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THE JURASSIC FAUNAS OF THE CANADIAN ARCTIC

Lower Jurassic Ammonites, Biostratigraphy and Correlations

Hans Frebold

Ottawa
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1975

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By
Hans Frebold

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Preface

Several new collections of Lower Jurassic ammonites made in the Canadian Arctic in recent years formed the basis of the study whose results are reported in this bulletin. The new collections not only yielded a number of new species that prove the presence of previously unknown stages or substages, but they also offer a clearer picture of the distribution of the various Lower Jurassic faunas in part of the Canadian Arctic.

To meet one of its objectives, the estimation of the potential abundance and probable distribution of the mineral and fuel resources available to Canada, the Geological Survey requires extensive stratigraphic and paleontological data. This report presents information and interpretations that will be of considerable assistance in better understanding the geology of an important part of the Canadian Arctic.

D. J. McLaren,
Director, Geological Survey of Canada

Ottawa, March 4, 1974

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Lower Jurassic Ammonites, Biostratigraphy and Correlations

Abstract

A number of ammonite genera and species previously unknown in the Lower Jurassic beds of the Canadian Arctic are described in this report. These are: Psiloceratinae? (possibly Hettangian), *Charmasseiceras* and *Coroniceras* (*Primarietites*) (Bucklandi Zone of the Lower Sinemurian), *Gleviceras plauchuti* Frebold sp. nov. (Oxynotum Zone of the Upper Sinemurian), *Echioceras aklavikense* Frebold sp. nov. and *Echioceras arcticum* Frebold sp. nov. (Raricostatum Zone of the Upper Sinemurian), *Amaltheus stokesi* (J. Sowerby) (Margaritatus Zone of the Upper Pliensbachian), *Hildaites* sp. indet. (Falcifer Subzone of the Lower Toarcian), and *Zugodactylites* cf. *braunianus* (d'Orbigny) (Braunianus Subzone of the Middle Toarcian). The generic position of some previously described ammonites is revised: the Late Toarcian species *Peronoceras spinatum* (Frebold) and *P. polare* (Frebold) were assigned formerly to *Catacoeloceras* Buckman.

The sequence of Lower Jurassic ammonites in the Canadian Arctic Archipelago is now more complete. Moreover, it is virtually identical to that in the Richardson and British Mountains and in northern Alaska. In addition, the principal gaps in the sequences of the three compared areas (Lower Pliensbachian and upper part of Upper Toarcian) are the same. There are also close similarities to the sequence in northeastern Russia.

Résumé

L'auteur décrit ici un certain nombre de genres et d'espèces d'ammonites inconnues auparavant dans les couches du Jurassique inférieur de l'Arctique canadien. Ce sont: Psiloceratinae? (possiblement de l'Hettangien), *Charmasseiceras* et *Coroniceras* (*Primarietites*) (zone à Bucklandi du Sinémurien inférieur), *Gleviceras plauchuti* Frebold sp. nov. (zone à Oxynotum du Sinémurien supérieur), *Echioceras aklavikense* Frebold sp. nov. et *Echioceras arcticum* Frebold (zone à Raricostatum du Sinémurien supérieur), à *Amaltheus stokesi* (J. Sowerby) (zone à Margaritatus du Pliensbachien supérieur), *Hildaites* sp. indet. (sous-zone à Falcifer du Toarcien inférieur) et *Zugodactylites*, cf. *braunianus* (d'Orbigny) (sous-zone à Braunianus du Toarcien moyen). L'auteur modifie la position générique de quelques ammonites déjà décrites: les espèces *Peronoceras spinatum* (Frebold) et *P. polare* (Frebold) du Toarcien supérieur appartenaient auparavant au genre *Catacoeloceras* de Buckman.

La séquence d'ammonites du Jurassique inférieur dans l'archipel Arctique canadien est maintenant plus complète. De plus, elle est pratiquement identique à celles des montagnes Richardson et British et du nord de l'Alaska. En outre, les principales lacunes dans les séquences des trois régions comparées (Pliensbachien inférieur et partie supérieure du Toarcien supérieur) sont les mêmes. Il existe aussi de profondes ressemblances avec la séquence située dans le nord-est de la Russie.

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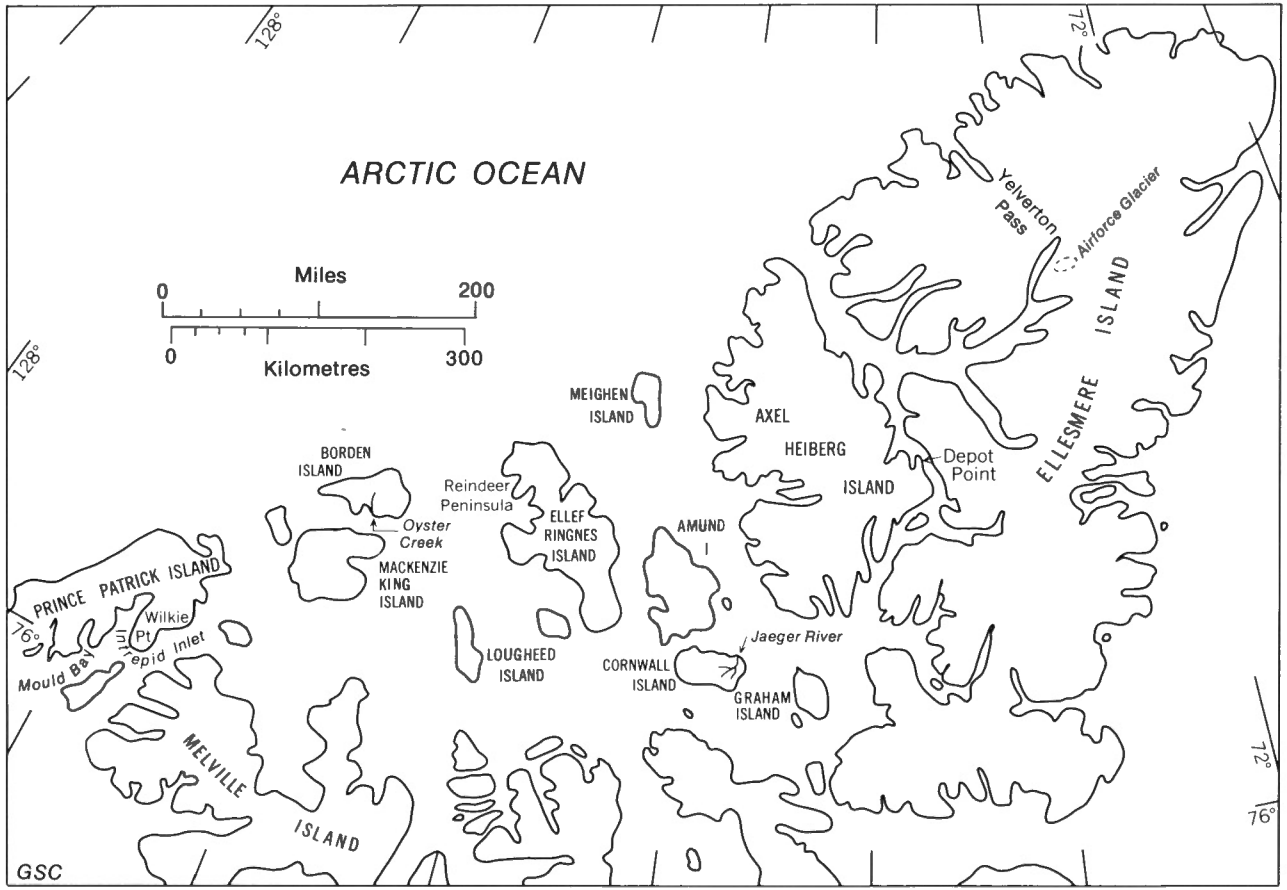


Figure 1. The Canadian Arctic Islands

Introduction

Since 1967 several new and interesting collections of Lower Jurassic ammonites have been made from the Canadian Arctic; these form the basis of this study. The new collections not only have yielded a number of new species that prove the presence of some previously unknown stages or substages, but also offer a clearer picture of the distribution of the various Lower Jurassic faunas of this region. Previous descriptions include those of Frebold (1957, 1960) and Frebold *et al.* (1967). New publications on the Lower Jurassic ammonites and stratigraphy in neighbouring northern Alaska and in northeastern Russia have offered better opportunities for correlation of the Lower Jurassic faunas and sequences in the Canadian Arctic than had been available.

Accounts of the distribution, facies, and thickness of the various formations distinguished in the Canadian Arctic Archipelago are given in publications by Nassichuk and Christie (1969), Stott (1969), Tozer (1970), and Plauchut (1971).

This report is based on collections made by R. L. Christie, H. Greiner, J. A. Jeletzky, W. W. Nassichuk, D. K. Norris, and D. F. Stott of the Geological Survey of Canada, and by Elf Oil Exploration and Production Canada Limited, Panarctic Oils Limited, Shell Canada Limited, and J. C. Sproule and Associates Limited.

The author expresses his thanks to these collectors for all information on their collections.

Ammonite Localities

Localities of the specimens described herein and of other new specimens follow (*see* Frebold, 1957, 1960; Frebold *et al.*, 1967, for localities of previously described specimens).

Hettangian?

Bonnet (=Bonny) Lake area, Yukon. South shore of confluent of Johnson Creek draining Bonnet Lake, 5 miles west of the lake (approx. 68°09′45″N, 137° 58′W). Unnamed basal Jurassic unit; in place and fresh talus. Collected by J. A. Jeletzky, Geological Survey of Canada, 1970; field no. JA-F 70-23-7, GSC loc. 85526, and field no. JA-F 70-23-8, GSC loc. 85527.

According to Jeletzky (1971, p. 205), the beds concerned consist of siliceous siltstone, which he considers to be equivalent to the north Alaskan Kingak Shale. Imlay and Detterman (1973, p. 13), however, do not include the basal Jurassic clastics with *Psiloceras* in their north Alaskan Kingak Shale.

Ammonites collected:

Poorly preserved ammonites, possibly belonging to the subfamily Psiloceratinae Hyatt, 1867.

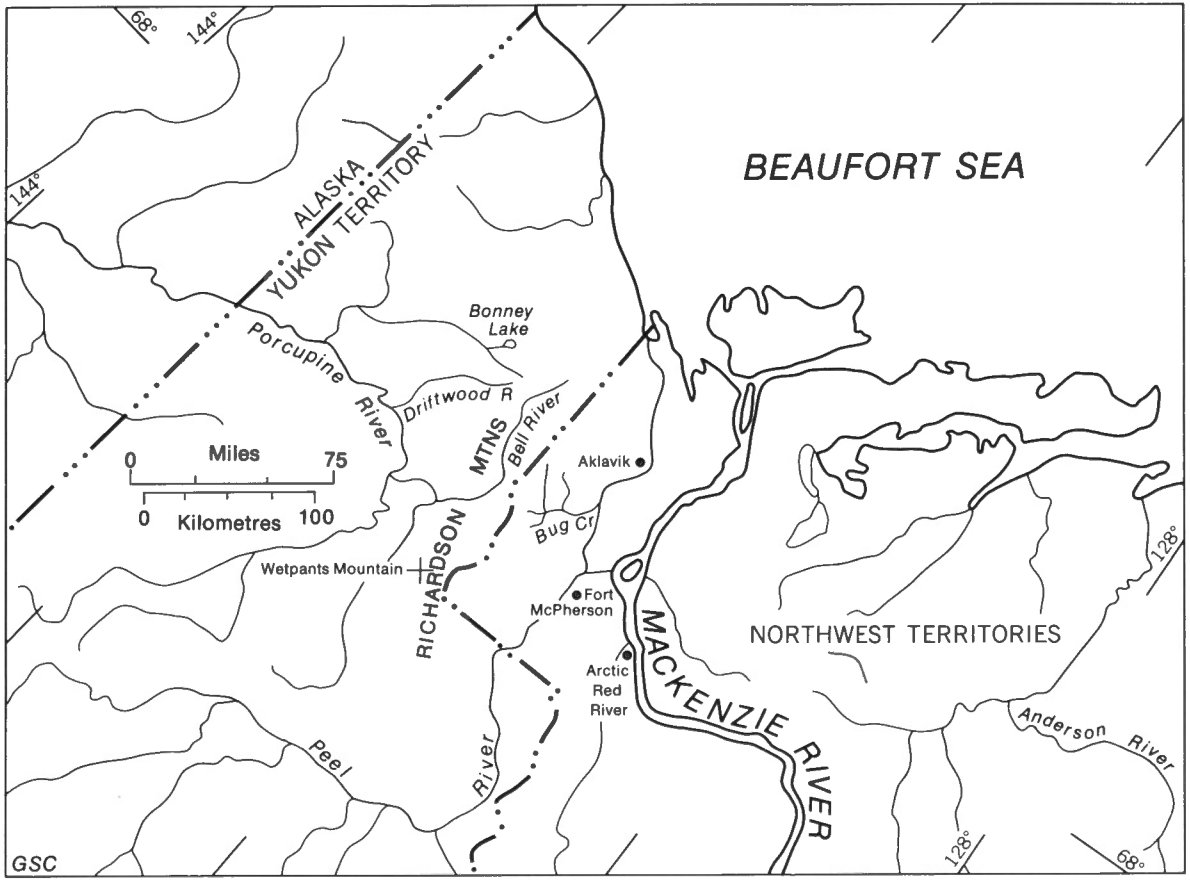


Figure 2. Northern parts of the Yukon and Northwest Territories

Lower Sinemurian

North end of Reindeer Peninsula, Ellef Ringnes Island. Borden Island Formation. Collected by D. F. Stott, Geological Survey of Canada, 1967; field no. SI 67-2-33, GSC loc. 80753 (Stott, 1969, p. 17).

