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New Ammonites of the Family Cardioceratidae from the Lower Callovian of the Russian Platform

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Abstract—New cardioceratid species, *Costacadoceras pisciculus*, *Stenocadoceras? confusum*, and *Cadoceras (Bryocadoceras) laetum*, are described from the Lower Callovian of the central part of the Russian Platform. The systematic position of the genera *Costacadoceras* and *Stenocadoceras* is discussed.

INTRODUCTION

The family Cardioceratidae is one of the dominant ammonite groups in the Callovian of the Boreal-Atlantic Paleozoogeographic Province which includes the territory of the Russian Platform. Species described in the present paper belong to the genera *Cadoceras, Costacadoceras*, and *Stenocadoceras*, in the family Cardioceratidae.

I recovered the ammonoids under study between 1992–1995 from several outcrops in the upper part of the Volga River, on the right bank, close to the villages of Prosek and Isady, in the Nizhnii Novgorod Region. These outcrops represent a rather complete Lower Callovian succession of the Russian Platform and contain many fossils. The succession of Callovian rocks in these outcrops overlies the aleurolites and silty sandstones of presumably Bathonian age and is described as follows:

LOWER CALLOVIAN, ELATMAE ZONE

(1) Dark ~~blue~~ grey clays, with a horizon of large (up to 1m) marly concretions 4–5 m below the top. These concretions contained *Cadoceras (Paracadoceras) elatmae* (Nikit.), *C. (Bryocadoceras) simulans* Spath, *Pseudocadoceras mundum* (Sason.), *Macrocephalites (Macrocephalites) macrocephalus* (Schloth.), *Pleurocephalites* sp., and *Procerites* sp. In the topmost part of the bed *Cadoceras (Cadoceras ?) surense* Nikit, *C. (C.?) subpartum* Nikit., *C. (Paracadoceras) primaevum* Sason., *Macrocephalites (Macrocephalites)* cf. *formosus* (Sow.), *Kepplerites (Gowericeras) aff. gowerianus* (Sow.), and *Crassiplanulites* sp. were recognized. Thickness 10–15 m.

LOWER CALLOVIAN, CALLOVIENSE ZONE

(2) Greeinsh-grey, argillaceous, fine-grained sandstone, containing isolated shells of *Costacadoceras pisciculus* sp. nov., and *Kepplerites (Seymourites)* ex. gr. *tychonis* Ravn. Thickness 0.3–0.5 m. This bed is only tentatively referred to the *calloviense* Zone since it does not contain the faunistic assemblage characteristic of this zone.

