



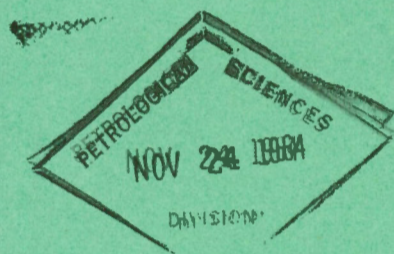
GEOLOGICAL
SURVEY
OF
CANADA

DEPARTMENT OF MINES
AND TECHNICAL SURVEYS

This document was produced
by scanning the original publication.

Ce document est le produit d'une
numérisation par balayage
de la publication originale.

BULLETIN 119



**THE JURASSIC FAUNAS OF
THE CANADIAN ARCTIC**

CADOCERATINAE

Hans Frebald

THE JURASSIC FAUNAS OF
THE CANADIAN ARCTIC
Cadoceratinae



GEOLOGICAL SURVEY
OF CANADA

BULLETIN 119

THE JURASSIC FAUNAS OF
THE CANADIAN ARCTIC

CADOCERATINAE

By
Hans Frebald

DEPARTMENT OF
MINES AND TECHNICAL SURVEYS
CANADA

© Crown Copyrights reserved

Available by mail from the Queen's Printer, Ottawa,
from Geological Survey of Canada,
601 Booth St., Ottawa,
and at the following Canadian Government bookshops:

OTTAWA

Daly Building, corner Mackenzie and Rideau

TORONTO

Mackenzie Building, 36 Adelaide St. East

MONTREAL

Æterna-Vie Building, 1182 St. Catherine St. West

or through your bookseller

A deposit copy of this publication is also available
for reference in public libraries across Canada

Price \$2.50 Catalogue No. 42-119

Price subject to change without notice

ROGER DUHAMEL, F.R.S.C.
Queen's Printer and Controller of Stationery
Ottawa, Canada
1964

PREFACE

This report is based on fossil collections made over a vast area of the Canadian Arctic extending from Axel Heiberg Island in the north to the Aklavik region of the mainland and is a further contribution by the author on the Jurassic faunas of the Canadian Arctic. Detailed study of these ammonite faunas permits correlation of the associated Jurassic rocks and shows their faunal and stratigraphic relationships with Alaska, East Greenland, and the Arctic areas of Europe and Asia.

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

OTTAWA, December 2, 1963

BULLETIN 119 — Die Jurafaunen der kanadischen
Aektis CADOCERATINAE.
Von Hans Frebald

Бюллетень 119 — Г. Фребольд. Юрские фауны
арктического подсемейства
Cadoceratinae Канады.

CONTENTS

	PAGE
<i>Introduction</i>	1
<i>Fossil localities</i>	1
British and Richardson Mountains	1
Arctic Islands	1
<i>Systematic descriptions</i>	3
Subfamily Cadoceratinae Hyatt	3
Genus <i>Arctocephalites</i> Spath	3
Genus <i>Cadoceras</i> Fischer	6
Other ammonites	18
Genus <i>Phylloceras</i> Suess	18
Genus <i>Arkelloceras</i> Frebold	18
<i>Stratigraphy, age, and correlation of Cadoceratinae in the Canadian Arctic</i>	21
<i>Arctocephalites</i> bed	21
<i>Cadoceras</i> beds	22
Stratigraphic conclusions	24
<i>Appendix. Fossil localities in Savik Formation, 15 miles northeast of Cape Level, western Axel Heiberg Island by E. T. Tozer</i>	25
<i>References</i>	26

Table I. Distribution of <i>Cadoceras</i> species in the Canadian Arctic	19
Table II. Occurrence and stratigraphy of Cadoceratinae in the Canadian Arctic	20

Illustrations

Plates I-XX. Illustrations of fossils	<i>Following p.</i> 29
Figure 1. Geological sketch map, 15 miles northeast of Cape Level, western Axel Heiberg Island by E. T. Tozer	2

THE JURASSIC FAUNAS OF THE CANADIAN ARCTIC Cadoceratinae

Abstract

This report describes representatives of the genera *Arctocephalites* Spath and *Cadoceras* Fischer, and includes one new *Arctocephalites* and five new species and varieties of *Cadoceras*.

The *Arctocephalites* species belong to the zone of *A. nudus*, the *Cadoceras* species to two stratigraphically different horizons, the lower and the upper *Cadoceras* beds. These two beds are best exposed on Axel Heiberg Island (the section concerned is described in the *Appendix* by E. T. Tozer), and contain new species that have some affinities to Russian and English Cadoceratids but are easily distinguishable. The faunal differences may be partly due to slight differences in age. The two Arctic *Cadoceras* beds are probably of late early Callovian age. The collection from Axel Heiberg Islands shows that the genus *Arkelloceras* Frebold, whose exact stratigraphic position is still unknown, is older than the beds containing *Arctocephalites*.

Résumé

L'auteur décrit des spécimens types des genres *Arctocephalites* Spath et *Cadoceras* Fischer de même qu'une nouvelle espèce d'*Arctocephalites* et cinq nouvelles espèces et variétés de *Cadoceras*.

L'espèce *Arctocephalites* appartient à la zone de *A. nudus* et les espèces *Cadoceras* à deux horizons stratigraphiques différents, soit le lit *Cadoceras* inférieur et le lit *Cadoceras* supérieur. Ces deux lits sont le mieux exposés sur l'île Axel Heiberg (la coupe en question est décrite en appendice par E. T. Tozer) et ils renferment de nouvelles espèces qui ressemblent aux Carocédatidés russes et anglais, mais qui peuvent en être distinguées facilement. L'auteur croit que ces différences fauniques peuvent être le résultat d'une légère différence d'âge. Les deux lits *Cadoceras* de l'Arctique remontent probablement à la fin du Callovien inférieur. La collection recueillie à l'île Axel Heiberg indique que le genre *Arkelloceras* Frebold, dont on ignore encore la position stratigraphique exacte, est plus ancien que les lits qui renferment les *Arctocephalites*.

INTRODUCTION

After publication of the more common Jurassic guide-fossils of the Canadian Arctic (Frebald, 1957; 1960; 1961) additional ammonites were studied, particularly those collected in recent years. These include Cadoceratids that have distinct palaeontological and stratigraphical interests. The specimens described belong to the genera *Arctocephalites* and *Cadoceras*, the latter group being characterized by a number of easily distinguishable forms that are described in this report as different species. Some of these are similar to one another but as they occur in different stratigraphic horizons, they cannot be regarded as varieties. Further material must be collected and studied before all problems of their systematic and stratigraphic positions can be solved. Unfortunately, experience has shown that in the Canadian Arctic ammonites are very often restricted to thin beds in comparatively thick sections and may be easily overlooked.

Palaeogeographic conditions are not discussed here, but reference is made to the author's previous publications (Frebald, op. cit.) and, as far as the Arctic Islands are concerned, to Tozer's studies (Tozer, 1960).

FOSSIL LOCALITIES

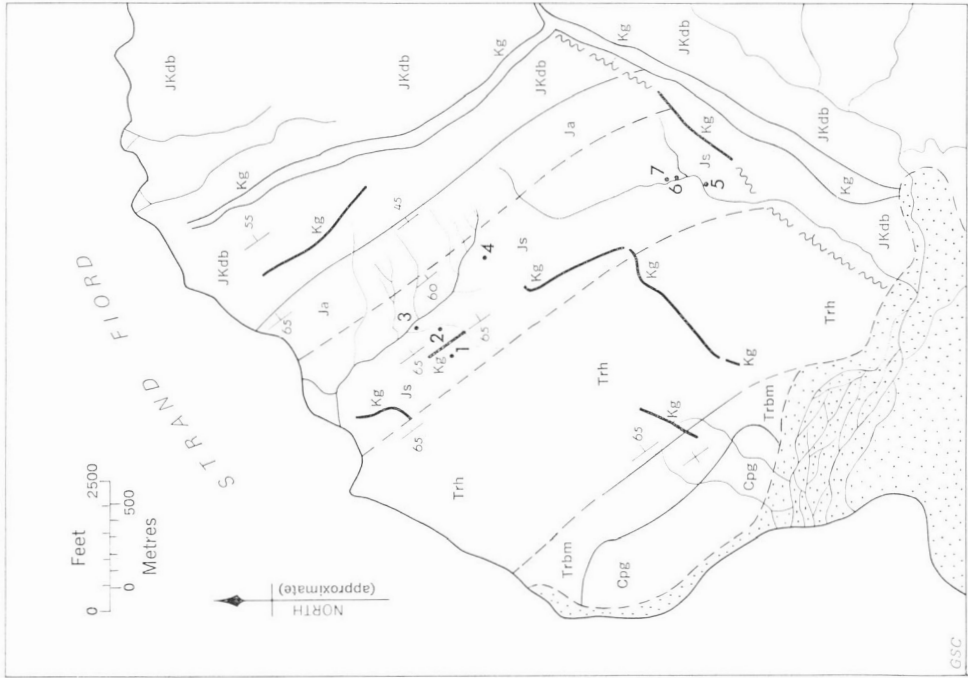
The Canadian Arctic Cadoceratinae described were collected by various geologists in two main areas, i.e., the Arctic Islands and the Richardson-British Mountains. With the exception of a section on Axel Heiberg Island which is described by E. T. Tozer in the *Appendix*, all the ammonites were collected in outcrops where no sections were measured.

British and Richardson Mountains

1. Firth River (Yukon-Alaska boundary area). Lower part of the river. See J. J. O'Neill and S. S. Buckman (O'Neill, 1924, pp. 12A-15A).
2. Babbage River (British Mountains). GSC loc. 44102: lat. 68°50', long. 138°41'. Collected by Triad Oil Company.
3. GSC loc. 42646: west of Porcupine and east of Waters River at the northeast end of Dave Lord Ridge (lat. 67°35', long. 137°27'). Collected by A. Lenz, California Standard Company, in 1958.
4. GSC loc. 4811: west of Mackenzie River, exact position unknown.
5. Aklavik Range (northeastern Richardson Mountains). GSC loc. 27003: 2 to 3 miles south of Bug Creek. Collected by J. A. Jeletzky, 1955.

Arctic Islands

6. Cornwall Island. GSC loc. 25980: mid-eastern part. Collected by H. R. Greiner, 1955.
7. Ellef Ringnes Island. GSC loc. 44041: extreme head of southwest-flowing stream that enters the northeast side of Deer Bay. Collected by J. L. Usher, 1960.
8. Axel Heiberg Island. See detailed description by E. T. Tozer, p. 25. South side of Strand Fiord, 15 miles northeast of Cape Levvel; GSC loc. 51628: *Arctocephalites* bed; GSC loc. 51629: lower *Cadoceras* bed collected by Tozer in 1962; GSC loc. 43619: upper *Cadoceras* bed. Collected by A. A. Ormiston and A. H. McNair.



Base map from air photographs

FIGURE 1. Geological sketch map, gypsum diapir, 15 miles northeast of Cape Levvel, western Axel Heiberg Island (Geology by E. T. Tozer, 1962)

LEGEND

CRETACEOUS
Kg / Kg Gabbro dykes and sills

UPPER JURASSIC AND LOWER CRETACEOUS
JKdb DEER BAY FORMATION: shale

JURASSIC
Ja AWINGAK FORMATION: sandstone, shale
Js SAVIK FORMATION: shale, ironstone nodules, minor siltstone and sandstone

TRIASSIC
Trh HEIBERG FORMATION: sandstone, minor siltstone and shale
Trbm BLAA MOUNTAIN FORMATION: shale, siltstone

(INTRUSIVE CONTACT)
PENNSYLVANIAN
Cpg Gypsum, limestone

Alluvium
Bedding, (inclined, vertical).....
Fault (tick indicates downthrow side).....

FOSSIL LOCALITIES

1. GSC loc. 51627 Lower Bajocian
2. GSC loc. 51628 *Arctocéphalites* Middle Bathonian
3. GSC loc. 51629 Lower *Cadoceras* bed Callovian
4. GSC loc. 43619 Upper *Cadoceras* bed Callovian
(Collected by A. H. McNair and A. A. Ormiston, 1960)
5. GSC loc. 51630 Lower Bajocian
6. GSC loc. 51631 *Artelloceras* bed Bajocian-Lower Bathonian
7. *Arctocéphalites* observed above *Artelloceras*

SYSTEMATIC DESCRIPTIONS

The genus *Arctocephalites* has been assigned by different authors to different families. Spath (1928, p. 174; 1932, pp. 9, 32) placed it as well as the closely related *Cranocephalites* Spath (1932, pp. 9, 14) into the family Macrocephalitidae; Arkell (1957, p. L 301) considered both genera as belonging to the subfamily Cadoceratinae Hyatt, 1900, family Cardioceratidae Siemiradzki, 1891. Spath's opinion was accepted by Voronets (1962, pp. 32-45), while the author (1961, pp. 10-14) followed Arkell in placing *Arctocephalites*, *Cranocephalites*, and *Arcticoceras* Spath into the subfamily Cadoceratinae Hyatt. *Cranocephalites* is now considered by some authors as a subgenus of *Arctocephalites* (Arkell, 1957, p. L 301; Frebold, 1961, p. 12; Imlay, 1962, p. C-23), while others (for example, Voronets, 1962, p. 32) retain the generic status of *Cranocephalites*. The author has recently (1963) excluded the west Canadian and western Interior species previously referred to *Arctocephalites* (Imlay, 1948, 1962) from this genus and has referred them to Buckman's genus *Paracephalites* (Buckman, 1929, p. 8) while the '*Arcticoceras*' species found in the same areas are placed into the new genus *Warrenoceras* Frebold.

No discussion is offered here whether the opinion of Spath or that of Arkell should be preferred. Justifications for the one or the other could be given, however, without guarantee that these would conform with the actual relationships of the genus. The author has placed the genus into the Cadoceratinae merely to avoid conflict with Arkell's treatise (Arkell, 1957).

Most of the forms of *Cadoceras* described are assigned to new species, some of which are similar to one another or to known *Cadoceras* species. As there is a certain possibility, if not probability, that these forms came from hitherto unknown beds or zones, a description as new species seems justified and necessary. In this approach the author is in accord with Imlay (1953), Bodylevsky (1960), and Voronets (1962), all of whom described new species of *Cadoceras* from Alaska and northern Siberia.

Subfamily CADOCERATINAE Hyatt, 1900

Genus *Arctocephalites* Spath, 1928

Arctocephalites elegans Spath

Plate I, figures 1a to 3b; Plate II, figures 1a to 2b

Arctocephalites elegans Spath, 1932, pp. 37, 38; Pl. 10, figs. 4a, b.

Arctocephalites elegans Spath, Frebold, 1961, pp. 10, 11; Pl. 9, fig. 1; Pl. 10, figs. 1a, b; Pl. 11, figs. 1a, b, 2, 3, 4.

Material. About eleven specimens collected by E. T. Tozer in Savik Formation, Axel Heiberg Island, 255 to 260 feet below bed with *Cadoceras bodylevskyi* n. sp. and 85 to 90 feet above bed with *Arkelloceras* (GSC loc. 51628).

Description. Descriptions of the species were given by Spath (loc. cit.) and Frebold (loc. cit.), however, none of the previously described specimens reached the large adult size now represented in the Axel Heiberg Island material. Spath's holotype has a diameter of 85 mm whereas the largest Axel Heiberg Island speci-

men measures 100 mm. The last whorl of these adult specimens appears to be entirely smooth. There is one large constriction at the anterior end. Four fifths of the last whorl belongs to the body-chamber. The umbilicus is still narrow and fairly deep, with steep walls.

One fairly well preserved aperture apparently belonging to this species is illustrated in figures 3a, b, on Plate I.

The dimensions in millimetres of the largest specimens are:

<u>GSC No.</u>	<u>Diameter</u>	<u>Whorl height</u>	<u>Whorl thickness</u>	<u>Umbilical width</u>
17644	100 (100)	51 (0.51)	48 (0.48)	12 (0.12)
17643	99 (100)	49 (0.49)	46 (0.46)	10 (0.10)

The percentages of these measurements agree fairly well with the measurements of the Canadian Arctic specimens previously described (Friebold, 1961, p. 10) but not with those of the holotype (Spath, 1932, p. 37), which is much higher than wide.

Remarks. The specimens here assigned to *A. elegans* Spath are easily distinguishable from the associated species *A. callomoni* n. sp. by their more compressed shape and their finer ribs. It is pointed out that the species *A. elegans* Spath has been taken here in a rather broad sense. As Spath figured only one specimen, the variability of the species is not known. Some of the Canadian Arctic specimens could just as well be assigned to similar 'species' as for instance *A. arcticus* (Newton) (Newton and Teall, 1897, Pl. 40, 1-1a only) but this 'species' is based on a young specimen whose adult stage is unknown. The same applies to the Franz Josef Land specimen of *A. arcticus* figured by Spath (op. cit., p. 32, Pl. 12, fig. 2) and his species *A. ellipticus* (Spath, op. cit., p. 33, Pl. 13, fig. 6). *A. pilaeformis* Spath (=Newton and Teall, 1897, Pl. 40, figs. 2, 2a), which was mistaken by Pompeckj (1902, p. 106, see Spath, 1932, p. 33) for '*Macrocephalites pila*', is clearly distinguished from the Canadian *elegans* by more depressed whorl section. *A. nudus* Spath (Spath, loc. cit., p. 35, Pl. 11, figs. 1a, b; Pl. 12, figs. 4a, b; Pl. 15, figs. 2a, b) becomes smooth at an earlier stage of growth.

