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AMMONITES FROM THE UPPER BOREAL BATHONIAN ON KOTEL'NYI ISLAND

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Traces of Late Bathonian sea transgression that occurred in the *Cadoceras barnstoni* phase were established on Kotel'nyi Island. Finds in redeposited concretions of two ammonite species of the genus *Cadoceras (Catacadoceras)* are evidence. Descriptions of the species *C. (C.) barnstoni* (Meek) and *C. (C.) perrarum* Voronez are given.
Ammonites, Boreal Bathonian, Kotel'nyi Island

INTRODUCTION

Mesozoic deposits occupy considerable areas on islands of the New Siberian Archipelago. Triassic deposits dominate, Cretaceous deposits are less widespread. Up until 1970 the Jurassic was not known for certain, though there were mentions in the reports of M. I. Brusnev and E. V. Toll at the start of the century about boulders with Upper Jurassic *Cadoceras* on a divide in the region of Cape Vysokii on Novaya Sibir Island [1, p. 338].

In 1955, during mapping of some of the New Siberian Islands by researchers of the Arctic Geology Research Institute (NIIGA, Leningrad), the presence of the Jurassic in the indicated place was not confirmed. The problem of Jurassic outcrops on the islands remained unsolved.

In the early 1970s, islands of polar seas were studied anew by researchers of NIIGA by thematic investigations and a group geological survey. Qualitative new geological and paleontological data were obtained during 1972-1974: sections of Paleozoic and Meso-Cenozoic deposits were found and studied; the presence of the Jurassic on Kotel'nyi island was established for the first time [2].

Jurassic deposits are developed on Kotel'nyi Island in limited areas in its eastern part. Their study is hampered by poor exposure conditions. The Jurassic is composed on terrigenous deposits, mainly sandstones and siltstones.

A direct contact with the underlying and completely represented marine Triassic was not observed, and the boundary between the Triassic and Jurassic was drawn on the basis of a change in the microfauna assemblage. Lower and upper divisions were established in the Jurassic sediments.

The Lower Jurassic (apparent thickness 250-300 m) is represented by black silty argillites with interlayers (up to 0.5 m) of gray and greenish-gray clayey siltstones and fine-grained polymictic sandstones. Concretions are often found in various types of rocks: siderite with an admixture of phosphate or pyrite in the form of layerlike accumulations and separated. The siderite concretions are diverse in size and configuration: from small oblate and irregular form to large bun-shaped (up to 0.6 x 0.2 m). Pyrite concretions and pyrite scattered in the rock are characteristic for the lower half of the Lower Jurassic deposits. Siderite concretions as well as large bun-shaped one (0.5 x 1.0m) composed of sandstones with pyrite cement are confined to the higher part of the section. On the bedding surface are found impressions of bivalves - *Otapiris* cf. *litnaeformis* Zakarov, *0.* cf. *limaeformis affecta* Polubotko et al., on the basis of which N. I. Shul'gina, E. S. Shuraeva-Gorskaya, and M. D. Burdykina established a Hettangian-Pliensbachian age of the entire member. This conclusion about the age was confirmed by identification of foraminifers by V. A. Basov and N. V. Sharovskaya, as well as by the composition of spores and pollen discovered by V. D. Korotkevich in the upper half of the section.

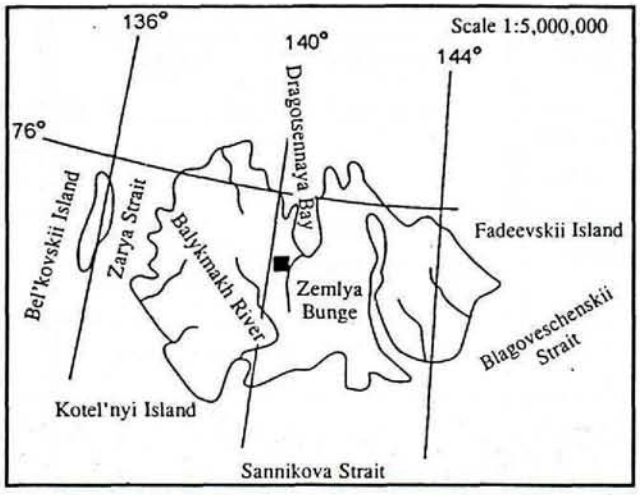

Fig. 1. Place of collecting ammonites on Kotel'nyi Island (shown by a square).