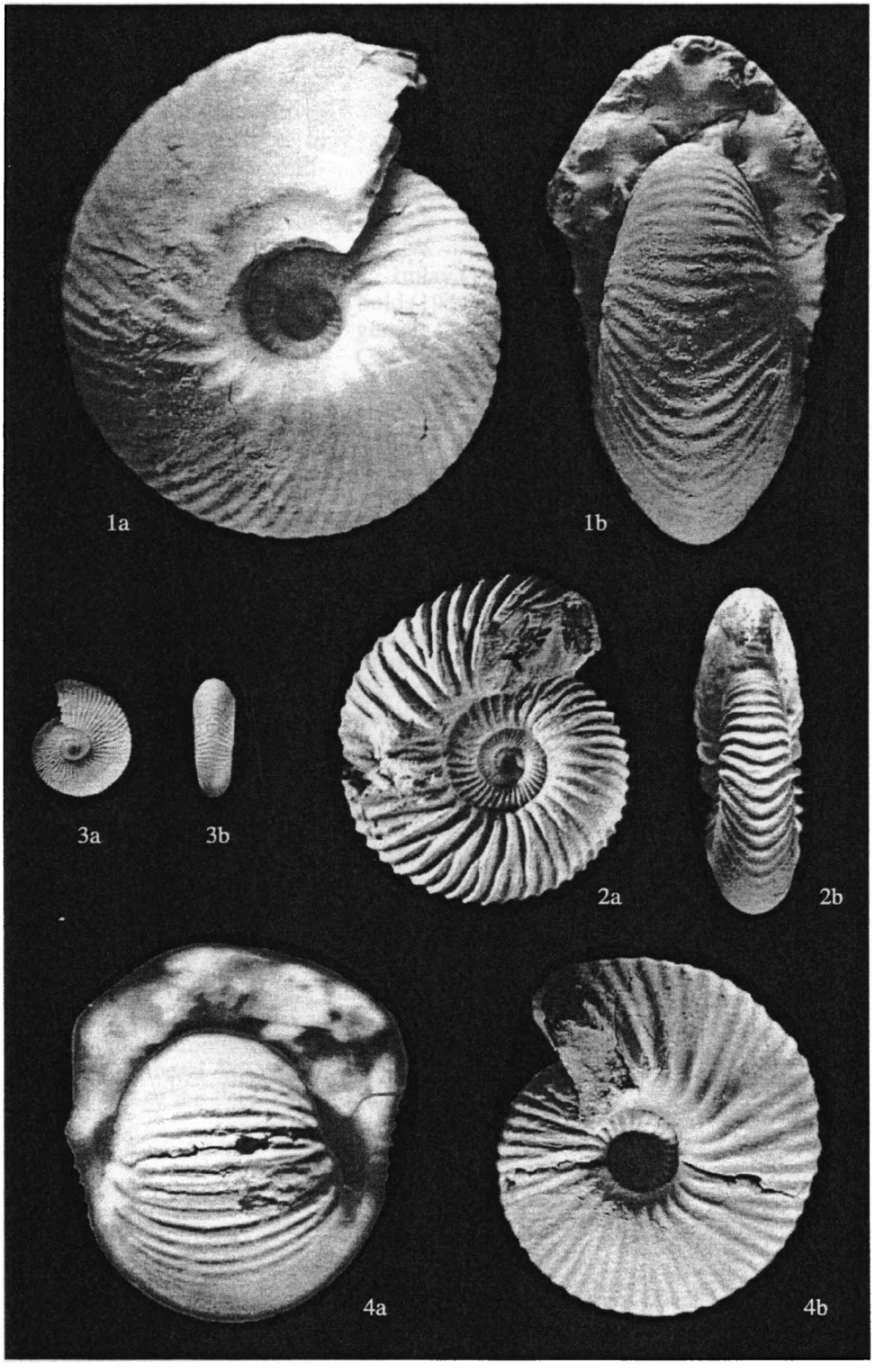
(3) Unit of argillaceous aleurolites and fine-grained yellow and yellowish-brown argillaceous sandstone yielding bands of oolitic marl. The unit contained the following ammonoids *Kepplerites (Gowericeras) gowerianus* (Sow.), *Torocellites* ex gr. *approximatus* Buckm., ~~*C. (C.) cf. ablaevi* (Sow.)~~, *Cadoceras (Cadoceras) emelianzevi* Voron., *C. (C.) tolype* Buckm., *C. (C.)* cf. *sublaeve* (Sow.), *C. (Bryocadoceras) laetum* sp. nov., *Stenocadoceras ? confusum* sp. nov., *Pseudocadoceras boreale* Buckm., *P.* ex gr. *grewingki* (Pomp.), *P.* ex gr. *crassicostatum* Imlay, *Chamoussetia chamousseti* (Orb.), *Proplanulites* spp., etc. At the top of this bed *Sigaloceras (Sigaloceras) calloviense* (Sow.), *Kosmoceras (Guliemites?)* aff. *enodatum* Nikit., *Cadoceras (Rondiceras?)* aff. *tschefkini* (Orb.) were recognized. Thickness 0.2–0.6 m.

Bed 3 is overlain by the Oxfordian–Kimmeridgian grey clays.

Of the genera comprising the species described in this paper, *Costacadoceras* and *Stenocadoceras* deserve special discussion because their systematic position is not yet resolved.