Occurrence and age. Richardson Mountains; Savik Formation, Axel Heiberg Island; East Greenland; Middle Bathonian; in Axel Heiberg Island associated with *A. callomoni* n. sp., *A. cf. arcticus* (Newton), and *A. aff. pilaeformis* Spath, and *A. arcticus* (Newton).

Arctocepalites callomoni n. sp.

Plate III, figures 1a to 2; Plate IV, figure 1; Plate V, figure 3;
Plate VII, figure 3

Holotype is specimen GSC No. 17647, Plate III, figures 1a, b. The species is named in honour of Dr. J. H. Callomon, University College, London, England.

Material. About ten specimens collected in 1962 by E. T. Tozer from Savik Formation, Axel Heiberg Island, 255 to 260 feet below bed with *Cadoceras bodylevskyi* n. sp. and 85 to 90 feet above bed with *Arkelloceras* (GSC loc. 51628).

Description. The general shape of the species is slightly inflated with moderately convex flanks that grade into the gently rounded, moderately broad venter. Cross-section wider than high, umbilicus narrow and deep with steep walls, funnel-shaped, not scaphitoid. Living-chamber three quarters of a whorl or more, with fairly deep and broad constriction near anterior end. Strong ribs, subdivided into two and occasionally three branches that cross the venter transversely up to a shell diameter of about 65 mm, fine lines of growth on body-chamber. Suture lines follow each other very closely, not traceable in detail.

The dimensions in millimetres of the holotype and one younger specimen are:

<u>GSC No.</u>	<u>Diameter</u>	<u>Whorl height</u>	<u>Whorl thickness</u>	<u>Umbilical width</u>
Holotype 17647	approx. 110 (100)	60 (0.55)	69 (0.63)	13 (0.12)
Paratype 17642	77 (100)	43 (0.56)	48 (0.62)	approx. 9 (0.12)

Remarks. This species is somewhat similar to the genotype of the genus, *Arctocephalites arcticus* Newton, but differs from it by its more bullate shape and the persistence of the primary ribs, which in *arcticus* disappear earlier than the secondaries. Furthermore, as no adult specimens of *arcticus* are figured in the existing literature, mature stages of growth cannot be compared. The same difficulty arises when comparing *A. callomoni* with *A. pilaeformis* Spath (1932, p. 33) = *Macrocephalites ishmae* var. *arctica* Newton (inflated variety only: Newton, 1897, Pl. 40, fig. 2) = *Macrocephalites pila* Pompeckj (1902, p. 106), of which only the inner whorls are known. It is true that the strong ribs may suggest comparable stages of growth of *callomoni*, but as the mature stages of *pilaeformis* Spath are unknown complete identity cannot be established.

Arctocephalites elegans Spath with which *A. callomoni* is associated clearly differs from *callomoni* in its laterally more compressed shape and finer ribs. *A. koettlitzii* Pompeckj (1900b, p. 70, Pl. 2, figs. 12a-c) of which adult stages are not figured has a similar cross-section but is smooth at a much earlier stage of growth as compared with younger stages of *callomoni*. *A. ornatus* Spath, *A. nudus* Spath have finely ribbed inner whorls contrary to *A. callomoni* whereas *A. greenlandicus* Spath is much more laterally compressed.

Occurrence and age. Savik Formation, Axel Heiberg Island, Middle Bathonian. Associated with *Arctocephalites elegans* Spath, *A. cf. arcticus* (Newton), and *A. aff. pilaeformis* Spath, and *A. arcticus* (Newton).

Arctocephalites cf. A. arcticus (Newton)

Plate I, figure 4; Plate III, figure 3

Macrocephalites ishmae var. *arcticus* Newton and Teall, 1897, p. 500, Pl. 40, figs. 1, 1a.
Arctocephalites arcticus (Newton) Spath, 1932, p. 32, Pl. 12, fig. 2.

Material. One fragmentary specimen (GSC No. 17641) collected by E. T. Tozer, 1962, from Savik Formation, Axel Heiberg Island, 255 to 260 feet below bed with

Cadoceras bodylevskiyi n. sp. and 85 to 90 feet above bed with *Arkelloceras* (GSC loc. 51628).

Description and remarks. The specimen is characterized by strong ribs that are subdivided into two and three branches that cross the medium-broad venter transversely; only part of the last whorl is ribbed but it is possible that the anterior part of the whorl is smooth because the outer rib-bearing shell is broken off. In general shape and type of ribbing the specimen is very similar to the holotype of *A. arcticus* (Newton) and is clearly distinguished from the associated more compressed and fine-ribbed *A. elegans*. It is, however, possible that this small form represents the inner whorls of *A. callomoni* n. sp.

Occurrence and age. Savik Formation, Axel Heiberg Island, Middle Bathonian. Associated with *A. elegans* Spath, *A. callomoni* n. sp., and *A. aff. pilaeformis* Spath, and *A. arcticus* (Newton).

Arctocephalites aff. *A. pilaeformis* Spath and *A. arcticus* (Newton)

Material. One specimen collected by E. T. Tozer from Savik Formation, Axel Heiberg Island, 255 to 260 feet below bed with *Cadoceras bodylevskiyi* n. sp. and 85 to 90 feet above bed with *Arkelloceras* (GSC loc. 51628).

Description and remarks. The general shape of this medium-sized specimen is intermediary to those of *A. elegans* Spath and *A. callomoni* n. sp., being less compressed than the former and less bullate than the latter species. The venter is broader than that of *elegans* but not as broad as in *callomoni*. The ribs are inclined forward on the flanks where most of them bifurcate. They are only slightly stronger on the venter than those of *A. elegans*. It differs from *A. arcticus* (Newton) (Newton, 1897, Pl. 40, figs. 1, 1a) by its more flattened venter and from *A. pilaeformis* Spath (1932, p. 33) = '*Macrocephalites*' *pila* Pompeckj (non Nikitin) (Pompeckj, 1900a, p. 73) = '*Macrocephalites*' *ishmae* var. *arctica* Newton (inflated variety, see Newton, 1897, Pl. 40, fig. 2) by a higher cross-section.

Occurrence and age. Savik Formation, Axel Heiberg Island, Middle Bathonian. Associated with *A. elegans* Spath, *A. callomoni* n. sp., *A. cf. arcticus* (Newton).

Genus *Cadoceras* Fischer, 1882

Cadoceras septentrionale n. sp.

Plate IV, figure 3; Plate V, figures 1a to 2b;
Plate VI, figures 1a to 3b

Holotype is specimen GSC No. 17651, Plate IV, figure 3; Plate V, figures 1a, b.

Material. Five adult, one medium-sized, and one young specimen collected by Ormiston and McNair in 1960 on south shore of Strand Fiord, Axel Heiberg Island (GSC loc. 43619). Upper *Cadoceras* bed. Same locality as E. T. Tozer's lower *Cadoceras* bed (GSC loc. 51629) but 255 feet higher.

Description. Semi-globose in adult stage of growth with deep and narrow umbilicus and whorls embracing each other almost entirely. In the largest specimen (the holotype) the umbilicus becomes wider and the anterior half of the last whorl does not embrace the preceding whorl completely leaving the innermost part of it visible. The cross-section of the species is wider than high, the venter broad but slightly arched. There are three specimens with a much wider and not arched venter that are described below as a variety of this species. The umbilical edge is abrupt but rounded. The umbilical wall steep and high. Four of the adult specimens are wholly septate but in the paratype, Plate VI, figures 1a, b, the posterior part of the living chamber is preserved while the holotype has about one third of the living chamber. Only one of the smaller adult specimens has ribs in the posterior part of the last whorl. They begin at the umbilical edge in form of elongated nodes and are subdivided below the middle of the flanks into two or three branches; they are weak and inclined forward and cross the venter almost transversely. All the other specimens are smooth except for the elongated umbilical nodes, which, however, become weak on the living chamber. Fine wavy lines of growth are present on several parts of the last whorl of the paratype figured in figure 1a, Plate VI.

The suture lines are very deeply incised and follow one another very densely; they are difficult to unravel. The first lateral lobe is longer than the ventral and second lateral lobes. The suture line can be seen best in the variety illustrated in figure 1, Plate VII.

The medium-sized specimen, Plate V, figures 2a, b, belongs probably to the same species, although this could not be proved. Its cross-section is only slightly wider than high, the ribs are sharper than in the more adult specimen, Plate VI, figures 2a, b, and are divided at about the middle of the flanks. They are slightly inclined forward, also on the venter; most of them bifurcate but there are also some intercalaries. No nodes are present at this stage on the umbilical edge. The young specimen, Plate VI, figures 3a, b, shows largely the same features as the medium-sized except for its being slightly higher than wide. It could not be proven that this young specimen belongs to the same species as the adult ones although it seems likely.

The dimensions in millimetres of some of the specimens are:

<u>GSC No.</u>	<u>Diameter</u>	<u>Whorl height</u>	<u>Whorl thickness</u>	<u>Umbilical width</u>
Holotype 17651	113 (100)	47 (41)	76 (67)	33 (29)
Paratype 17654	94 (100)	45 (48)	59 (63)	22 (23)
Paratype 17652	82 (100)	36 (44)	54 (66)	20 (24)
Paratype 17658	54 (100)	25 (46)	27 (50)	10 (19)
Paratype 17657	19 (100)	8 (42)	7 (37)	4 (21)

This species is very closely related to *Cadoceras tolype* Buckman (1922-23, vol. 4, pl. 406) but differs from Buckman's species by somewhat weaker ribbing, an arched venter, and a longer first lateral lobe. The broad venter of *C. tolype* is, however, similar to that of the broad variety of *C. septentrionale* described below

as var. *latidorsata*. *Cadoceras sublaeve* Sowerby (1814, vol. 1, p. 117, Pl. 54 [large figure only]) is also related but differs from the Canadian species by a more globose shape, the absence of nodes at the umbilical rim, stronger costation and much lower cross-section in medium-sized specimens.

Remarks. The Canadian species cannot be identified with any of the Alaskan, north Siberian, Russian or East Greenland representatives of the genus *Cadoceras*. It is similar to *Cadoceras tschefkini* (Nikitin) (Nikitin, 1881b, p. 287, Pl. 7, figs. 21-23) in general aspect but differs by a somewhat narrower umbilicus and the presence of umbilical nodes. Another related species is *C. milaschewici* (Nikitin) (Nikitin, 1881a, Pl. 12, fig. 26a, 1881b, Pl. 7, fig. 25) but Nikitin's specimens are too small for comparison. The recently described *C. milaschewici* var. *pura* Voronets (1962, p. 56, Pl. 13, fig. 1; Pl. 16, fig. 1) differs from *C. septentrionale* by a much narrower cross-section.

Occurrence and age. Savik Formation, Axel Heiberg Island, Callovian. Associated with *C. septentrionale* var. *latidorsata*.

Cadoceras septentrionale var. *latidorsata* n. sp. et n. var.

Plate IV, figures 2a, b; Plate VII, figure 1;
Plate VIII, figure 1; Plate X, figure 1; Plate XI, figure 1

Material. One large specimen (GSC No. 17656) collected by J. A. Jeletzky in 1955 in the Aklavik Range, 2 to 3 miles south of Bug Creek (GSC loc. 27003). One whorl fragment (GSC No. 17653) and one medium-sized specimen (GSC No. 17652) collected by Ormiston and McNair in 1960 from Savik Formation on the south shore of Strand Fiord, Axel Heiberg Island, 15 miles northeast of Cape Levvel, upper *Cadoceras* bed (GSC loc. 43619). Same locality as Tozer's lower *Cadoceras* bed (GSC loc. 51629) but 255 feet higher.

Description. This variety differs from the holotype by a lower cross-section and a flatter venter. In other features it is very similar to the holotype. All specimens are septate to the end of the last whorl.

The best preserved specimen is illustrated in figure 1, Plate VII and figure 1, Plate VIII. The cross-sections of the whorls are fairly low in young specimens and become very wide when adult. The venter is flat-rounded, the umbilicus deep and crater-shaped, the umbilical rim is well marked. The whorls embrace each other almost entirely. No costation is visible and even the nodes at the umbilical rim are not noticeable. The suture line is, to judge from the limited possibility of comparison with the suture line of the holotype, similar to that of the species.

The fragment Plate X, figure 1 and Plate XI, figure 1, shows part of the venter of a larger specimen and the cross-sections of some of the preceding whorls.

The smallest specimen has no costation preserved but the nodes on the umbilical rim are well developed.

The dimensions in millimetres are as follows:

<u>GSC No.</u>	<u>Diameter</u>	<u>Whorl height</u>	<u>Whorl thickness</u>	<u>Umbilical width</u>
17656	136 (100)	66 (0.49)	125 (0.92)	43 (0.32)
17652	82 (100)	39 (0.48)	66 (0.80)	21 (0.26)

Remarks. This variety seems to be closely related to *Cadoceras tolype* Buckman (1922-23, vol. 4, Pl. 406), which has a similar suture line, similar general shape and nodes at the umbilical rim. *C. emelianzewi* Voronets from northern Siberia (Voronets, 1962, p. 50, Pl. 18, fig. 2; Pl. 21, figs. 1a, b; Pl. 22, fig. 1) is similar in lateral aspect but differs from the Canadian form mainly by the absence of nodes at the umbilical rim. Dr. Callomon during a recent visit to Ottawa saw these specimens and he believes that they are closely related to or identical with *Cadoceras sublaeve* (Sowerby) and that this species is also present in Greenland in the zone of *Sigaloceras calloviense*. Sowerby's figure of the holotype is too unsatisfactory to permit identification with *C. septentrionale*.

Occurrence and age. Savik Formation, Axel Heiberg Island; Aklavik Range; Callovian. In Axel Heiberg Island associated with *C. septentrionale*, in the Aklavik Range with *C. (Stenocadoceras) canadense* n. sp.

Cadoceras voronetsae n. sp.

Plate XV, figure 1; Plate XVI, figure 1

Holotype is specimen GSC No. 17669. The species is named in honour of Dr. N. S. Voronets, Leningrad.

Material. The holotype is the only specimen. It was collected west of Porcupine and east of Waters River at the northeast end of Dave Lord Ridge, by A. Lenz, California Standard Company in 1958 (GSC loc. 42646).

Description. The large specimen is fairly globose with broadly arched venter in adult stage of growth, deep crater-shaped umbilicus with sloping non-perpendicular walls. Umbilical edge fairly sharp. The preserved anterior half of the last whorl belongs to the body-chamber that is entirely smooth except for some fine lines of growth in places where the shell is preserved. The posterior part of the last whorl and the mouth are missing. The visible part of the penultimate whorl that shows part of the deeply incised suture line is also smooth. Only the cross-sections of some of the inner whorls are visible, they are higher than wide and at these younger stages of growth the ammonite is fairly compressed.

The measurements in millimetres are:

<u>GSC No.</u>	<u>Diameter</u>	<u>Whorl height</u>	<u>Whorl thickness</u>	<u>Umbilical width</u>
Holotype 17669	187	98 (0.52)	141 (0.75)	57 (0.30)

Remarks. Superficially the species resembles *Cadoceras septentrionale* n. sp. var. *latidorsata* and *C. emelianzewi* Voronets. The main differences of these two species

from *voronetsae* are in the shape of the umbilicus and the inner whorls, which are depressed in *septentrionale* and *emelianzewi* and compressed in *voronetsae*, while the umbilicus of both species has much steeper, almost perpendicular walls contrary to those of *voronetsae* which are more gently sloping. There is also a slight resemblance to the Alaskan group of *C. comma* Imlay in certain stages of the ontogenetic development, but the change from the compressed whorls to the semi-globose takes place at a much earlier stage. The cross-section of the inner whorls is reminiscent of *C. canadense* n. sp. but this species does not change into a globose or semi-globose stage, its whorls remain much narrower than in *C. voronetsae*.

Occurrence and age. As this new species was found only at one locality in the Richardson Mountains and was not associated with other forms nothing can be said of its age relative to the other Canadian species. There is, however, little doubt that it is younger than the *C. crassum* fauna, and that it belongs to the Callovian.

Cadoceras bodylevskyi n. sp.

Plate XVII, figures 1a-c; Plate XIX, figures 1, 2

Holotype is GSC No. 17666. The species is named in honour of Dr. V. I. Bodylevsky, Leningrad.

Material. Three specimens collected by E. T. Tozer in 1962 on south shore of Strand Fiord, Axel Heiberg Island, lower *Cadoceras* bed (GSC loc. 51629). Same locality as Ormiston's and McNair's upper *Cadoceras* bed (GSC loc. 43619) but 255 feet below.

Description. The innermost preserved whorls can be seen in a paratype of the species (GSC No. 17667, Pl. XIX, fig. 2). At a diameter of about 16 mm the cross-section of the whorl shows a rounded venter, apparently slightly higher than wide. Rather fine straight ribs are present on the inner part of the posterior half of the whorl, the outer half of the whorl and venter are smooth. In the anterior half of the whorl the ribs are stronger but as the outer part of the whorl is covered by the following whorl it cannot be seen whether they continue to and on the venter. In the course of the ontogenetic development the ribs become very strong on the flanks and venter while they are rather weak on the umbilical wall. They are strongly inclined forward on the flanks and particularly on the venter (*see* holotype, GSC No. 17666, Pl. XVII, fig. 1b), and are subdivided into two or three branches below the middle of the flank. This ribbed stage is present up to a diameter of about 93 mm.

The preserved parts of the body-chambers of the three specimens are one half to three quarters of a whorl. The elongated swellings of the ribs between the umbilical rim and the middle of the flanks are still present in the posterior part of the body-chamber but there are no ribs on the outer flank and venter. After an almost entirely smooth stage and a rather shallow and broad constriction, blunt

and weak ribbing appears in the anterior part of the body-chamber. The aperture is not preserved in any of the specimens.

