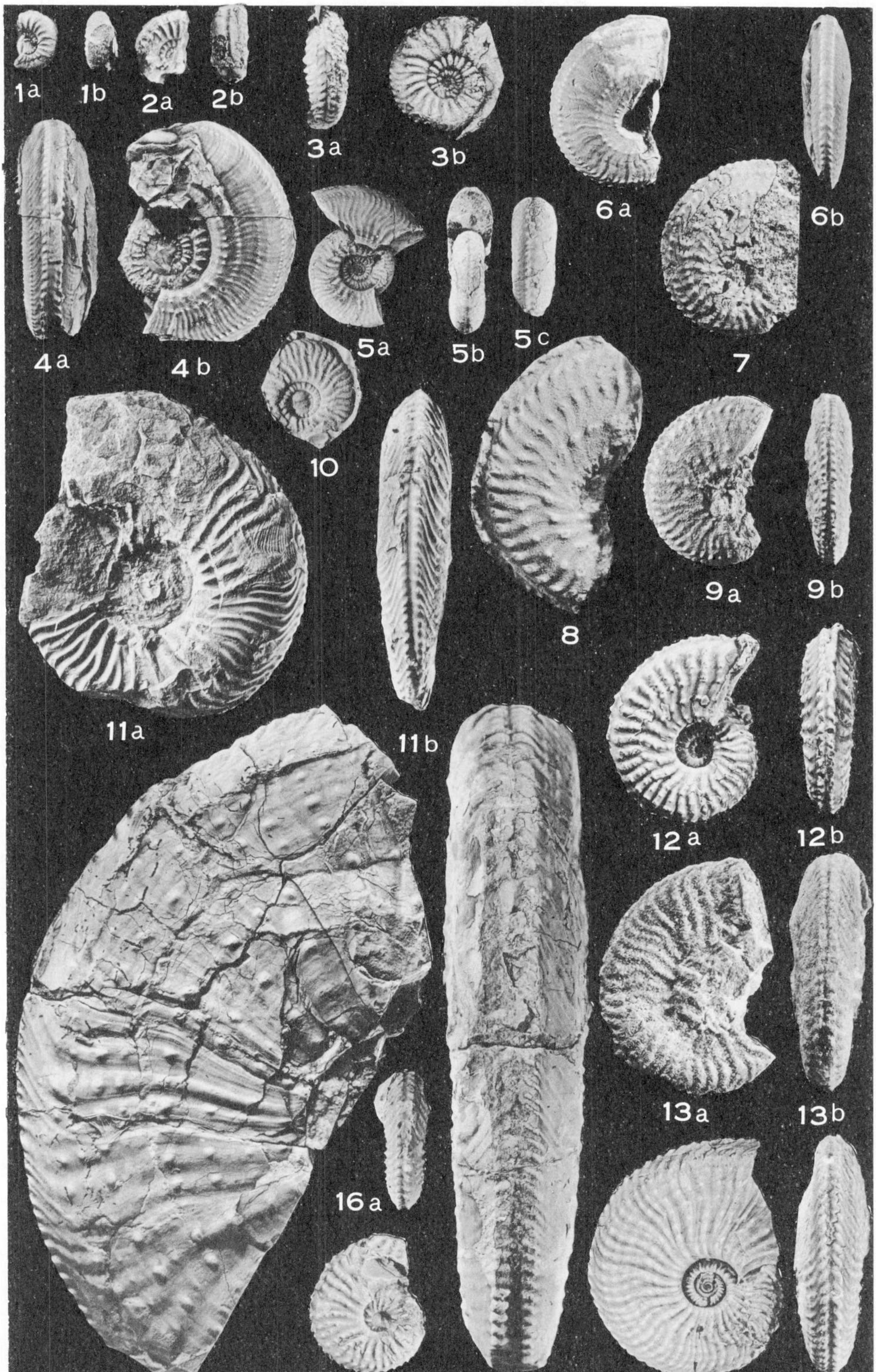

1a
1b
2a
2b
3a
3b
6a
6b
4a
4b
5a
5b
5c
7
10
8
9a
9b
11a
11b
12a
12b
13a
13b
16a
16b
15a
15b
14a
14b

