

# First Finds of *Eckhardites* (Ammonoidea: Cardioceratidae) in the Upper Bathonian of the Russian Platform

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**Abstract**—The genus *Eckhardites* was known until now only from the Lower Callovian of Central Russia and Northern Germany, from three species of one phyletic line. This paper describes another representative of this genus, *E. atmensis* Mitta, sp. nov., based on the type series from the *Calyx* Zone of the Upper Bathonian of the Middle Volga area. New records significantly push back the time of origin of the genus and strongly support its boreal origin. The shells of *Cadoceras calyx* Spath found in the interval of distribution of *E. atmensis*, and *C. apertum* Callomon et Birkelund, which characterizes the overlying beds, are illustrated.

**Keywords:** ammonites, Arctocephalitinae, Cadoceratinae, *Eckhardites*, biostratigraphy, *Calyx* Zone, Central Russia

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## INTRODUCTION

The genus *Eckhardites* Mitta, 1999 is one of the most enigmatic taxa in terms of origin of the family Cardioceratidae Siemiradzki, 1891. It has generally been very well studied throughout the entire interval of its existence (Bajocian–Kimmeridgian) (Callomon, 1985; Howarth, 2017). Until now, species of this genus were known only from the Lower Callovian of the sub-boreal regions (Central Russia and Northern Germany).

In recent years, several ammonite shells of the genus *Eckhardites* have been found in the Upper Bathonian of the Middle Volga region. This paper describes these finds.

The studied specimens are housed at the A.A. Borissiak Paleontological Institute (PIN RAS), collection no. 5029.

## HISTORY OF STUDY

N.S. Smorodina (1929), based on several specimens from the Lower Callovian (Elatmae Zone) of the Kostroma (collections by M.I. Sokolov and M.A. Veidenbaum, 1920s) and Nizhny Novgorod provinces (collections by A.P. Pavlov, late 19th Century), established the species *Macrocephalites pavlowi* Smorodina (family Macrocephalitidae). However, Smorodina's publication raises significant doubts about the generic assignment of the species due to its

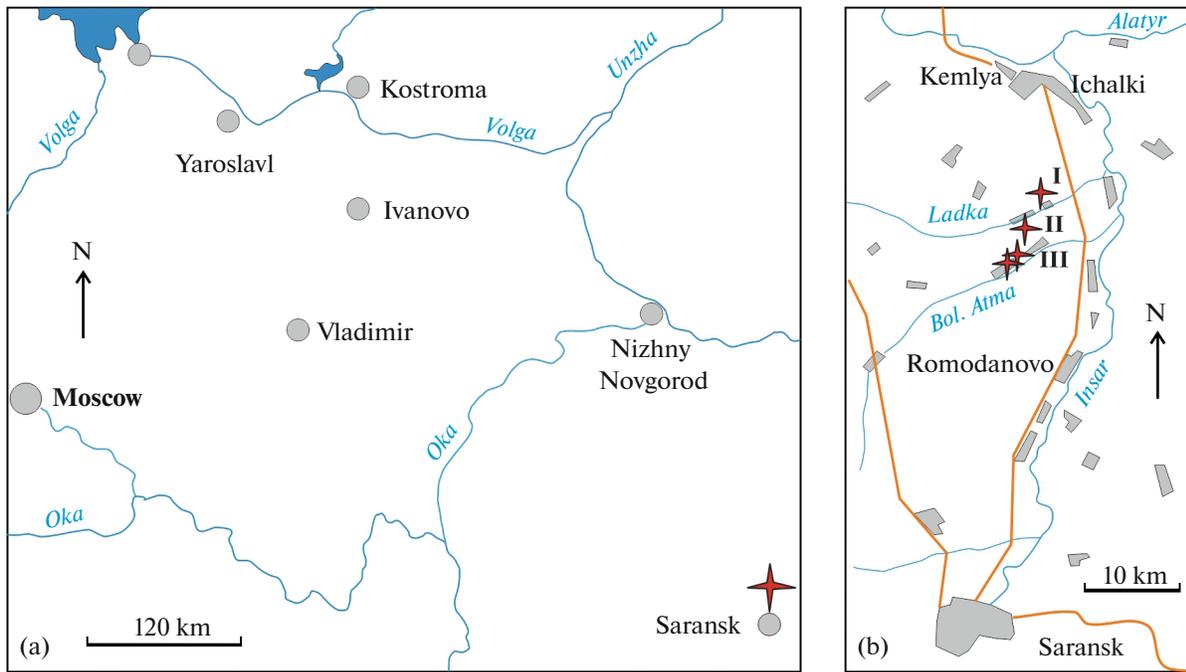
close similarity to the genus *Chamoussetia* (family Cardioceratidae).