Ammonites collected:

Charmasseiceras sp. indet.
Coroniceras (*Primarietites*) sp. indet.

Upper Sinemurian

Prince Patrick Island, east side of Intrepid Inlet, 7 miles south of Hiccles Cove. Borden Island Formation. Collected by Elf Oil Exploration and Production Canada Limited, 1965; field no. E 30622, GSC loc. 70402.

Ammonite collected:

Gleviceras plauchuti Frebold sp. nov.

Melville Island. Borden Island Formation. Collected by J. C. Sproule and Associates Limited, 1963; GSC loc. 60220.

Ammonites collected:

Echioceras aklavikense Frebold sp. nov.

Northern Richardson Mountains (67°37′N, 136°10′W). Bug Creek Formation? Collected by Shell Canada Limited; field no. KJ 175-N-38, GSC loc. 88066.

Ammonites collected:

Arctoasteroceras jeletzkyi Frebold

Oyster Creek, Borden Island. Borden Island Formation. Collected by Elf Oil Exploration and Production Canada Limited; field no. 30439, GSC loc. 72608.

Ammonites collected:

Echioceras arcticum Frebold sp. nov.

Porcupine River between Driftwood and Bell Rivers, about 11 miles north (downstream) from mouth of Bell River. Talus. Collected by W. W. Nassichuk, Geological Survey of Canada, 1970; field no. NF 70-1-5, GSC loc. 85359.

Ammonites collected:

Echioceras cf. *E. arcticum* Frebold sp. nov.

Upper Pliensbachian

North of Wilkie Point, Prince Patrick Island (76°21′N, 117°30′W). Borden Island Formation. Collected by Elf Oil Exploration and Production Canada Limited, 1971; field no. F 8, GSC loc. C-12544.

Ammonites collected:

Amaltheus stokesi (J. Sowerby)

Depot Point, Axel Heiberg Island (79°76′30″N, 85°46′W). Collected by Panarctic Oils Limited, 1970; field no. 69-PI-8-5F, GSC loc. C-4728.

Ammonites collected:

Amaltheus stokesi (J. Sowerby)
Amaltheus sp. indet.

Lower Toarcian

Northwestern end of Richardson Mountains, Yukon; crest of low shale ridge on west side of north-flowing creek (68°17′N, 137°47′35″W). Kingak Shale equivalent; mostly float. Collected by J. A. Jeletzky, Geological Survey of Canada, 1970; field no. JA-F 70-17-2, GSC loc. 86821.

Ammonites collected:

Harpoceras aff. *H. exaratum* (Young and Bird)
Dactylioceras spp. (mainly fine-ribbed specimens)

Mid-eastern part of Cornwall Island; stream bed along Jaeger River. Jaeger Formation. Collected by H. Greiner, Geological Survey of Canada, 1955; GSC loc. 25981 (Greiner, 1963, p. 535).

Ammonite collected:

Hildaites sp. indet.

Middle Toarcian

North-central Reindeer Peninsula, Ellef Ringnes Island (78°57′N, 104°32′W). Savik Formation. Collected by D. F. Stott, Geological Survey of Canada, 1967; field no. SI 67-1-26, GSC loc. 80734 (Stott, 1969, p. 19).

Ammonites collected:

Zugodactylites cf. *Z. braunianus* (d'Orbigny)

Upper Toarcian

West of Intrepid Inlet, Prince Patrick Island (76°41′N, 118°43′W). Wilkie Point Formation. Collected by Elf Oil Exploration and Production Canada Limited, 1971; field no. F 10, GSC loc. C-12546.

Ammonites collected:

Pseudolioceras spitsbergense Frebold sp. nov.
Pseudolioceras sp. indet.

Prince Patrick Island, 4 to 6 miles northeast of Mould Bay Weather Station. Wilkie Point Formation. Collected by Elf Oil Exploration and Production Canada Limited, 1965; field no. PK 1-30-469, GSC loc. 70390.

Ammonites collected:

Pseudolioceras cf. *P. compactile* (Simpson)
Peronoceras polare (Frebold)

Yelverton Pass, Ellesmere Island (81°37′N, 78°15′W). Unnamed Jurassic beds. Collected by R. L. Christie, Geological Survey of Canada, 1963; field no. CB 63-320 F, GSC loc. 58289 (Nassichuk and Christie, 1969, p. 20).

Ammonites collected:

Peronoceras spinatum (Frebold)

Bell River, Yukon; Wetpants Mountain area (67°44′N, 137°09′W). Kingak Shale equivalent. Collected by Shell Canada Limited, 1961; field no. KG 8-N-61, GSC loc. 86535.

Ammonites collected:

Peronoceras cf. *P. polare* (Frebold)

Toarcian

(Substage not identified)

Bug Creek area, Northwest Territories. Kingak Shale equivalent. Collected by D. K. Norris, Geological Survey of Canada, 1969; field no. 354, GSC loc. C-4215. Collected from the same shale ridge as for GSC loc. 86821.

Fossils collected include:

Dactylioceras sp.
Harpoceras? sp. indet.

Lower Bajocian

Air Force Glacier, Ellesmere Island (81°48′N, 76°32′W). Unnamed Jurassic beds. Collected by R. L. Christie, Geological Survey of Canada, 1963; field no. CB 63-1-24 F, GSC loc. 57133 (Nassichuk and Christie, 1969, p. 20).

Ammonite collected:

Pseudolioceras m'clintocki (Haughton)

Grammoceras cf. *G. boreale* (Whiteaves) does not occur at this locality (*see* under heading "Age and correlation, Upper Toarcian," this report).

Systematic Descriptions

Family PSILOCERATIDAE Hyatt, 1867

Subfamily PSILOCERATINAE Hyatt, 1867

Ammonites gen. et sp. indet.

Plate 1, figures 9, 10

Material. Several very poorly preserved specimens, mainly impressions, from basal Jurassic unit in Bonnet Lake area, Yukon. Collected by J. A. Jeletzky, 1970; GSC loc. 85527.

Description. The specimens are moderately evolute, the flanks are slightly convex, and grade into the rounded venter. As far as can be seen, ribbing is present on the inner whorls. In later stages of growth there are fewer ribs and these have become blunt. No divided ribs have been

seen and there are no ribs on the venter. In one specimen, remnants of the last suture line are preserved. The ventral and lateral lobes seem to be equal in depth. The external and lateral saddles have the same height. The suture line seems to be very moderately incised.

Comparisons. These ammonites are undeterminable, and no ammonites known from the Canadian Arctic or other parts of Canada are similar. However, they bear some resemblance to certain Psiloceratinae. *Psiloceras* is known to be present in the Porcupine River area of northern Alaska (Imlay and Detterman, 1973) and, as the ammonites were found in a basal Jurassic bed, they may belong possibly to the Hettangian. Better material is needed before reliable identifications can be made.

Family SCHLOTHEIMIIDAE Spath, 1923

Genus ***Charmasseiceras*** Spath, 1924

Charmasseiceras sp. indet.

Plate 1, figures 1a,b, 2a,b, 3a,b, 4a,b

Material. Several small and medium-size whorl fragments from the Borden Island Formation at the north end of Reindeer Peninsula, Ellef Ringnes Island. Collected by D. F. Stott; field no. SI 67-2-33, GSC loc. 80753.

Description: The various fragments appear to belong to the same species. Specimen GSC Cat. no. 24031 (Pl. 1, fig. 3a) represents about one-half of a young whorl 17 mm high. The rubbercast of the imprint of about one-half of the preceding whorl (Pl. 1, fig. 3b) has straight undivided ribs that swing forward in the ventro-lateral region where they are considerably elevated. They stop before reaching the mid-ventral line leaving a smooth band. The preserved half whorl of the same specimen has slightly convex flanks with the greatest width just below their mid-height. The cross-section of the whorl is nearly oval with the mid-ventral region flat. The height of the whorl increases rather markedly from its beginning to its end. On this whorl the ribs are inclined forward on the flanks, they are sharp, particularly in the ventro-lateral region where they are considerably elevated. Some of the ribs continue sharply bent forward over the flat median part of the venter but die out before joining each other. Some of the ribs bifurcate close to the umbilical margin. There are also intercalated ribs that reach from the venter to the inner part of the whorl. The same character of the ribs is present in whorl fragment specimen no. 24035 (Pl. 1, figs. 4a, b).

The two medium-size fragments, nos. 24029 (Pl. 1, figs. 1a, b) and 24030 (Pl. 1, figs. 2a, b) have ribs that are more blunt than those of the above-described younger whorls. The point of their bifurcation is between the middle of the flanks and the umbilical border. At this stage of growth, the whorls are much higher than in young specimens. The venters are not preserved. The rubbercasts of the venters of the preceding whorls (Pl. 1, figs, 1b, 2b) show clearly the forward continuation of the ribs on the venter. Some of them cross the venter contrary to the ribs of the described inner whorls.

The suture line is well preserved on the smaller fragments of nos. 24031 and 24035. The larger whorl fragment has some parts of the suture preserved.

Comparison. The fragments belong to the genus *Charmasseiceras* Spath, 1924, as defined by Donovan (1952a, p. 652). Because only fragments have been collected, comparison with known species of the genus is difficult and is postponed until better material is available.

Family ARIETITIDAE Hyatt, 1874

Subfamily ARIETITINAE Hyatt, 1874

Genus ***Coroniceras*** Hyatt, 1867

Subgenus *Primarietites* Buckman, 1926

Coroniceras (*Primarietites*) sp. indet.

Plate 1, figures 5a,b, 6a,b,c, 7a,b,c,d, 8

Material. Several fragments or incompletely preserved specimens from north end of Reindeer Peninsula, Ellef Ringnes Island. Borden Island Formation. Collected by D. F. Stott; field no. SI 67-2-33, GSC loc. 80753.

Description. Due to unsatisfactory preservation, the measurements (in mm) are approximate (ratios to diameter given in brackets).

Specimen No.	Diameter	Whorl height	Whorl thickness above the ribs	Umbilical width	Number of ribs
24026	26	9 (0.35)	10 (0.38)	11 (0.48)	22
24027	66	21 (0.32)	22 (0.33)	– –	28

The cross-sections of the whorls as measured between the ribs are almost quadratic, measured above the ribs slightly wider than high. The flanks are very gently convex, the shoulders gently sloping. The venter has a fairly high keel and fairly wide sulci. Both are present at the earliest visible diameter. The ribs are straight on the flanks and have a node at the ventro-lateral border from where they swing forward. The number of ribs increases in larger specimens.

The suture line has trifid lateral and external saddles and trifid umbilical and lateral lobes. The centre branch of the lateral lobes is rather short, equal in length or only slightly longer than the two adjoining side branches. The lateral saddle, which is higher than the external saddle, lies in the middle of the flank, and the first lateral lobe, which is considerably shorter than the ventral lobe, occupies part of the shoulder and part of the outer part of the flank, its central part encircling the lateral nodes.

Comparisons. Due to the unsatisfactory preservation, no species identification seems possible. *Coroniceras lyra* (Hyatt) (Hyatt, 1889, Pl. 4, figs. 4, 5) has, at about the same diameter as specimen no. 24027 (Pl. 1, figs. 6a–c), the same number and shape of ribs but the cross-section of *C. lyra* (Hyatt) is slightly higher than wide and the ventral shoulders are more steeply sloping. *Coroniceras* (*Primarietites*) *reynesi* (Spath), including Reynès' *multicostatus* var. *spinaries* (Reynès, 1879, Pl. 24, figs. 25–28) is distinguished from the Canadian specimens by a higher cross-section, a generally greater number of ribs, and by the position of the first lateral lobe which lies closer to the middle of the flank. *Coroniceras* (*Primarietites*) *sublyra* (Spath), proposed for *C.* (*P.*) *lyra* (Hyatt) (Hyatt, 1889, Pl. 4, figs. 6, 7 only), has more ribs and a higher cross-section than the Canadian specimens. *Coroniceras* (*Primarietites*) sp. indet. described by Donovan (1952b, p. 738, Textfig. 15), has more massive whorls and in this respect is similar to our specimens but they cannot be compared in detail. *Coroniceras* (*Primarietites*) *subrotiformis* (Parona) (Parona, 1896, p. 36, Pl. 7, fig. 3) is distinguished mainly by more steeply sloping shoulders.

Family OXYNOTICERATIDAE Hyatt, 1875

Genus *Gleviceras* Buckman, 1918

Gleviceras plauchuti Frebold sp. nov.

Plate 2, figures 1a–d

Material. One specimen, the holotype (GSC 24024) from east side of Intrepid Inlet, 7 miles south of Hiccles Cove, Prince Patrick Island. Borden Island Formation below Wilkie Point Formation. Elf field no. E 30622, GSC loc. 70402.

Description. The specimen has a maximum diameter of 54 millimetres. At 45 mm diameter the measurements (ratios to diameter in brackets) are:

At diameter	Whorl height	Whorl thickness	Umbilical width
48	23 (0.48)	13 (0.27)	12 (0.25)

The specimen is somewhat corroded, remnants of the shell are preserved only in parts of the inner half of the last whorl. The cross-section is elliptical, the venter sharpened, but no real keel is preserved. The umbilical wall is rather steep, its transition to the flanks rounded. Only very faint ribs are indicated on the flanks; they are, however, clearly visible in the ventro-lateral region where they are forwardly inclined. They cross the venter at an angle. Faintness or absence of the ribs on the flanks and absence of a real keel are due apparently to unsatisfactory preservation. There are fine striae where the shell is preserved. About half of the last whorl is septate; its anterior part belongs to the body chamber. The first lateral lobe is rather slender, tripartite and a little shorter than the ventral lobe. The external saddle is tripartite.

