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# New Data on Jurassic Cerithiopsidae (Gastropoda) from European Russia

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**Abstract**—The Oxfordian–Kimmeridgian Cerithiopsidae, represented by two genera *Cosmocerithium* Cossmann, 1906 and *Dragonia* gen. nov. are re-investigated. Three species (*C. renardi* (Rouillier, 1849), *C. pumilum* (Gerasimov, 1992), and *C. veliger* sp. nov.), representing the same phylogenetic line, are distinguished in the genus *Cosmocerithium*. These species formed during the gradual morphological evolution, traced from the Middle Oxfordian to Early Kimmeridgian. The diagnosis of all *Cosmocerithium* species was revised and improved. As a result, the species *C. contiae* Guzhov, 2002 was included into synonymy of *C. pumilum*. Two new species are described in the composition of *Dragonia*: *D. minuta* sp. nov. (index species) and *D. longa* sp. nov. It is proposed that *Cosmocerithium* species were necrophages. It was revealed that *Dragonia minuta* belongs to assemblages, which inhabited sunken wood and was able to bore wood fragments.

*Keywords:* Mesozoic, Oxfordian, Kimmeridgian, Russian Plate, ecology, habit of life

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## EVOLUTION AND PALEOECOLOGY OF STUDIED CERITHIOPSIDAE

Cerithiopsids played insignificant role in the Jurassic benthos within the Russian Plate territory except for the Oxfordian interval, where their role increased essentially. This is due to the distribution of the genus *Cosmocerithium*, the first occurrence of which is noted in the Middle Oxfordian, with its widest distribution in the Upper Oxfordian. As usual, *Cosmocerithium* occures sctatteredly in the Middle Oxfordian and number of their shells is very small. By now, the author knows only two compact mass localities of representatives of this genus: in clays of Cardioceras tenuiserratum Zone in a quarry of the Shchurovo cement manufacture (Shchurovo town, Moscow Region; collection of K.M. Shapovalov) and near the Mikhalenino village (author's collection). In the Upper Oxfordian, this species is replaced by *C. pumilum* (Gerasimov, 1992), which occurs enough widely in dissipated condition. At this, the role of accumulations became important. It is likely that these accumulations represent autochthonous thanatocenoses. They occur visually as an oval or rounded shell-rich body of up to a few tens of centimeters in diameter, crossing the sediments in the vertical direction. The enclosing sediments within the shell accumulations and beyond show no visible differences. The shell accumulation can concentrate from several tens to several thousands of shells of the same species. A characteristic feature of these accumulations is mono- or bitaxonomy: they are represented by shells of one or two (see below) species with single shells of other gastropods. The mass distribution of *Cosmocerithium* in a dispersed form can be explained by the water transportation of such thanatocenoses. Apart form *Cosmocerithium*, the genus *Maturifusus* is abundant in the same stratigraphic interval. This genus forms beds, enriched with the dispersed material and similar local monotaxonic and bitaxonic accumulations, together with any species of *Cosmocerithium*. The character of accumulations gives ground to assume that they developed around animal corpses at the sea bottom. The remains of the latter were not preserved, but there occur gastropod shells around them, buried in-situ, which were attracted by the food. The shell accumulations were formed in/on pelitic and aleuro/pelitic soft substrates under the calm hydrological conditions contributed to their preservation. There is insufficient information about the diet of modern Cerithiopsidae, whereas it is suggested that necrophagy in Nassariidae, which are considered as descendants of Maturifusidae (Guzhov, 2004), played significant role (Tsikhon-Lukanina, 1987).

Beyond the Oxfordian, *Cosmocerithium* shells are known from the Lower Kimmeridgian and the Upper Volgian Substage. The new material from the Lower Kimmeridgian collected in the outcrop near the Mikhalenino village, Kostroma Region (the upper part of bed $BV_{14}$) is quite remarkable. The collected material is represented by almost only larvae and only rare specimens have 1–4 teleoconch whorls. This is due to the predominant burial of larval shells, but not the brittleness of the material, and can be explained only by the fact that the conditions in that period of time were unfavorable for development of *Cosmocerithium*. As a result, larvae were transported to this area being alive or predominantly dead, and only some of living individuals accumulated at the sea bottom and were able to survive during a short period of time after their transformation. A similar phenomenon is known for the genus *Cryptaulax* from the Callovian–Oxfordian boundary deposits exposed in a quarry near the settlement of Dubki (Saratov Region). Here, clays of Quenstedtoceras lamberti Zone (Q. paucicostatum biohorizon)–Vertumniceras mariae Zone (Cardioceras scarburgense Subzone) are saturated by larval shells *Cryptaulax* without the occurrence of even juvenile ones. It is highly likely that larvae were already dead when were transported.