The genus *Costacadoceras* was erected by Rawson (1982) from the *Arcticoceras* beds of Spitsbergen, which were dated according to Callomon (1959, 1975) as the Middle Bathonian. The genus included three species, *C. bluethgenis* Rawson, 1982, *"Pseudocadoceras" nanseni* (Pompeckj, 1899), and *"Arcticoceras" michaelis* (Spath, 1932). The two latter species were recognized from Franz Joseph Land and East Greenland, respectively. Meledina (1987) assigned to this genus a species, *"Pseudocadoceras" insolitum*, that she had previously described (1977) from the Middle? Callovian of North Siberia.

Costacadoceras possesses a medium-sized compressed conch (diameter up to 60 mm), with shallow, moderately wide to wide umbilicus, subinvolute whorls, rounded venter, and ribs closely spaced at early


1a
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4b

stages and more widely spaced and prominent at the later stages (particularly in the living chamber). Of the above species, *"Arcticoceras" michaelis* (Spath, p. 56, pl. 13, fig. 3), possessing a more inflated conch with moderately narrow umbilicus, does not fully fit this diagnosis.

Rawson (1982) placed *Costacadoceras* in the subfamily Arcocephalitinae. However, the representatives of this genus show much more resemblance to *Pseudocadoceras* Buckman (subfamily Cadoceratinae), than with any of the forms belonging to the Arctocephalitinae. They differ from the member of the latter subfamily in the smaller conch, more evolute whorls and in the shallow and wide umbilicus throughout ontogeny. Some Early and Middle Callovian species, that are at present referred to *Pseudocadoceras*, show characters resembling *Costacadoceras* to such an extent that the distinction between these two genera becomes vague. These are *Pseudocadoceras grewingki* (Pompeckj, 1900), *P. mundum* (Sasonov, 1957), and *P. crassicostatum* Imlay, 1953. In conch shape and ornamentation *Costacadoceras* is similar to the young whorls of the genus *Catacadoceras* Bodylevsky, the most archaic in the subfamily Cadoceratinae, and apparently ancestral to the genus *Cadoceras* s. l. This resemblance may suggest a direct phylogenetic relationship between *Costacadoceras* and *Catacadoceras*, first in the lineages of micro- and macroconchs of cardioceratins. All this and the stratigraphic distribution of *Costacadoceras* up to the Middle Callovian support the assignment of this genus to the subfamily Cadoceratinae. *Stenocadoceras* was established by Imlay (1953) as a subgenus of *Cadoceras* Fischer. Later, Meledina (1977) correctly regarded it as a genus. The genus *Stenocadoceras* shows compressed whorls throughout ontogeny, narrow umbilicus, narrowed venter, and absent or weakly developed umbilical nodes. Species of this genus were recognized from the upper part of the Lower Callovian and Middle Callovian of South Alaska (Imlay, 1953), from the Middle Callovian of the Richardson Mountains and on Cornwall Island in Canada (Frebold, 1964; Frebold and Tipper, 1967), from the Middle and Upper Callovian of British Columbia, and Middle and Upper Callovian of North Siberia (Kaplan *et al.*, 1974; Meledina, 1977, 1983) and of the Pechora Basin (Meledina, 1977).

Suture outline of *Costacadoceras pisciculus* sp. nov., specimen no. A139 at WH = 9.0 mm, ×4; right bank of the Volga River, close to the village of Prosek; Lower Callovian, *elatmae* and *calloviense* zones boundary deposits (Bed 2).