PLATE XXV

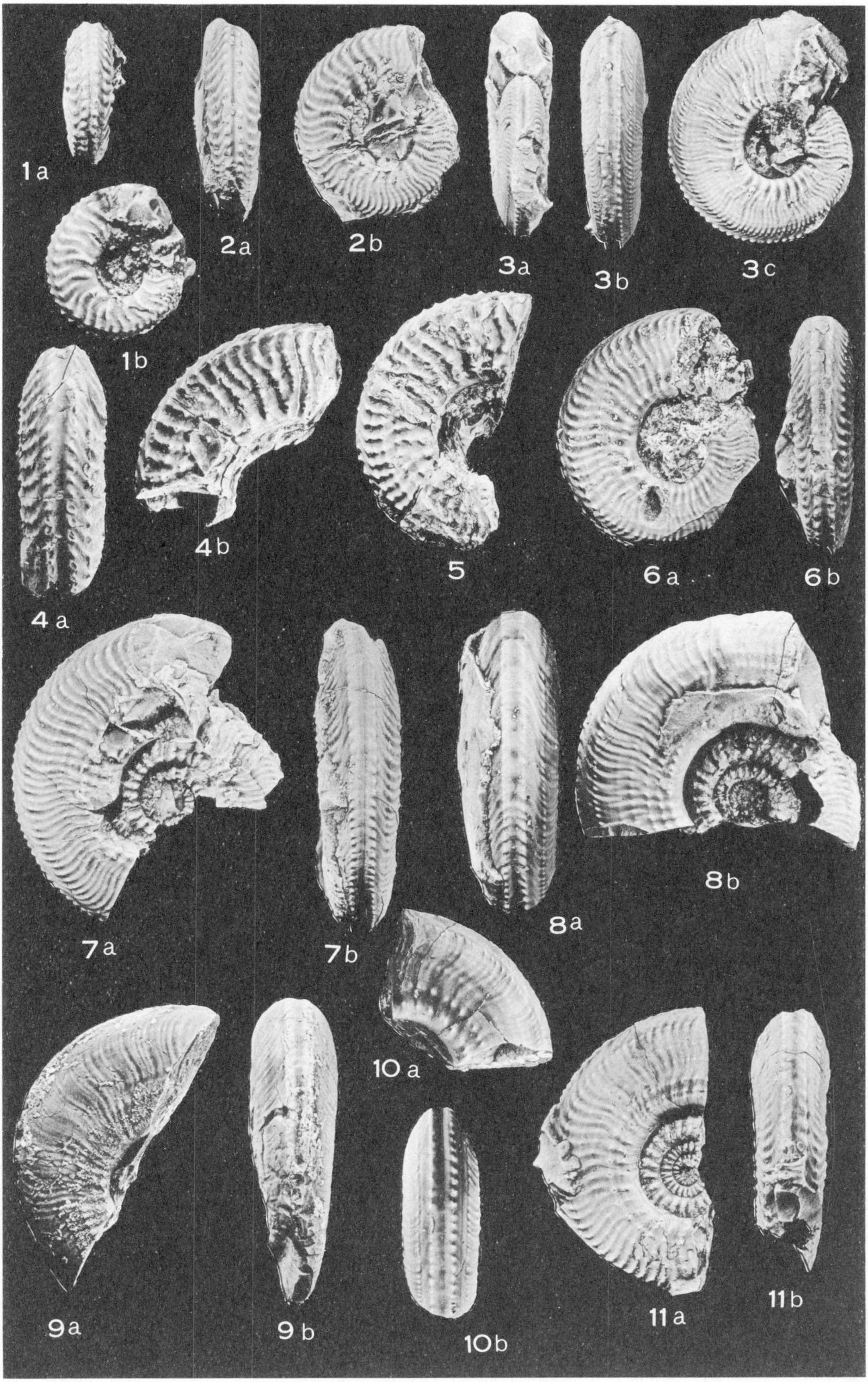


Plate XXV

(All figures natural size)

Arctosirenites canadensis n. gen., n. sp.

(Karnian)

(Page 82)

All specimens illustrated on this plate are from the Blaa Mountain formation, Buchanan Lake, Axel Heiberg Island.

Numbers 1a, b. Paratype, GSC No. 14124.