Much later, Mönnig (1995) described *Chamoussetia menzeli* Mönnig from the Lower Callovian (Macrocephalen–Oolith Formation, *Herveyi* Zone) in the vicinity of Hildesheim (Germany, Lower Saxony) based on the holotype (collections by H. Menzel, 1900).

At the end of the last century, V.V. Mitta assigned the two aforementioned species to a new genus, *Eckhardites* (Mitta, 1999, p. 132), homeomorphic with *Chamoussetia*, suggesting that *Eckhardites* originated from the Bathonian subfamily Arctocephalitinae (family Cardioceratidae). It should be noted that the results of a re-examination of the type material of “*Macrocephalites*” *pavlowi* Smorodina, as well as new collections, and the description of this species in the genus *Eckhardites*,<sup>1</sup> were published a year earlier (Mitta and Starodubtseva, 1998, p. 12).

Subsequently, a detailed description of the genus *Eckhardites* and two of its species, *E. pavlowi* and *E. aff. menzeli*, was published based on supplemented collections from the Kostroma and Nizhny Novgorod

<sup>1</sup> The proceedings of the IV International Symposium on Cephalopods (Granada, 1996), which included the paper (Mitta, 1999), were published with a delay, and the genus name *Eckhardites*, which appeared in the paper (Mitta and Starodubtseva, 1998) was a nomen nudum until 1999, when it was published with the designation of the type species of this genus.



**Fig. 1.** The studied Upper Bathonian section: (a) overview, (b) detailed (I—location of Alatyr I, II—location of Alatyr II, III—locations of Alatyr III and III bis).

regions and the Chuvashian Republic (Mitta, 2000). Later, another species, *E. dietli* Mitta, presumably its most recent representative, was described from the Kostroma region (Mitta, 2009); the microconchs of *Eckhardites* were also published then for the first time.

Some Russian researchers did not recognize the genus *Eckhardites* as an independent genus in the family Cardioceratidae and continued to classify *E. pavlowi* and related forms in the genus *Macrocephalites*, as had been done about a century previously by Smorodina (Gulyaev, 1999, 2001, 2007; Kiselev and Rogov, 2007a, 2007b; Gulyaev and Ippolitov, 2021; Kiselev, 2022). Mitta (2009) made a comparison of the shells of Central Russian *Eckhardites* and German *Macrocephalites* from the Lower Callovian—they differ sharply in the shape of the section at the early stages and the course of ornamentation development at all stages of ontogenesis—except, perhaps, the latest, when the ornamentation becomes smoother in representatives of both genera.

Mönnig (1995, 2014) likely still assigned the species *menzeli* to the genus *Chamoussetia*. However, it has long been shown that the phyletic lineage *Cadoceras* → *Cadochamoussetia* → *Chamoussetia* arose later, in the early Callovian (Gerasimov et al., 1996; Mitta, 1999, 2000, 2016; etc.). There is no disagreement here among Russian authors, except perhaps in the species composition of these genera.

In the revised edition of “Treatise...” (Howarth, 2017), *Eckhardites* is considered an independent genus