Comparisons. The general outline of the specimen is that of the genus *Gleviceras* Buckman. Arkell (1957, p. L242) has synonymized with *Gleviceras* the genera *Guibaliceras*, *Victoriceras* Buckman, 1918, and *Tutchericeras* Buckman, 1919. Most previous illustrations of representatives of this genus are of larger specimens at reduced size and show some differences from our specimen. In particular, the width of the umbilicus of previously described specimens is smaller.

Some measurements of specimens of *Gleviceras subguibalianum* (Pia) (Pia, 1914, p. 36) illustrate, however, that the umbilicus of larger specimens is relatively smaller than that in smaller specimens.

Our specimen cannot be identified with any known species and is considered to belong to a new species, which is named for B. Plauchut.

Family ECHIOCERATIDAE Buckman, 1913

Genus *Echioceras* Bayle, 1878

The hitherto known Echioceratidae of the Canadian Arctic are here assigned to the genus *Echioceras* Bayle. Two species are present, one with a low ventral keel without sulci (*E. aklavikense* Frebold sp. nov.) and the other with ventral keel and subsulci at maturity (*E. arcticum* Frebold sp. nov.). The latter species is somewhat similar to some representatives of *Pleurechioceras* Trueman and Williams (1925) which, according to Arkell (1957), is a synonym of the genus *Echioceras* Bayle.

Echioceras aklavikense Frebold sp. nov.

Plate 2, figures 2–8, 9a–c

Echioceras sensu lato sp. indet. Frebold, 1960, p. 17, Pl. 5, figs. 1–3.

Material. Fragmentary specimens including small and medium-size whorl fragments from the Borden Island Formation on Melville Island; GSC loc. 60220. Larger fragmentary specimens from the Bug Creek Formation in the Aklavik Range, Richardson Mountains; GSC loc. 26976.

Description. The specimens from the Aklavik Range were collected by Jeletzky (1967) and described by the author (Frebold, 1960, p. 17, 18, Pl. 5, figs. 1–3) as *Echioceras* sensu lato sp. indet. The better preserved fragmentary specimens from Melville Island are identical in all observable characteristics with those from the Aklavik Range. Some of them show also the suture line which is not preserved in the Aklavik Range specimens.

The largest previously described specimen (GSC Cat. no. 14638; Frebold, 1960, Pl. 5, fig. 1) is selected to serve as holotype; paratypes are GSC Cat. nos. 14639, 14640, 24018–24022. The smallest specimen has a diameter of 12 mm. Already at this stage of growth, the cross-section is wider than high and the venter is very slightly rounded. At later stages of growth, the venter becomes wider and, though still slightly arched, is flatter. In these young specimens the ribs are straight on the flanks but are inclined forward in the ventro-lateral region. The venter is smooth and no keel is present. At a later stage of growth, at an approximate diameter of 20 to 25 mm, the ribs begin to be inclined forward and a faint and low keel appears on the venter. The ribs are more inclined and the ventral keel is stronger in medium-size and larger specimens. In some specimens, the strong ribs are subdivided at the ventro-lateral border into several very fine ribs which are sharply bent forward. No sulci are present on the venter at any stage of growth.

The suture line is incompletely preserved on some small and medium-size specimens. The first lateral lobe is irregularly subdivided, rather broad and shorter than the ventral lobe. The shape of the second lateral lobe is similar to that of the first lateral lobe. The external saddle is very wide.

Comparisons. This species is distinguished from *E. arcticum* sp. nov. by the absence of sulci and a different suture line.

Echioceras arcticum Frebold sp. nov.

Plate 3, figures 1–6

Material. About 12 specimens, some of them partly preserved as imprints or fragments. One complete well-preserved specimen. Oyster Creek, Borden Island. Borden Island Formation. Elf field no. 30439, GSC loc. 72608. Also found at Porcupine River, GSC loc. 85359.

Description. The holotype of this new species (GSC Cat. no. 24012; Pl. 3, figs. 1a–c) has a maximum diameter of 68 mm. Septation is visible close to the end of the last whorl. At 56 mm diameter the measurements are as follows (ratios to diameter in brackets):

Diameter	Whorl height	Whorl thickness	Umbilical width
56	14 (0.25)	16 (0.29)	31 (0.55)

At this stage of growth, the cross-section is almost quadratic with rounded flanks and venter. The ventral keel is clearly developed. There are shallow sulci on each side. There are about 40 to 43 prorsiradiate ribs on each of the last two whorls. They are inclined forward strongly in the ventro-lateral area. The inner whorls of the holotype are preserved only as imprint. Inner whorls are represented by the paratypes GSC Cat. nos. 24014 (Pl. 3, fig. 2) and 24015 (Pl. 3, fig. 3). The ribs of the inner whorls are straight and not forwardly inclined and there is no ventral keel nor sulci. First indication of the keel is at a diameter of about 18 mm. Forward inclination of the ribs begins at a diameter of about 28 mm. At a diameter of 23 mm, the number of ribs is about 40. The inner whorls are considerably wider than high with the greatest width at the ventro-lateral border, and the venter is flatter than in later stages of growth. Very shallow subsulci were observed at a diameter of about 44 mm (paratype, GSC Cat. no. 24016). They are clearer developed in larger specimens.

Specimens larger than the holotype show a considerable decrease in the number of ribs (paratype GSC Cat. no. 24017, Pl. 3, fig. 6).

The suture lines of some of the specimens differ from each other. On the last whorl of the holotype, the first lateral lobe is fairly slender, and shorter than the ventral lobe. The second lateral lobe also is slender and shorter than the first lateral lobe. It is also tripartite but somewhat irregular. The lateral and external saddles are fairly broad, tripartite and about equal in height. In another specimen, paratype 24013 (Pl. 3, figs. 4a, b), the lateral lobes are much more slender than at equal whorl heights of the holotype. Paratype 24016 (Pl. 3, fig. 5) differs from both the holotype and paratype 24013 in having an irregular, almost bifid lateral lobe.

Comparisons. This species is clearly distinguished from such species of *Echioceras* as *E. raricostatum* (Zieten) by the absence of raricostate ribs and by the development of subsulci in medium stages of growth. The presence of subsulci in the Canadian specimens resembles *Pleurechioceras* Trueman and Williams which was included in *Echioceras* by Arkell, but "*Pleurechioceras*" has a different suture line, the lateral lobe being bifid and as deep as the ventral lobe. The species differs from *Echioceras aklavikense* sp. nov. mainly by the presence of subsulci and in the suture line (first lateral lobe irregular in *E. aklavikense*, usually tripartite in *E. arcticum*).

Some species of the genus *Paltechioceras* Buckman are superficially somewhat similar to our species but are distinguished by early development of a tricarinate-bisulcate venter.

Family AMALTHEIDAE Hyatt, 1867

Genus ***Amaltheus*** de Montfort, 1808

Amaltheus stokesi (J. Sowerby)

Plate 4, figures 3, 4

Ammonites stokesi J. Sowerby, 1818, p. 205, Pl. 191.

Amaltheus cf. *A. nudus* (Quenstedt) Imlay, 1955, p. 87, Pl. 10, fig. 5.

Amaltheus stokesi (J. Sowerby) Howarth, 1958, p. 3, Pl. 1, figs. 5–7, 12–14; Pl. 2, figs. 1, 3, 10; Textfigs. 4, 5.

Amaltheus stokesi (Sowerby) Dean, 1961, Pl. 70, figs. 2a, b.

Amaltheus stokesi (J. Sowerby) Frebold, 1964a, p. 9, Pl. 2, figs. 2–6; 1964b, Pl. 6, figs. 6, 7, 13; 1966, Pl. 1, figs. 1–4; 1970, p. 441, Pl. 3, fig. 1; Frebold *et al.*, 1967, p. 14, Pl. 1, figs. 1–3, 5, 7.

For additional synonymy *see* Howarth, 1958, p. 3.

Material. Several specimens from the Borden Island Formation on Axel Heiberg Island collected by Panarctic Oils Limited (GSC loc. C-4728) and from the Borden Island Formation on Prince Patrick Island collected by Elf Oil Exploration and Production Canada Limited (GSC loc. C-12544).

Description. Specimen GSC Cat. no. 35237 is preserved as an imprint. It is the largest representative of this species in the collection from Axel Heiberg Island. Its measurements (in mm) are as follows (ratios to diameter in brackets):

Maximum diameter	Whorl height	Whorl thickness	Umbilical width
69	30 (0.43)	——	23 (0.33)

The umbilical edge is rounded, the ribs are very slightly sigmoidal. Close to the venter they swing forward, become weaker and are subdivided into two or three branches which form well-developed chevrons. The ventral keel is barely differentiated. Suture lines and spiral striae are not preserved.

The smaller specimen GSC Cat. no. 35238 from Prince Patrick Island shows inner whorls on which the chevrons begin to appear and a medium-size whorl fragment with well-developed chevrons.

Fragments and imprints of small specimens occur at both localities.

Comparisons. The large specimen agrees well with the holotype of the species. The inner whorls of the smaller specimen are similar to a specimen of Howarth (1958, Pl. 2, fig. 3).

Family HILDOCERATIDAE Hyatt, 1867

Subfamily HILDOCERATINAE Hyatt, 1867

Genus ***Hildaites*** Buckman, 1921

Hildaites sp. indet.

Plate 4, figure 2

Material. One specimen, GSC Cat. no. 24034, from Jaeger Formation in the mid-eastern part of Cornwall Island, from stream bed. Collected by H. R. Greiner, 1955; GSC loc. 25981.

Description. The specimen is badly worn, most of the outer part of the last whorl is broken off, so that no reliable measurements can be taken. Part of the preceding whorl is better preserved and shows fairly numerous, slightly rursiradiate ribs on the outer half of the whorl. The ribs on the inner half are only very faintly visible in one small area. A narrow, somewhat irregular spiral furrow is indicated on the middle part of the flank but apparently does not belong primarily to the specimen. It is absent in other parts of the specimen. The umbilical wall is moderately high and steep, its transition to the flanks is rounded. No traceable suture lines can be seen.

Comparisons. Because of the absence of a genuine lateral groove, the specimen is assigned to the genus *Hildaites* Buckman and not to *Hildoceras* Hyatt. The poor preservation prevents identification of the species.

Subfamily HARPOCERATINAE Neumayr, 1875

Genus *Pseudolioceras* Buckman, 1899

Pseudolioceras m'clintocki (Haughton)

Plate 4, figures 1a, b

Ammonites m'clintocki Haughton, 1858, p. 244, Pl. 9, figs. 2–4.
Harpoceras m'clintocki Neumayr, 1885, p. 85, Pl. 1, figs. 5–8.
Ludwigella cf. *rudis* (Buckman) Imlay, 1955, p. 75, Pl. 11, figs. 1–3.
Ludwigia m'clintocki Frebold, 1958, p. 7, Pl. 5, figs. 3a, b; 4a, b.
Pseudolioceras m'clintocki Frebold, 1960, p. 20, Pl. 8, figs. 1–9; Pl. 9, figs. 2–4.
Pseudolioceras m'clintocki A. A. Dagis and A. C. Dagis, 1967, p. 56, Pl. 3, fig. 1.

Material. One specimen, GSC Cat. no. 33335 from unnamed Jurassic beds, Air Force Glacier, Ellesmere Island (81°48′N, 76°32′W). Collected by R. L. Christie, 1963; GSC loc. 57133.

Description. The specimen is septate to the end of the last whorl, the body chamber is not preserved. The cross-section of the last whorl is oval, the greatest thickness is below mid-height of the whorl. The venter is rounded, its transition to the flanks gentle. There is a low ventral keel. The umbilical region and the innermost part of the last whorl are concealed by matrix and the umbilical width cannot be determined.

There are 28 ribs which are forwardly inclined on the inner half of the flanks. At about half the height of the flanks they swing sharply backwards in a rounded angle and increase in thickness. In the ventro-lateral area they are sharply bent forward again and become almost invisible. Some of the backwardly bent ribs on the outer part of the flank are considerably thicker and still more sharply bent backwards than the other backwardly inclined ribs. There are two such irregular ribs on both flanks which correspond to each other. This irregularity may have been caused by injury.

The suture line has a deep fairly slender tripartite first lateral lobe which is considerably longer than the ventral and second lateral lobes. The external and ventral saddles are fairly slender and of about the same size. The ventral saddle has a deep accessory lobe.

The specimen agrees well with *P. m'clintocki* (Haughton), a well-known species in the Lower Bajocian of the Canadian Arctic, other Arctic regions, and Alaska.

Pseudolioceras spitsbergense Frebold sp. nov.

Plate 4, figures 6–9

Grammoceras cf. *G. saemanni* Frebold, 1929, p. 263, Pl. 2, figs. 6, 7 (non Dumortier).
Grammoceras? sp. indet. Frebold, 1960, p. 23, Pl. 12, figs. 5a, b, 6, 7.

Material. Several whorl fragments from the Wilkie Point Formation at Intrepid Inlet, Prince Patrick Island (76°41′N, 118°43′W). Collected by Elf Oil Exploration and Production Canada Limited; GSC loc. C-12546.

Description. The inner whorls of this moderately involute species have a high oval cross-section; it is more rectangular in later stages of growth. The transition of the flanks to the venter is gradational on the inner whorls but becomes abrupt on larger specimens which have comparatively wide flat zones on both sides of the ventral keel. These flat zones are barely visible on the inner whorls. The undivided ribs are forwardly inclined on the inner half of the flanks, in their outer half they become thicker and are bent backward in an obtuse angle.

They swing forward again in the area near the venter and follow the rounded edge between the flanks and the venter. There are no ribs on the flat ventral zones. The thickness of the ribs seems to vary, being thicker in some specimens than in others. The illustrated specimens belong to body chambers, one of them with remains of the last suture line.

The holotype of this species is the specimen previously described as *Grammoceras?* sp. indet. (Frebold, 1960, p. 23, Pl. 12, figs. 5a, b; refigured in this report on Pl. 4, fig. 6).