Numbers 2a, b. Paratype, GSC No. 14125.

Numbers 3a-c. Paratype, GSC No. 14126.

Numbers 4a, b. Paratype, GSC No. 14133.

Number 5. Paratype, GSC No. 14130.

Numbers 6a, b. Paratype, GSC No. 14129.

Numbers 7a, b. Paratype, GSC No. 14135.

Numbers 8a, b. Holotype, GSC No. 14136.

Numbers 9a, b. Paratype, GSC No. 14139.

Numbers 10a, b. Paratype, GSC No. 14138.

Numbers 11a, b. Paratype, GSC No. 14134.

Plate XXVI

(All figures natural size unless otherwise stated)

Numbers 1a-d. *Rhacophyllites zitteli* Mojsisovics. Hypotype, GSC No. 14178. Blaa Mountain formation, Upper Shale member, near Eureka, Ellesmere Island (Karnian). (Page 96.)

Numbers 2a, b. *Jovites borealis* n. sp. Inner whorls (x2), paratype, GSC No. 14107. Blaa Mountain formation, Buchanan Lake, Axel Heiberg Island (Karnian). (Page 86.)

Numbers 3a, b. *Jovites borealis* n. sp. Paratype, phragmocone, GSC No. 14109. Blaa Mountain formation, Buchanan Lake, Axel Heiberg Island (Karnian). (Page 86.)

Numbers 4a-c. *Jovites borealis* n. sp. Holotype, GSC No. 14112. Blaa Mountain formation, Buchanan Lake, Axel Heiberg Island (Karnian). (Page 86.)

Number 5. *Jovites borealis* n. sp. Paratype, GSC No. 141115. Schei Point formation, Cape Ursula, Table Island (Karnian). (Page 86.)

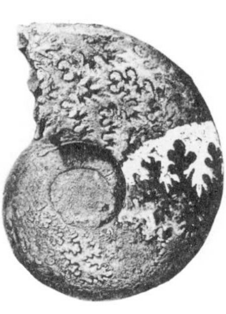
Number 6. *Jovites borealis* n. sp. Paratype, GSC No. 14114. Blaa Mountain formation, Buchanan Lake, Axel Heiberg Island (Karnian). (Page 86.)

Number 7. *Jovites borealis* n. sp. Paratype, GSC No. 14113. Blaa Mountain formation, Buchanan Lake, Axel Heiberg Island (Karnian). (Page 86.)


1a


1b


1c


1d

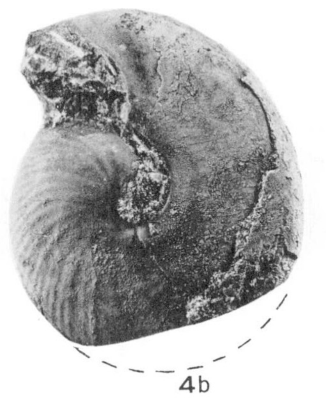

2a


2b


3a


3b


4a


4b

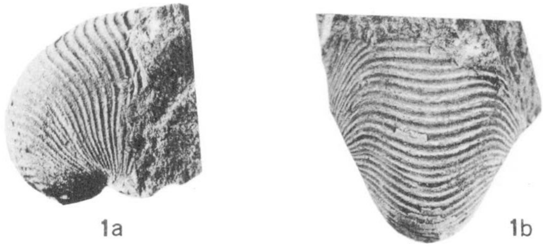

4c


5


6


7

PLATE XXVII



1a 1b

2

3

4

5

6a 6b

7

8a 8b 8c

PLATE XXVII

(All figures natural size)

Numbers 1a, b. *Proclydonautilus spirolobus* (Dittmar). Hypotype, GSC No. 14184. Schei Point formation, Borden Island (Karnian). (Page 96.)

Number 2. *Proclydonautilus spirolobus* (Dittmar). Ventral view showing part of septal suture, GSC No. 14185. Blaa Mountain formation, probably Upper Calcareous member, Schei Peninsula, Axel Heiberg Island (Karnian). (Page 96.)

Number 3. *Tropites* cf. *T. morani* Smith. Rubber mould from natural cast, hypotype, GSC No. 14180. Schei Point formation, Cameron Island (Karnian). (Page 85.)