The umbilicus of the species is rather narrow and deep with steep umbilical walls. It becomes proportionally narrower with increasing age. The whorls embrace each other almost completely in adult, less in young specimens. The cross-section of the whorls is wider than high, the venter is rounded to arched. No suture line could be studied.

Remarks. This species differs from *C. cf. C. falsum* by a narrower umbilicus, by a higher and less wide cross-section, by ribs that are more strongly bent forward, particularly on the venter and by the recurrence of ribs in the anterior part of the body-chamber preceded by a constriction and a smooth stage of the body-chamber. *C. barnstoni* (Meek) is similar but has a wider umbilicus, and lower cross-section.

None of the hitherto described species from East Greenland, southern Alaska or northern Siberia can be identified with this species though there are some similarities. *C. subcatostoma* Voronets, *C. subcalyx* Voronets, and *C. variabile* Spath differ from *C. bodylevskyi* mainly by the absence of forwardly bent ribs on the venter. *C. catostoma* Pompeckj (see Imlay, 1953, Pl. 34, figs. 1-14) is similar in the shape of the cross-section and the recurrence of ribs on the body-chamber. However in *C. catostoma* the umbilicus opens up, the ribs are not forwardly bent on the venter and the recurrent ribs on the body-chamber are much stronger.

Dimensions in millimetres are:

<u>GSC No.</u>	<u>Diameter</u>	<u>Whorl height</u>	<u>Whorl thickness</u>	<u>Umbilical width</u>
Holotype 17666	117 (100)	52 (0.44)	64 (0.55)	31 (0.26)
Paratype 17667	130 (100)	60 (0.46)	76 (0.58)	23 (0.18)

Occurrence and age. Savik Formation, Axel Heiberg Island, Callovian. Associated with *C. cf. C. falsum* Voronets and *C. barnstoni* (Meek) var. *latidorsata* n. var.

Cadoceras cf. C. falsum Voronets

Plate VIII, figure 2; Plate IX, figures 2a, b; Plate XVIII, figures 1a-c

Material. Two specimens (GSC Nos. 17659, 17661) collected by E. T. Tozer in 1962 on south shore of Strand Fiord, Axel Heiberg Island, 15 miles northeast of Cape Level from Savik Formation, lower *Cadoceras* bed (GSC loc. 51629). Same locality as Ormiston's and McNair's upper *Cadoceras* bed (GSC loc. 43619) but 255 feet below.

Description. The specimens have a deep, more or less crater-shaped umbilicus; the whorls embrace each other less in young than in adult specimens. The transition from the umbilical wall to the flanks is rounded, the cross-section of the whorls is much wider than high, the venter very slightly rounded. Ribs are already present in very young stages of growth. They are strong, fairly high, almost straight on the umbilical wall but inclined forward on the flanks and venter, where they are curved

forward. They form elongated nodes at the umbilical margin and are divided at this point into two or three branches. Some intercalaries are present. The ribs gradually disappear on the body-chamber.

The smaller specimen is septate to the anterior end of the last whorl, whereas in the larger specimen the preserved part of the body-chamber occupies almost an entire whorl.

The suture line is deeply incised. As it is covered by shell it could not be unravelled in detail.

The dimensions in millimetres of the two specimens are:

<u>GSC No.</u>	<u>Diameter</u>	<u>Whorl height</u>	<u>Whorl thickness</u>	<u>Umbilical width</u>
17659	87 (100)	about 39 (0.45)	68 (0.78)	28 (0.32)
17661	at 105 (100) (maximum is about 117)	about 43 (0.50)	about 80 (0.76)	33 (0.31)

Remarks. The specimens are somewhat similar, particularly in the strong ribs, to *Cadoceras barnstoni* (Meek) from which they are distinguished by a lower and wider cross-section, narrower and deeper umbilicus, and a sharper forward bend of the ribs on the venter.

Cadoceras falsum Voronets (1962, p. 49, Pl. 7, fig. 2; Pl. XI, figs. 1a, b; Pl. 18, figs. 1a, b; Pl. 19, figs. 1, 2a, b) agrees fairly well with the Canadian specimens in general outline and the strong, ventrally forward bent ribs. *C. falsum* Voronets seems, however, to be distinguished by a lower cross-section, and an earlier effacement of the ribs. Whether these differences are within the variability of one and the same species or not, could only be decided if more material were available for study.

Another somewhat similar species is *Cadoceras calyx* Spath (1932, p. 69, Pl. 20, fig. 1) that has a similar general outline but is distinguished from *C. cf. falsum* by a wider umbilicus, and smaller whorl height and apparently weaker ribbing. None of the south Alaskan species described by Imlay (Imlay, 1953b) can be identified with the Canadian form.

Occurrence and age. Savik Formation, Axel Heiberg Island, Callovian. Associated with *C. bodylevskiyi* n. sp., and *C. barnstoni* (Meek) var. *arcuata* n. var.

Cadoceras arcticum n. sp.

Plate XII, figure 1; Plate XIII, figure 1;
Plate XVII, figure 2; Plate XX, figure 2

Cadoceras sp. Frebold, 1961, p. 19, Pl. 17, fig. 3; Pl. 18, fig. 1.

Holotype is GSC No. 15127.

Material. The holotype was collected by H. Greiner in 1955, on Cornwall Island (GSC loc. 25980) and was previously described as *Cadoceras* sp.; two larger specimens, one small specimen and some medium-sized fragments are from Triad

Oil Company collections from Babbage River, lat. 68°50', long. 138°41' (GSC loc. 44102).

Description. A description of the holotype was given previously (Friebold, op. cit.).

The large specimens from Babbage River show only the last whorl that is entirely smooth and has a sharp umbilical edge from which the umbilical walls slope fairly gently. The cross-section at the adult stages of growth represented by the two specimens is still not depressed and the venter remains gently rounded. The specimen shown on Plate XII, figure 1, has one constriction at the mouth and one weaker one somewhat behind. The last whorls of both large specimens seem to belong to the body-chamber. Only at the posterior end of the last whorl of the smaller specimen is septation visible.

The small rather poorly preserved specimen Plate XVII, figure 2, is considered to belong to this species. Its shape is already semi-globose, the width of the umbilicus is of moderate size. Flanks and venter are covered with straight ribs, that cross the venter transversely. Bifurcation at about the middle of the flanks seems to be the rule. Slight swellings near the umbilical rim seem to be present.

Remarks. This species differs from *C. sublaeve* (Sowerby) (1814, Pl. 54, large figure only) by a much less depressed cross-section and an apparently wider umbilicus. *C. septentrionale* n. sp. has a much more depressed cross-section when adult, narrower umbilicus, and steeper umbilical walls. As already stated in the previous description of the holotype (Friebold, op. cit.), the species is similar to *C. stenolobum* (Nikitin) (Nikitin, 1881a, pp. 121, 122, Pl. 5, figs. 28-30). Nikitin's species, however, still has compressed inner whorls at a diameter of 59 mm. Unfortunately, the three adult Canadian specimens do not show the inner whorls but as it is assumed that the small specimen illustrated on Plate XVII, figure 2, belongs to *C. arcticum* and as this young specimen is already semi-globose, the species cannot be referred to *C. stenolobum* (Nikitin). Also similar in general appearance are Imlay's south Alaskan species *C. comma* and *C. glabrum*, which both become inflated at a comparatively early stage of growth. Both south Alaskan species have the sharp umbilical edge and the compressed cross-section in common with the Canadian species but they differ from it mainly by their wider umbilicus. Furthermore, the comma-shaped umbilical swellings of the ribs that are characteristic of *C. comma* and *C. glabrum* persist to a greater diameter than the holotype of *C. arcticum*. *C. milashevici* var. *pura* Voronets (1962, Pl. 13, fig. 1; Pl. 16, fig. 1) is very similar to the Canadian species in general shape but as shape and strength of ribs of the inner whorls of *milashevici* var. *pura* are unknown, an identification with the Canadian species is not warranted. The medium-sized specimen of *C. milashevici* Nikitin (1881a, p. 121, Pl. 5, fig. 26) has no ribs and cannot be identified with the young Canadian specimens of *C. arcticum*.

Occurrence and age. Cornwall Island (loose in river bed) and British Mountains. Callovian. On Babbage River (British Mountains) associated with *Cadoceras* (*Stenocadoceras*) cf. *canadense* n. sp. et n. var., and *Phylloceras bakeri* Imlay.

Cadoceras barnstoni (Meek)

Plate VIII, figure 3; Plate XI, figure 2; Plate XII, figure 2

Ammonites barnstoni Meek, 1859, p. 184, Pl. 2, figs. 1, 2.

Polyptychites (Euryptychites) sp. indet. (cf. *barnstoni* Meek) Jeletzky, 1958, p. 9.

Cadoceras crassum Jeletzky (MS.), non Madsen.

Holotype is *Ammonites barnstoni* Meek (op. cit.), GSC No. 4811.

Material. The locality of the holotype is given as "in the valley of Mackenzie River" (Meek, 1859). No Jurassic outcrops occur on Mackenzie River and the specimen was probably obtained west of the Mackenzie, possibly on Porcupine River. Another specimen was collected by J. L. Usher on Ellef Ringnes Island, at the extreme head of southwest-flowing stream that enters the northeast side of Deer Bay (GSC loc. 44041).

Description. Most of the right whorl half of the holotype is missing but otherwise the specimen is well preserved. Most of the last whorl is septate, only the anterior fifth belongs to the body-chamber, the major part of which is missing. The umbilicus is deep, conical, moderately wide. The umbilical wall is less steep on younger whorls but almost perpendicular near the end. The umbilical edge is rounded. The last whorl is wider than high with its greatest width at the umbilical edge. Venter round, slightly arched. There are 22 primary ribs and about 56 secondary ribs on the last whorl. The primaries are straight and only very slightly forwardly inclined. They are much more clearly visible on the inner whorls than on the last one. At the umbilical edge they swing abruptly forward, and on or somewhat below the middle of the flank they are divided into two or three branches. They are elevated in the region of furcating. Both the primaries and secondaries are moderately sharp but they become weaker on the anterior part of the whorl, particularly near and on the preserved part of the body-chamber. The secondaries are slightly bent forward on the venter.

The suture line is deeply incised, ventral and the tripartite first lateral lobes are of about equal length. The external saddle is fairly broad and subdivided into four branches. The other elements of the suture line are not clearly visible.

Dimensions in millimetres:

<u>GSC No.</u>	<u>Diameter</u>	<u>Whorl height</u>	<u>Whorl thickness</u>	<u>Umbilical width</u>
Holotype 4811	90 (100)	42 (0.41)	54 (0.60)	27 (0.30)

Specimen GSC No. 17662, Plate XI, figure 2, from Ellef Ringnes Island is slightly larger than the holotype but less well preserved. Inner whorls are missing and in some parts of the last whorl the sculpture is covered by rock material. No suture line is visible and apparently at least the anterior part of the last whorl belongs to the body-chamber. Shape and number of the ribs are equal to those of the holotype. They fade towards the anterior part of the last whorl particularly on the venter and outer part of the flanks. The elevations of the ribs on the inner part of the whorl are, however, still present.

Dimensions in millimetres:

<u>GSC No.</u>	<u>Diameter</u>	<u>Whorl height</u>	<u>Whorl thickness</u>	<u>Umbilical width</u>
17662	95 (100)	39 (0.41)	51 (0.54)	not accurately measurable.

Remarks. By placing the species into *Polyptychites* (*Euryptychites*) Jeletzky (1958, p. 9) was aware of the similarity of the species to certain Lower Cretaceous ammonites. Later, the same author (MS.) assigned *barnstoni* (Meek) rightly to *Cadoceras* and placed *C. crassum* Madsen in the synonymy with *C. barnstoni*. However, the writer considers that *C. crassum* Madsen is distinguished from *C. barnstoni* by the absence of the forward bend of the ribs on the venter and a narrower umbilicus.

Cadoceras variabile Spath (1932, Pl. 18, fig. 1; Pl. 19, figs. 1, 2) seems to be similar to a certain degree but the ribs in Spath's specimen Plate 19, figure 1b are weaker than in *barnstoni*, and *variabile* Spath becomes apparently smooth at an earlier stage of growth. Spath's specimen Plate 18, figure 1a is larger than the specimens of *barnstoni* and is clearly distinguished from them by its almost smooth last whorl and narrower umbilicus. *Cadoceras barnstoni* (Meek) is also similar to *Cadoceras subcatostoma* Voronets, which has a very similar general shape and the same type of ribbing. However, the secondary ribs of *subcatostoma* are finer and more numerous. In *C. catostoma* Pompeckj (1900a, pp. 263-265, Pl. 5, figs. 1a-e, 2a, b; Imlay, 1953, p. 82, Pl. 34, figs. 1-14), the whorls embrace each other more, the ribs are finer and the whorls less wide.

Occurrence and age. West of Mackenzie River (exact locality unknown), and Ellef Ringnes Island. Callovian. Not associated with any other *Cadoceras* described in this report.

Cadoceras barnstoni (Meek) var. *C. arcuata* n. var.

Plate X, figures 2a, b

Material. One specimen (GSC No. 17663) collected by E. T. Tozer, from Savik Formation, on south shore of Strand Fiord, Axel Heiberg Island, 15 miles northeast of Cape Level, lower *Cadoceras* bed (GSC loc. 51629). Same locality as Ormiston's and McNair's upper *Cadoceras* bed (GSC loc. 43619), but 255 feet below.

Description. The left side of the specimen is fairly well preserved, though with somewhat corroded surface. The last whorl is septate to its end. Inner whorls of an early ontogenetic stage are secondarily pushed up in the umbilicus and clearly visible. Most of the right side of the specimen is destroyed.

In general shape and the type and number of ribs, the specimen is very similar to the holotype of *barnstoni* (Meek). Most of the primaries are bifurcate,

but in the anterior part of the whorl one tripartite rib is present. Also one intercalary rib that does not join the point of division of the secondaries was observed. In the anterior part of the last whorl the ribs fade except on its inner part. The umbilical wall gets steeper with increasing growth of the specimen as is so in the holotype.

The innermost visible whorl (at a diameter of 13 mm) is laterally compressed. In its anterior part there are fine straight to recti-radiate ribs that bifurcate on the middle of the flanks and cross the rounded venter transversely. They become still finer towards the posterior part of the whorl and eventually disappear so that the posterior half of this whorl appears to be smooth.

The suture line is somewhat corroded and does not show the fine incisions observed in the holotype.

Dimensions in millimetres:

<u>GSC No.</u>	<u>Diameter</u>	<u>Whorl height</u>	<u>Whorl thickness</u>	<u>Umbilical width</u>
17663	87 (100)	37 (0.43)	about 48 (0.55)	27 (0.31)

Remarks. The specimen is very close to *C. barnstoni* (Meek). It differs from the holotype mainly in a more arched venter and the slightly more pronounced forward bend of the ribs on the venter.

Occurrence and age. Savik Formation, Axel Heiberg Island. Callovian. Associated with *C. bodylevskyi* n. sp. and *C. cf. falsum* Voronets.

Cadoceras (Stenocadoceras) canadense n. sp.

Plate VII, figure 2; Plate X, figures 3a, b

Holotype is GSC No. 17664.

Material. One specimen (holotype) from the Aklavik Range (northeastern Richardson Mountains), 2 to 3 miles south of Bug Creek (GSC loc. 27003). Collected by J. A. Jeletzky.

Description. The specimen is septate almost to the anterior end of the last whorl, only the very posterior part of the body-chamber is preserved. Moderately compressed, has a fairly narrow and deep umbilicus, with distinctly rounded umbilical edge. The whorls embrace each other almost completely. The venter is narrowly rounded. The posterior quarter of the last whorl has fairly sharp forwardly inclined narrowly spaced ribs. They are strongest on the venter where they are sharply bent forward. Most of them bifurcate somewhat above the middle of the flanks. Some intercalaries are present. There are no ribs on the flanks in the anterior three quarters of the last whorl but they are still present on the venter up to about half the whorl.

The suture line is fairly deeply incised, saddles and lobes are slim. The first lateral lobe is as deep as the ventral lobe, the second lateral is about half as deep.

The dimensions in millimetres are:

<u>GSC No.</u>	<u>Diameter</u>	<u>Whorl height</u>	<u>Whorl thickness</u>	<u>Umbilical width</u>
Holotype 17664	76 (100)	37 (0.49)	26 (0.34)	13 (0.17)

Remarks. In general aspect this *Cadoceras* is similar to species of the group of *Cadoceras stenoloboide* Pompeckj as *C. stenoloboide* Pompeckj, *C. multicostratum* Imlay, *C. bowserense* Imlay. From all these species *C. canadense* is distinguished by greater involution, narrower umbilicus, narrower venter, and stronger forward bend of the ribs on the venter. The strong forward bend of the ribs is reminiscent of *Arcticoceras ishmae* Keyserling which, however, has a much narrower umbilicus. The inner whorls of *C. stenolobum* illustrated by Nikitin (1881a, Pl. 12, fig. 28) are also similar but are distinguished by a wider umbilicus and less forward bend of the ribs. None of the Siberian *Cadoceras* recently described by Bodylevsky (1960) and Voronets (1962) is similar to the Canadian species.

Cadoceras cf. *canadense* as described in this report may represent the adult stage of this species.

Age. Callovian. In Aklavik Range, associated with *Cadoceras septentrionale* var. *latidorsata* n. sp. et n. var.

Cadoceras (Stenocadoceras) cf. C. canadense n. sp.

Plate XIII, figure 2; Plate XIV, figures 1a, b

Material. One specimen (GSC No. 17665) collected by Triad Oil Company on Babbage River, lat. 68°50', long. 138°41' (GSC loc. 44102).