Comparisons. Specimens belonging to this species are known from Spitsbergen and Ellesmere Island. The fragmentary specimens from Spitsbergen were compared originally with *Grammoceras saemanni* (Frebold, 1929) but assignment to *Grammoceras* subsequently was questioned (Frebold, 1960). The whorl fragments described in this report agree very well with the specimens from Spitsbergen and Fosheim Peninsula, Ellesmere Island. The species is distinguished from the associated *P.* cf. *P. compactile* (Simpson) mainly by its wider umbilicus, lesser whorl height and stronger sickle-formed ribs.

Pseudolioceras cf. *P. compactile* (Simpson)

Plate 4, figure 5

For the description of representatives of the group of *Pseudolioceras compactile* (Simpson) in the Canadian Arctic, the reader is referred to the report on the Jurassic fauna of Prince Patrick Island (Frebold, 1957, p. 5, Pl. 3, figs. 3, 4, 5a–c, 6). The specimen GSC Cat. no. 35239 illustrated on Plate 4, figure 5 of the present report is from the Wilkie Point Formation, 4 to 6 miles northeast of Mould Bay Weather Station on Prince Patrick Island. It is imperfectly preserved but shows part of the suture line. The shape of the ribs of this specimen is very similar to that of the specimen figured by Buckman (1911) which is probably the holotype of the species. Very similar is also *P. compactile* from northern Siberia (Efimova *et al.*, 1968, p. 121, pl. 53, figs. 1a,b).

In the Canadian Arctic and on Spitsbergen the species is associated with *Peronoceras spinatum* (Frebold), *P. polare* (Frebold), and *Pseudolioceras spitsbergense* Frebold.

Family DACTYLIOCERATIDAE Hyatt, 1867

Genus ***Peronoceras*** Hyatt, 1867

Peronoceras spinatum (Frebold)

Plate 5, figures 1a, b

Coeloceras spinatum Frebold, 1957, p. 3, Pl. 2, figs. 1a–e, 2, 3, 4a, b.
Catacoeloceras spinatum (Frebold), 1964, Pl. 7, figs. 8a–e.
Peronoceras spinatum (Frebold), Efimova *et al.*, 1968, p. 113, Pl. 50, figs. 1a, b, 2.

Material. Several specimens from unnamed Jurassic beds on Ellesmere Island, Yelverton Pass, 81°37′N, 78°15′W. Collected by R. L. Christie, 1963; GSC loc. 58289.

Description. The fairly well preserved large specimen, GSC Cat. no. 33334, has the following dimensions (in mm; ratios to diameter in brackets):

Maximum diameter	Whorl height	Whorl thickness	Width of umbilicus
79	23 (0.31)	29 (0.37)	42 (0.53)

The specimen is very evolute and massive. The umbilicus is wide and rather deep, the broad venter is slightly arched, the cross-section of the whorls is wider than high. The entire last whorl belongs to the body chamber. The numerous primary ribs are straight and radial. About one-third of the primaries are looped together in pairs in a node at the ventro-lateral border where they are subdivided into as many as four secondaries. The primaries which are not looped in a node are usually subdivided into two secondaries. The secondaries cross the venter transversely or very slightly bent forward. The nodes are the bases of spines which are clearly visible in the impression left by a previously described specimen (Frebold, 1957, p. 4, Pl. 2, figs. 1a–e).

Comparisons. Buckman (1911, p. V) created the genus *Porpoceras* [Type species *P. vortex* (Simpson), *see* Buckman, op. cit., p. 29b, Pl. 29A, Figs. 1, 2] "for the strongly ornamented, massive, fibulate Dactyloids." The genus *Peronoceras* Hyatt [Type species *P. fibulatum* (Sowerby)] comprises the more "compressed fibulate Dactyloids." Arkell (1957, p. L253) and Schmidt-Effing (1972, p. 69) consider *Porpoceras* Buckman as a synonym of *Peronoceras* Hyatt. This opinion is shared by the author.

Peronoceras polare (Frebold)

Plate 5, figures 2a–d

Coeloceras polare Frebold, 1929, p. 258, Pl. 2, figs. 11–13; 1930, p. 61, Pl. 22, figs. 4, 4a; 1960, p. 18, Pl. 5, figs. 7a–b, 8; 1964, Pl. 7, figs. 12a, b.

Coeloceras aff. *C. desplacei* (d'Orbigny) Frebold, 1957, p. 4, Pl. 2, fig. 5; Pl. 3, figs. 1, 2.

Porpoceras polare A. A. Dagis, 1967a, p. 71, Pl. 1, figs. 1, 2; 1968, p. 66, Pl. 12, figs. 1–7 partim.

Material. One specimen GSC Cat no. 35245 and several fragments from Wilkie Point Formation, 4 to 6 miles northeast of Mould Bay Weather Station on Prince Patrick Island. Collected by Elf Oil Exploration and Production Canada Limited, 1965; GSC loc. 70390. Also at other localities.

Description. The last whorl of this evolute ammonite belongs to the body chamber, the inner whorls are preserved as imprint from which a rubbercast was made. Maximum diameter is 50 millimetres. The measurements at smaller diameters are as follows (ratios to diameter in brackets):

Diameter	Whorl height	Whorl thickness	Umbilical width
45	11 (0.24)	14 (0.31)	26 (0.58)
30	10 (0.33)	11 (0.37)	14 (0.47)

The whorls embrace each other only slightly at the ventro-lateral margin. The cross-section wider than high with the greatest width at about mid-height of the flanks. The venter is slightly arched.

The primary ribs are straight, rather sharp and slightly forwardly inclined. At the ventro-lateral margin, most of them are subdivided into two secondaries, others remain undivided. On the last whorl some of the primaries are looped together and are subdivided into three secondaries. At the point of division are fine nodes. At least some of them are the bases of spines, which are preserved on the inner whorls. The secondary ribs cross the venter without interruption in a slightly forward bent arch.

No details of the suture line can be traced.

Comparisons. Peronoceras spinatum (Frebold), which is associated with *P. polare* (Frebold), is distinguished mainly by the development of more looped ribs and finer secondaries that cross the venter transversely whereas they are arching forward in *P. polare*.

Genus ***Zugodactylites*** Buckman, 1926

Zugodactylites cf. Z. *braunianus* (d'Orbigny)

Plate 5, figures 3–6

Material. A number of specimens from one piece of rock from the Savik Formation, north-central Reindeer Peninsula, Ellef Ringnes Island; GSC loc. 80734. Talus 50 feet above base. Collected by D. F. Stott, 1967.

Description. Most of the specimens are small with a maximum diameter of about 28 mm. The largest specimen which is preserved as an imprint has a diameter of 33 mm. The general shape is evolute, the whorls embrace each other slightly at the row of fine tubercles on the ventro-lateral border of the preceding whorl. The flanks are compressed and parallel to each other and the venter is rounded.

The measurements (in mm) of specimen No. 33336 (Pl. 5, figs. 4a, b) are as follows (ratios to diameter in brackets):

Maximum diameter	Whorl height	Whorl thickness	Umbilical width
28	8 (0.29)	7 (0.25)	15 (0.54)

The primary ribs of this specimen are fine, sharp, and straight. About a third of them are subdivided at the ventro-lateral border into two secondaries which, together with the undivided primaries, cross the venter in a slightly forward bent arch. There are fine tubercles at the ventro-lateral border.

The smaller specimens have generally the same shape as the one described, but in some the venter is higher than in others and in some the primaries are very slightly flexuous (Pl. 5, fig. 5a).

The larger specimen no. 33338 (Pl. 5, fig. 6) has on the last whorl more ribs than specimen no. 33336 (Pl. 5, figs. 4a, b) and more of its primaries remain undivided. Specimen no. 33339 (Pl. 5, fig. 3) has considerably fewer ribs which apparently bifurcate more regularly than in the other specimens.

Comparisons. Our specimens are smaller than the holotype of *Zugodactylites braunianus* (d'Orbigny) (d'Orbigny, 1845, p. 327, Pl. 104, figs. 1–3) and the specimens of this species illustrated by Dumortier (1874, p. 103, Pl. 28, fig. 5), Buckman (1926, Pl. 658, figs. 1, 2), and Dean *et al.* (1961, Pl. 73, figs. 1a, b). Specimens assigned to *braunianus* of a size equal to that of our specimens are illustrated by Monestier (1931, p. 53, Pl. 3, figs. 10, 13–19, 24), Fischer (1966, p. 43, Pl. 2, fig. 6; Pl. 5, fig. 9), and Dagis (1968, p. 46, Pl. 8, figs. 4, 5, 6). Our specimens nos. 33336–33338 (Pl. 5, figs. 4–6) are similar to Monestier's specimens in general outline and sculpture but in Monestier's specimens the primary ribs apparently bifurcate more regularly than in ours. Our specimen no. 33338 (Pl. 5, fig. 6) is also similar to a specimen described by Dagis (op. cit., Pl. 10, figs. 15a, b) as *Z. pseudobraunianus* (Monestier), a 'species' created by

Monestier (1931, p. 54, Pl. 3, figs. 2, 4, 7; Pl. 9, fig. 15) for small forms with smooth inner whorls. Fischer's (op. cit.) specimen differs from our specimen by its entirely flat venter[1].

Our specimens may include two species which are considered to be closely related to *Z. braunianus*. No direct identification of our small forms with this or other related species is attempted.

Biostratigraphy and Correlations

The biostratigraphic subdivision of the Lower Jurassic beds in the Canadian Arctic and their correlation with the Lower Jurassic strata in other Arctic regions is summarized in Table 1 (*in pocket*). Additional notes and comments given here also include correlation with the Lower Jurassic sequence in northeastern Russia.

Hettangian

No marine Hettangian beds are known from the Canadian Arctic Islands. On some of the islands, the uppermost part of the mainly Upper Triassic Heiberg Formation consists of entirely nonmarine beds with plants and thin coal seams, which, according to Thorsteinsson and Tozer (1970, p. 578, 579), possibly may be of earliest Jurassic age.

In the Bonnet Lake area of northern Yukon, Jeletzky (1971, p. 205) found some very poorly preserved ammonites which may belong to the subfamily Psiloceratinae. If this could be proved to be correct, the presence of marine Hettangian in this area would be established.

In northern Alaska, *Psiloceras* occurs in marine Hettangian beds (Imlay and Detterman, 1973). In Spitsbergen and East Greenland, nonmarine beds with plants and thin coal seams of latest Triassic or earliest Jurassic age are present. In northern Siberia, marine Hettangian beds are indicated by *Psiloceras*, *Alsatites*, and *Schlotheimia* (Efimova *et al.*, 1968).

Lower Sinemurian

Zone of *Arietites bucklandi*

In the Canadian Arctic Archipelago, beds of Early Sinemurian age are known in the Borden Island Formation on Ellef Ringnes Island (Stott, 1969, p. 16, 17). They contain *Coroniceras* (*Primarietites*) sp. indet. and *Charmasseiceras* sp. indet. which are described in this report. Both genera are represented by fragmentary specimens. The association of these two genera suggests the presence of part of the Bucklandi Zone. In northwestern Europe, *Charmasseiceras* occurs throughout this zone (Dean *et al.*, 1961, p. 448) and species of *Coroniceras* (*Primarietites*) are common in the Rotiforme and Bucklandi Subzones.

Some indeterminate ammonites from Borden and Melville Islands previously described as *Arietites* sensu lato gen. et sp. indet. (Frebold, 1960, p. 13) do not warrant an accurate age determination. The same applies to a poorly preserved imprint of an ammonite found in the Rat River area close to the Yukon–Northwest Territories border (Frebold, loc. cit.).

Beds of the Borden Island Formation on northern Ellesmere Island and on eastern Axel Heiberg Island have not yielded any distinctive fossils of Early Sinemurian age. Beds of this

[1] Schmidt-Effing (1972, p. 66) stated that the cross-section of *Z. braunianus* (d'Orbigny) is quadratic to high-rectangular. The venter is, however, rounded in the holotype and also in Monestier's, Buckman's, Dagis', and our specimens.

age are present in northern Alaska where *Arietites* occurs (Imlay, 1955; Imlay and Detterman, 1973).

In northern Siberia, beds of Early Sinemurian age are indicated by species of *Arietites* and *Coroniceras*. According to Efimova *et al.* (1968), they are assigned to the Bucklandi, Semicostatum, Turneri, and Obtusum Zones.

Upper Sinemurian

Zone of *Oxynoticeras oxynotum*

The zone of *Oxynoticeras oxynotum* is best known from the Aklavik Range where it occurs in the Basal Sandstone Member of the Bug Creek Formation (Jeletzky, 1967, p. 95). *Oxynoticeras oxynotum* (Quenstedt), *Gleviceras* sp. indet., and *Arctoasteroceras jeletzkyi* Frebold were described from this area and the fauna was attributed to the Oxynotum Zone (Frebold, 1960). This age assignment is retained. Jeletzky (1967, p. 11, 95, 104) refers to these beds as the "*Arctoasteroceras jeletzkyi* Zone" but, although he employs different terminology, he does not amend the correlation proposed by the writer. *Arctoasteroceras jeletzkyi* occurs also in the British Mountains (Frebold *et al.*, 1967) and in the northern Richardson Mountains. *Gleviceras plauchuti* Frebold sp. nov., described in this report, was found in the Jameson Bay section on Prince Patrick Island in beds assigned to the Borden Island Formation.

These are the only known occurrences of the Oxynotum Zone in the Canadian Arctic. The zone has not been found in northern Alaska, Spitsbergen, or East Greenland.

Zone of *Echioceras raricostatum*

In the Bug Creek and Bug Lake area of the Aklavik Range, the beds with *Oxynoticeras oxynotum* are overlain by beds containing *Echioceras* (Frebold, 1960), which are described in this report as *Echioceras aklavikense* Frebold sp. nov. The same species also was found on Melville Island. The beds containing this species are assigned to the Raricostatum Zone.