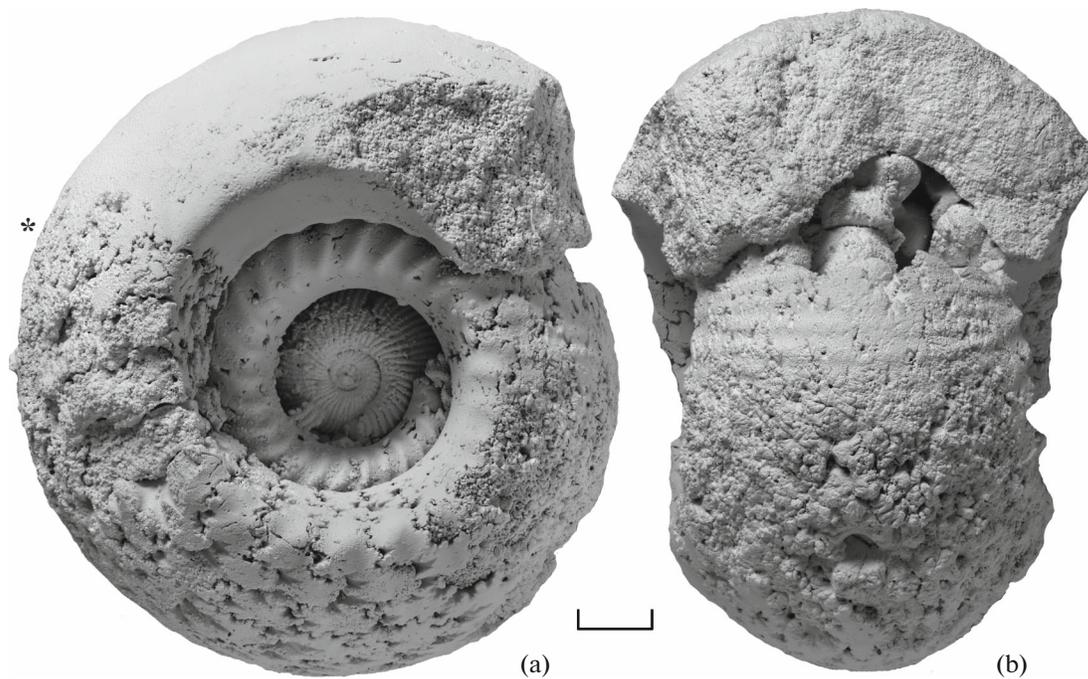
within the subfamily Cadoceratinae of the family Cardioceratidae.

#### LOCALITY AND AGE

At the turn of the 20th and 21st Centuries, several Upper Bathonian localities, well characterized by ammonites, were discovered in the Middle Volga region. These localities are located in the Alatyr River basin, and in the geological literature they are known as Alatyr I (located north of the village of Ropyevka), Alatyr II (near the village of Bolshaya Pestrovka), and Alatyr III (near the village of Trofimovshchina) in the Ichalki and Romodanovo districts of the Republic of Mordovia (Fig. 1). All the indicated locations represent sand excavations for local needs, and the Upper Bathonian is represented by light and yellow quartz sands with a visible thickness of 8–10 m. These beds are unconformably overlain by clays of the Lower Callovian (Mitta, 2004, 2005a, 2005b, 2008; *Unifitsirovannaya...*, 2012; etc.).

The new locality (Alatyr III bis), from which the material described below originates, is located on the northern outskirts of the village of Trofimovshchina in the Romodanovo District, two kilometers southwest of the Alatyr III locality. A description of the geological cross-section of this locality is planned for a subsequent study, following its completion.

In the middle part of the sand member, I.A. Meleshin and Yu.V. Zenina, in addition to the



**Fig. 2.** *Cadoceras calyx* Spath, specimen PIN, no. 5029/207: (a) lateral view, (b) apertural view; Mordovia, Romodanovo District, sand pit near the village of Trofimovshchina (Alatyr III bis locality); Upper Bathonian, *Calyx* Zone; collected by Yu.V. Zenina, 2024. Scale bar 10 mm; the asterisk (\*) marks the beginning of the body chamber.

new species of *Eckhardites* described below, found ammonites that, based on the shell shape and ornamentation, undoubtedly belong to *Cadoceras calyx* Spath (Fig. 2). This species, the type series of which comes from the Upper Bathonian of East Greenland (Spath, 1932), has already been described from Central Russia (Mitta, 2004, pl. 1, fig. 2; Mitta, 2005, pl. 8, fig. 1; Kiselev and Rogov, 2007b, pl. 3, fig. 1; Kiselev, 2022, pl. 20, figs. 2, 3; pl. 21, fig. 1). All of these finds come from the uppermost sandstone strata of another Upper Bathonian locality (Alatyr II), located slightly to the north, on the right bank of the Ladka River near the village of Bolshaya Pestrovka in the Ichalki District (Fig. 1). *C. calyx* is the index species of the eponymous Upper Bathonian zone of the Boreal scale, allowing reliable dating of the new *Eckhardites* species.