Description. The specimen has inner whorls that seem to be very similar to *Cadoceras canadense*. Insufficient preservation, however, prohibits detailed comparison. The last whorl that belongs to the body-chamber is entirely smooth, the transition from the gently sloping umbilical wall is rounded, the flanks are moderately convex and grade into the rounded comparatively narrow venter.

Remarks. The specimen possibly represents an adult form of *C. canadense* n. sp. The cross-section of the adult whorl is higher than that of the somewhat similar *C. (Stenocadoceras) stenolobum* (Nikitin) (Nikitin, 1881, Pl. 5, figs. 28, 29) and *C. (Stenocadoceras) stenoloboide* Pompeckj (see Imlay, 1953, p. 92, Pl. 47, figs. 1-15). *C. (Stenocadoceras) multicostratum* Imlay (Imlay, op. cit., p. 90, figs. 1-16) seems to have a similar cross-section.

Occurrence and age. In British Mountains associated with *C. arcticum* n. sp. and *Phylloceras bakeri* Imlay. Callovian.

Other Ammonites

Genus *Phylloceras* Suess

Phylloceras bakeri Imlay

Plate XX, figure 1

Phylloceras bakeri Imlay, 1953, p. 72, Pl. 25, figs. 10, 14.

The specimen agrees very well with the description and figures of the species given by Imlay (loc. cit.). It was found on Babbage River, lat. 68°50', long. 138°41', associated with *Cadoceras arcticum* n. sp. and *C. canadense* n. sp.

Genus *Arkelloceras* Frebold

Arkelloceras mclearni Frebold

Plate IV, figure 4

Arkelloceras mclearni Frebold, 1957, p. 11, Pl. 12, figs. 1a-c; 2a-g; 3a-c; Pl. 13, figs. 1a-d; 2a-c; 3a, b.

Arkelloceras mclearni Frebold, 1961, Pl. 4, figs. 3a, b.

One of the specimens of this species that was found in the Strand Fiord section of Axel Heiberg Island, 15 miles northeast of Cape Levvel, is illustrated here. The species occurs at this locality about 85 to 90 feet below the bed with *Arctocephalites elegans* Spath, thus indicating that it is older than *Arctocephalites*. Its accurate age relationship to *Cranocephalites* is still unknown. The species was also recently found by E. Mountjoy on Upper Fish Creek, Northwest Territories, where it is associated with *Inoceramus lucifer* Eichwald.

Species	Axel Heiberg Island		Ellef Ringnes Island	Cornwall Island	Aklavik Range	Richardson and British Mountains
	Upper Cadoceras bed	Lower Cadoceras bed				
<i>Cadoceras septentrionale</i> n. sp.	X					
<i>C. septentrionale</i> var. <i>latidorsata</i> n. sp. n. var.	X				X	
<i>C. bodylevskiyi</i> n. sp.		X				
<i>C. cf. falsum</i> Voronets		X				
<i>C. barnstoni</i> (Meek) var. <i>arcuata</i> n. var.		X				
<i>C. barnstoni</i> (Meek)			X			X
<i>C. arcticum</i> n. sp.				X		X
<i>C. voronetsae</i> n. sp.						X
<i>C. canadense</i> n. sp.					X	X
<i>C. crassum</i> Madsen						X
<i>C. cf. frebaldi</i> Spath						X
<i>C. aff. pseudoishmae</i> Spath						X
<i>C. sp. indet.</i>						X

Table 1. *Distribution of Cadoceras Species in the Canadian Arctic*

PERIOD	STAGES	ZONES OR INDEX FOSSILS RESP. (based on East Greenland)	STRAND FIORD SECTION AXEL HEIBERG ISLAND	OTHER CANADIAN ARCTIC ISLANDS	RICHARDSON AND BRITISH MOUNTAINS	
MIDDLE JURASSIC	Middle? Callovian	Unknown	?	?	?	
		<i>Sigaloceras calloviense</i>	Approximate position of upper Cadoceras bed (1200)		Upper Cadoceras bed locally present	
	Lower Callovian	<i>Kepplerites tychonis</i>	Approximate position of lower Cadoceras bed (945)	Lower Cadoceras bed locally present	?	?
		<i>Cadoceras variabile</i>	Unknown		?	?
	Upper Bathonian	<i>Articooceras kochi</i>	Articooceras beds (750-860)	Articooceras ishmae	Articooceras kochi	
		<i>Arctocephalites greenlandicus</i>	Unknown	Unknown	Unknown	Unknown
	Middle Bathonian	<i>Arctocephalites nudus</i>	Arctocephalites beds (685-690)	Unknown	Unknown	Arctocephalites elegans
		<i>Cranoecephalites pompeckii</i>	Unknown	Approximate position of Arkelloceras bed (600)	<i>Cranoecephalites vulgaris</i>	Unknown
	Lower Bathonian	<i>Cranoecephalites indistinctus</i>	Unknown	Unknown	Unknown	Approximate position of Arkelloceras bed
		<i>Cranoecephalites borealis</i>	Unknown	Unknown	Unknown	<i>Cranoecephalites borealis</i>
	Upper Bajocian	Absent	Absent			
		Probably absent	Probably absent	Pseudolloceras bed (215-310)	<i>Leioceras opalinum</i> , <i>Pseudolloceras m'clintocki</i> , <i>Oxytoma jacksoni</i>	<i>Erycites cf. howelli</i> <i>Pseudolloceras</i> sp.

Numbers in parentheses refer to feet above top of underlying Triassic Heiberg Formation

GSC

Table II. Occurrence and Stratigraphy of Cadoceratinae in the Canadian Arctic

STRATIGRAPHY, AGE, AND CORRELATION OF CADOCERATINAE IN THE CANADIAN ARCTIC

Following Arkell (1957) the author places the genera *Arctocephalites* Spath (with the subgenus *Cranocephalites* Spath), *Arcticoceras* Spath, and *Cadoceras* Fischer into the subfamily Cadoceratinae Hyatt, family Cardioceratidae Siemiradzki (see p. 3). The subgenus *Cranocephalites* and the genus *Arcticoceras* are not represented in the collections described in this report, for an account of their distribution and correlation the reader is referred to a previous bulletin (Frebold, 1961). Only the *Arctocephalites* and *Cadoceras* beds are discussed here.

Arctocephalites Bed

According to Tozer's field observations in Axel Heiberg Island (*Appendix*), the *Arctocephalites* species occur in a bed about 5 feet thick that is 250 to 255 feet below the lower *Cadoceras* bed and 85 to 90 feet above the *Arkelloceras* bed, which in turn was found by Tozer 290 to 385 feet above the lower Bajocian *Pseudolioceras* horizon.¹

In East Greenland (see Callomon, 1959, p. 508) two zones are present in the *Arctocephalites* beds, i.e., a lower zone of *Arctocephalites nudus* Spath with *A. elegans* Spath, *A. ornatus* Spath, and *A. arcticus* Newton and Teall, and an upper zone of *A. greenlandicus* Spath, which also contains *Cadoceras crassum* Madsen. In Tozer's Axel Heiberg Island section the *nudus* zone only was found. At least the *nudus* zone is present in the Richardson Mountains where the *greenlandicus* zone also may be indicated by *Cadoceras crassum* Madsen (Frebold, 1961, stratigraphic chart, p. 26).

Callomon (op. cit., p. 507) has placed the *nudus* and *greenlandicus* zones of East Greenland in the middle Bathonian, in which the author has followed him (1961). In East Greenland, as well as in the Canadian Arctic, the *greenlandicus* zone is followed by the zone of *Arcticoceras kochi* Spath (Donovan, 1953; Callomon, 1959; Frebold, 1961), which forms the lower part of the Arctic upper Bathonian. This zone was found recently by Harker and Thorsteinsson (unpublished report) in Tozer's Axel Heiberg section about 60 and 170 feet above the

¹It can now be considered as established that the *Arkelloceras* bed is older than the *Arctocephalites* bed, but its stratigraphic relationship to the beds with *Cranocephalites* which could have been expected in Tozer's Axel Heiberg Island section to be present below the *Arctocephalites* bed still remains uncertain, as no *Cranocephalites* was hitherto found in this section. The age of the *Arkelloceras* bed is still considered to be approximately late Bajocian to early Bathonian (Frebold, 1961, p. 26) and close to that of some of the *Cranocephalites* beds. Whether the absence of *Cranocephalites* beds in this section is due to lack of collecting or non-deposition is not known.

The genus *Arkelloceras* was hitherto known only from Prince Patrick and Melville Islands. In addition to the new occurrence in Tozer's Strand Fiord section, it is also known to occur on Fosheim Peninsula, GSC loc. 28961 (unpub. rept.), where it was found by Tozer and on Upper Fish Creek, Northwest Territories, GSC loc. 52699, where it was found by Mountjoy (unpub. rept.).

Arctocephalites bed while this report was in press but the succeeding zones of *Cadoceras variabile* Spath have hitherto not been found in this section. The *Arcticoceras* zone is also present in the Richardson Mountains and on other Arctic Islands (Frebald, 1961).

The lower Callovian zone of *Kepplerites tychonis* Ravn, which is well developed in East Greenland, Spitsbergen, and Alaska Peninsula, has hitherto not been found in any part of the Canadian Arctic and the author is inclined to assume that it is primarily missing.

In Axel Heiberg Island the Callovian lower *Cadoceras* bed lies about 125 feet above the *Arcticoceras* zone.

Cadoceras Beds

Axel Heiberg Island

Two *Cadoceras* beds have been found in Axel Heiberg Island. They are exposed on the south side of Strand Fiord, 15 miles northeast of Cape Levvel at localities 3 and 4 (see Fig. 1). The two beds contain different species, and are separated from each other by about 255 feet of shale from which no fossils were reported.

Lower *Cadoceras* Bed

The lower *Cadoceras* bed (loc. 3, Fig. 1) yielded several species that were collected by Tozer in 1962: *Cadoceras bodylevskyi* n. sp., *Cadoceras* cf. *C. falsum* Voronets, *Cadoceras barnstoni* (Meek) var. *arcuata* n. var.

In the Canadian Arctic *Cadoceras bodylevskyi* and *C.* cf. *C. falsum* have not been found associated with other species of the genus. *C. barnstoni* (not the var. *arcuata*) is also known from Ellef Ringnes Island and from Mackenzie River.

Cadoceras cf. *C. falsum* is very similar to the north Siberian species and *Cadoceras barnstoni* var. *arcuata* to *Cadoceras crassum* Madsen.

Upper *Cadoceras* Bed

The upper *Cadoceras* bed (loc. 4, Fig. 1) was found by A. Ormiston and A. H. McNair in 1960 and contains *Cadoceras septentrionale* n. sp., and *Cadoceras septentrionale* var. *latidorsata* n. sp. et n. var.

The variety *latidorsata* was also found in the Aklavik Range, where it is associated with *Cadoceras canadense* n. sp.

Cadoceras tolype Buckman is very similar to this species, particularly, to the variety *latidorsata*, which according to Callomon is also similar to or identical with *Cadoceras sublaeve* (Sowerby) and to specimens found in the uppermost Callovian horizon in East Greenland.

Above the upper *Cadoceras* bed are dark shales of probably late Jurassic age.

Ellef Ringnes Island

One collection made on Ellef Ringnes Island by Dr. J. L. Usher contains *Cadoceras barnstoni* (Meek). This species has hitherto not been found associated

with any other Cadoceratinae in the Canadian Arctic. The variety *latidorsata* n. var., however occurs together with *Cadoceras bodylevskyi* n. sp. and *Cadoceras* cf. *C. falsum* Voronets in the lower *Cadoceras* bed on Axel Heiberg Island.

Cornwall Island

Only one *Cadoceras*, i.e., *C. arcticum* n. sp., was found on this island. The species is associated with *C.* cf. *C. canadense* n. sp. on Babbage River, British Mountains, and is similar to certain south Alaskan species such as *C. comma* Imlay and *C. glabrum* Imlay, and to *C. milashevici* var. *pura* Voronets from northern Siberia.

Aklavik Range (Northeastern Richardson Mountains)

The collection from the Aklavik Range was made by Jeletzky and contains two species, *Cadoceras septentrionale* var. *latidorsata* n. sp. et n. var., and *Cadoceras* (*Stenocadoceras*) *canadense* n. sp. The former was also found in the upper *Cadoceras* bed on Axel Heiberg Island, and a specimen tentatively assigned to *C. canadense* came from Babbage River, British Mountains, where it is associated with *C. arcticum* n. sp. The latter species was also found on Cornwall Island.

C. canadense n. sp. is similar to *C. stenolobum* (Nikitin) and to south Alaskan species of the group of *C. stenoloboide* Pompeckj.

Richardson Mountains

The holotype of *Cadoceras barnstoni* was found on Mackenzie River (exact locality is unknown), *C. voronetsae* n. sp. at the northeast end of Dave Lord Ridge. Other representatives of the genus *Cadoceras* found in the Richardson Mountains, i.e., *C. crassum* Madsen, *C.* cf. *frebaldi* Spath, *C.* ? aff. *pseudoishmae*, and *C.* sp. indet. were described in another report (Frebald, 1961). They have not been found associated with any species of *Cadoceras* described here.

Babbage River (British Mountains)

At this locality two species of *Cadoceras* were found, *Cadoceras arcticum* n. sp., and *Cadoceras* (*Stenocadoceras*) cf. *canadense* n. sp.

The latter species seems to be associated with *C. septentrionale* var. *latidorsata* n. sp. et n. var. in the Aklavik Range. *C. arcticum* is also known from Cornwall Island.

Firth River (Yukon-Alaska boundary Area)

Buckman (*in* O'Neill, 1924, pp. 14a, 15a) mentions the occurrence of some species of *Cadoceras* in this area. The material, which has never been described and cannot be located, apparently consisted of some small specimens whose identity was doubted by Buckman himself. It is therefore not considered in this report.

The areal distribution of the various *Cadoceras* species described in this report is summarized in Table I.

Stratigraphic Conclusions about the Canadian Arctic *Cadoceras* Species

At present, the age of the *Cadoceras* faunas of the two *Cadoceras* beds of Axel Heiberg Island relative to *Cadoceras* faunas of other areas, such as East Greenland, can only be determined tentatively, as the new East Greenland material collected by Callomon is still undescribed. However, some of the Axel Heiberg Island species are similar to a certain degree to some species in East Greenland, but in no species could identity be proven.

The fact that in the Axel Heiberg Island section the *Keplerites* beds are not indicated by their respective guide-fossils adds to the difficulties in correlating the lower *Cadoceras* bed of Axel Heiberg Island with the sections in East Greenland and southern Alaska. *Keplerites* beds are entirely unknown in the Canadian Arctic.

In East Greenland (see Callomon, 1959, pp. 508-509) the zone of *Arcticoceras kochi* Spath (designated zone by Donovan, 1953) is overlain by the zone of *Cadoceras variabile* Spath, which contains *Cadoceras variabile* Spath, *C. franciscus* Spath, *C. calyx* Spath, *Keplerites* of the *tychonis* Ravn and *antiquus* Spath groups and also typical *Arcticoceras*. The *Cadoceras* species of Axel Heiberg Island appear to be unrelated to those of the *Arcticoceras kochi* zone.

The next younger zones in Greenland characterized by *Keplerites tychonis* and *Sigaloceras calloviense* also contain cadoceratids. According to Callomon, *C. victor* occurs in the *Keplerites tychonis* zone. This species has not been recognized with certainty on Axel Heiberg Island and accordingly no reliable correlation can be made until Callomon's material is described. From the zone of *Sigaloceras calloviense*, Callomon records *Cadoceras* of the *sublaeve* group. This Greenland species has not been described as yet but Dr. Callomon (pers. com.) believes that *C. septentrionale* n. sp. described in this paper is similar to or identical with his East Greenland specimens of the *sublaeve* group.

The author is inclined to conclude, tentatively, that *Keplerites* faunas (and beds?) are missing in Axel Heiberg Island and apparently also in other parts of the Canadian Arctic. However, the lower *Cadoceras* bed of Axel Heiberg Island may belong to a horizon that is stratigraphically close to the *K. tychonis* zone of East Greenland.

The upper *Cadoceras* bed of Axel Heiberg Island with its index fossils *C. septentrionale* n. sp. and *C. septentrionale* var. *latidorsata* that are related to species of the *sublaeve* group, is probably an equivalent of Callomon's *calloviense* zone of East Greenland which according to him contains similar forms.

A correlation of the *Cadoceras* beds of Axel Heiberg Island with those of Russia and northern Siberia is, at present, impossible because none of the species concerned is identical and none of the other ammonites associated with *Cadoceras* in Russia and northern Siberia was found in Axel Heiberg Island.

APPENDIX

Fossil localities in the Savik Formation exposed on the east flank of the gypsum diapir 15 miles northeast of Cape Levvel, western Axel Heiberg Island
E. T. Tozer

An unusually well exposed section, ranging from the Blaa Mountain Formation (Triassic) to the Christopher Formation (Lower Cretaceous) occurs on the east flank of the gypsum diapir 15 miles northeast of Cape Levvel, Axel Heiberg Island (Fig. 1).

Parts of this section were examined in 1955, by E. F. Roots, J. G. Souther, and the writer in the course of 'Operation Franklin', but during that Operation there was no time to examine the Jurassic part. In 1960, A. H. McNair and A. A. Ormiston, while working for a petroleum exploration company, examined the Jurassic section and collected well-preserved specimens of *Cadoceras* from one bed. These ammonites were presented to the Geological Survey in 1961.