Imlay (1953), also see *Treatise...* (1957), and Freebold (1964) regard *Stenocadoceras* as a subgenus of the genus *Cadoceras*, which belongs to the subfamily Cadoceratinae. In Meledina's (1977) view, since most of the characters of *Stenocadoceras*, an intermediate genus between *Cadoceras* and a group of genera constituting the subfamily Quenstedtoceratinae, are typical of the latter subfamily, it should be referred to the Quenstedtoceratinae. This view suffers serious contradictions. The ventral keel of the early whorls characteristic of the Quenstedtoceratinae is either absent or weakly developed in *Stenocadoceras*. Hence, the genus resembles *Cadoceras* in conch shape and ornamentation, particularly with some younger species of the subgenus *Streptocadoceras*: *C. (S.) tenuicostatum* Imlay, 1953, *C. (S.) doroschini* (Eichwald, 1871) and others, which co-occur with *Stenocadoceras* in the upper part of the Lower Callovian of South Alaska (Imlay, 1953). Such features of *Stenocadoceras* as compressed whorls, closely spaced fine ribs and narrow umbilicus, which in Meledina's view, support its assignment to in the subfamily Quenstedtoceratinae cannot be regarded as taxonomically important since they are recognized in different combinations in each of the considered subfamilies. Of all Quenstedtoceratinae representatives only the Late Callovian genus *Longaeviceras* shows all these features together. However, the latter genus differs from *Stenocadoceras* in the keel-shaped venter at early stages, cadiconic whorls at late stages and generally in the wider and deeper umbilicus. The differences between *Stenocadoceras* and other quenstedtoceratins are even more significant.

Plate 5

In all figured specimens sizes are natural.

Fig. 1. *Stenocadoceras? confusum* sp. nov., holotype no. A474, conch without the living chamber: (1a) lateral view, (1b) apertural view, right bank of the Volga River, close to the village of Isady; Lower Callovian, *calloviense* Zone, *koenigi* Subzone (Bed 3).

Figs. 2, 3. *Costacadoceras pisciculus* sp. nov., (2) holotype no. A137: (2a) lateral view, (2b) apertural view; (3) specimen no. A138: (3a) lateral view, (3b) ventral view, right bank of the Volga River, close to the village of Prosek; Lower Callovian, *elatmae* and *calloviense* zone boundary deposits (Bed 2).

Fig. 4. *Cadoceras (Bryocadoceras) laetum* sp. nov., holotype no. A446: (4a) lateral view, (4b) apertural view, right bank of the Volga River, close to the village of Isady; Lower Callovian, *calloviense* Zone, *koenigi Subzone* (Bed 3).