Data on the presence also of younger Jurassic deposits in the northeastern part of Kotel'nyi Island were given for the first time. Redeposited siderite concretions and lumps of glauconite sandstones containing shells of ammonites, belemnites, bivalves, and foraminifers were found in alluvial deposits of the Dragotsennaya River basin.

From here N. I. Shul'gina and M. D. Burdykina preliminarily identified *Cadoceras subcatostoma* Voronez, *C.* cf. *catostoma* Pompeckj, *C.* cf. *wosnessenskii* (Greqingk), *Belemnites* sp., *Retroceramus* cf. *vagt* Koschelkina and gave a conclusion about the presence of the Lower Bathonian and Lower and Middle Callovian.

The thickness and volume of the Upper Jurassic deposits remained obscure; however, the discovery of the Callovian permits stating that the Jurassic sections increase in the northeastern part of the island compared with its southern part, where only the Lower Jurassic is developed.

The collection of ammonites from Kotel'nyi Island (Fig. 1), gathered in 1973 by D. A. Vol'nov on the Dragotsennaya River (exposure 53, specimens 2053 and 2043) and also, as follows from the labels to the specimens, by M. K. Kos'ko and G. V. Trufanov on Zemlya Bunge (specimens 6340/1217 and 6366) and E. N. Preobrazhenskaya on Srednyaya River (specimen 2043/1221), was subsequently sent to the author by N. I. Shul'gina for a detailed study. The collection is stored at the Central Siberian Geological Museum in Novosibirsk, No. 756.

RESULTS OF STUDYING AMMONITES

The ammonites from Kotel'nyi Island belong to the genus *Cadoceras,* subgenus *Catacadoceras* Bodylevsky, 1960, since they have a shell of a cadicone form with a narrow, deep funnel-shaped umbilicus, with a coarse-ribbed phragmocone and more or less ribbed living chamber.

The *Cadoceras* with these features were described on the basis of separate finds in the northern part of Middle Siberia under various species names: *Cadoceras (Catacadoceras) laptievi* Bodylevsky and *C. (C.) ognevi* Bodylevsky [3], *Cadoceras subcatostoma* Voronez, and *C. subcalyx* Voronez [4]. They were all identified later by T. Poulton and the author of this article with the species *Cadoceras barnstoni* (Meek), described in detail from Canada [5, 6] and established in the lower reaches of the Lena River [7, 8].

The subspecies *Catacadoceras,* to which the species mentioned was assigned, was considered by its author V. I. Bodylevskii to be the most ancient in the phyletic series of the genus *Cadoceras* and characterizing the lowermost part of the Lower Callovian Substage. And the author, having treated this group of Cadoceratinae as an independent genus, assigned *Catacadoceras* to the Lower Callovian. Among others, *Catacadoceras* species were indicated by me in Siberia in the Lower Callovian *Cadoceras elatmae* zone.

In Western Yukon, in the Porcupine River basin, was found the mass occurrence of the species *Cadoceras barnstoni* (Meek) in the Jurassic interval between the *Arcticoceras ishmae* and *Cadoceras bodylevskyi* zones, where a zone of the same name is distinguished [6]. The *Cadoceras barnstoni* zone on Porcupine River is separated from the over- and underlying ammonite zones by intervals without ammonites. T. Poulton placed the *barnstoni* zone in the upper part of the Boreal Bathonian, having compared it approximately with the uppermost zone of the Bathonian in the *Clydoniceras discus* standard. Proof of such a correlation is based on the