To this zone belongs also *Echioceras arcticum* Frebold sp. nov. which was found on Borden Island. This species was not found associated with *E. aklavikense* and may be slightly younger or older than *E. aklavikense*.

The *Echioceras* fauna has not been found at other localities on the Canadian Arctic Islands but is represented in the Porcupine River area of northern Yukon by *E.* cf. *E. arcticum* Frebold.

The Raricostatum Zone is indicated by *Crucilobiceras* in northern Alaska (Imlay and Detterman, 1973) but *Echioceras* is unknown in this area. The zone seems to be absent in the eastern part of the Canadian Arctic Islands, East Greenland and on the islands of the Barents Sea. In northern Siberia, beds with *Angulaticeras* were assigned to this substage (Efimova *et al.*, 1968).

Lower Pliensbachian

No ammonites of Early Pliensbachian age are known from the Canadian Arctic, northern Alaska and the islands of the Barents Sea. In East Greenland, *Uptonia jamesoni* and *Beaniceras* indicate the presence of this substage (Rosenkrantz, 1934) and, in northern Siberia, beds with *Polymorphites* are considered to belong to it (Efimova *et al.*, 1968).

Upper Pliensbachian

Zone of *Amaltheus margaritatus*

Subzone of *Amaltheus stokesi*

Ammonites of Late Pliensbachian age are present in the British and Richardson Mountains, on Prince Patrick and Axel Heiberg Islands. At Loney Creek in the British Mountains, 20 miles southwest of Herschel Island, *Amaltheus stokesi* (J. Sowerby) and *Amaltheus bifurcus* Howarth were found (Frebold *et al.*, 1967, p. 8, 14, 15), and *Amaltheus* sp. occurs at a locality 10 miles north of Bonnet Lake in the Richardson Mountains (Frebold, 1960, p. 4). The new collections from Prince Patrick Island and Axel Heiberg Island yielded *Amaltheus stokesi* (J. Sowerby) (described in this report). Various species of *Amaltheus* are known also from northern Alaska (Imlay, 1955; Imlay and Detterman, 1973).

The species of *Amaltheus* hitherto found in the Canadian Arctic belong to the lower part of the Margaritatus Zone, i.e., the Stokesi Subzone of the Upper Pliensbachian. The occurrences in northern Alaska are probably of equivalent age. No marine beds of Late Pliensbachian age are known from East Greenland or the islands of the Barents Sea, but they are present in northern Siberia (Efimova *et al.*, 1968).

Lower Toarcian

Zone of *Harpoceras falcifer*

The presence of Lower Toarcian beds in the Canadian Arctic has been established. Imlay (1955) described *Harpoceras* cf. *H. exaratum* (Young and Bird) and *Dactylioceras* cf. *D. crassiusculum* (Simpson) from a locality east of Mould Bay Weather Station on Prince Patrick Island. On the southern peninsula of Borden Island, *Harpoceras* cf. *H. exaratum* (Young and Bird) occurs 100 feet stratigraphically above the base of the Wilkie Point Formation (Frebold, 1960, p. 19). *Hildaites* sp. indet., found on Cornwall Island, probably belongs to the Falcifer Subzone. At Loney Creek in the British Mountains, *Harpoceras* aff. *H. exaratum* (Young and Bird) and *Dactylioceras* aff. *D. semicelatum* (Simpson) were collected (Frebold *et al.*, 1967, p. 8, 16, Pl. 1, fig. 8). At the northwestern end of Richardson Mountains, poorly preserved ammonites have been found, including *Harpoceras* aff. *H. exaratum* (Young and Bird) and *Dactylioceras* sp. indet. It is assumed that the substage has a wider distribution than indicated by previous collections.

Lower Toarcian beds are present also in northern Alaska (Imlay, 1955; Imlay and Detterman, 1973). In northern Siberia (Efimova *et al.*, 1968) the substage is indicated by the presence of *Ovaticeras* and *Harpoceratoides*, which are unknown in other Arctic regions, and of *Harpoceras exaratum*. In East Greenland, marine beds of Early Toarcian age apparently are present, but on the islands of the Barents Sea, the guide-fossils of this substage are unknown.

Middle Toarcian

Zone of *Hildoceras bifrons*

Subzone of *Dactylioceras commune*

Middle Toarcian beds, i.e., equivalents of the zone of *Hildoceras bifrons*, are fairly widespread in the Canadian Arctic. *Dactylioceras commune* (Sowerby), the guide-fossil of the Commune Subzone, has been described from localities close to Mould Bay Weather

Station on Prince Patrick Island (Imlay, 1955, p. 88, Pl. 11, figs. 4–6; Frebold, 1957, p. 2, Pl. 1, figs. 2, 4–7). The species also was found along Jaeger River on Cornwall Island and on the southern peninsula of Borden Island (Frebold, 1960, p. 8, 18, Pl. 5, figs. 4–6). *Dactylioceras* sp. was found at some localities in the Aklavik Range and in the Richardson Mountains and some of the poorly preserved specimens may belong to *D. commune*. The species is present also in northern Alaska (Imlay, 1955; Imlay and Detterman, 1973).

At the same locality on Jaeger River, Cornwall Island where *D. commune* was found, another ammonite was collected which is described as *Hildaites* sp. indet. in this report. As the ammonites at this locality originated from different levels, it is not certain whether this *Hildaites* came from the Commune Subzone. In northwest Europe, *Hildaites* belongs to the Falcifer Subzone of the Lower Toarcian. This is the first *Hildaites* found in the Canadian Arctic. The genus occurs also in the Omolon area of northern Siberia (Efimova *et al.*, 1968, p. 118) where it is reported from the Commune Subzone, but it is unknown in other parts of the Arctic.

Subzone of *Zugodactylites braunianus*

In a section on north-central Reindeer Peninsula, on Ellef Ringnes Island, D. F. Stott (1969) discovered an ammonite fauna consisting exclusively of Dactylioceratids which, in a preliminary report (Frebold *in* Stott, ibid.), were assigned to the Falcifer Zone of the Lower Toarcian. These Dactylioceratids, described in this report, belong to the group of *Zugodactylites braunianus* (d'Orbigny) and are now placed in the Braunianus Subzone of the Middle Toarcian. This new fauna is unknown in other parts of the Canadian Arctic, northern Alaska, East Greenland and the islands of the Barents Sea but is present in northern Siberia (A. A. Dagis, 1967b, 1968; Efimova *et al.*, 1968).

According to Stott's (1969, p. 18, 19) description of the section, the *Zugodactylites* bed is 50 feet thick, and occurs 50 feet above the base of the Savik Formation which rests on the Borden Island Formation. Above is 65 feet of mudstones without ammonites which, in turn, is overlain by 30 feet of mudstones that contain the Upper Toarcian *Peronoceras–Pseudolioceras* fauna.

Upper Toarcian

The youngest Early Jurassic ammonites hitherto known in the Canadian Arctic occur in the *Pseudolioceras–Peronoceras* bed, previously called the "*Pseudolioceras–Coeloceras*"[1] bed (Frebold, 1957, p. 22; 1960, p. 27), which the author (Frebold, 1957, p. 23) considered to be a "widespread Arctic marker bed." This bed contains *Peronoceras spinatum* (Frebold), *Peronoceras polare* (Frebold), *Pseudolioceras* cf. *P. compactile* (Simpson), and *P. spitsbergense* Frebold sp. nov. In the Canadian Arctic, it is now known to occur on Prince Patrick Island (Mould Bay Weather Station, east of Landing Lake, Intrepid Inlet), Ellef Ringnes Island, Cornwall Island, Axel Heiberg Island (at Strandford), and Ellesmere Island (Fosheim Peninsula, east side of Black Top Ridge, east of Eureka Weather Station and a new locality at Yelverton Pass). Due to a mix-up of some small collections, the author reported the presence of *Grammoceras* cf. *G. boreale* (Whiteaves) of Late Toarcian age at the Air Force Glacier on Ellesmere Island (*see* Nassichuk and Christie, 1969, p. 20). At this locality, only the above-described *Pseudolioceras m'clintocki* (Haughton) which is of Early Bajocian age was found. In the Bell River area of northern Yukon, *P. polare* is present. In other parts of the Arctic, the *Pseudolioceras–Peronoceras* bed is known from East Greenland (Rosenkrantz,

[1] The guide-ammonites *Peronoceras spinatum* (Frebold) and *P. polare* (Frebold) originally had been placed into *Coeloceras* (Frebold, 1929, 1957).

1934), the Barents Sea (Frebold, 1929, 1930, 1935, 1951), northern Alaska (Imlay, 1955), and northern Siberia (Dagis, 1967a, 1968; Efimova *et al.*, 1968). In some of these areas, only part of the guide fauna is present. *Peronoceras* has not been found in East Greenland or northern Alaska.

Frebold (1929, 1957, 1960) assigned these beds to the Striatulum Subzone of the Upper Toarcian. An early Late Toarcian age was proposed also for the equivalent occurrences in East Greenland (Rosenkrantz, 1934) and northern Alaska (Imlay, 1955).

In northern Siberia part of the ammonites, i.e., *Peronoceras spinatum* (Frebold), *P. polare* (Frebold), *Pseudolioceras compactile* (Simpson) and others were placed by the Russian authors (Efimova *et al.*, 1968, p. 9, 12) in a zone of *Peronoceras spinatum* which they consider to be an equivalent of the West European zone of *Haugia variabilis*.[1] Another part of the North Siberian fauna, i.e., *Pseudolioceras rosenkrantzi* A. Dagis and *P.* cf. *compactile* (Simpson) the Russian authors assign to a zone of *Pseudolioceras rosenkrantzi* which is considered to be an equivalent of the Upper Toarcian Thouarsense Subzone (lower part of Striatulum Zone) in West Europe.

A definite assignment of the Arctic *Pseudolioceras–Peronoceras* bed is at present impossible because of the absence of typical guide ammonites of both the Variabilis and Thouarsense Zones, as *Haugia* and *Grammoceras*. The two Arctic *Peronoceras* species are unknown in West Europe and the age of *Pseudolioceras compactile* is somewhat doubtful. Buckman (1911, p. 41b) and others believe that it belongs to the Upper Toarcian Striatulum Zone, whereas Monestier (1931) and Guex (1972, p. 627) assigned it to the Middle Toarcian Variabilis Zone.

In the stratigraphic chart, Table 1, the *Pseudolioceras–Peronoceras* bed is tentatively assigned to the lower part of the Upper Toarcian in which it had been placed previously.

No younger Toarcian beds or faunas are known from the Canadian Arctic Region.

Summary of the Present Status of the Lower Jurassic in the Canadian Arctic

In previous reports on the fauna, age and correlation of the Lower Jurassic in the Canadian Arctic (Frebold, 1957, 1960), the presence of larger and smaller gaps in the sequence was assumed. At that time, no real proof could be given of the presence of Lower and Upper Sinemurian and Upper Pliensbachian beds in the Canadian Archipelago. The present study has revealed that the Bucklandi Zone of the Lower Sinemurian, the Oxynotum and Raricostatum Zones of the Upper Sinemurian, and the Margaritatus Zone of the Upper Pliensbachian occur on some of the islands. Furthermore, the Lower Toarcian Falcifer Subzone now has yielded also *Hildaites* (the first representative of this genus in the Canadian Arctic) and, in the Middle Toarcian Bifrons Zone, the presence of the Braunianus Subzone is established in addition to the previously already known Commune Subzone. No new discoveries were made in Upper Toarcian strata, of which only part of the Thouarsense Zone is represented by the *Pseudolioceras–Peronoceras* bed. Younger Upper Toarcian beds are unknown.

The Lower Jurassic sequence is now more complete also in the Richardson and British Mountains. The Upper Sinemurian Raricostatum Zone, previously known only from the

[1] Contrary to common usage in North-West Europe where the Variabilis Zone is considered to be the youngest zone of the Middle Toarcian, the Russian authors (Efimova *et al.*, loc. cit., p. 9) place this zone at the base of the Upper Toarcian).

Aklavik Range, now is found also in the Richardson and British Mountains. The slightly older Oxynotum Zone already had been established. The Upper Pliensbachian Margaritatus Zone and the Lower Toarcian Falcifer Subzone now are represented in the British Mountains and the lower part of the Upper Toarcian is known to occur in the Bell River area of northern Yukon.

A comparison of the Lower Jurassic sequence in the archipelago and on the continent shows now a nearly identical development with almost all zones present in one of the two areas indicated also in the other. Also, the gaps in the sequence, as for instance in part of the Lower Sinemurian, Lower Pliensbachian, and part of Upper Toarcian are identical, in both regions. However, it has to be emphasized that this uniformity is valid only when comparing entire regions. Some of the zones hitherto have been found only in a restricted area. Thus, for instance, in the archipelago the Oxynotum Zone has been found only on Prince Patrick Island, the Bucklandi Zone only on Ellef Ringnes Island, and the Raricostatum Zone only on Borden and Melville Islands. Some of the zones which apparently are absent on some of the islands or in some areas in the Richardson and British Mountains may be found in the course of further exploration but in other places their absence may be the result of local nondeposition or erosion. For example, the Borden Island Formation on Prince Patrick Island, containing the Oxynotum and Margaritatus Zones, is present only locally; in other parts of the island the Toarcian rests directly on the Devonian.