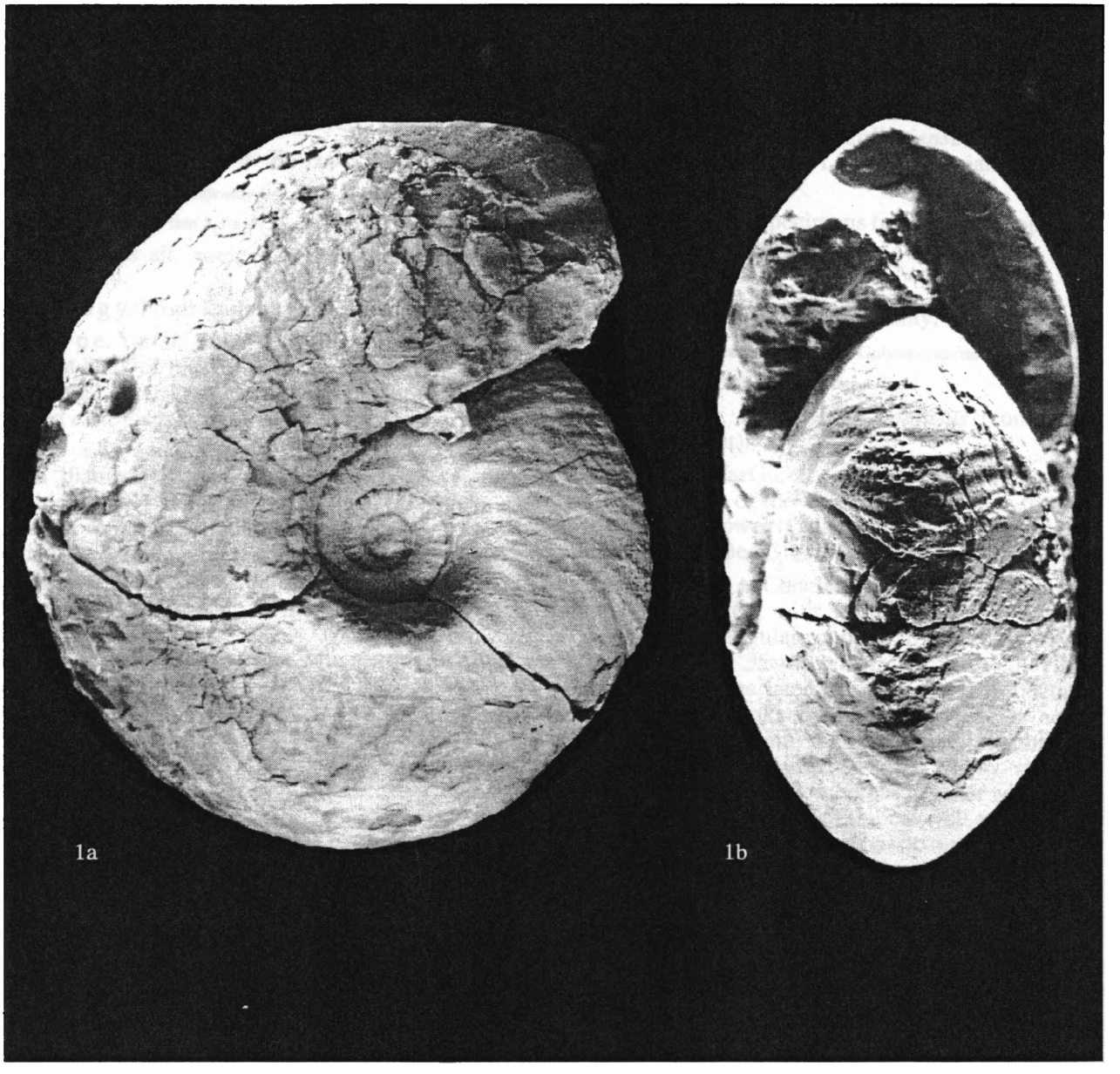

Plate 6

Stenocadoceras? confusum sp. nov., holotype no. A474, complete conch: (1a) lateral view, (1b) apertural view; right bank of the Volga River, close to the village of Isady; Lower Callovian, *calloviense* Zone, *koenigi* Subzone (Bed 3).

Almost all species of *Stenocadoceras* are recognized from the upper part of the Lower Callovian and from the Middle Callovian, where they usually occur in association with *Cadoceras* and *Pseudocadoceras*. A single species of true *Stenocadoceras* is described from the Upper Callovian of North Siberia, although this time corresponding to the flourish of Quenstedtoceratinae (Meledina, 1977).

Thus based on the conch morphology and stratigraphic distribution the genus *Stenocadoceras* should be assigned to the subfamily Cadoceratinae and be interpreted as a descendant of *Cadoceras*. The phylogenetic relationship between *Stenocadoceras* and the family Quenstedtoceratinae is uncertain, and additional material is needed to resolve it.

Holotypes of the species described in this paper are housed in the Department of Zoology of Yaroslavl State University (YarGU).

Abbreviations: D—diameter, WH—whorl height, WW—whorl width, UW—umbilical width.

SYSTEMATIC PALEONTOLOGY

Family Cardioceratidae Siemiradzki, 1891

Subfamily Cardioceratinae Hyatt, 1900

Genus *Costacadoceras* Rawson, 1982

***Costacadoceras pisciculus* Gulyaev, sp. nov.**

Plate 5, figs. 2, 3

Pseudocadoceras aff. *nanseni*: Efremova *et al.*, 1983, p. 130, pl. 10, fig. 4.

Etymology. From Latin *pisciculus* (fish).

Holotype. YarGU, no. A137; Nizhnii Novgorod Region, right bank of the Volga River, close to the village of Prosek; Lower Callovian, boundary between the *elatmae* and *calloviense* zones (bed 2).