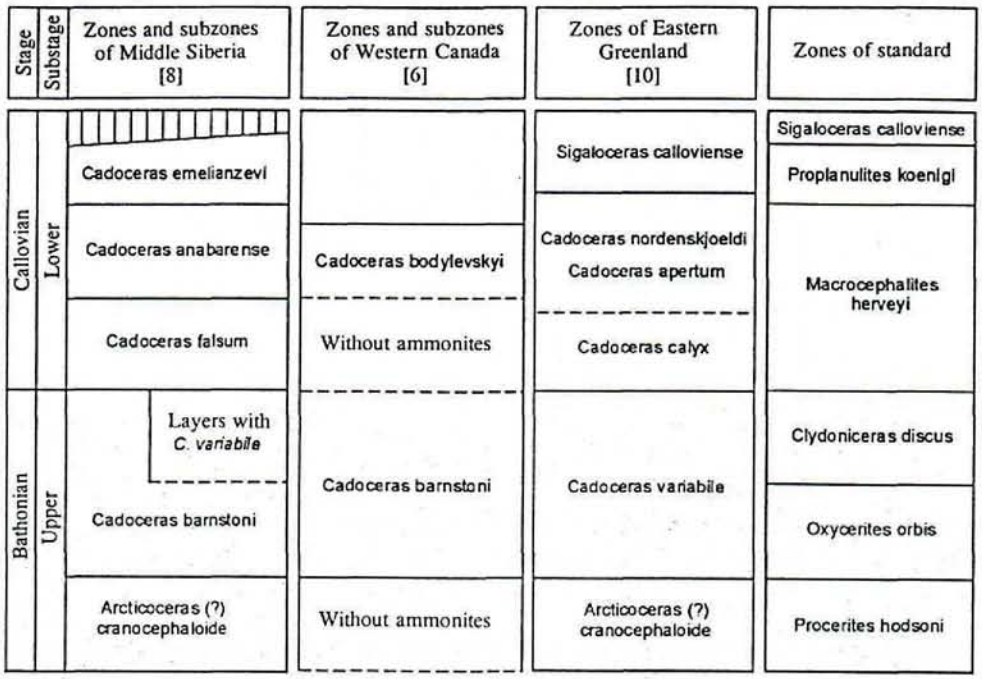

Fig. 2. Zonal correlation of Upper Bathonian and Lower callovian of Middle Siberia, Western Canada, Eastern Greenland, and the standard.

presence in the *C. barnstoni* zone in the Northern Yukon of the genus *Kepplerites: K.* aff. *rosenkrantzi* Spath and *K.* sp. The species *K. rosenkrantzi* Spath is known in Eastern Greenland in the Boreal Bathonian, in the *Cadoceras variabile* zone [10]. T. Poulton paralleled the Canadian *barnstoni* zone with the Eastern Greenland *variabile* zone and, partly, with a higher zone of the Boreal Bathonian - *Cadoceras calyx;* a considerable part of the *variabile* zone in T. Poulton's scheme corresponds to an interval without ammonites in Northern Yukon. And an interval not characterized by ammonites was compared with the Eastern Greenland *Arcticoceras (?) cranocephaloide* zone (6, PI. 3).

In Siberia the species *C. barnstoni* is found in the lower course of the Lena River in a continuous Boreal Bathonian-Callovian section [7]. The *Catacadoceras* characterize the interval between the last *Arcticoceras* (transitional forms *from Arcticoceras* to *Cadoceras)* and the first *Cadoceras* having signs typical for the genus, in particular, a cadicone shell. The detection of a *Catacadoceras* biozone made it possible to establish the presence of a *barnstoni* zone in sections of the lower reaches of the Lena River. It is preceded *by an Arcticoceras (?) cranocephaloide* zone, detected for the first time in the region, which is the youngest among the three *Arcticoceras* zone, and it is replaced by a *Cadoceras falsum* zone, to which is assigned the lower part of the former Siberian *Cadoceras elatmae* zone. The *barnstoni* zone is placed by the author, following T. Poulton, in the upper substage of the Boreal Bathonian. The argument was that *the variabile* zone on the Pechora River, where this zone is located below the *falsum* zone starting the Callovian, as follows from an analysis of the paleontological data [8, 11], belongs to the Upper Bathonian. The species C *barnstoni* (Meek) and *C. variabile* converge stratigraphically in the Siberian sections; however, their exact interrelation has not been fully explained. Therefore the *barnstoni* zone with beds with *variabile* in its upper part was singled out [8, 11].

The *barnstoni* zone belongs to the upper part of the Upper Bathonian encompassing approximately the standard *orbis* and *discus* zones, whereas the Siberian *cranocephaloide* zone underlying it is considered as approximately corresponding to the lower zone of the Upper Bathonian Substage (Fig. 2).