Above the uppermost *Eckhardites* find in the section (Fig. 3) R.A. Gunchin found an ammonite (Plate 2,

fig. 1) similar in all respects to the holotype of the East Greenland species *Cadoceras apertum* (Callomon and Birkelund, 1985, pl. 2), but differing in its small size and, perhaps, a higher cross-section. However, Callomon and Birkelund (1985, p. 82) indicated a maximum shell diameter of 120–150 mm for their species (our specimen reaches a diameter of 90.5 mm) and a relatively wide variability in the shape of cross-section. Considering that Central Russian late Bathonian ammonites generally have smaller final shell sizes than coeval East Greenland ammonites, we believe our identification of this find is entirely justified. The species *C. apertum* is an index species of the *Apertum* Zone of the East Greenland scale following the *Calyx* Zone and was previously described from a sandstone bed at the top of the Upper Bathonian sand member of the Alatyr III section (Mitta, 2005a; 2024).

#### Explanation of Plate 2

**Fig. 1.** *Cadoceras apertum* Callomon et Birkelund, specimen PIN, no. 5029/208, adult shell: (1a) lateral view, (1b) apertural view; Mordovia, Romodanovo District, sand pit near the village. Trofimovshchina (locality Alatyr III bis); Upper Bathonian, *Apertum* Zone; coll. R.A. Gunchin, 2024.

**Fig. 2.** *Eckhardites pavlowi* (Smorodina), specimen PIN, no. 5029/215: (2a) phragmocone of the lateral view, (2b) ventral view; Kostroma Region, Makariev District, bank of the Unzha River, near the former villages of Popovo and Mikhalenino; Lower Callovian, *Elatmae* Zone, *tschernyschewi* faunal horizon; coll. by V.V. Mitta, 2008.

**Fig. 3.** *Eckhardites atmensis* Mitta, sp. nov., specimen PIN, no. 5029/204: (3a) body chamber with the anterior part of the phragmocone, lateral view; (3b–3d) inner whorls: (3b) lateral view, (3c) apertural view, (3d) ventral view; Mordovia, Romodanovo District, sand pit near the village of Trofimovshchina (Alatyr III bis locality); Upper Bathonian, *Calyx* Zone; coll. by I.A. Meleshin, 2016. Scale bar 10 mm long; the asterisk (\*) marks the beginning of the body chamber.





**Fig. 3.** Part of the Alatyry III bis locality (Mordovia, Romodanovo District, sand pit near the village of Trofimovshchina); the arrow indicates the in situ find of *Eckhardites atmensis* Mitta, sp. nov., paratype PIN, no. 5029/206. Photograph by R.A. Gunchin, 2024.

### SYSTEMATIC PALEONTOLOGY

Superfamily Stephanoceratoidea Neumayr, 1875

Family Cardioceratidae Siemiradzki, 1891

Subfamily Arctocephalitinae Meledina, 1968

Genus *Eckhardites* Mitta, 1999 [M, m]

*Eckhardites atmensis* Mitta, sp. nov.

Plate 2, fig. 3; Plate 3, fig. 1

**E t y m o l o g y.** After the type locality on the Bolshaya Atma River.

**H o l o t y p e.** PIN, no. 5029/205; Mordovia, Romodanovo District, sand quarry near the village of

Trofimovshchina (Alatyry III bis locality); Upper Bathonian, *Cadoceras calyx* Zone.