A comparison of the Lower Jurassic sequence in the Canadian Arctic with that of northern Alaska shows great similarities, not only in the identical representation of various stages or substages but also in the main gaps. The guide-ammonites of northern Alaska, described by Imlay (1955) and listed in a recent paper (Imlay and Detterman, 1973), contain species or genera also known from the Canadian Arctic, but there are some exemptions. *Psiloceras* of the Hettangian is present in northern Alaska but is not yet known with certainty from the Canadian Arctic. As stated above, it may be present in the Bonnet Lake area of northern Yukon but there is no proof. The Oxynotum Zone and the *Echioceras* fauna of the Raricostatum Zone of the Canadian Arctic have not yet been found in northern Alaska and *Crucilobiceras* from Upper Sinemurian beds in northern Alaska is unknown in the Canadian Arctic.

Correlation of the Upper Toarcian *Pseudolioceras–Peronoceras* bed of the Canadian Arctic Islands with that of Spitsbergen is good; almost all ammonite species are common to both areas. Older Early Jurassic ammonite faunas are unknown in Spitsbergen. The Lower Jurassic sequence in East Greenland is distinguished from that of the Canadian Arctic by the absence of Upper Pliensbachian ammonites or other marine faunas of that substage, by the presence of marine Lower Pliensbachian beds which contain *Beaniceras* and *Uptonia jamesoni*, and by the absence of marine Sinemurian faunas.

The Lower Jurassic sequence in northeastern Russia has the following substages in common with the Canadian Arctic: part of the Lower Sinemurian; part of the Upper Pliensbachian; most of the Lower Toarcian; the Middle Toarcian; and the lower part of the Upper Toarcian. Differences between the two regions are as follows. Marine Hettangian beds are present in northeastern Russia but have not been found with certainty in the Canadian Arctic. The *Oxynoticeras* and *Echioceras* faunas of the Canadian Arctic are not reported from northeastern Russia. The Upper Sinemurian in northeastern Russia, according to the Russian authors, is characterized by a new species of *Angulaticeras*. Lower Pliensbachian beds are unknown in the Canadian Arctic but in northeastern Russia are indicated by the presence of the genus *Polymorphites*.

References

Arkell, W. J.
1957: Treatise on Invertebrate Palaeontology, Part L, Mollusca 4, Cephalopoda, Ammonoidea; Geol. Soc. Amer. and Univ. Kansas Press.

Buckman, S. S.
1887–1907: A Monograph of the ammonites of the Inferior Oolite Series; Palaeontogr. Soc., London.
1909–1930: Type Ammonites; London.

Dagis, A. A.
1967a: The genus *Porpoceras* Buckman in the north-east of the USSR; Publ. Inst. Geol., Geophys., Siberian Sec., Acad. Sci. USSR, no. 40, p. 68–73.
1967b: On the genus *Zugodactylites* Buckman and its stratigraphic importance; Publ. Inst. Geol., Geophys., Siberian Sec., Acad. Sci. USSR, no. 40, p. 61–67.
1968: Toarcian ammonites (Dactylioceratidae) from Northern Siberia; Publ. Inst. Geol., Geophys., Siberian Sec., Acad. Sci. USSR, no. 40, p. 1–108.
1971: Genetic relationship between *Tiltoniceras*, *Eleganticeras* and *Harpoceras*; Paleontological J. 1971, no. 2.

Dagis, A. A. and Dagis, A. C.
1965: On the zonal subdivision of the Toarcian deposits in the north-east of the USSR; Acad. Sci. USSR, p. 15–26.
1967: Stratigraphy of Toarcian deposits in the Vilyui Depression; Problems of the palaeontological evidence of the detailed stratigraphy of the Mesozoic in Siberia and the Far East of USSR; "Nauka", Leningrad.

Dean, W. T., Donovan, D. T., and Howarth, M. K.
1961: The Liassic Zones and Subzones of the north-west European Province; Bull. Brit. Mus. (Nat. Hist.), Geology, v. 4, no. 10, p. 435–505.

Denckmann, A.
1887: Über die geognostischen Verhältnisse der Umgegend von Dörnten nördlich Goslar; Abh. Geol. Specialkarte Preussen, Bd. 8, 2, Berlin.

Donovan, D. T.
1952a: The Ammonites of the Blue Lias of the Bristol District, Pt. 1; Psiloceratidae and Schlotheimiidae; Ann. Mag. Nat. Hist., v. 5, p. 629–655.
1952b: The Ammonites of the Blue Lias of the Bristol District, Pt. 2: Arietitidae; Ann. Mag. Nat. Hist., v. 5, p. 717–752.
1954: Synoptic Supplement to T. Wright's "Monograph on the Lias Ammonites of the British Islands" (1878–86); Palaeontogr. Soc., London.

D'Orbigny, A. D.
1844–1845: Paléontologie Française. Terrains Jurassiques; Tome 1, Céphalopodes; Paris.

Dumortier, E.
1864–1874: Études palaeontologiques sur les depots Jurassiques du Bassin du Rhone; Paris.

Efimova, A. F., Kinasov, V. P., Paraketsov, K. V., Polubotko, I. V., Repin, Yu.S., and Dagis, A. C.
1968: Field Atlas of the Jurassic fauna and flora of the northeastern part of the USSR; Mag. Knigo-Izdat.

Fischer, R.
1966: Die Dactylioceratidae (Ammonoidea) der Kammerker (Nordtirol) und die Zonengliederung des alpinen Toarcien; Bayr. Akad. Wiss., math.-nat. Kl., Abh. N.F., 126.

Frebold, Hans
1929: Die Schichtenfolge des Jura und der Unterkreide an der Ostküste von Südwest Spitzbergen; Abh. nat. Ver., Hamburg, Bd. 22.
1930: Verbreitung und Ausbildung des Mesozoikums in Spitzbergen; Skr. om Svalbard og Ishavet, no. 31, Oslo.
1935: Geologie von Spitzbergen, der Bären-Insel, des König Karl-und Franz-Joseph-Landes; Berlin.
1951: Geologie des Barentsschelfes; Abh. Deutsche Akad. Wiss. Berlin (Kl.M. and A.N.) Jahrg. 1950, no. 5.

1957: Fauna, age and correlation of the Jurassic rocks of Prince Patrick Island; Geol. Surv. Can., Bull. 41.
1960: The Jurassic faunas of the Canadian Arctic, Lower Jurassic and lowermost Middle Jurassic ammonites; Geol. Surv. Can., Bull. 59.
1964a: Lower Jurassic and Bajocian ammonoid faunas of northwestern British Columbia and southern Yukon; Geol. Surv. Can., Bull. 116.
1964b: Illustrations of Canadian fossils. Jurassic of Arctic and western Canada; Geol. Surv. Can., Paper 63-4.
1966: Upper Pliensbachian in the Fernie Group of Alberta; Geol. Surv. Can., Paper 66-27.
1970: Pliensbachian ammonoids from British Columbia and southern Yukon; Can. J. Earth Sci., v. 7, no. 2, p. 435–456.

Frebold, Hans, Mountjoy, Eric W., and Tempelman-Kluit, D. J.
1967: New occurrences of Jurassic rocks and fossils in central and northern Yukon Territory; Geol. Surv. Can., Paper 67-12.

Greiner, H.
1963: Jaeger River, Eastern Cornwall Island; *in* Geology of north-central part of Arctic Archipelago (Operation Franklin); Geol. Surv. Can., Mem. 320, p. 533–537.

Guex, Jean
1972: Répartition biostratigraphique des ammonites du Toarcien moyenne de la bordure sud des Causses (France) et révision des ammonites décrites et figurées par Monestier (1931); Eclogae geol. Helv., vol. 65/3. Bale.

Haughton, Samuel
1858: Geological notes and illustrations in M'Clintock's reminiscences of Arctic ice travel; J. Roy. Dublin Soc., v. 1, p. 183–250.

Howarth, M. K.
1958: A monograph of the ammonites of the Liassic Family Amaltheidae in Britain; Palaeontogr. Soc., London, 1957, 1958.
1962: Whitbian and Yeovilian Substages; Colloque du Jurassique, Luxembourg. Comptes Rendus et Memoires; Inst. grand-ducal Sect. sc. nat., phys., math.

Hyatt, A.
1867: The fossil cephalopods of the Museum of Comparative Zoology; Bull. Mus. Comp. Zool. 1, p. 71–102.
1889: Genesis of the Arietitidae; Smithsonian Contrib. Knowl., no. 673.

Imlay, R. W.
1955: Characteristic Jurassic mollusks from northern Alaska; U.S. Geol. Surv., Prof. Paper 274-D.

Imlay, R. W. and Detterman, R. L.
1973: Jurassic paleobiogeography of Alaska; U.S. Geol. Surv., Prof. Paper 801.

Jeletzky, J. A.
1967: Jurassic and (?) Triassic rocks of the eastern slope of Richardson Mountains, Northwestern District of Mackenzie, 106M and 107B (parts of); Geol. Surv. Can., Paper 66-50.
1971: Stratigraphy, facies and paleogeography of Mesozoic rocks of northern and west-central Yukon; Rept. of Activities, Part A, Geol. Surv. Can., Paper 71-1, Pt. A, p. 203–221.

Monestier, J.
1931: Ammonites rares ou peu connues et Ammonites nouvelles du Toarcien moyen de la région sud-est de l'Avéyron; Mém. Soc. Géol. France (n.s.), Mem. 15.

Nassichuk, W. W.
1967: Studies of Permo-Carboniferous and Mesozoic strata on northern Ellesmere Island; Rept. of Activities, Part A, Geol. Surv. Can., Paper 67-1, Pt. A, p. 10–12.

Nassichuk, W. W. and Christie, R. L.
1969: Upper Palaeozoic and Mesozoic stratigraphy in the Yelverton Pass region, Ellesmere Island, District of Franklin; Geol. Surv. Can., Paper 68-31.

Neumayr, M.
1885: Die geographische Verbreitung der Juraformation; K. Akad. Wiss. math.-nat. K. Wien, Bd. 50.

Parona, C. F.
1896: Contribuzione alla conoscenza delle ammoniti liasiche di Lombardia, Pt. 1, Soc. Pal. Suisse, Mem. 23.

Pia, J. von
1914: Untersuchungen über die Gattung Oxynoticeras und einige damit zusammenhängende allgemeine Fragen; Abh. k.k. Geol. Reichsanstalt, v. 23.

Plauchut, B. P.
1971: Geology of the Sverdrup Basin; Bull. Can. Petrol. Geol., v. 19, no. 3, p. 659–679.

Quenstedt, F. A.
1883–1885: Die Ammoniten des schwäbischen Jura; v. 1, Stuttgart.

Reynès, P.
1879: Monographie des Ammonites; Atlas, Marseille et Paris.

Rosenkrantz, A.
1934: The Lower Jurassic rocks of East Greenland; Medd. om Grønland, Bd. 110, Nr. 1.

Schmidt-Effing, R.
1972: Die Dactylioceratidae, eine Ammoniten-Familie des unteren Jura; Münstersche Forsch. zur Geol. u. Pal., Heft 25/26.

Sowerby, J. and Sowerby, J. de C.
1812–1829: The mineral conchology of Great Britain.

Spath, L. F.
1924: The ammonites of the Blue Lias; Proc. Geol. Assoc. London, v. 35.

Stott, D. F.
1969: Ellef Ringnes Island, Canadian Arctic Archipelago; Geol. Surv. Can., Paper 68-16.

Thorsteinsson, R. and Tozer, E. T.
1970: Geology of the Arctic Archipelago *in* R. J. W. Douglas (ed.), Geology and Economic Minerals of Canada, 5th ed., Econ. Geol. Rept. No. 1, p. 547–590.

Trueman, A. E. and Williams, D. M.
1925: Studies in the ammonites of the Family Echioceratidae; Trans. Roy. Soc. Edinburgh, v. 53.

Wright, T.
1879–1884: Monograph on the Lias ammonites of the British Islands; Palaeontogr. Soc., London.

Young, G. M. and Bird, J.
1828: A geological survey of the Yorkshire Coast; Whitby, second edition.

Plates 1–5

All figures in natural size

Types in Type collection of the Geological Survey of Canada

PLATE 1

Figures 1a, b. *Charmasseiceras* sp. indet. Figured specimen. GSC Cat. no. 24029. 1a—lateral view, 1b—venter of preceding whorl, rubbercast. GSC photos: 1a—202115G, 1b—202115X. Reindeer Peninsula, Ellef Ringnes Island. Borden Island Formation. GSC loc. 80753.

Figures 2a, b. *Charmasseiceras* sp. indet. Figured specimen. GSC Cat. no. 24030. 2a—lateral view, 2b—venter of preceding whorl, rubbercast. GSC photos: 2a—202115K, 2b—202115Y. Same formation and locality as for figure 1.

Figures 3a, b. *Charmasseiceras* sp. indet. Figured specimen. GSC Cat. no. 24031. 3a—lateral view, 3b—venter of preceding whorl, rubbercast. GSC photos: 3a—202115I, 3b—202115M. Same formation and locality as for figure 1.

Figures 4a, b. *Charmasseiceras* sp. indet. Figured specimen. GSC Cat. no. 24035. 4a—lateral view, 4b—cross-section. GSC photos: 4a—202115H, 4b—202115T. Same formation and locality as for figure 1.

Figures 5a, b. *Coroniceras* (*Primarietites*) sp. indet. Figured specimen. GSC Cat. no. 24026. 5a—lateral view, 5b—venter and cross-section. GSC photos: 5a—202115J, 5b—202115S. Same formation and locality as for figure 1.