Thus, on Kotel'nyi Island there are traces of Late Bathonian sea transgression occurring at the *barnstoni* phase, the evidence of which is the finding of two species of *Cadoceras (Catacadoceras)* ammonites in redeposited concretions: *C. (C.) barnstoni* (Meek) and *C. (C.) perrarum* Voronez.

DESCRIPTION OF AMMONITES
FAMILY CARDIOCERATIDAE SIEMIRADZKI, 1891
SUBFAMILY CADOCERATINAE HYATT, 1900
Genus *Cadoceras* Fischer, 1882
Subgenus *Catacadoceras* Bodylevsky, 1960
Cadoceras (Catacadoceras) barnstoni (Meek, 1859)
Plate I, figs. 1-7; plate II, figs. 1-5

Ammonites barnstoni: [12, p. 184, Pl. 2, fig. 1-3].
Cadoceras crassum: [13, p. 17, Pl. XIV, fig. 2].
Cadoceras barnstoni: [5, p. 14-15, Pl. VIII, fig. 3, Pl. XII, fig. 2].
Cadoceras (Catacadoceras) laptievi: [3, p. 64-65, Pl. 1, fig. 1, Pl. II, fig. 1].
Cadoceras (Catacadoceras) ognevi; [13, p. 64-65].
Cadoceras subcalyx: [4, p. 5], Pl. XX, fig. 1, 2, 4].
Cadoceras subcatostoma: [4, p. 51, Pl. XXIV, fig. 1].
Cadoceras laptievi: [9, p. 91-93, Pl. 8, fig. 4; Pl. 15, fig. 3; Pl. 39, fig. 2].
Cadoceras barnstoni: [6, p. 54-56; Pl. 24, fig. 1-18; Pl. 25, fig. 1-8; Pl. 26, fig. 1-18].
Cadoceras (Catacadoceras) barnstoni: [7, p. 23; Pl. 8, fig. 3; Pl. 6, fig. 2, 3].

Holotype. No. 4811 in the museum of the Geological Survey of Canada, Ottawa. Shown in [5, p. 14-15, Pl. VIII, fig. 3; Pl. XII, fig. 2]. Lower layers with *Cadoceras,* Mackenzie River; Upper Bathonian, *barnstoni* zone, according to [6].

Material. More than 35 shells of various sizes with good and satisfactory preservation.

Table of Measurements 1

No. of specimen	D	H	T	U	H/O	T/O	U/O	T/H	B/W	R.R
756-14	115	37	~60	36	32.1	~52	31.3	1.6		
	75	25	43	22	33.3	57.3	29.3	1.7		
	45	15	22	13	33.3	48.9	28.9	1.5		
756-16	95	37	~42	24	38.5	44.2	25.8	1.1		
	50	20	24	13	40	48	26	1.2		
756-18	85	25	–	30	29.4	–	35	–	32/14	2.3
756-20	76	32.5	~36	23.5	42.7	~47.4	30.9	1.1	31/14	2.2
756-15	73	26.5	35	21.5	36.3	42.4	29.4	1.3	36/14	2.5
756-17	69	26	38	23	37.7	55	33.3	1.4		
	45	13.5	16.7	–	30	37.1	–	–		
756-10	65	23.5	34.5	22	36.1	53	33.8	1.4	52/26	2
756-5	~65	19.5	31	–	30	47.6			24/11	2.1
756-11	58	24	30.5	18	41.3	52.5	31	1.3	30/13	2.3
756-13	58	23	25.5	19	39.6	43.9	32.5	1.1	28/14	2
	40	14	17	12	35	42.5	30	1.2		
	20	8	9	–	40	45	–	1.1		
756-6	56	23	27	16.5	41	48.2	29.4		20/13	1.5
756-12	53	21	30	13.5	40	56.5	25.5	1.3	25/12	2
756-2	46	18	20.5	13	39.1	44.5	28.2	1.1	28/13	2.1
756-3	43	16	20	–	37.2	46.5	–	1.2	64/32	2
756-4	41	16	21	12	39	45.6	29.2	1.3	46/27	1.7
756-1	35	12.5	13.8	12.5	35.7	39.4	35.7	1.1	48/24	2

Note: D) diameter; H) height; T) thickness; U) umbilicus, mm; ratio of diameter, %.