In 1962 the writer spent one day examining the Savik and Awingak Formations and obtained ammonites from six localities, representing four different horizons. When Dr. Frebold examined the collections made in 1962 he discovered that although the genus *Cadoceras* was represented, the species were not the same as those collected by Dr. McNair. This suggested that two *Cadoceras* horizons might be present and that at least five ammonite faunas occur in the section. Towards resolving the relative position of the two *Cadoceras* beds Dr. McNair has kindly indicated the exact position of his *Cadoceras* discovery on an air photograph (loc. 4, Fig. 1). The position leaves little doubt that the *Cadoceras* specimens obtained by McNair are from a higher stratigraphic level than those obtained by the writer at locality 3.

The ammonites obtained by the writer from localities 1, 2, and 3 occur in a continuous, well-exposed section, and their relative stratigraphic position is clearly displayed. These localities account for the *Pseudolioceras* fauna (loc. 1), the *Arctocephalites* fauna (loc. 2), and the lower *Cadoceras* fauna (loc. 3).¹

At locality 6, about a mile along strike from the continuously exposed section of localities 1-3, the *Arkelloceras* fauna was obtained. Nearby, at locality 7, specimens of *Arctocephalites* were obtained at a somewhat higher level, and Lower Bajocian fossils were found at a lower horizon, at locality 5.

In summary, the relative stratigraphic position of the ammonite beds in this area appears to be as follows:

Upper *Cadoceras* bed—about 1,200 feet above top of Triassic Heiberg Formation.

Lower *Cadoceras* bed—945 feet above top of Triassic Heiberg Formation.

Arctocephalites bed—685-690 feet above top of Triassic Heiberg Formation.

Arkelloceras bed—about 600 feet above top of Triassic Heiberg Formation.

Pseudolioceras beds—215-310 feet above top of Triassic Heiberg Formation.

The total thickness of the Savik Formation in this area is about 1,800 feet.

¹As stated above, the *Pseudolioceras*, *Arkelloceras*, and *Arcticoceras* faunas were recently found by Harker and Thorsteinsson (unpublished report) in this section.

REFERENCES

- Arkell, W. J., *et al.*
1957: Treatise on Paleontology, Part L, Mollusca 4, Cephalopoda, Ammonoidea; *Geol. Soc. Amer.*
- Bodylevsky, V. I.
1960: Callovian ammonites from northern Siberia; *Mem. Leningrad Min. Inst.* vol. 37, No. 2.
- Buckman, S. S.
1922-23: Type Ammonites; Author, vol. 4, London.
1924: *see* O'Neill, 1924, pp. 14A-15A.
1929: Jurassic Ammonoidea in F. H. McLearn: Mesozoic Palaeontology of Blairmore Region, Alberta; *National Mus. Canada*, Bull. 58.
- Callomon, J. K.
1959: The ammonite zones of the Middle Jurassic beds of East Greenland; *Geol. Mag.*, vol. 46, No. 6.
- Donovan, D. T.
1953: The Jurassic and Cretaceous Stratigraphy and Paleontology of Traill Ö, East Greenland; *Medd. o. Grönland*, vol. 3, No. 4, Köbenhavn.
1957: The Jurassic and Cretaceous Systems in East Greenland; *Medd. o. Grönland*, vol. 155, No. 4, Köbenhavn.
- Fischer, P.
1880-1887: Manuel de Conchyliologie et de Paléontologie Conchyliologique; Paris.
- Frebald, H.
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.
1961: The Jurassic faunas of the Canadian Arctic: Middle and Upper Jurassic ammonites; *Geol. Surv. Can.*, Bull. 74.
1963: Ammonite faunas of the upper Middle Jurassic beds of the Fernie Group in western Canada; *Geol. Surv. Can.*, Bull. 93.
- Hyatt, A.
1900: Cephalopoda: in Zittel, K. A.: Textbook of Palaeontology.
- Imlay, R. W.
1948: Characteristic marine Jurassic fossils from the western interior of the United States; *U.S. Geol. Surv.*, Prof. Paper 214-B, pp. 13-33.
1953: Callovian (Jurassic) ammonites from the United States and Alaska; Part 2, Alaska Peninsula and Cook Inlet Regions; *U.S. Geol. Surv.*, Prof. Paper 249-B.
1962: Jurassic (Bathonian or early Callovian) ammonites from Alaska and Montana; *U.S. Geol. Surv.*, Prof. Paper 374-C.
- Jeletzky, J. A.
1958: Uppermost Jurassic and Cretaceous rocks of Aklavik Range, northeastern Richardson Mountains, N.W.T.; *Geol. Surv. Can.*, Paper 58-2.

- Jeletzky, J. A. (cont'd)
 (MS.): Macrofossil zones of the marine Cretaceous rocks of the Canadian western interior and their correlation with the European and the United States western interior zones and stages.
- Madsen, V.
 1904: On Jurassic fossils from East Greenland; *Medd. o. Grönland*, vol. 29, Copenhagen.
- Meek, F. B.
 1859: Remarks on the Cretaceous fossils collected by Professor Henry Y. Hind, on the Assiniboine and Saskatchewan Exploring Expedition, with descriptions of some new species; Northwest Territory. Repts. Prog.; together with a preliminary and general report on the Assiniboine and Saskatchewan Exploring Expedition, by Henry Youle Hind. Toronto.
- Newton, E. T., and Teall, J. J. H.
 1897: Notes on a collection of rocks and fossils from Franz Josef Land, made by the Jackson-Harmsworth Expedition during 1894-96; *Quart. J. Geol. Soc. London*, vol. 53.
- Nikitin, S.
 1881a: Der Jura der Umgegend von Elatma; *Nouveaux Mém. Soc. Imp. de Moscow*, vol. XIV, Moscow.
 1881b: Die Jura-Ablagerungen zwischen Rybinsk, Mologa und Myschkin; *Mém. Acad. Imp. Sci.*, St. Pétersbourg, VII, Sér., vol. 28, No. 5.
- O'Neill, J. J.
 1924: The geology of the Arctic Coast of Canada west of the Kent Peninsula; *Canadian Arctic Expedition 1913-1918 Rept.*, vol. 11, part A, pp. 7-107.
- Pompeckj, J. F.
 1900a: The Jurassic fauna of Cape Flora, Franz Josef Land; Norw. North Polar Exped. 1893-1896., *Sci. Res.* No. 1, Kristiania.
 1900b: Jura-Fossilien aus Alaska; *Russ. K. Min. Gesell. Verh.*, ser. 2, vol. 38, pp. 239-278, Pls. 5-7.
- Spath, L. F.
 1928: Revision of the Jurassic cephalopod fauna of Kachh (Cutch); *Pal. Indica*, N.S., vol. 9, No. 2, pt. 3, Calcutta.
 1932: The invertebrate faunas of the Bathonian-Callovian deposits of Jameson Land (East Greenland); *Medd. o. Grönland*, vol. 87, No. 7, Köbenhavn.
- Sowerby, J.
 1814: Mineral Conchology of Great Britain; London.
- Tozer, E. T.
 1960: Summary account of Mesozoic and Tertiary stratigraphy, Canadian Arctic Archipelago; *Geol. Surv. Can.*, Paper 60-5.
- Voronets, N. S.
 1962: Stratigraphy and cephalopod molluscs of the Jurassic and Lower Cretaceous deposits of the Lena Anabar Region; *Trans. Sci. Res. Inst.*, Arctic Geology, Ministry of Geol. and Preserv. of Resources, vol. 110, Moscow.

PLATES I TO XX

Types in collections of Geological Survey
of Canada

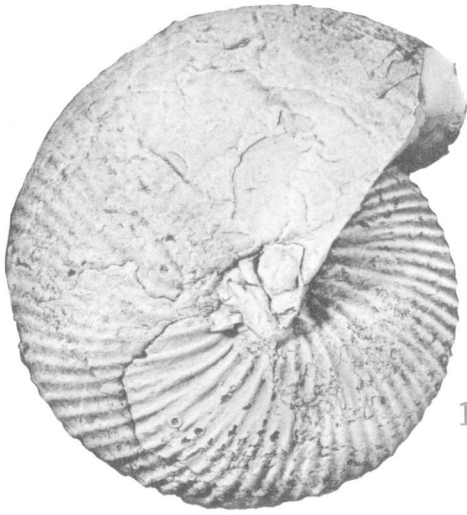
All figures natural size, unless
otherwise stated.

PLATE I

(All figures natural size)

Types in collections of the Geological Survey of Canada

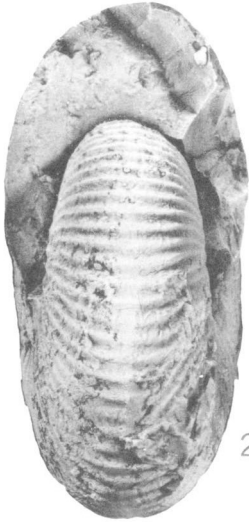
- Figures 1a, b. *Arctocephalites elegans* Spath (Page 3). 1a, lateral view; 1b, venter and cross-section. GSC No. 17640. Savik Formation, *Arctocephalites* bed. Middle Bathonian. Axel Heiberg Island, Strand Fiord. GSC loc. 51628.
- Figures 2a, b. *Cadoceras septentrionale* var. *latidorsata* n. sp. n. var. (Page 8). 2a, and cross-section. GSC No. 17639. Same locality as fig. 1.
- Figures 3a, b. *Arctocephalites elegans* Spath (Page 3). 3a, lateral view; 3b, ventral view of mouth. GSC No. 17646. Same locality as fig. 1.
- Figure 4. *Arctocephalites* cf. *A. arcticus* (Newton) (Page 5). Lateral view. GSC No. 17641. Same locality as fig. 1. See venter and cross-section on Pl. III, fig. 3.



1a



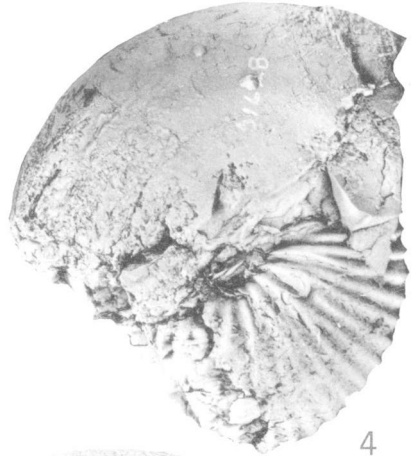
3a



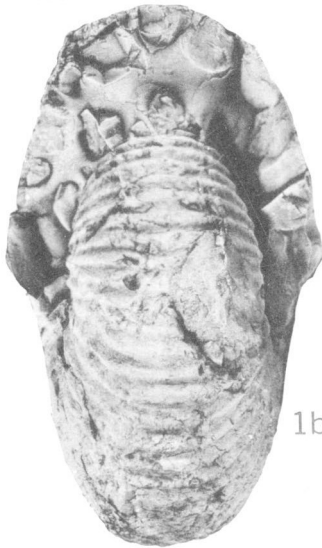
2b



3b



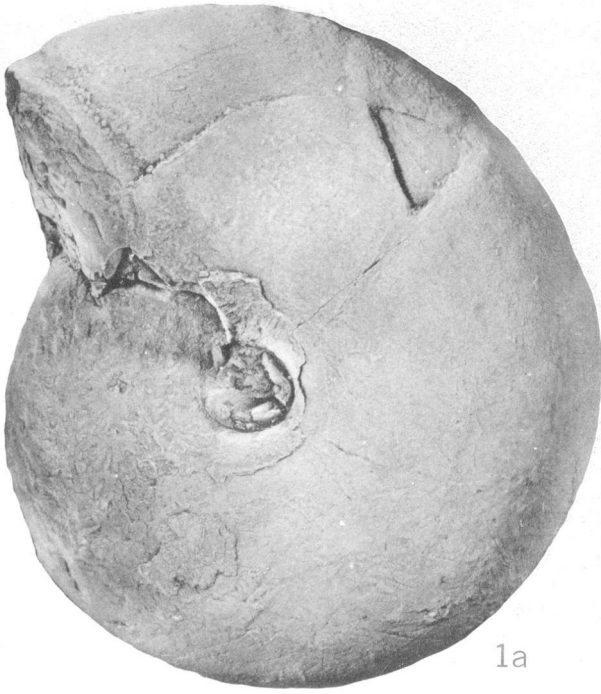
4



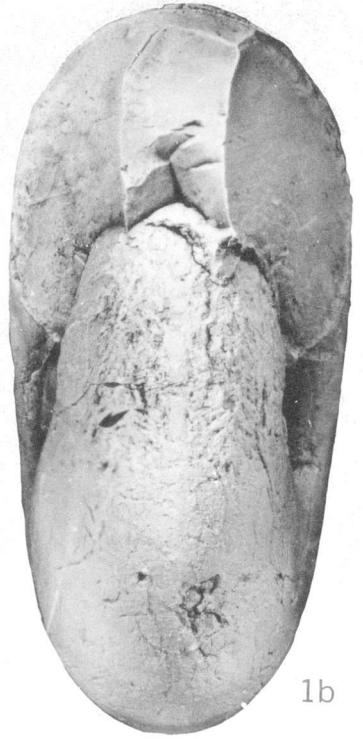
1b



2a



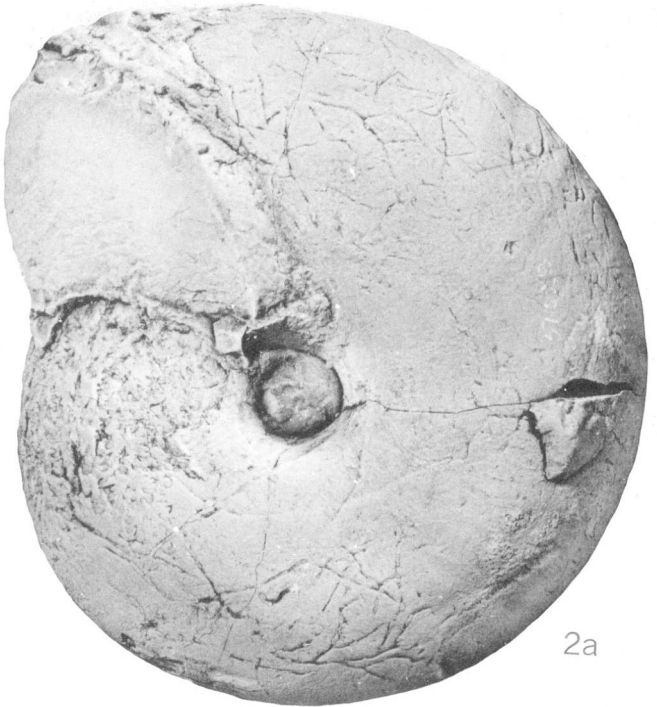
1a



1b



2b



2a

PLATE II

(All figures natural size)

Types in collections of the Geological Survey of Canada

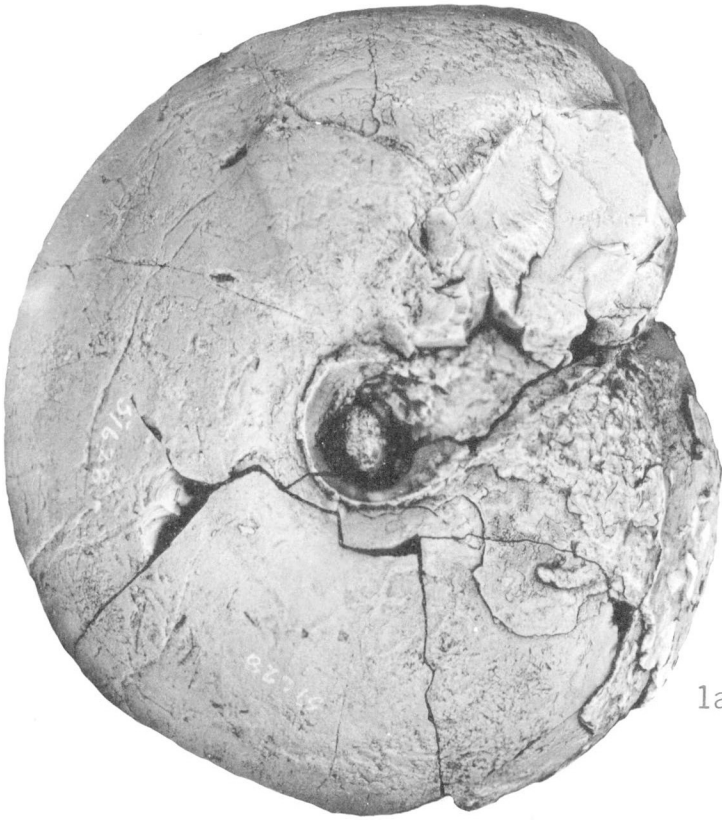
- Figures 1a, b. *Arctocephalites elegans* Spath (Page 3). 1a, lateral view; 1b, venter and cross-section. GSC No. 17643. Savik Formation, *Arctocephalites* bed. Middle Bathonian. Axel Heiberg Island, Strand Fiord. GSC loc. 51628.
- Figures 2a, b. *Arctocephalites elegans* Spath (Page 3). 2a, lateral view; 2b, venter and cross-section. GSC No. 17644. Same locality as fig. 1.

PLATE III

(All figures natural size)

Types in collections of the Geological Survey of Canada

- Figures 1a, b. *Arctocephalites callomoni* n. sp. (Page 4). 1a, lateral view; 1b, venter and cross-section. Holotype, GSC No. 17647. Savik Formation, *Arctocephalites* bed. Middle Bathonian. Axel Heiberg Island, Strand Fiord. GSC loc. 51628.
- Figure 2. *Arctocephalites callomoni* n. sp. (Page 4). Venter and cross-section. Paratype, GSC No. 17645. Same locality as fig. 1. See lateral view on Pl. IV, fig. 1.
- Figure 3. *Arctocephalites* cf. *A. arcticus* (Newton) (Page 5). Venter and cross-section. GSC No. 17641. Same locality as fig. 1. See lateral view on Pl. I, fig. 4.