Number 4. *Tropites* cf. *T. morani* Smith. Hypotype, GSC No. 14181. Schei Point formation, Cameron Island (Karnian). (Page 85.)

Number 5. *Tropites* cf. *T. morani* Smith. Ventral view of fragmentary hypotype, GSC No. 14182. Schei Point formation, Cameron Island (Karnian). (Page 85.)

Numbers 6a, b. *Jovites richardsi* n. sp. Inner whorls, paratype, GSC No. 14116. Schei Point formation, Cameron Island (Karnian). (Page 88.)

Number 7. *Jovites richardsi* n. sp. Paratype, GSC No. 14117. Schei Point formation, Cameron Island (Karnian). (Page 88.)

Numbers 8a-c. *Jovites richardsi* n. sp. Holotype, GSC No. 14118. Schei Point formation, Cameron Island (Karnian). (Page 88.)

Plate XXVIII

(All figures natural size)

Number 1. *Claraia stachei* Bittner. Left valve, from East Greenland (Lower Scythian). (Page 97.)

Number 2. *Claraia stachei* Bittner. Right valve, hypotype, GSC No. 14195, from beds about 50 feet above base of Blind Fiord formation, Bunde Fiord, Axel Heiberg Island (Lower Scythian). (Page 97.)

Number 3. *Claraia clarai* (Emmrich). Right valve, hypotype, GSC No. 14196. Spray River group, Brazeau River, Alberta (Lower Scythian). (Page 98.)

Number 4. *Pseudomonotis boreas* (Oeberg). Left valve, hypotype, GSC No. 14199. *Meekoceras* bed of Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island (Upper Scythian). (Page 99.)

Number 5. *Pseudomonotis boreas* (Oeberg). Left valve, hypotype, GSC No. 14200. *Meekoceras* bed of Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island (Upper Scythian). (Page 99.)

Number 6. *Posidonia mimer* Oeberg. Left valve, hypotype, GSC No. 14201. *Meekoceras* bed of Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island (Upper Scythian). (Page 101.)

Number 7. *Pseudomonotis occidentalis* (Whiteaves). Left valve, hypotype, GSC No. 14197. *Wasatchites* bed of Blind Fiord formation, Bunde Fiord, Axel Heiberg Island (Upper Scythian). (Page 98.)

Number 8. *Pseudomonotis occidentalis* (Whiteaves). Left valve, hypotype, GSC No. 14198. *Wasatchites* bed of Blind Fiord formation, Bunde Fiord, Axel Heiberg Island (Upper Scythian). (Page 98.)

Number 9. *Pseudomonotis occidentalis* (Whiteaves). Left valve, holotype of "*Monotis ovalis* Whiteaves", GSC No. 4728. Presumably Toad formation, Liard River, British Columbia (Upper Scythian). (Page 98.)

Number 10. *Pseudomonotis occidentalis* (Whiteaves). Left valve, holotype, GSC No. 4722. Presumably Toad formation, Liard River, British Columbia (Upper Scythian). (Page 98.)

Number 11. *Pseudomonotis occidentalis* (Whiteaves). Right valve showing anterior auricle, paratype of "*Pseudomonotis ovalis* var. *kindli* McLearn", GSC No. 9598. *Wasatchites bed,* Toad formation, Liard River, British Columbia. (Page 98.)

Number 12. *Pseudomonotis occidentalis* (Whiteaves). Fragmentary right valve, above, and left valve, below. These specimens were doubtfully referred to "*Halobia occidentalis*" by Whiteaves, GSC No. 4722a. Presumably Toad formation, Liard River, British Columbia (Upper Scythian). (Page 98.)

Number 13. *Posidonia aranea* n. sp. Right valve, holotype, GSC No. 14202. *Olenikites* bed of Blind Fiord formation near mouth of Otto Fiord, Ellesmere Island (uppermost Scythian). (Page 102.)

Number 14. *Posidonia aranea* n. sp. Crushed left valve, paratype, GSC No. 14204. *Olenikites* bed of Blind Fiord formation, near mouth of Otto Fiord, Ellesmere Island (uppermost Scythian). (Page 102.)

Number 15. *Posidonia aranea* n. sp. Interior of broken left valve. Paratype, GSC No. 14203. *Olenikites* bed of Blind Fiord formation, between Hare and Otto Fiords, Ellesmere Island (uppermost Scythian). (Page 102.)