Description. Shells large or medium, changing during growth from inflated pachycones on the middle whorls (up to D ~ 60 mm) to strongly inflated cadicones - in the case of large diameters. The whorls are slowly incremental. The lateral sides are convex, gradually passing into the rounded ventral side. With the occurrence of the cadicone form the lateral and ventral sides are converted into a single wide convex surface. The umbilicus is moderately wide, not deep, cup-shaped, with a gently sloping wall and rounded border - with diameters up to 40-50 mm, and then it becomes funnel-shaped, deep, stepped, with a steep wall and more or less angular border, especially sharp on the living chamber. The cross section of the whorls changes during ontogeny from oval with almost equal height and thickness to rounded trapezoidal, transversely elongated (T/H for D > 70 mm is 1.1-


1
2a
3
4a
4b
2c
2b
7b
6b
6a
7a
5

Plate I. Figs. 1-7. *Cadoceras (Catacadoceras) barnstoni* (Meek). Upper Bathonian, *barnstoni* zone. Fig. 1) specimen No. 756-14, side view, Zemlya Bunge; Fig. 2) specimen No. 756-16: 2a -side view (1.15X), 2b - side view of inner whorl (0.9x). 2c - view from aperture side of the same whorl (0.9 x), Zemlya Bunge; Fig. 3) specimen No. 756-15 (0.8x), side view, Srednyaya River; Fig. 4) specimen No. 756-3 (0.9x): 4a - side view, 4b - view from ventral side, Dragotsennaya River; Fig. 5) specimen No. 756-18, side view, Zemlya Bunge; Fig. 6) specimen No. 756-13: 6a - side view, 6b - view from aperture side, Dragotsennaya River; Fig. 7) specimen No. 756-2 (1.1 x): 7a) side view, 7b - view from aperture side, Dragotsennaya River. All images (Plates I and II), except those specially marked, are given in natural size.

1.7). Length of the living chamber is about 3/5 whorl.

Sculpture. The ribs are moderately high, frequent, narrow. On the inner whorls, starting with a shell diameter of 5 mm up to 40-45 mm, the ribs originate from the umbilical suture; farther - on the middle of the umbilical wall. With approach to the living chamber the ribs fade away, and are preserved to a greater or less degree on the living chamber. At early stages of growth (up to D = 25-30 mm) the ribs are bifurcate, more rarely simple; at middle stages (up to D = 60 mm) they are regularly bifurcate, and at late stages intercalary ribs are added to them. The point of branching is located in the middle of the lateral sides. The primary ribs are thicker than the secondary. The ribs are curved backward on the umbilical wall; they are straight and inclined on the lateral sides; they intersect the ventral side with a very gentle curve toward the mouth. The ribs rise mushroomlike above the umbilical border. The distances between primary ribs exceed the width of the ribs themselves by 2-2.5 times, and between the secondary ribs by not more than 1.5 times. The number of ribs on the whorl (R/W) varies, but the ratio of secondary to primary ribs at all stages stays close to 2-2.1, though cases of a smaller rib ratio (R.R) are noted (see Table of Measurements 1: specimens No. 756-6: No. 756-4).

Variability manifests itself in the scatter of the values of the main shell parameters: when D > 60 mm, H/D is from 30 to 43 %; T/D is from 42 to 57 %; U/D is from 26 to 35 %; T/H is from 1.1 to 1.7 %. The density of the ribs changes; on a half-whorl there are from 11 to 14 primary ribs and from 24 to 36 secondary ones.

Comparison and comments. The given species differs from the species *Cadoceras (Catacadoceras) perrarum* [4, p. 55, Pi. XV; fig. 1] on average by less thick whorls and more pronounced arid frequent ribs. A number of species, described by V. I. Bodylevskii and N. S. Voronetz on the basis of individual specimens from the lower reaches of the Lena and Olenek Rivers were considered formerly in the frameworks of the genus 01 subgenus *Catacadoceras* [9, p. 90]: *C. (C.) laptievi, C. (C.) ognevi, C. (C.) subcatostoma, C. (C.) subcalyx.* They all, as was mentioned above, are synonyms of C. *(C.) barnstoni* and are confined in Siberian sections and in Western Canada to a thin ammonite zone of the same name. T. Poulton [6] gave a detailed description of (he species *C. (C.) barnstoni* from type sections of Northern Yukon. The images of numerous shells of various sizes of C. *(C.) barnstoni* shown by him in three plates make it possible to search in the collection from Kotel'nyi Island for analogues of this species from Canada.