The Upper Volgian *Cosmocerithium brateevense* (Gerasimov, 1992) was described on the basis of single finds from the unit, lithologically transitive between the Kuntsevo and Lytkarino formations. This unit is represented by ferruginous sands with horizons of weakly cemented nodules of sandstone with ferruginous cement. The outcrops of this unit are along the Moscow River left bank between the Brateevo district (Moscow) and the village of Sloboda. The unit was dated by Craspedites nodiger Zone, Craspedites mosquensis Subzone (Gerasimov, 1992; Guzhov, 2004). In the new stratigraphic scheme (Rogov, 2017), on the example of the section near the village of Milkovo (Leninsky district, Moscow Region) this unit is dated by C. nodiger Subzone, and the interval, which provides sandstone nodules similar to the Brateevo ones, by the biohorizon with Craspedites transitionis. As there is no new material on *C. brateevense*, this species is not discussed below.

The discontinuous succession of the genus *Cosmocerithium* was described only for the Oxfordian–Lower Kimmeridgian interval. As the changes in morphology were gradual, there are no strong qualitative differences between species. The changes in the succession of *C. renardi*–*C. pumilum*–*C. veliger* were resulted in the development of the morphology of the planktonic stage of the protoconch and teleoconch. In *C. renardi* two spiral ribs developed within the protoconch II. In *C. pumilum* these ribs were transformed into a series of a few threads. *C. veliger* shows the tendency for the further reduction in a number of spiral elements and increase in a number of spiral elements on the protoconch II. The changes in the morphology of the teleoconch from *C. renardi* to *C. veliger* also follow a definite trend: gradual increase in a number of spiral ribs and the build-up of the convexity of whorls; the latter is especially pronounced in *C. veliger*. An increase in number of ribs occurs by the increase in a number of intercalated ribs and initiation time shift towards the earlier stage of the ontogenesis. For *C. renardi* and *C. pumilum* there is the most complete stratigraphic succession of the collected material. Due to this, the boundary between species is indistinct due to gradual quantitative variations in features. There is a morphological gap between *C. pumilum* and *C. veliger* due to a lack of the material from the lower part of the Lower Kimmeridgian. However, there is visible gradual transformation *C. pumilum* towards *C. veliger* during the Upper Oxfordian. However, the sample from Gerasimov's collection, previously depicted by the author (Guzhov, 2004: pl. 10, fig. 5) does not fit the gradient evolution of *Cosmocerithium* confirmed by by our material. According to Gerasimov's label, it comes from the Lower Kimmeridgian (the Unzha River, the village of Ogarkovo, Kostroma Region). In light of new data, there are doubts about the correct stratigraphic reference of this shell that was previously established for some other samples from the Gerasimov's collection (Guzhov, 2017).

The following genus of the family is Dragonia gen. nov. The shells, attributed by the author to this genus, were ascribed previously to the species *Procerithium (Rhabdocolpus) pumilum* Gerasimov, 1992. Gerasimov depicted four shells under this name (Gerasimov, 1992: pl. 21, figs. 15, 17–19); the specimen from fig. 19 was redefined as *Cosmocerithium contiae* Guzhov, 2002 (Guzhov, 2002a, b, 2004). Holotype of *P.* (*R.*). *pumilum* is represented by a shell fragment, consisting of the last whorl of the protoconch and three whorls of the teleoconch of the same species, in fact, as *C. contiae*. Due to this, *P.* (*R.*) *pumilim* was included into the genus *Cosmocerithium* as an older synonym of *C. contiae*. Here we present the reproduction of the holotype of *C. pumilum* based on the Gerasimov's negative (Pl. 5, fig. 6), as it is not possible to make photo of the original with higher quality due to it was greatly spotted with plasticine. Shells from the Gerasimov's collection, ascribed to *Dragonia*, were reimagined previously (Guzhov, 2004: pl. 10, figs. 10, 11) as *Cosmocerithium pumilum*. In the subsequent years, an additional material was obtained, which provided the understanding that we deal with a distinctly different representative of Cerithiopsidae, which is described here as *Dragonia minuta* sp. nov. The most remarkable find of this species is an accumulation of shells in bed $BV_7$. When washing the sample a lot of shells *Dragonia* and flat wood chip, which are densely bored by the same gastropods from one side, are remained in the sieve. There is no doubt that namely *Dragonia* bored the holes in the wood chip as shells fit well in them. The holes created by bivalves are known from the local Jurassic coarser-grained deposits, where there are genera, specializing in the wood boring (*Turnus* Gabb, 1864), as well as genera boring the crinoids (*Gastrochaena* Spengler, 1873), bedrock and corals (*Lithophaga* Röding, 1798) (Gerasimov, 1955, 1969: *Turnus, Gastrochaena*; Gerasimov et al., 1996, author's data: *Lithophaga*). Bivalves bored much thicker holes and, if it was taphonomically possible, preserved at their terminal parts (Gerasimov, 1955: pl. 15, fig. 3; Gerasimov, 1969: pl. 19, figs. 2, 3). For example, the shell height reaches up to 14 mm in *Turnus waldheimii* (Orbigny, 1846), 4–4.5 mm in *Gastrochaena pusilla* Gerasimov, 1955, and 15 mm in *Lithophaga* (Gerasimov, 1955, 1969), whereas the shells of *Dragonia* are just over a millimeter in diameter. Another accumulation comes from a small piece of rock, provided by A.A. Shkolin. This sample was collected in the Upper Oxfordian section in the Brateevo district (Moscow). There are no wood fragments here, but the concentration of shells of *Dragonia* is also high: more 200 shells per half a kilogram of the rock. The find in bed $BV_7$ opened a question about the xylophagy, the type of diet, which is unknown among modern gastropods. The *Leptochiton shapovalovi* Sirenko, 2013 chiton was described from the same bed. In terms of the confinement to the bed full of wood fragments and features of the refined group, characteristic of modern leptochitons-xylophages, this species is also attributed to xylophages (Sirenko, 2013). Shells *Dragonia* are bullet-shaped; *D. minuta* sp. nov. shells stop increasing in a diameter at the last whorl, while the increase of more ancient *D. longa* sp. nov. in diameter is noted within a few last whorls. Due to this, the shell becomes cylindrical in shape. A similar transformation is logical for shells inhabited bored holes. It is not improbable that *Dragonia* created holes as refuges, but not during the feeding.