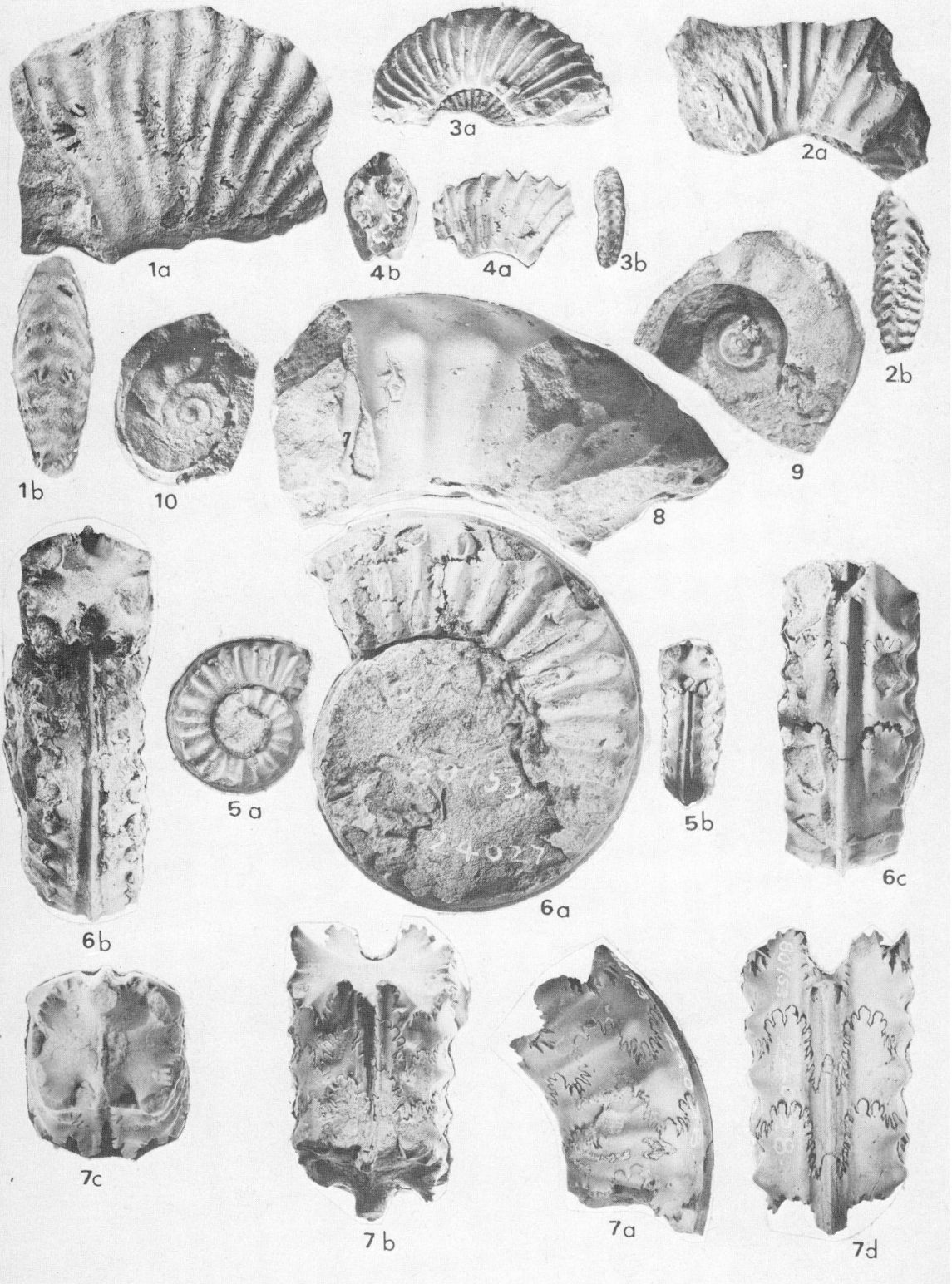
Figures 6a–c. *Coroniceras* (*Primarietites*) sp. indet. Figured specimen. GSC Cat. no. 24027. 6a—lateral view, 6b—venter and cross-section, 6c—venter. GSC photos: 6a—202115Q, 6b—202158J, 6c—202158H. Same formation and locality as for figure 1.

Figures 7a–d. *Coroniceras* (*Primarietites*) sp. indet. Figured specimen. GSC Cat. no. 24028. 7a—lateral view and suture line, 7b—dorsal view and suture line, 7c—cross-section, 7d—venter and suture line. GSC photos: 7a—202115N, 7b—202158L, 7c—202158D, 7d—202115O. Same formation and locality as for figure 1.

Figure 8. *Coroniceras* (*Primarietites*) sp. indet. Figured specimen. GSC Cat. no. 24032. Lateral view of whorl fragment. Same formation and locality as for figure 1.

Figure 9. Ammonites gen. et sp. indet. (Subfamily Psiloceratinae?). Figured specimen. GSC Cat. no. 35243. Lateral view. GSC photo 202176V, Bonnet Lake area, Yukon. GSC loc. 85527.

Figure 10. Ammonites gen. et sp. indet. (Subfamily Psiloceratinae?). Figured specimen. GSC Cat. no. 35244. Lateral view. GSC photo 202176U. Same locality as for figure 9.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7d

PLATE 2

Figures 1a–d. *Gleviceras plauchuti* Frebold sp. nov. Holotype. GSC Cat. no. 24024. 1a, b—lateral views, 1c—venter, 1d—venter and cross-section. GSC photos: 1a—202176D, 1b—202176C, 1c—202158B, 1d—202158G. Prince Patrick Island, east side Intrepid Inlet. Borden Island Formation. GSC loc. 70402.

Figure 2. *Echioceras aklavikense* Frebold sp. nov. Holotype. GSC Cat. no. 14638. Lateral view. GSC photo 202176W. Aklavik Range, Bug Creek Canyon. Bug Creek Formation. GSC loc. 26976.

Figure 3. *Echioceras aklavikense* Frebold sp. nov. Paratype. GSC Cat. no. 14639. Venter. GSC photo 202176S. Same formation and locality as for figure 2.

Figure 4. *Echioceras aklavikense* Frebold sp. nov. Paratype. GSC Cat. no. 14640. Venter. GSC photo 202176T. Same formation and locality as for figure 2.

Figure 5. *Echioceras aklavikense* Frebold sp. nov. Paratype. GSC Cat. no. 24020. Lateral view. GSC photo 202115U. Melville Island. Borden Island Formation. GSC loc. 60220.

Figure 6. *Echioceras aklavikense* Frebold sp. nov. Paratype. GSC Cat. no. 24021. Lateral view. GSC photo 202158. Same formation and locality as for figure 5.

Figure 7. *Echioceras aklavikense* Frebold sp. nov. Paratype. GSC Cat. no. 24022. Lateral view. GSC photo 202115V. Same formation and locality as for figure 5.

Figure 8. *Echioceras aklavikense* Frebold sp. nov. Paratype. GSC Cat. no. 24018. Lateral view. GSC photo 202115Z. Same formation and locality as for figure 5.

Figures 9a–c. *Echioceras aklavikense* Frebold sp. nov. Paratype. GSC Cat. no. 24019. 9a—lateral view, GSC photo 202115W; 9b—venter, GSC photo 202158P; 9c—cross-section, GSC photo 202158F. Same formation and locality as for figure 5.

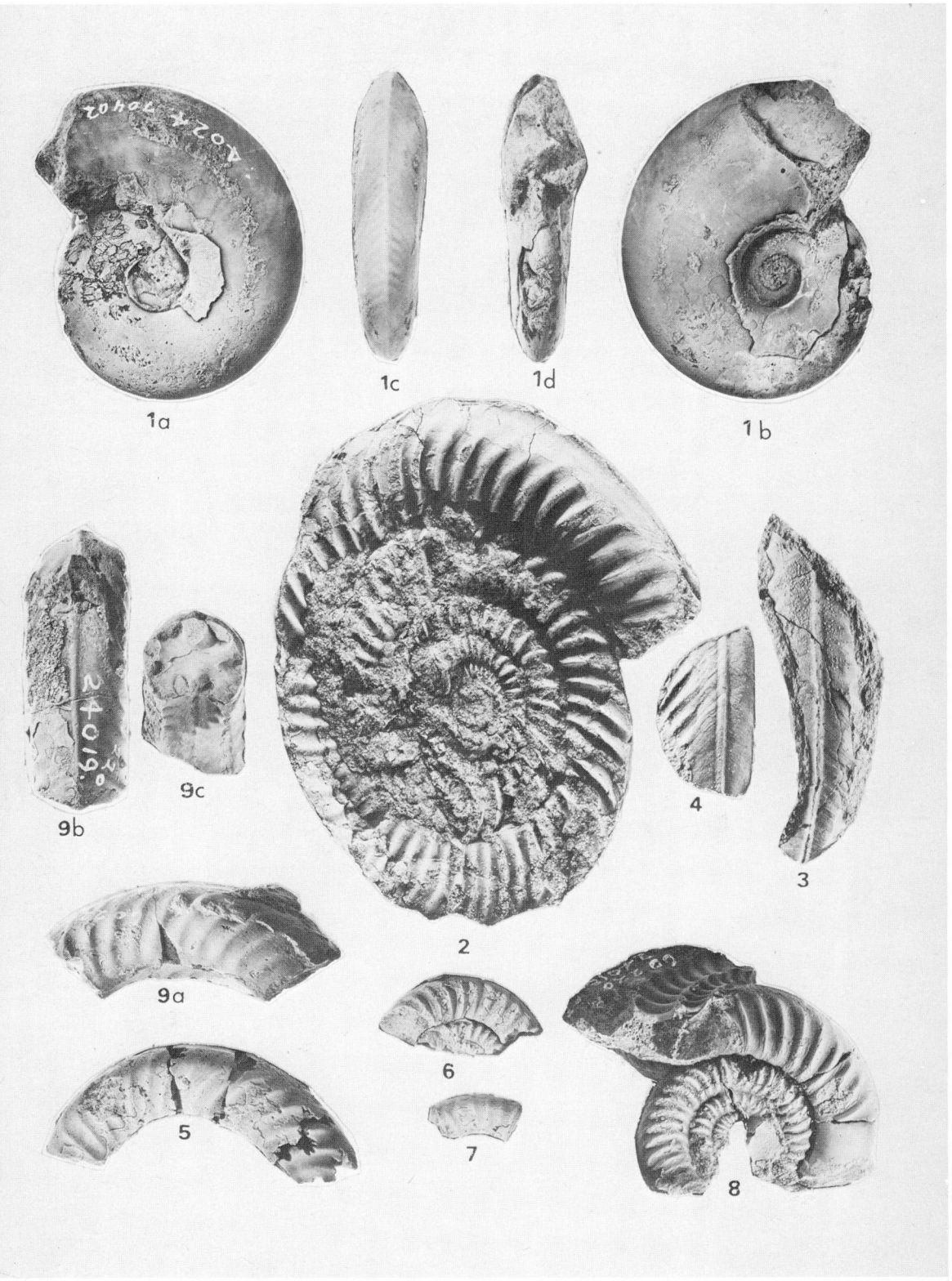
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PLATE 3

Figures 1a–c. *Echioceras arcticum* Frebold sp. nov. Holotype. GSC Cat. no. 24012. 1a—lateral view, 1b—venter and cross-section, 1c—venter. GSC photos: 1a—201223XX, 1b—201223E, 1c—201223B. Borden Island, Oyster Creek Section. Borden Island Formation. GSC loc. 72608.

Figure 2. *Echioceras arcticum* Frebold sp. nov. Paratype. GSC Cat. no. 24014. Lateral view. GSC photo 201223. Same formation and locality as for figure 1.

Figure 3. *Echioceras arcticum* Frebold sp. nov. Paratype. GSC Cat. no. 24015. Lateral view. GSC photo 201223C. Same formation and locality as for figure 1.

Figures 4a,b. *Echioceras arcticum* Frebold sp. nov. Paratype. GSC Cat. no. 24013. 4a—lateral view, 4b—venter. GSC photos: 4a—201223YY, 4b—201223V. Same formation and locality as for figure 1.

Figure 5. *Echioceras arcticum* Frebold sp. nov. Paratype. GSC Cat. no. 24016. Lateral view. GSC photo 201223F. Same formation and locality as for figure 1.

Figure 6. *Echioceras arcticum* Frebold sp. nov. Paratype. GSC Cat. no. 24017. Lateral view. GSC photo 201223A. Same formation and locality as for figure 1.