Distribution. Upper Bathonian, *Cadoceras barnstoni* zone in Western Canada, in the northern part of Middle Siberia, on Kotel'nyi Island.

Locality. Kotel'nyi Island, 1973: Dragotsennaya River, exposure 3, specimen 2053,24 specimens, D. A. Vol'nov's collections; Zemlya Bunge, specimen 6366, five specimens, specimen 6340/1217, three specimens, M. K. Kos'ko and G. V. Trufanov's collections; Srednyaya River, specimen 2043/1221, three specimens; E. N. Preobrazhenskaya's collections.

Cadoceras (Catacadoceras) perrarum Voronez, 1962

Cadoceras (?) perrarum [4, p. 55, PL XV, Fig. la, b].
Catacadoceras perrarum [9, p. 91].
Cadoceras (Catacadoceras) perrarum [7, Pl. 9, Figs. 1, 2; Pl. 10, Fig. 4; 8, p. 19].

Table of Measurements 2

No. of specimen	D	H	T	U	H/D	T/D	U/D	T/H
756-19	100	–	~50	–	–	50	–	
756-9	~100	42	65	–	42	65	–	1.6
756-8	~70	28	42	–	40	60		1.5
	64	26	38.5	16.0	40.6	60	25	1.5
	30	12	18	10	40	60	33.3	1.5