Conch shape. Conch is medium-sized (up to 50 mm in diameter), compressed, with moderately involute highly-oval whorls. The widest part corresponds to the umbilical shoulder. Flanks weakly convex, gradually coalesce with the rounded venter. Umbilicus shallow, widely stepped, throughout ontogeny ranges from moderately wide to wide. Umbilical wall short. Umbilical shoulder widely rounded. Living chamber 2/3 of the whorl. Aperture with ventral margin protruding orad.

Dimensions in mm and ratios:

specimen no.	D	WH	WW	UW	WH/D	WW/D	UW/D
holotype							
A137	48	17	16	17	0.35	0.33	0.35
A139	42	15	13	16	0.36	0.31	0.38
A138	18	7	6	5	0.39	0.33	0.28

Ornamentation. Ribbing prominent, at early stages fine and closely spaced (up to 40 primary and 70 secondary ribs per whorl). Later, in ontogeny ribs become more widely spaced and higher. From the umbilical seam primary ribs gently slant backward, after the umbilical shoulder they slant orad, and in the last whorls they are raised as sharp and thin ridges. Secondary ribs arc-shaped and slant orad, and on the venter they form a well developed projection. The bifurcation occurs at 1/2 distance from the umbilical seam or slightly earlier. Bifurcating ribs are predominant, whereas single ordinary and intercalated ribs are infrequent. Ribbing coefficient 1.6–1.8.

Suture is figured (figure).

Comparison. This species differs from the closely resembling *C. insolitum* (Meledina, 1977) in the more compressed whorls, wider umbilicus, and in the more projected ribs on the venter, from *C. bluethgeni* Rawson, 1982 and *C. nanseni* (Pompeckj, 1899) it is distinguished by the wider umbilicus and by the more strongly bent ribs.

Remarks. The ammonite from the Lower Callovian of Franz Joseph Land, described by Meledina in Efremova *et al.*, 1983 as *Pseudocadoceras* aff. *nanseni* (Pompeckj) judging from its morphology may be referred to *C. pisciculus*.

Occurrence. Lower Callovian, boundary deposits between the *elatmae* and *calloviense* zones of the central Russian Platform; Lower Callovian of Franz Joseph Land.

Material. Four specimens from the outcrop close to the village of Prosek.

Genus *Stenocadoceras* Imlay, 1953

***Stenocadoceras? confusum* Gulyaev, sp. nov.**

Plate 5, fig. 1, plate 6, fig. 1

Etymology. From Latin *confusus* (confusing, difficult to interpret).

Holotype. YarGu, no. A474; Nizhnii Novgorod Region, right bank of the Volga River, close to the village of Isady; Lower Callovian, *calloviense* Zone, *koenigi* Subzone (Bed 3).

Conch shape. Conch large (up to 110–120 mm in diameter), inflated, with strongly involute whorls. The whorls are triangular-rounded in cross section, at early stages (up to 35–40 mm in diameter) they are compressed, whereas later in ontogeny they become more depressed. Flanks flattened, converge at acute angle and coalesce with rounded venter. Umbilicus moderately narrow, in inner whorls widely stepped with a short umbilical wall, whereas in outer whorl it is funnel-shaped with a longer umbilical wall and distinct umbilical shoulder. Living chamber occupies 2/3 of the whorl. Aperture with ventral margin protruding orad.

Dimensions in mm and ratios:

specimen no.	D	WH	WW	UW	WH/D	WW/D	UW/D
holotype							
A474	113	50	54	25	0.44	0.48	0.22
	72	31	40	16	0.43	0.55	0.22
A439	45	21	25	9	0.47	0.55	0.20

Ornamentation. Inner whorls possess fine, closely spaced, moderately prominent ribbing, which gradually become weaker. Ribs more raised across the umbilical shoulder and across the venter. Primary ribs on the umbilical wall gently slant backward, and after the umbilical shoulder they bend orad. Secondary ribs strongly bent orad and form a well developed projection on the venter. As the umbilical shoulder becomes more distinct, the ribs across it become more raised forming low and elongate umbilical nodes, which gradually become obsolete and disappear by the beginning of the living chamber. Bifurcation occurs at a point between 1/3 and 1/2 the distance from the umbilical seam. Bifurcating ribs predominate, single simple and intercalate ribs are present. Ribbing coefficient 2.2–2.6 mm. Ribbing becomes weaker at the end of the last whorl at a diameter 65–70 mm. Ribs become weaker first at the

point of bifurcation, whereas on the venter they continue longer.