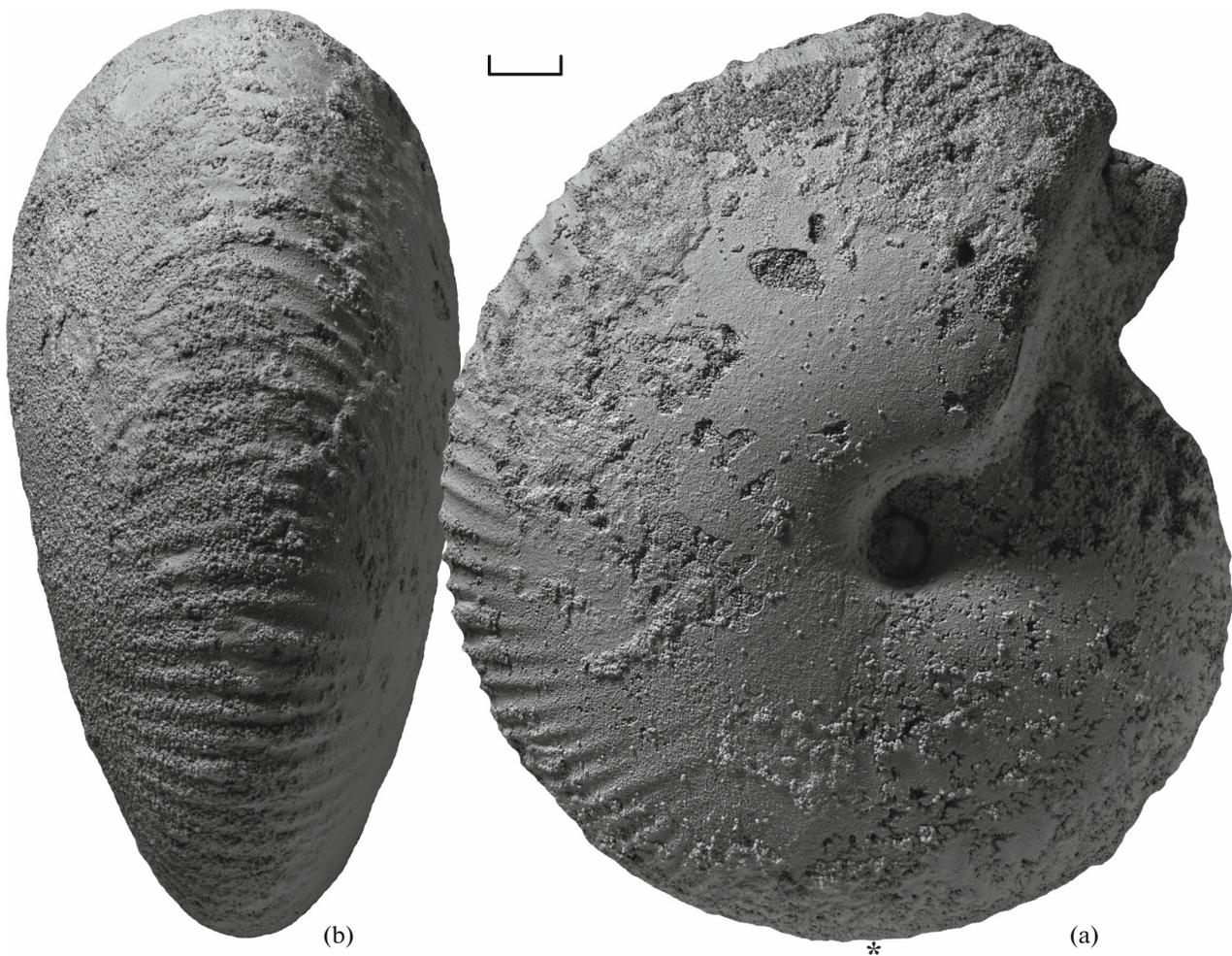
**D e s c r i p t i o n** (Fig. 4). The adult shell reaches a diameter of 175 mm; the whorls are inflated, subtriangular in cross-section, and are widest at the umbilical region. The umbilicus is narrow; the umbilical wall slopes steeply, with a rounded bend. In adult shells, the umbilical spiral uncoils ellipsoidally on the body chamber, causing the umbilicus to widen sharply. The body chamber occupies 0.6–0.7 of the whorl; the apertural margin is not preserved.