PLATE XXVIII

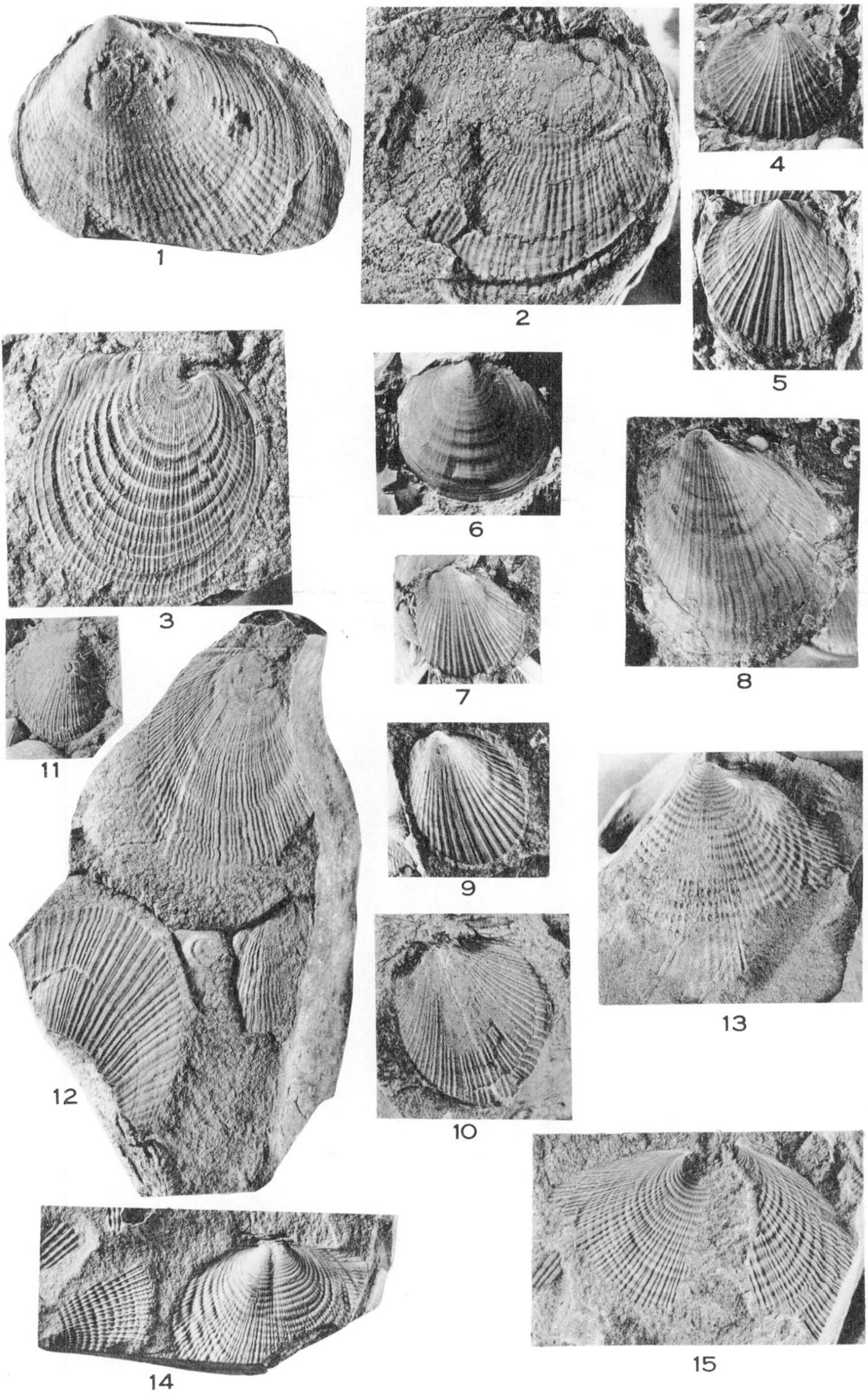


PLATE XXIX

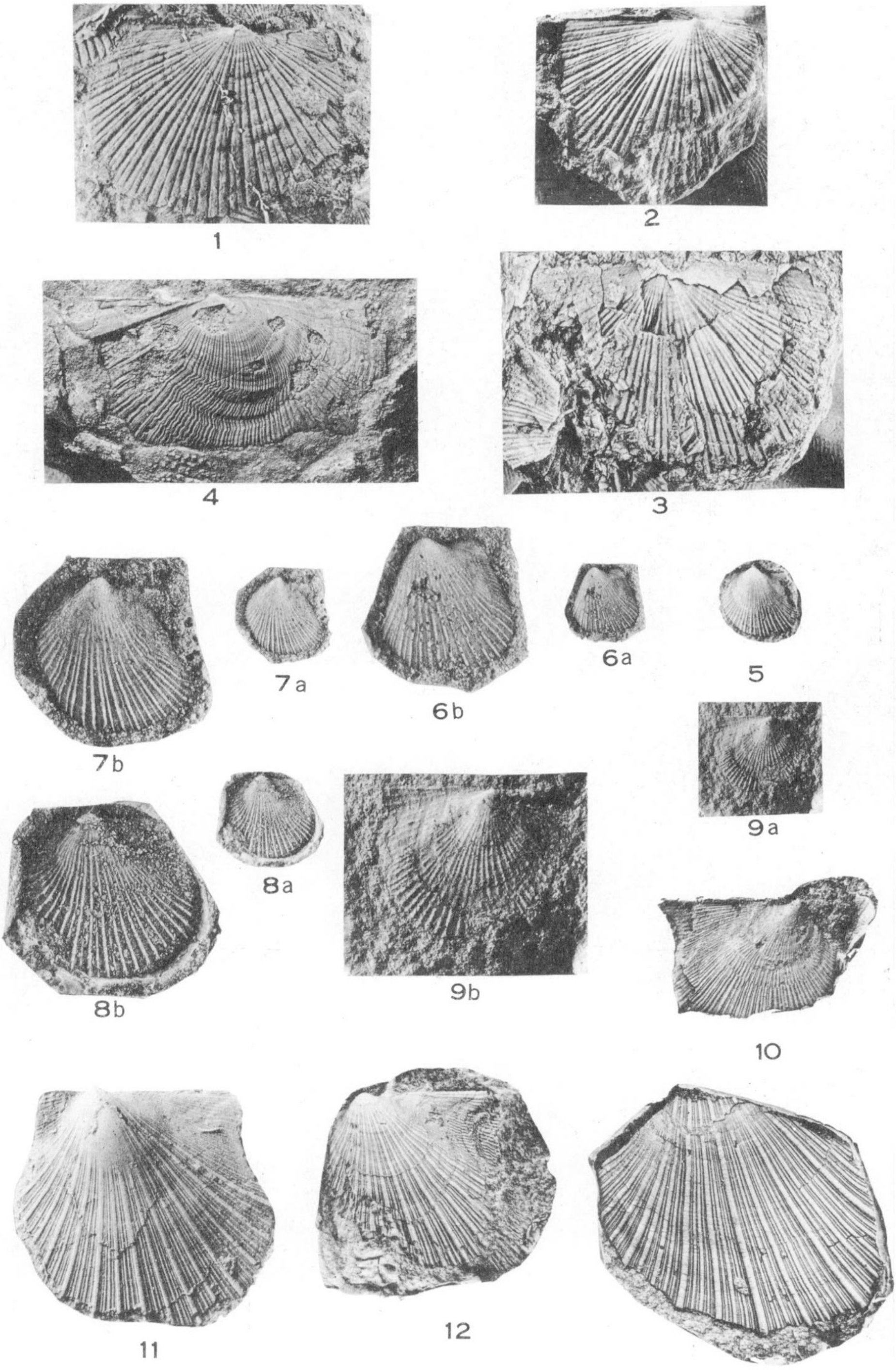


PLATE XXIX

(Figures natural size unless otherwise stated)

Number 1. *Daonella frami* Kittl. Rubber cast of impression of right valve, topotype, GSC No. 14205. Blaa Mountain formation, Lower Shale member, Blaa Mountain, Ellesmere Island (Anisian or Ladinian). (Page 103.)