Comparison. This species differs from all known representatives of *Stenocadoceras* in the more inflated conch and in the triangular-rounded shape of the whorls.

Remarks. This species is only tentatively referred to the genus *Stenocadoceras* since its occurrence does not correspond to the distribution of *Stenocadoceras*. *Stenocadoceras* evolved from *Cadoceras* at the end of the early Callovian within the Boreal-Pacific Paleozoogeographic Province, from where it radiated. Only in the Middle Callovian did *Stenocadoceras* spread to the Arctic and Pechora basins. Hence, *Stenocadoceras? confusum* was unlikely to have been directly related to *Stenocadoceras*. On the other hand, the assignment of the species under consideration to *Cadoceras* s. l., in view of current knowledge on the latter genus taxonomy and subgeneric composition, is problematic. The combination of such features of *S.? confusum* as relatively slightly inflated conch, narrow venter throughout ontogeny, and closely spaced ribs which are strongly bent orad is not typical for *Cadoceras*. Perhaps, this species should be assigned to a new subgenus of the genus *Cadoceras*.

Occurrence. Lower Callovian, *calloviense* Zone, central part of the Russian Platform.

Material. Three specimens from the outcrop close to the village of Isady and two specimens from the outcrop close to the village of Prosek (Bed 3).

Genus *Cadoceras* Fischer, 1882

Subgenus *Bryocadoceras* Meledina, 1977

***Cadoceras (Bryocadoceras) laetum* Gulyaev, sp. nov.**

Plate 5, fig. 4.

Etymology. From Latin *laetus* (fat).

Holotype. YarGU, no. A446; Nizhnii Novgorod Region, right bank of the Volga River, close to the village of Isady; Lower Callovian, *calloviense* Zone, *koenigi* Subzone (Bed 3).

Conch shape. Conch large (up to 60 mm in diameter), cadiconic, changes in ontogeny from inflated to strongly inflated. Whorls strongly involute, and rounded-trapezoid in cross section. As conch grows, the whorls expand and become widely semitrapezoid in cross section. Venter and flanks coalesce and form a wide gently convex surface. Umbilicus is moderately narrow, narrowly stepped at early stages of growth, later it deepens and becomes funnel-shaped.

Dimensions in mm and ratios:

specimen no.	D	WH	WW	UW	WH/D	WW/D	UW/D
holotype							
A446	55	21	52	12	0.38	0.95	0.22
	36	16	31	8	0.44	0.86	0.22
3/31	76	31	74	18	0.41	0.97	0.23

Ornamentation. Conch possesses prominent, relatively wide, and closely spaced ribs. At early whorls (up to diameter 20–25 mm) primary ribs run radially across the umbilical wall or slightly bend backward. Secondary ribs of flanks very weakly bend backward, whereas on the venter they form a feeble projection. At later stages ribs become radial, straight, just before the stage at which they disappear, the ribs may slightly bend forward. Umbilical shoulder possesses small elongate nodes, which remain after the ribbing disappears. Bifurcation occurs between 1/3 and 1/2 of the distance from the umbilical seam. There are single ordinary and intercalated ribs, and also bifurcating ribs, the latter predominating. Ribbing coefficient 2.2–2.3.

Comparison. This species differs from *C. (B.) simulans* Spath, 1932 and *C. (B.) comma* Imlay, 1953 in the narrower umbilicus, and from the latter also in the more strongly inflated conch and radial ribs. A new species is distinguished from *C. (B.) bathomphalum* Imlay, 1953 by the radial ribbing in the inner whorls.

Occurrence. Lower Callovian, *calloviense* Zone; central part of the Russian Platform.

Material. Four specimens from the outcrop close to the village of Isady and one specimen from the outcrop close to the village of Prosek (Bed 3).

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