The ornamentation up to a diameter of less than 20 mm consists of thin, dense ribs, arranged in bun-

### Explanation of Plate 3

**Fig. 1.** *Eckhardites atmensis* Mitta, sp. nov., specimen PIN, no. 5029/206, adult shell: (1a) lateral view, (1b) apertural view; Mordovia, Romodanovo District, sand pit near the village of Trofimovshchina (Alatyry III bis locality); Upper Bathonian, *Calyx* Zone; collected by Yu.V. Zenina, 2024. Scale bar 10 mm; the asterisk (\*) marks the beginning of the body chamber. Photograph by R.A. Gunchin.





**Fig. 4.** *Eckhardites atmensis* Mitta, sp. nov., holotype PIN, no. 5029/205: (a) lateral view, (b) ventral view; location and age are the same as in Fig. 2; collected by I.A. Meleshin, 2016. Scale bar 10 mm; the asterisk (\*) marks the beginning of the body chamber.

dles of two to five branches. Subsequently, the primary ribs gradually become smoother, and only their branches are visible on the shell from mid-flank. Subsequently, the secondary ribs shorten, becoming smoother in the mid-flank. On the body chamber, up to the apertural part, the ornamentation consists of relatively thick and prominent ribs on the ventral side and, to some extent, on the adjacent regions of the flanks.

#### Dimensions in mm and ratios:

Specimen no.	Dm	WH	WW	UW	WH/Dm	WW/Dm	UW/Dm
5029/206	175	89	79	25	0.5	0.45	0.14
	135.5	74	64	14	0.55	0.47	0.10
5029/204	139	65.5	61.5	20	0.47	0.44	0.14
	108	60	51	21.5	0.56	0.47	0.20
	32.5	17.4	14	5	0.54	0.43	0.15
	23.5	12	10	4	0.51	0.43	0.17
Holotype 5029/205	127.5	65	65	15.7	0.51	0.51	0.12
	100	58.5	50	10	0.58	0.50	0.10

**Comparison.** The species described is very closely related to *E. pavlowi* (Smorodina) and other early Callovian representatives of the genus, especially at diameters of 20–30 mm. It is distinguished by inflated whorls and longer secondary ribs that are preserved longer during ontogeny (for comparison, Pl. 2, fig. 2 shows a shell of *E. pavlowi*, in which, starting at diameters of 35 mm, sculpture is preserved only on the ventral side and adjacent parts of the flanks in the form of short secondary ribs).

**Variability.** Considering the uncoiling of the spiral on the body chamber in all specimens, it can be stated that the type series is represented by adult shells (albeit of varying final size), very similar in shell shape and ornamentation. However, some differences are still observed: the anterior part of the body chamber of the holotype differs in cross-section from its preceding whorls and the shells of the paratypes—it rapidly widens, and the cross-section takes on a nearly circular shape, with a height equal to its width.

**Remarks.** The recognition of a new species has little impact on the diagnosis of the genus. While early Callovian species had shells of moderate thickness or weakly inflated, the late Bathonian taxon extends this characteristic to inflated shells. This may support the hypothesis that *Eckhardites* originated from early Bathonian *Arcticoceras* (Mitta, 2009). Considering that only ammonites of Boreal origin are known in the Upper Bathonian of the Russian Platform (early Kosmoceratidae (genus *Kepplerites* of the subfamily Keppleritinae) and Cardioceratidae (genus *Alatyroceras* of the subfamily Arctocephalitinae and genus *Cadoceras* of the subfamily Cadoceratinae)), the genus *Eckhardites* is also of Boreal origin.

**Material.** Three specimens from the type locality.

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Field photographs indicating the levels of the finds, as well as photographs of one of the paratypes of *Eckhardites atmensis*, were provided by R.A. Gunchin (Samara Paleontological Society); he also provided the specimen of *Cadoceras apertum* used in the paper. The photographs were taken by S.V. Bagirov (Paleontological Institute, Russian Academy of Sciences). The comments of the reviewers—T.B. Leonova and S.V. Nikolaeva (both Paleontological Institute, Russian Academy of Sciences)—undoubtedly improved the original version of the manuscript. The authors are sincerely grateful to all those who contributed to the preparation of this work.

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#### ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This work does not include any studies involving human or animal subjects.

#### CONFLICT OF INTEREST

The authors of this work declare that they have no conflict of interest.

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