Number 2. *Daonella frami* Kittl. Right valve, hypotype, GSC No. 14206. Schei Point formation, Bjorne Peninsula, Ellesmere Island (Anisian or Ladinian). (Page 103.)

Number 3. *Daonella frami* Kittl. Left valve, hypotype, GSC No. 14207. Schei Point formation, Table Island (Anisian or Ladinian). (Page 103.)

Number 4. *Halobia zitteli* Lindstrom. Left valve, hypotype, GSC No. 14208. Schei Point formation, Bjorne Peninsula, Ellesmere Island (Karnian). (Page 104.)

Number 5. *Meleagrinella antiqua* n. sp. Left valve, paratype, GSC No. 14212. Heiberg formation, Buchanan Lake, Axel Heiberg Island (Karnian or Norian). (Page 104.)

Numbers 6a, b. *Meleagrinella antiqua* n. sp. Rubber cast of impression of left valve, 6b x2, paratype, GSC No. 14210. Heiberg formation, Bjorne Peninsula, Ellesmere Island (Karnian or Norian). (Page 104.)

Numbers 7a, b. *Meleagrinella antiqua* n. sp. Rubber cast of impression of left valve, 7b x2, holotype, GSC No. 14209. Heiberg formation, Bjorne Peninsula, Ellesmere Island (Karnian or Norian). (Page 104.)

Numbers 8a, b. *Meleagrinella antiqua* n. sp. Rubber cast of impression of left valve, 8b x2, paratype, GSC No. 14211. Heiberg formation, Bjorne Peninsula, Ellesmere Island (Karnian or Norian). (Page 104.)

Numbers 9a, b. *Meleagrinella antiqua* n. sp. Rubber cast of impression of right valve, 9b x2, paratype, GSC No. 14213. Heiberg formation, west coast of Raanes Peninsula, Ellesmere Island (Karnian or Norian). (Page 104.)

Number 10. *Oxytoma kiparisovae* n. sp. Rubber cast of impression of right valve, paratype, GSC No. 14214. Heiberg formation, near Eureka, Ellesmere Island (Karnian or Norian). (Page 100.)

Number 11. *Oxytoma kiparisovae* n. sp. Rubber cast of impression of left valve, holotype, GSC No. 14215. Heiberg formation, near Eureka, Ellesmere Island (Karnian or Norian). (Page 100.)

Number 12. *Oxytoma kiparisovae* n. sp. Rubber cast of impression of left valve, paratype, GSC No. 14216. Heiberg formation, near Eureka, Ellesmere Island (Karnian or Norian). (Page 100.)

Number 13. *Oxytoma kiparisovae* n. sp. Rubber cast of impression of lower part of left valve, paratype, GSC No. 14217. Heiberg formation, near Eureka, Ellesmere Island (Karnian or Norian). (Page 100.)

Plate XXX

(All figures natural size)

Monotis ochotica (Keyserling)

(Norian)

(Page 106)

Number 1. Left valve, hypotype, GSC No. 14218. Heiberg formation, near Wolf Fiord, Axel Heiberg Island.

Number 2. Right valve of variety showing weak sculpture on anterior part of valve, hypotype, GSC No. 14219. Heiberg formation, near Wolf Fiord, Axel Heiberg Island.

Number 3. Right valve showing weak anterior sculpture, hypotype, GSC No. 14220. Heiberg formation, near Wolf Fiord, Axel Heiberg Island.

Numbers 4a, b. Right and left valves of a bivalved specimen, hypotype, GSC No. 14221. Heiberg formation, west coast of Raanes Peninsula, Ellesmere Island.

Number 5. Left valve, hypotype, GSC No. 14222. Heiberg formation, west coast of Raanes Peninsula, Ellesmere Island.

Number 6. Rubber cast of impression of right valve showing byssal auricle, hypotype, GSC No. 14224. Heiberg formation, near Mount Nicolay, Cornwall Island.