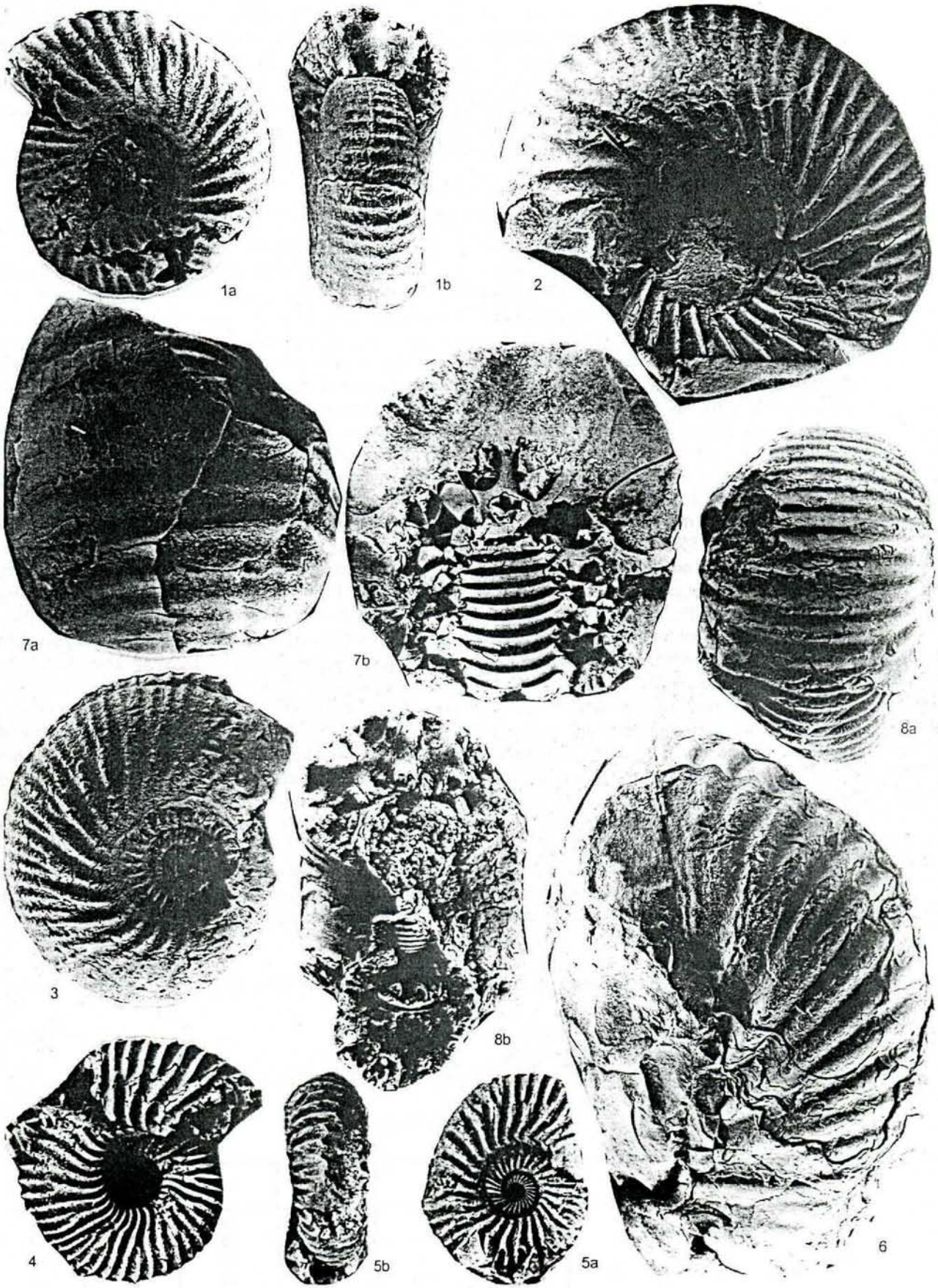
1a
1b
2
7a
7b
8a
3
8b
6
4
5b
5a

Plate II. Figs. 1-5. *Cadoceras (Catacadoceras) barnstoni* (Meek). Upper Bathonian, *barnstoni* zone.
Fig. 1) specimen No. 756-10 (0.85x): 1a - side view, 1b - view from aperture side, Dragotsennaya River; Fig. 2) specimen No. 756-20, side view, Srednyaya River; Fig. 3) specimen No. 756-11, side view, Dragotsennaya River; Fig. 4) specimen No. 756-4, side view, Dragotsennaya River; Fig. 5) specimen No. 756-1: 5a - side view, 5b - view from inner side, Dragotsennaya.
Figs. 6-8. *Cadoceras (Catacadoceras) perrarum* Voronez. Upper Bathonian, *barnstoni* zone.
Fig. 6) specimen No. 756-19, side, Srednyaya River; Fig. 7) specimen No. 756-9: 7a) view from the ventral side, 7b - view from aperture side, Dragotsennaya River; Fig. 8) specimen No. 756-8 (1.1 x): 8a - view from ventral side, 8b - view from aperture side.

Holotype. No. 1057, described in [4, p. 55, Pl. XV, Fig. 1a, b]. Arctic Geology Research Institute. Lena River, Cape Chekurovskii. Upper Bathonian.

Material. Three incomplete shells.

Description. Large shells (D up to 100 mm) with thick low whorls and slightly convex, wide ventral side. The cross section is low, subtrapezoidal, with a width exceeding the height by 1.5 times and more. The umbilicus on the inner whorls is moderately wide, and for shells with a diameter greater than 60 mm it becomes moderately narrow (Table of Measurements 2). The wall of the umbilicus is steep, the border is rounded. The living chamber occupies about a half-whorl. The aperture is simple, overhanging.

Sculpture. The ribs are pointed and high, become slightly lower on the ventral side, as well as with approach to the living chamber and become wider and less high. The ribs proceed radially from the umbilical suture, but before the border on the umbilical wall they bend forward. On the lateral sides the ribs are subradial, slightly inclined forward and directly intersecting the ventral side. Near the middle of the lateral sides the ribs bifurcate, oblong swellings form at the place of branching. There are intercalary ribs. On the last half-whorl of the largest specimen, which is the living chamber, there are seven primary and 21 secondary ribs.

Comparison. The species differs from only species of *Cadoceras (Catacadoceras)* by thick and comparatively few ribs and lower and more inflated whorls.

Distribution. Upper Bathonian, *Cadoceras barnstoni* zone in the northern part of Middle Siberia and Kotel'nyi Island.

Location. Kotel'nyi Island, 1973: Dragotsennaya River, specimen 2043, two specimens, D. A. Vol'nov's collections; Srednyaya River, specimen 2043/1221, one specimen, E. N. Preobrazhenskaya's collections.

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