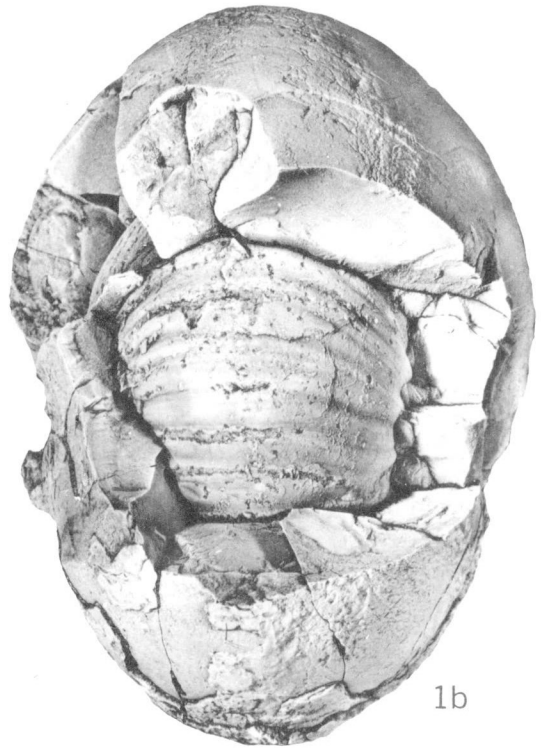


1a

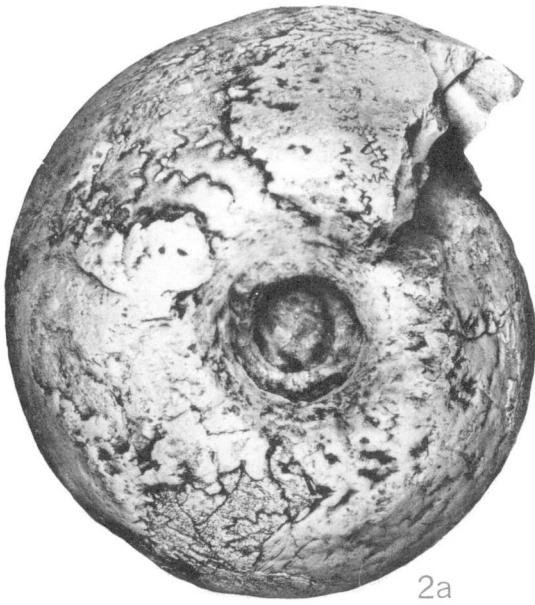
3



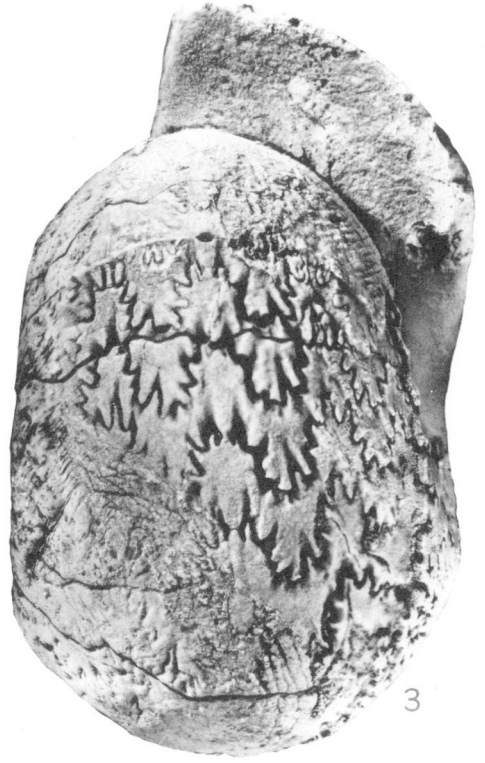
2



1b



2a



3



2b



4



1

PLATE IV

(All figures natural size)

Types in collections of the Geological Survey of Canada

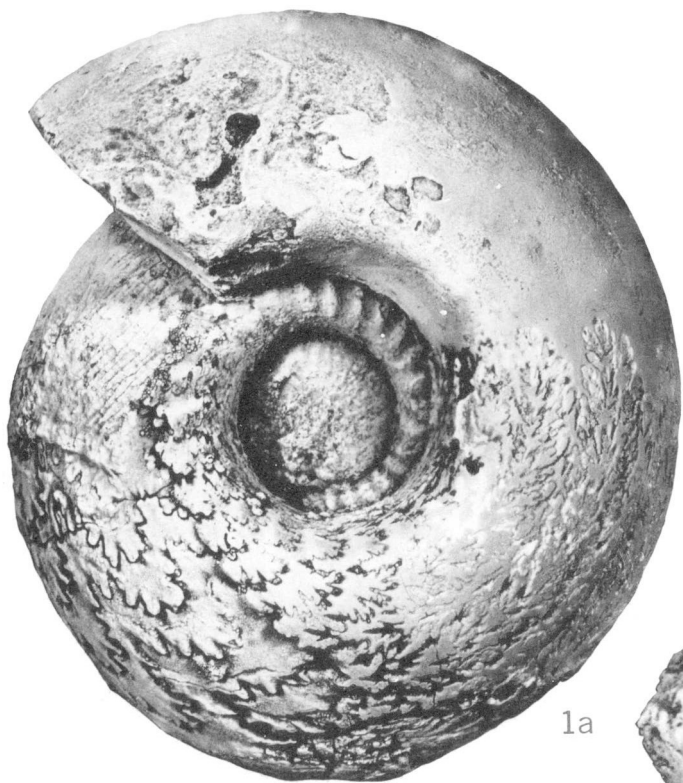
- Figure 1. *Arctocephalites callomoni* n. sp. (Page 4). Lateral view. Paratype, GSC No. 17645. Savik Formation, *Arctocephalites* bed. Middle Bathonian. Axel Heiberg Island, Strand Fiord. GSC loc. 51628. See venter and cross-section on Pl. III, fig. 2.
- Figures 2a, b. *Cadoceras septentrionale* var. *latidorsata* n. sp. n. var. (Page 8). 2a, lateral view; 2b, venter and cross-section. GSC No. 17652. Savik Formation, upper *Cadoceras* bed. Callovian. Axel Heiberg Island, Strand Fiord. GSC loc. 43619.
- Figure 3. *Cadoceras septentrionale* n. sp. (Page 6). Venter and cross-section. Holotype, GSC No. 17651. Same locality as fig. 2. See lateral view, suture line and umbilicus on Pl. V, figs. 1a, b.
- Figure 4. *Arkelloceras mclearni* Frebold (Page 18). Lateral view. GSC No. 17670. Savik Formation, *Arkelloceras* bed. Bajocian or lower Bathonian. Axel Heiberg Island, Strand Fiord. GSC loc. 51631.

PLATE V

(All figures natural size)

Types in collections of the Geological Survey of Canada

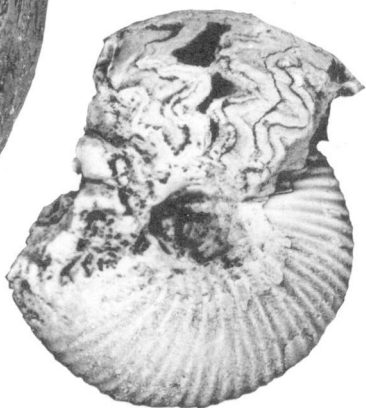
- Figures 1a, b. *Cadoceras septentrionale* n. sp. (Page 6). 1a, lateral view; 1b, venter, depth of umbilicus. Holotype, GSC No. 17651. Savik Formation, upper *Cadoceras* bed. Callovian. Axel Heiberg Island, Strand Fiord. GSC loc. 43619. See venter and cross-section on Pl. IV, fig. 3.
- Figures 2a, b. *Cadoceras septentrionale* n. sp. (Page 6). 2a, lateral view; 2b, venter and cross-section. Paratype, GSC No. 17658. Same locality as fig. 1.
- Figure 3. *Arctocephalites callomoni* n. sp. (Page 4). Venter and cross-section. Paratype, GSC No. 17642. Savik Formation, *Arctocephalites* bed. Middle Bathonian. Axel Heiberg Island, Strand Fiord. GSC loc. 51628. See lateral view on Pl. VII, fig. 3.



1a



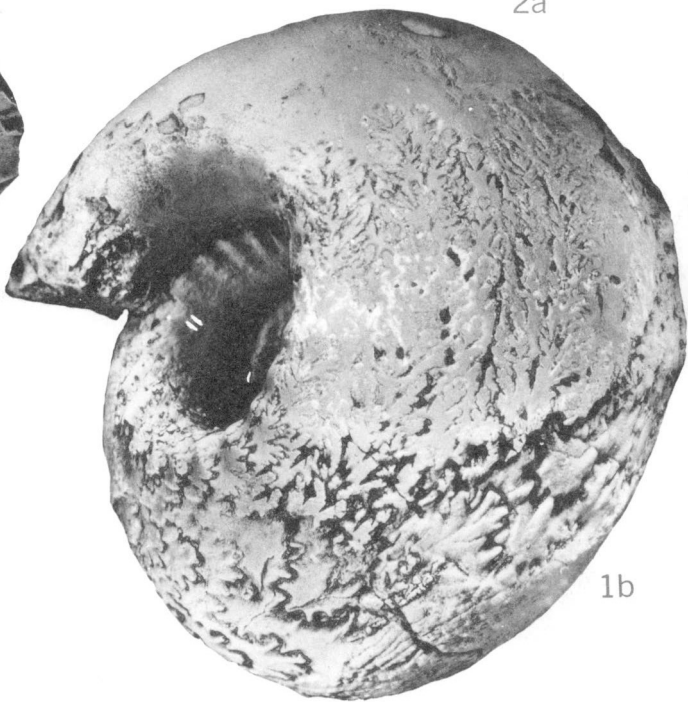
2b



2a



3



1b



1a



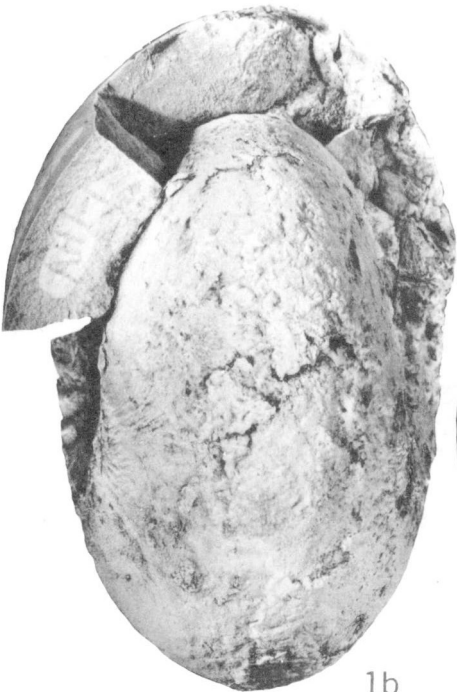
3b



3a



2b



1b



2a

PLATE VI

(All figures natural size)

Types in collections of the Geological Survey of Canada

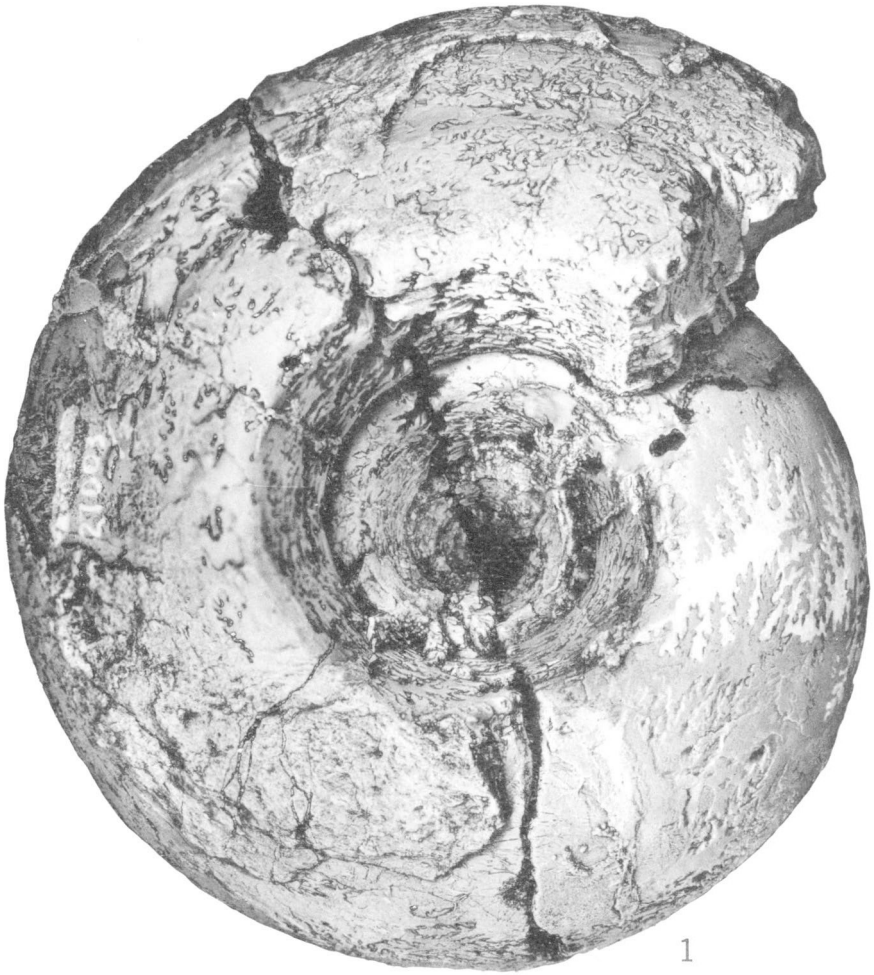
- Figures 1a, b. *Cadoceras septentrionale* n. sp. (Page 6). 1a, lateral view; 1b, venter and cross-section. Paratype, GSC No. 17654. Savik Formation, upper *Cadoceras* bed. Callovian. Axel Heiberg Island, Strand Fiord. GSC loc. 43619.
- Figures 2a, b. *Cadoceras septentrionale* n. sp. (Page 6). 2a, lateral view; 2b, venter and cross-section. Paratype, GSC No. 17655. Same locality as fig. 1.
- Figures 3a, b. *Cadoceras septentrionale* n. sp. (Page 6). 3a, lateral view; 3b, venter and cross-section. Paratype, GSC No. 17657. Same locality as fig. 1.

PLATE VII

(All figures natural size)

Types in collections of the Geological Survey of Canada

- Figure 1. *Cadoceras septentrionale* var. *latidorsata* n. sp. n. var. (Page 8). Lateral view, anterior part of last whorl not illustrated. GSC No. 17656. Callovian. Aklavik Range. GSC loc. 27003. See venter and cross-section on Pl. VIII, fig. 1, and cross-section on Pl. IX, fig. 1.
- Figure 2. *Cadoceras (Stenocadoceras) canadense* n. sp. (Page 16). Lateral view. Holotype, GSC No. 17664. Callovian. Same locality as fig. 1. See venter and cross-section on Pl. X, figs. 3a, b.
- Figure 3. *Arctocephalites callomoni* n. sp. (Page 4). Lateral view. Paratype, GSC No. 17642. Savik Formation, *Arctocephalites* bed. Middle Bajocian. Axel Heiberg Island, Strand Fiord. GSC loc. 51628. See venter and cross-section on Pl. V, fig. 3.



1



2



3



1



3



2

PLATE VIII

(All figures natural size)

Types in collections of the Geological Survey of Canada

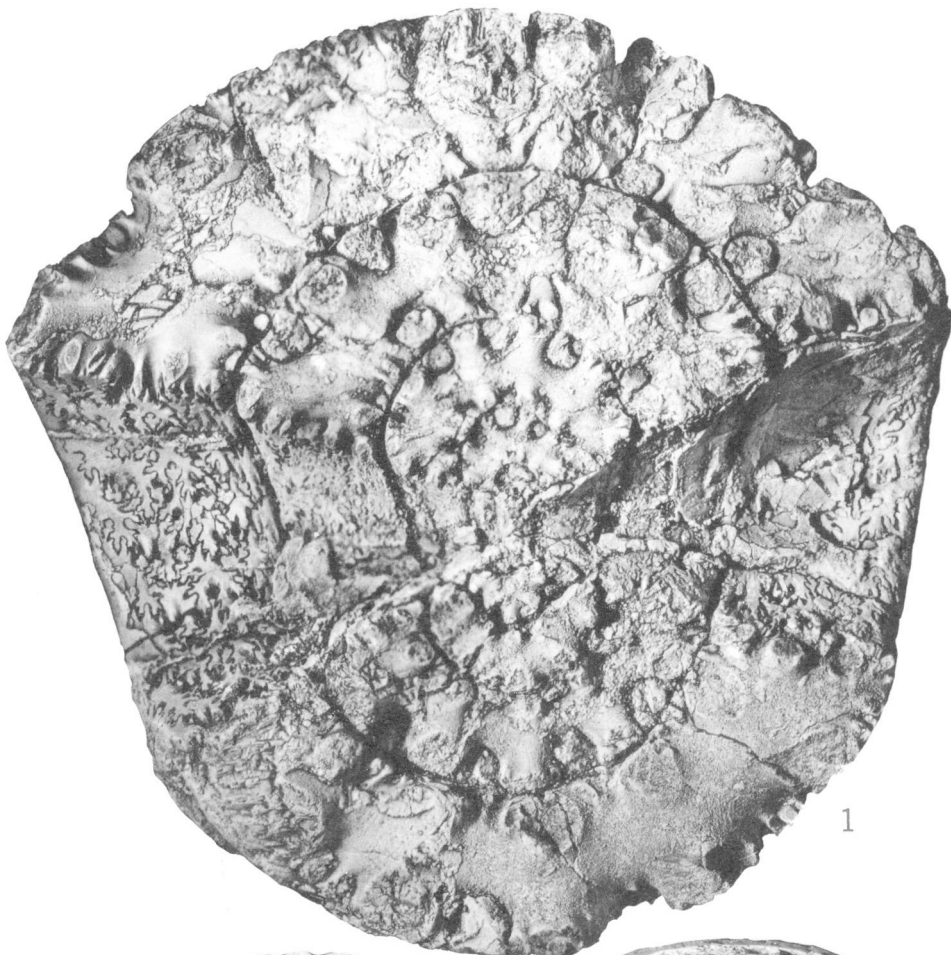
- Figure 1. *Cadoceras septentrionale* var. *latidorsata* n. sp. n. var. (Page 8). Venter and cross-section. Anterior part of last whorl not illustrated. GSC No. 17656. Callovian. Aklavik Range. GSC loc. 27003. See lateral view on Pl. VII, fig. 1, and cross-section Pl. IX, fig. 1.
- Figure 2. *Cadoceras* cf. *C. falsum* Voronets (Page 11). Venter. GSC No. 17659. Savik Formation, lower *Cadoceras* bed. Callovian. Axel Heiberg Island, Strand Fiord. GSC loc. 51629. See lateral view and cross-section on Pl. IX, figs. 2a, b.
- Figure 3. *Cadoceras barnstoni* (Meek) (Page 14). Venter and cross-section. Holotype, GSC No. 4811. Callovian. West of Mackenzie River. See lateral view on Pl. XII, fig. 2.