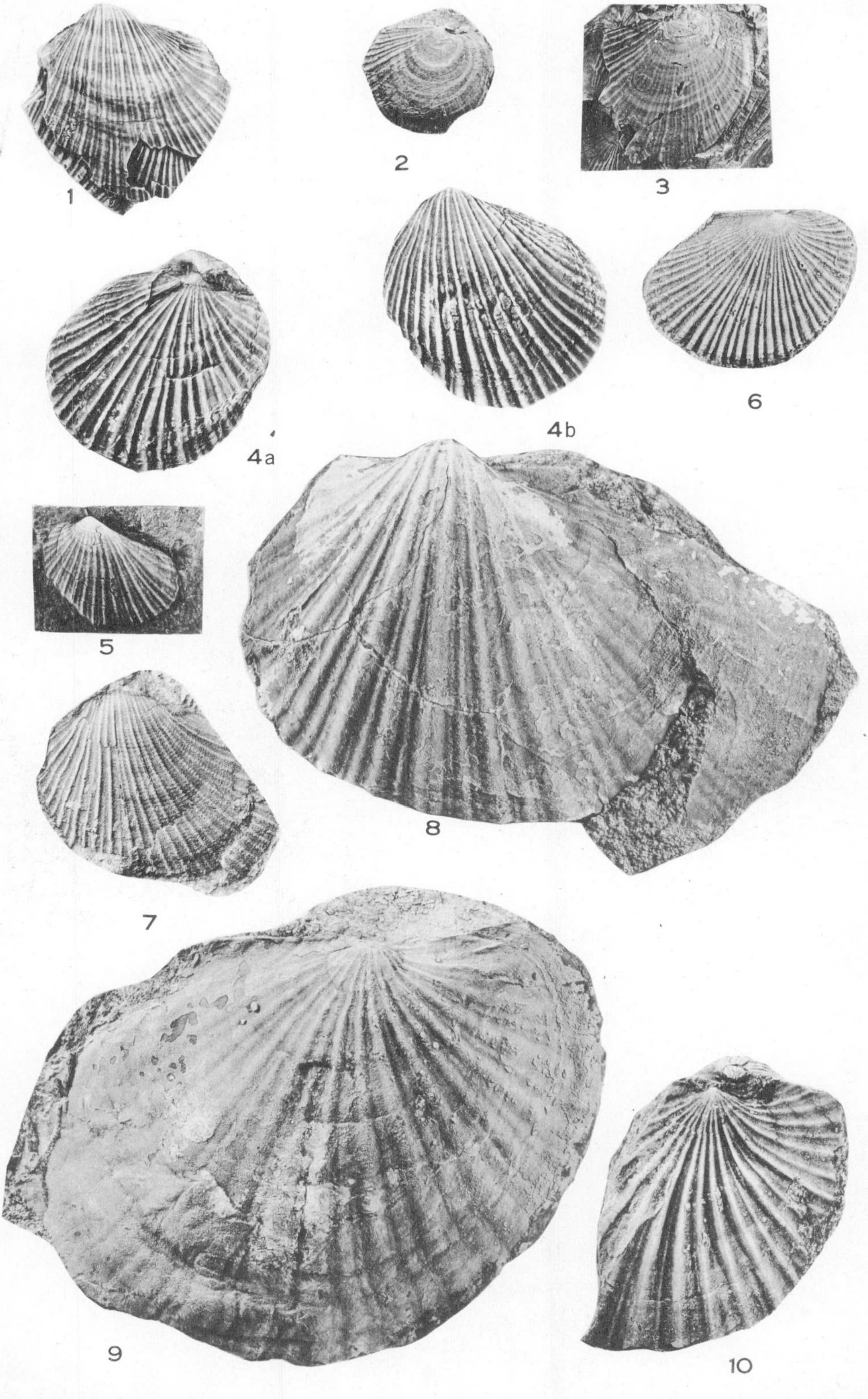
Number 7. Rubber cast of impression of left valve, showing concentric sculpture, hypotype, GSC No. 14223. Heiberg formation, near Mount Nicolay, Cornwall Island.

Number 8. Left valve of a large specimen, probably an adult, hypotype, GSC No. 14225. Heiberg formation, near Mount Nicolay, Cornwall Island.

Number 9. Right valve of a large specimen showing byssal auricle, hypotype, GSC No. 14226. Heiberg formation, near Mount Nicolay, Cornwall Island.

Number 10. Right valve of a fragmentary bivalved specimen, hypotype, GSC No. 14227. Heiberg formation, near Mount Nicolay, Cornwall Island.

PLATE XXX



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Numbers in **bold face** type indicate pages where species are described.