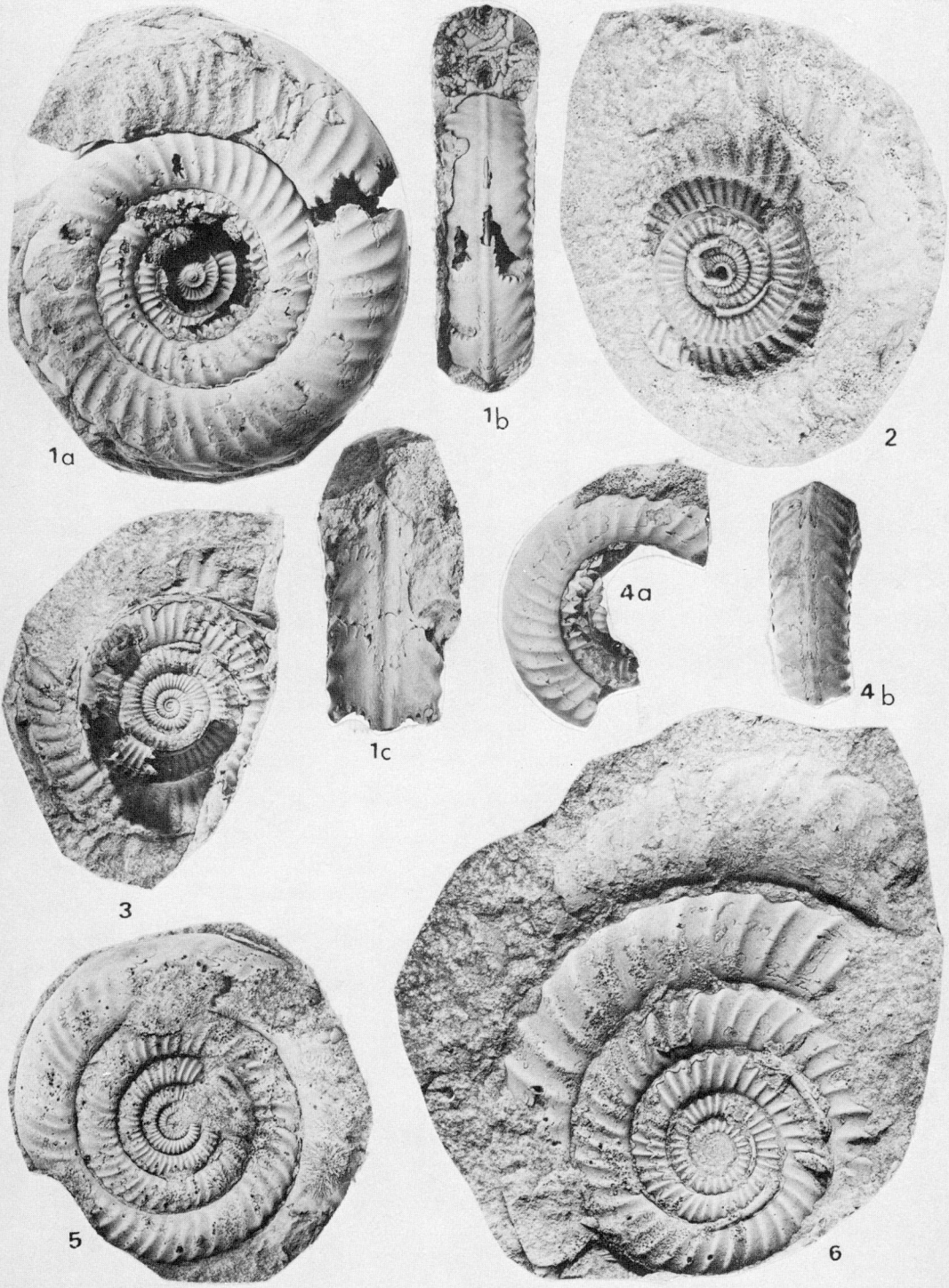
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PLATE 4

Figures 1a,b. *Pseudolioceras m'clintocki* (Haughton). Hypotype. GSC Cat. no. 33335. 1a—lateral view, 1b—venter and cross-section. GSC photos: 1a—202158R, 1b—202158V. Air Force Glacier, Ellesmere Island. Unnamed Jurassic beds. GSC loc. 57133.

Figure 2. *Hildaites* sp. indet. Figured specimen. GSC Cat. no. 24034. Lateral view. GSC photo 202158O. Middle eastern part of Cornwall Island. Jaeger Formation. GSC loc. 25981.

Figure 3. *Amaltheus stokesi* (J. Sowerby). Hypotype. Rubbercast. GSC Cat. no. 35237. Lateral view. GSC photo 202158N. Axel Heiberg Island. Borden Island Formation. GSC loc. C-4728.

Figure 4. *Amaltheus stokesi* (J. Sowerby). Hypotype. GSC Cat. no. 35238. Lateral view. Borden Island Formation. GSC photo 202158K. Prince Patrick Island. GSC loc. C-12544.

Figure 5. *Pseudolioceras* cf. *P. compactile* (Simpson). Figured specimen. GSC Cat. no. 35239. GSC photo 202176A. Prince Patrick Island. Wilkie Point Formation. GSC loc. 70390.

Figure 6. *Pseudolioceras spitsbergense* Frebold sp. nov. Holotype. GSC Cat. no. 14674. GSC photo 110482. Ellesmere Island, Fosheim Peninsula. Wilkie Point Formation. GSC loc. 28780.

Figures 7a,b. *Pseudolioceras spitsbergense* Frebold sp. nov. Paratype. GSC Cat. no. 35240. 7a—lateral view, 7b—venter. GSC photos: 7a—202158X, 7b—202176H. Prince Patrick Island, Intrepid Inlet. Wilkie Point Formation. GSC loc. C-12546.

Figures 8a,b. *Pseudolioceras spitsbergense* Frebold sp. nov. Paratype. GSC Cat. no. 35241. 8a—lateral view, 8b—venter. GSC photos: 8a—202158Y, 8b—202176F. Same formation and locality as for figure 7.

Figure 9. *Pseudolioceras spitsbergense* Frebold sp. nov. Paratype. GSC Cat. no. 35242. Lateral view. GSC photo 202158Z. Same formation and locality as for figure 7.

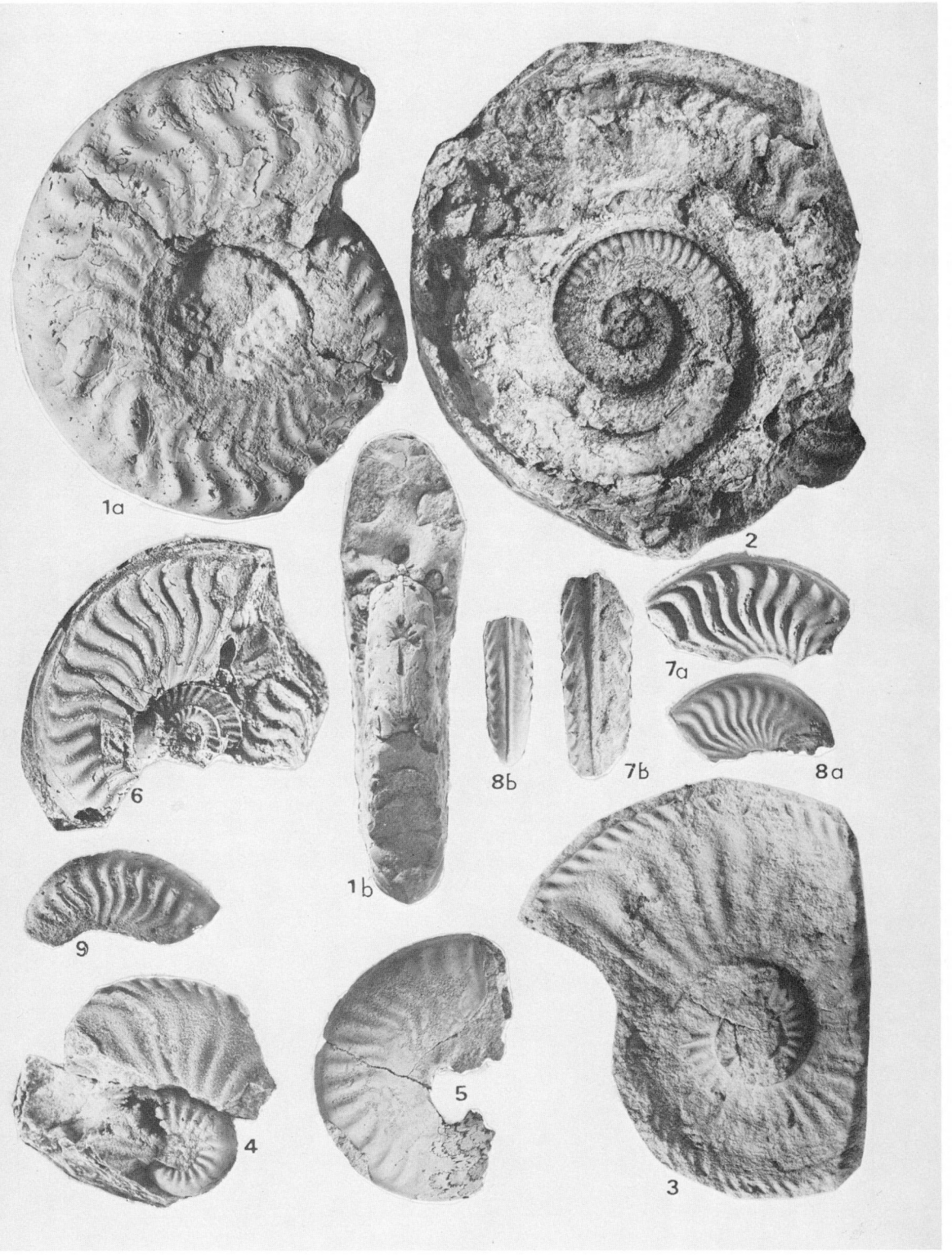
1a
2
1b
6
8b
7b
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PLATE 5

Figures 1a,b. *Peronoceras spinatum* (Frebold). Hypotype. GSC Cat. no. 33334. 1a—lateral view, 2b—venter. GSC photos: 202158S, 202176. Ellesmere Island. Unnamed Jurassic beds. GSC loc. 58289.

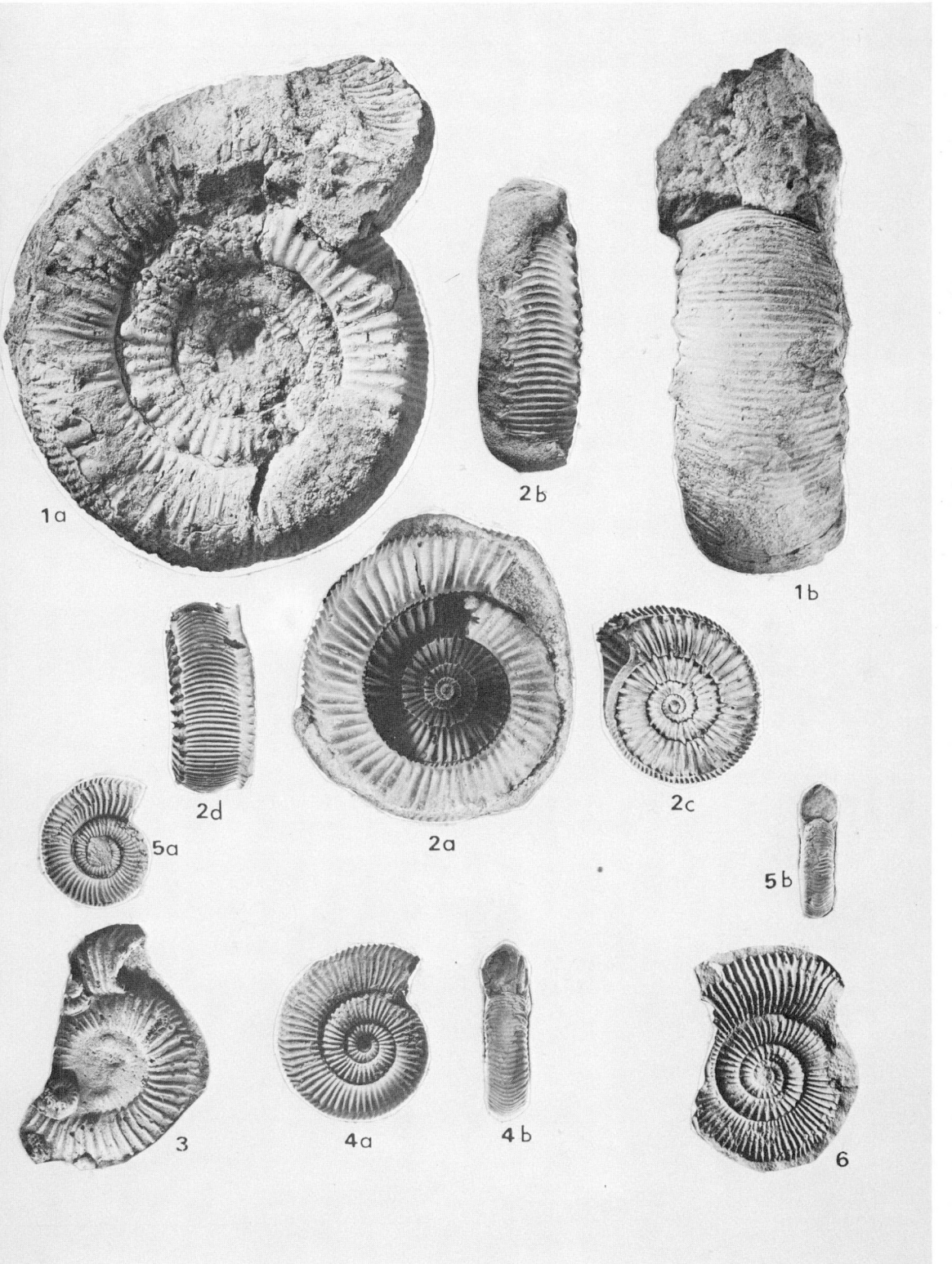
Figures 2a–d *Peronoceras polare* (Frebold). Hypotype. GSC Cat. no. 35245. 2a, 2c—lateral views, 2b, 2d—venters, 2c,d—rubbercast of imprint of inner whorls. GSC photos: 2a—202176E, 2b—202176K, 2c—202176B, 2d—202176L. Prince Patrick Island, Mould Bay. Wilkie Point Formation. GSC loc. 70390.

Figure 3. *Zugodactylites* cf. *Z. braunianus* (d'Orbigny). Figured specimen. GSC Cat. no. 33339. Lateral view. GSC photo 202176M. Reindeer Peninsula, Ellef Ringnes Island. Savik Formation. GSC loc. 80734.

Figures 4a,b. *Zugodactylites* cf. *Z. braunianus* (d'Orbigny). Figured specimen. GSC Cat. no. 33336. 4a—lateral view, 4b—venter and cross-section. GSC photos 202176P,Q. Same formation and locality as for figure 3.

Figures 5a,b. *Zugodactylites* cf. *Z. braunianus* (d'Orbigny). Figured specimen. GSC Cat. no. 33337. 5a—lateral view, 5b—venter and cross-section. Same formation and locality as for figure 3.

Figure 6. *Zugodactylites* cf. *Z. braunianus* (d'Orbigny). Figured specimen. GSC Cat. no. 33338. Lateral view. GSC photo 202176N. Same formation and locality as for figure 3.


1a
2b
1b
2d
2a
2c
5a
5b
3
4a
4b
6

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