PLATE IX

(All figures natural size)

Types in collections of the Geological Survey of Canada

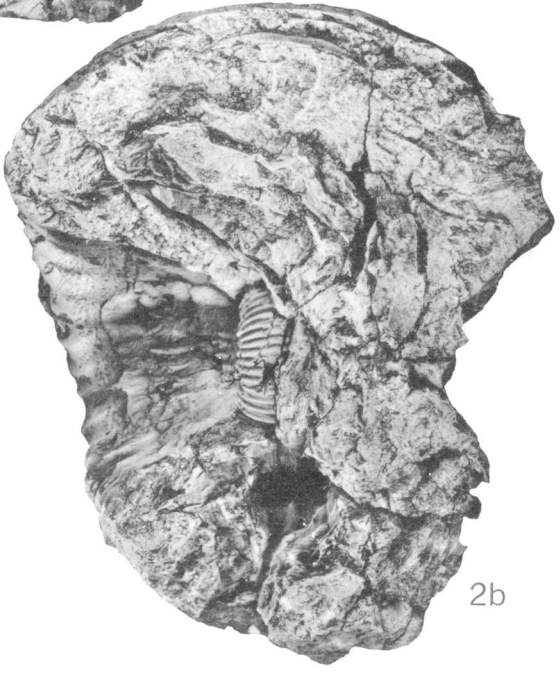
- Figure 1. *Cadoceras septentrionale* var. *latidorsata* n. sp. n. var. (Page 8). Cross-section. GSC No. 17656. Callovian. Aklavik Range. GSC loc. 27003. See lateral view on Pl. VII, fig. 1, and venter on Pl. VIII, fig. 1.
- Figures 2a, b. *Cadoceras* cf. *C. falsum* Voronets. (Page 11). 2a, lateral view; 2b, cross-section. GSC No. 17659. Savik Formation, lower *Cadoceras* bed. Callovian. Axel Heiberg Island, Strand Fiord. GSC loc. 51629. See venter on Pl. VIII, fig. 2.



1



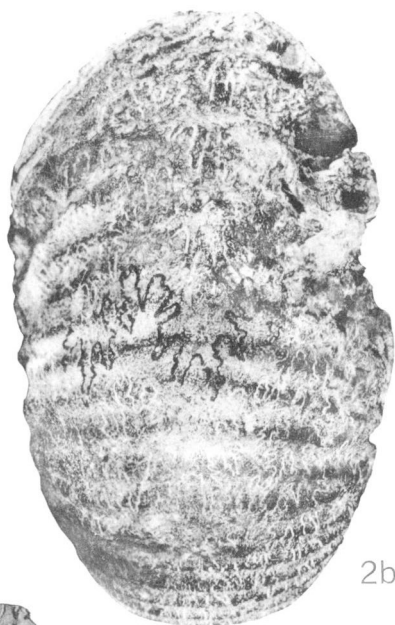
2a



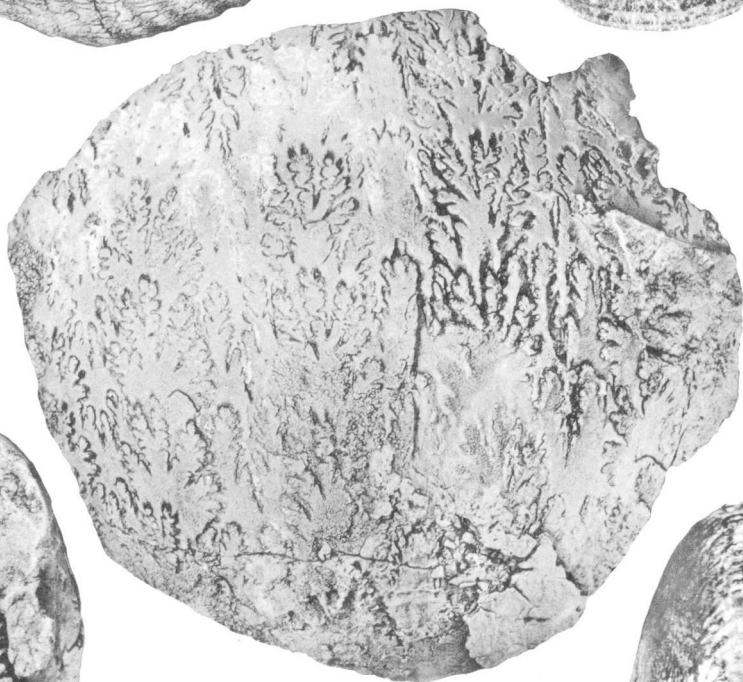
2b



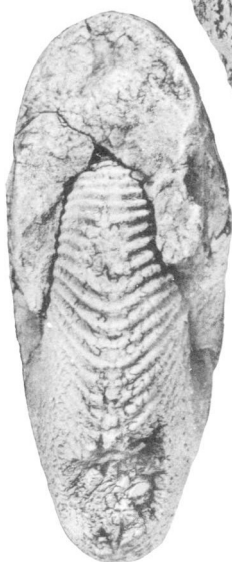
2a



2b



1



3a



3b

PLATE X

(All figures natural size)

Types in collections of the Geological Survey of Canada

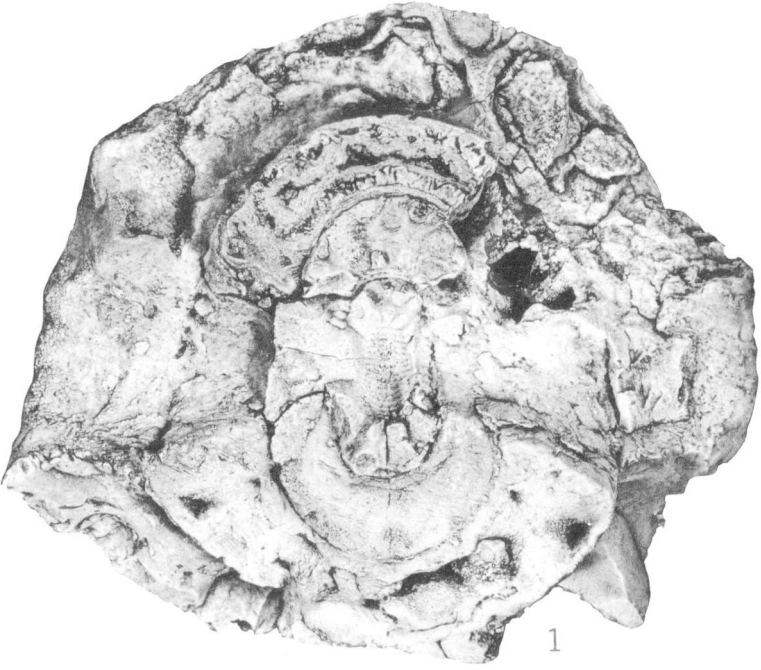
- Figure 1. *Cadoceras septentrionale* var. *latidorsata* n. sp. n. var. (Page 8). Venter. GSC No. 17653. Savik Formation, upper *Cadoceras* bed. Callovian. Axel Heiberg Island, Strand Fiord. GSC loc. 43619. See cross-section on Pl. XI, fig. 1.
- Figures 2a, b. *Cadoceras barnstoni* (Meek) var. *C. arcuata* n. var. (Page 15). 2a, lateral view; 2b, venter. GSC No. 17663. Savik Formation, lower *Cadoceras* bed. Callovian. Axel Heiberg Island, Strand Fiord. GSC loc. 51629.
- Figures 3a, b. *Cadoceras (Stenocadoceras) canadense* n. sp. (Page 16). 3a, venter and cross-section; 3b, venter. Holotype. GSC No. 17664. Callovian. Aklavik Range. GSC loc. 27003. See lateral view on Pl. VII, fig. 2.

PLATE XI

(All figures natural size)

Types in collections of the Geological Survey of Canada

- Figure 1. *Cadoceras septentrionale* var. *latidorsata* n. sp. n. var. (Page 8). Cross-section. GSC No. 17653. Savik Formation, upper *Cadoceras* bed. Callovian. Axel Heiberg Island, Strand Fiord. GSC loc. 43619. See venter on Pl. X, fig. 1.
- Figure 2. *Cadoceras barnstoni* (Meek) (Page 14). Lateral view. Paratype, GSC No. 17662. Callovian. Ellef Ringnes Island. GSC loc. 44041.



1



2



PLATE XII

(All figures natural size)

Types in collections of the Geological Survey of Canada

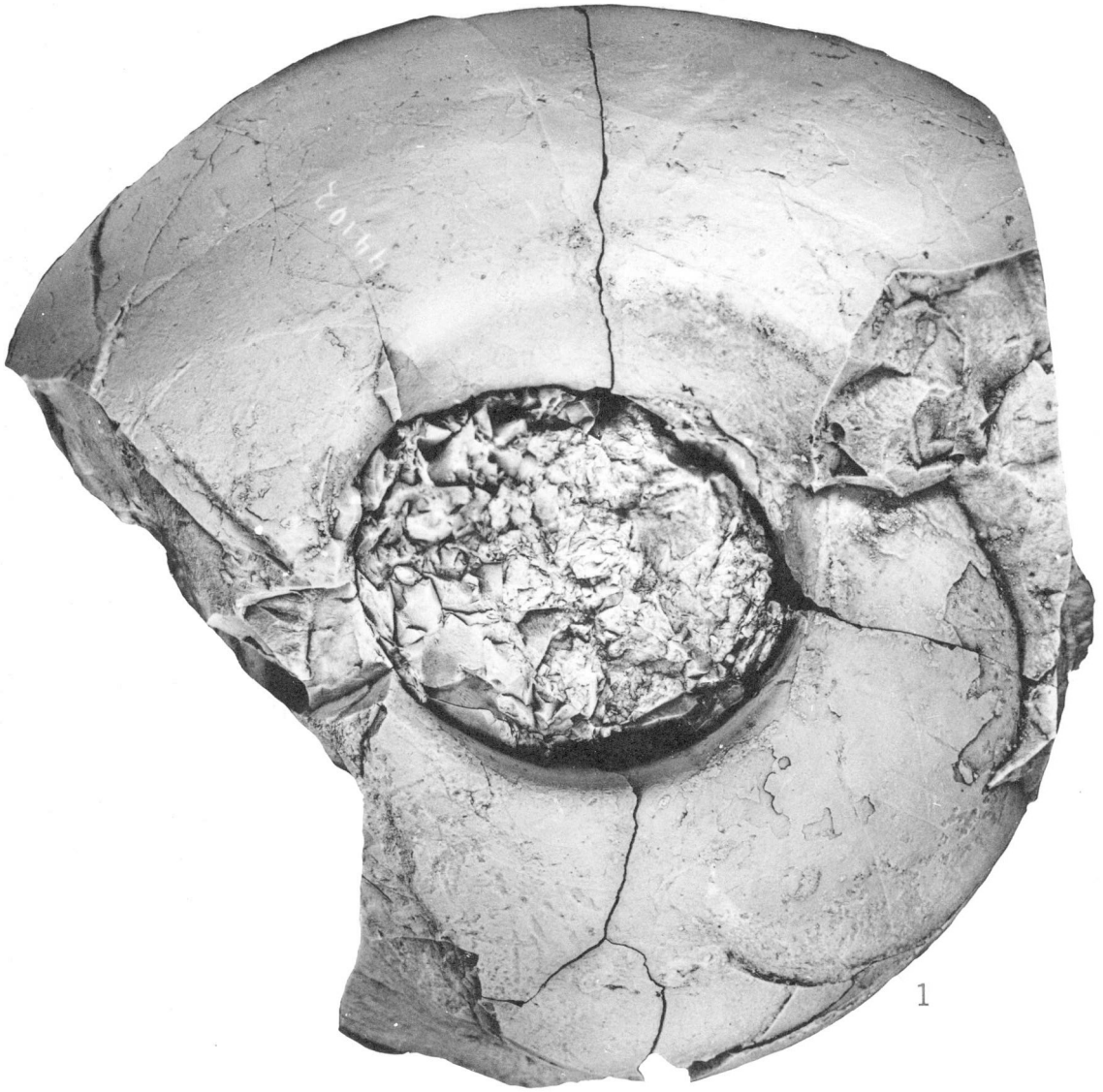
- Figure 1. *Cadoceras arcticum* n. sp. (Page 12). Lateral view. Paratype, GSC No. 17649. Callovian. Babbage River. GSC loc. 44102.
- Figure 2. *Cadoceras barnstoni* (Meek) (Page 14). Lateral view. Holotype, GSC No. 4811. Callovian. Mackenzie River. See venter and cross-section on Pl. VIII, fig. 3.

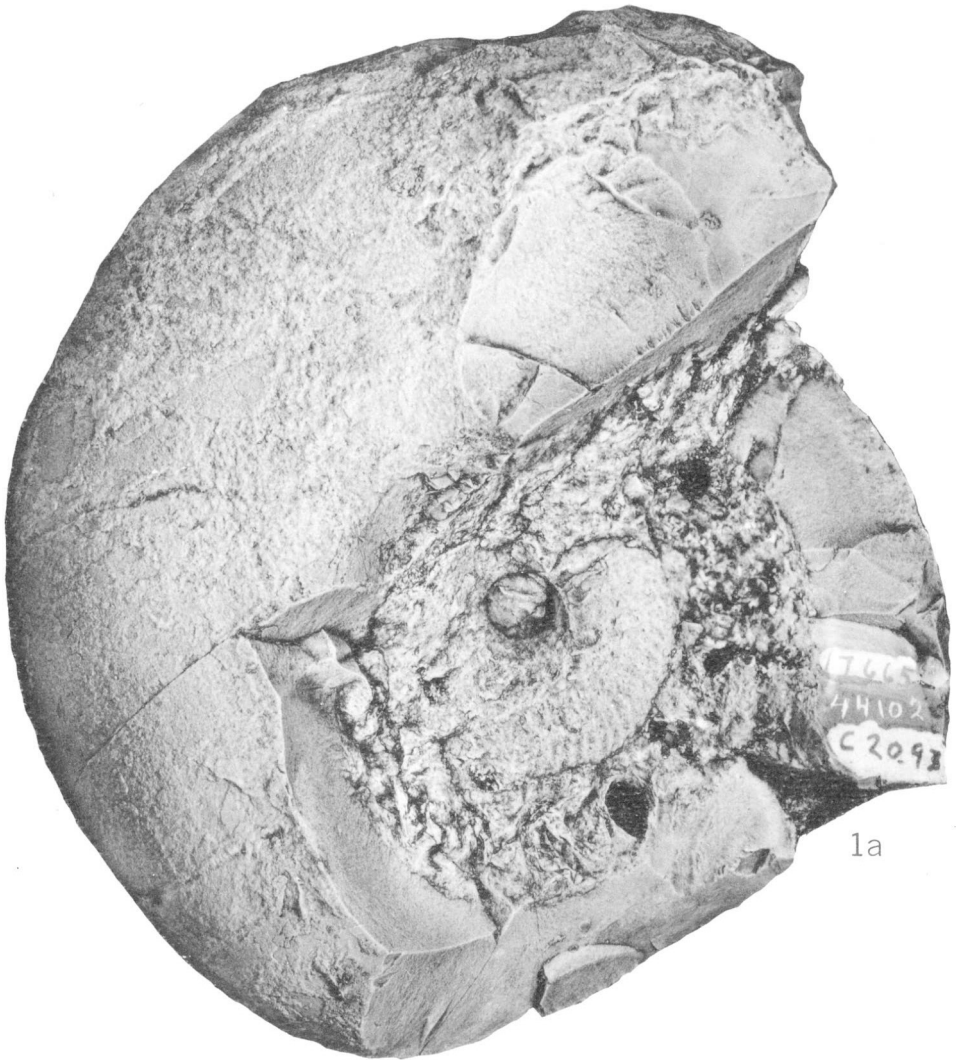
PLATE XIII

(All figures natural size)

Types in collections of the Geological Survey of Canada

- Figure 1. *Cadoceras arcticum* n. sp. (Page 12). Lateral view. Paratype, GSC No. 17648. Callovian. Babbage River. GSC loc. 44102. *See* cross-section and venter on Pl. XX, fig. 2.
- Figure 2. *Cadoceras (Stenocadoceras)* cf. *C. canadense* n. sp. (Page 17). Venter. GSC No. 17665. Callovian. Babbage River. GSC loc. 44102. *See* lateral view and cross-section on Pl. XIV, figs. 1a, b.





1a



1b

PLATE XIV

(All figures natural size)

Type in collections of the Geological Survey of Canada

Figures 1a, b.

Cadoceras (*Stenocadoceras*) cf. *C. canadense* n. sp. (Page 17). 1a, lateral view; 1b, cross-section. GSC No. 17665. Callovian. Babbage River. GSC loc. 44102. See venter on Pl. XIII, fig. 2.

PLATE XV

(Figure somewhat smaller than original [actual diameter = 187 mm])

Type in collections of the Geological Survey of Canada

Figure 1.

Cadoceras voronetsae n. sp. (Page 9). Lateral view. Holotype, GSC No. 17669. Callovian. West of Porcupine River and east of Waters River. GSC loc. 42646. See cross-section on Pl. XVI, fig. 1.

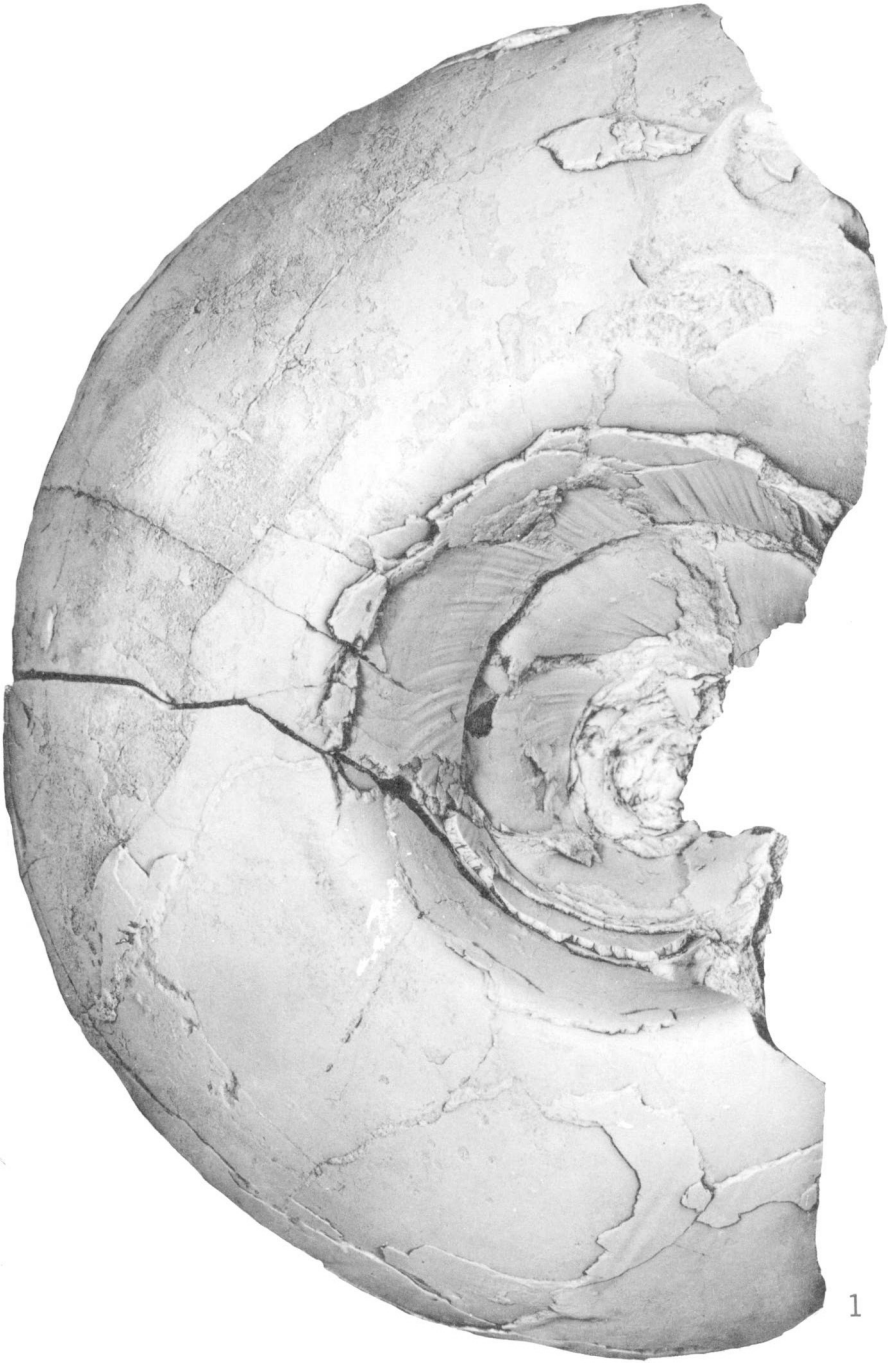




PLATE XVI

(Figure in about natural size)

Type in collections of the Geological Survey of Canada

Figure 1.

Cadoceras voronetsae n. sp. (Page 9). Cross-section. Holotype, GSC No. 17669. Callovian. West of Porcupine River and east of Waters River. GSC loc. 42646. See lateral view on Pl. XV, fig. 1.

PLATE XVII

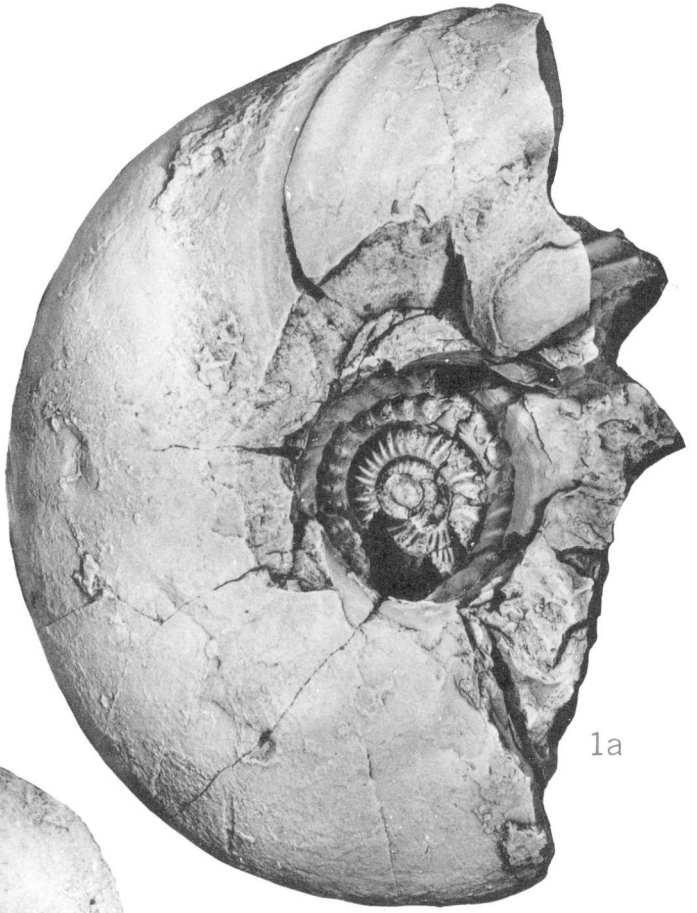
(All figures natural size)

Types in collections of the Geological Survey of Canada

- Figures 1a, b, c. *Cadoceras bodylevskyi* n. sp. (Page 10). 1a, lateral view; 1b, venter; 1c, cross-section. Holotype, GSC No. 17666. Savik Formation, lower *Cadoceras* bed. Callovian. Axel Heiberg Island, Strand Fiord. GSC loc. 51629.
- Figure 2. *Cadoceras arcticum* n. sp. (Page 12). Venter. Paratype, GSC No. 17650. Callovian. Babbage River. GSC loc. 44102.



2



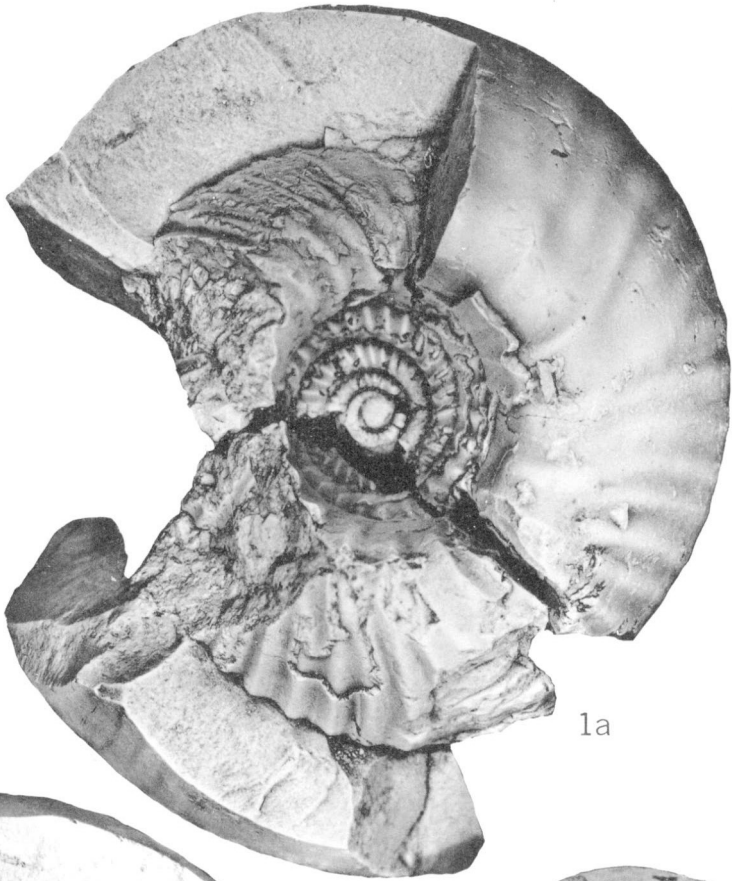
1a



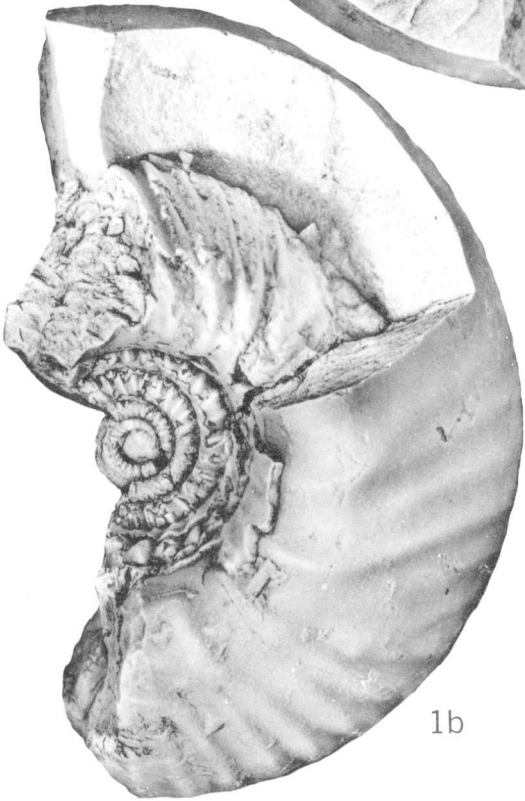
1c



1b



1a



1b



1c

PLATE XVIII

(All figures natural size)

Type in collections of the Geological Survey of Canada

Figures 1a, b, c.

Cadoceras cf. *C. falsum* Voronets (Page 11). 1a, lateral view; 1b, lateral view after removal of parts of last and penultimate whorls; 1c, venter. GSC No. 17661. Savik Formation, lower *Cadoceras* beds. Callovian. Axel Heiberg Island, Strand Fiord. GSC loc. 51629.

PLATE XIX

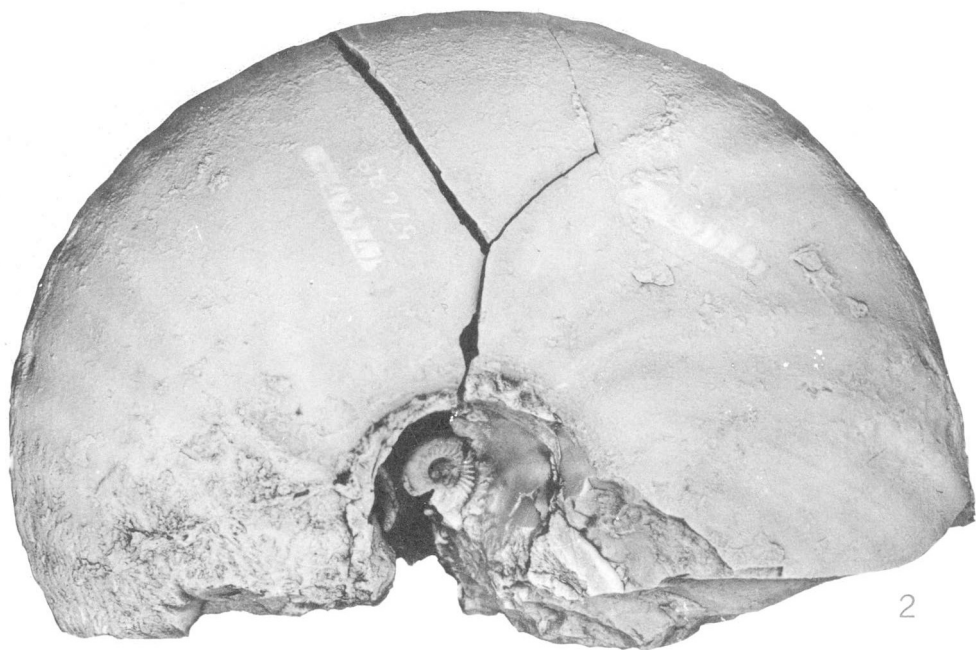
(All figures natural size)

Types in collections of the Geological Survey of Canada

- Figure 1. *Cadoceras bodylevskyi* n. sp. (Page 10). Lateral view. Paratype, GSC No. 17668. Savik Formation, lower *Cadoceras* bed. Callovian. Axel Heiberg Island, Strand Fiord. GSC loc. 51629.
- Figure 2. *Cadoceras bodylevskyi* n. sp. (Page 10). Lateral view, showing inner whorls. Paratype, GSC No. 17667. Same locality as fig. 1.



1



2

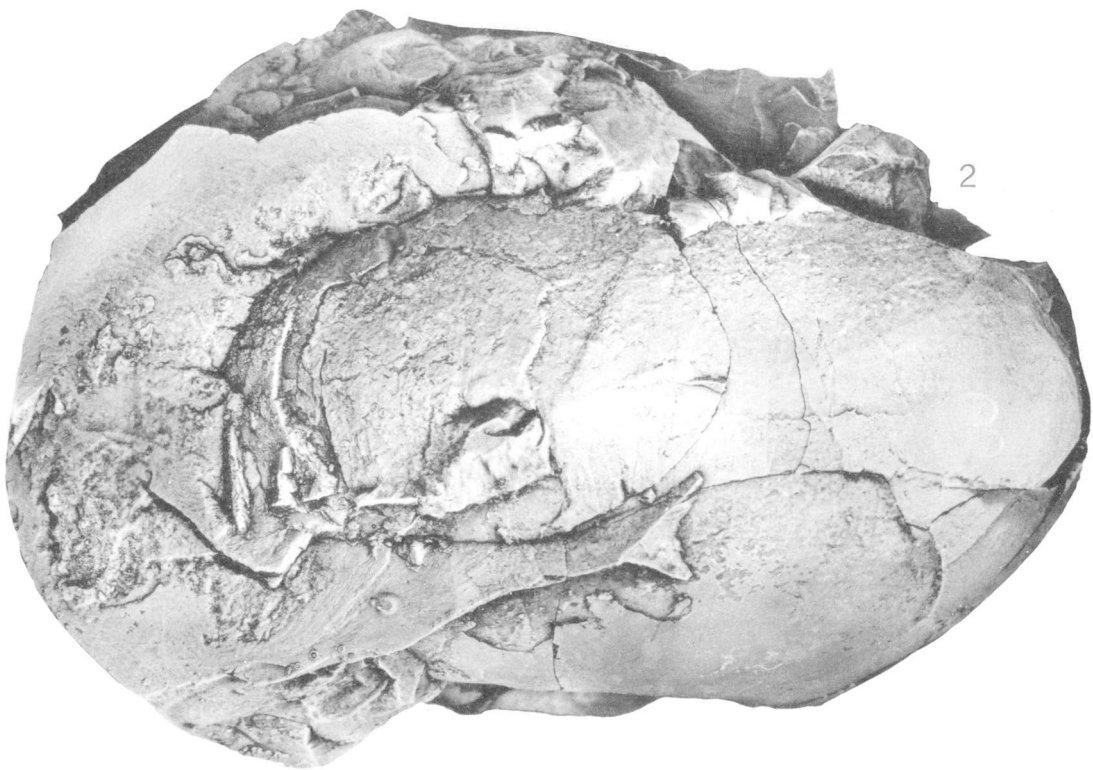


PLATE XX

(All figures natural size)

Types in collections of the Geological Survey of Canada

- Figure 1. *Phylloceras bakeri* Imlay (Page 18). Lateral view. GSC No. 17660. Callovian. Babbage River. GSC loc. 44102.
- Figure 2. *Cadoceras arcticum* n. sp. (Page 12). Venter and cross-section. Paratype, GSC No. 17648. Callovian. Babbage River. GSC loc. 44102. See lateral view on Pl. XIII, fig. 1.