Original specimens are stored in the Borissiak Paleontological Institute of Russian Academy of Sciences (PIN), collection no. 4814 (the author's material), and Vernadsky State Geological Museum (SGM), collection no. VI-222 (the material of P.A. Gerasimov).

## SECTION IN ENVIRONS OF MIKHALENINO VILLAGE

The important part of the studied material was collected in the outcrop near the village of Mikhalenino. In connection with this it seems useful to provide the description of the section indicating the distribution of the taxa described in the given article. Our description of the section and sampling of the main part of the material were made earlier, than the corresponding studies of ammonite experts, the results of which were published later (Rogov and Kiselev, 2007; Głowniak et al., 2010). In addition, the principles, which were the basis for subdivision of the section, rather monotonous in appearance, were also different. Due to this, it was impossible to make correct was comparison of the most of beds with previously published variants. In the previous articles, gastropods from this section were dated following the earlier scheme, proposed for the Southern Makariev section (Mesezhnikov et al., 1986; *Sredniy*..., 1989).

The Unzha River bank near the Mikhalenino village has two scarps: the lower scarp is composed of Lower Callovian sands, while the upper one is composed of the Middle Oxfordian–Lower Kimmeridgian clayey unit. The intermediate interval, described in outcrops in environs of the town of Makariev is folded here by landslide masses in the top of the lower scarp. Based on the rock fragments found out, containing abundant *Procerithium russiense* (Orbigny) it is evident that the lower part of Cardioceras densiplicatum Zone (Cardioceras popilaniense Subzone after M.S. Mesezhnikov) lies below the exposured part of the second scarp. The most pronounced marker horizon is a bed of bituminous shale, which is ascribed to the Amoeboceras ilovaiskii Subzone of A. alternoides Zone (Mesezhnikov et al., 1986; *Sredniy*..., 1989; Rogov and Kiselev, 2007) or A. glosense Zone (Hantzpergue et al., 1998; Głowniak et al., 2010). Preliminary in half a meter below the shale there is a well-defined disconformity level, which encloses a high amount of glauconite, redeposited and overgrown fossils, banks overgrown with serpules and eroded shells of *Bathrotomaria muensteri* (Roemer). This level is also traced in the Makariev sections. Mesezhnikov outlined Cardioceras tenuiserratum Zone by clays between the shale and the disconformity level. However, it was later proposed to put the boundary half a meter below (Rogov and Kiselev, 2007 (hereafter Guidebook)): for the intervals above and below the rewashing the biohorizons with *Cardioceras tenuiserratum* and with *Cardioceras zenaidae* were introduced. Below these horizons, C. densiplicatum Zone with the same-named biohorizon in the upper part was distinguished, while clays with *C.* ex gr. *popilaniense* (Boden) underlying the section described were not outlined. According to the later oral report by D.N. Kiselev, this species was not identified in the section. In the second paper (Głowniak et al., 2010) the similar layer by layer description of the section below the shale was used. Only in the scheme of the Boreal zoning, bed 3, comprising the most part of the C. zenaidae biohorizon from Guidebook, was not ascribed to any of the adjacent zones and the subordinate subdivisions were not distinguished with confidence in these zones. Here, the C. zenaidae biohorizon is included into C. tenuiserratum Zone.

Higher in the succession, two green interbeds lying in 0.75 m and in 1 m above the lower boundary of the shale are the most remarkable. The upper interbed encloses a horizon of fine-grained stromatolites, which is well developed in the Upper Oxfordian interval of the Moscow syneclise (Malenkina, 2014). The lower interbed in the Makariev sections was ascribed to Amoeboceras koldeweyense Subzone of Amoeboceras serratum Zone (Hantzpergue et al., 1998: bed 11c; *Sredniy*..., 1989: bed 6v). In the description of the section in environs of the village of Mikhalenino (Guidebook), it is correlated with bed 13, which is due to absence of a subzonal species is referred only to the zone. In the recent article (Głowniak et al., 2010), the age is confirmed by the occurrence of *A. koldeweyense* Subzone. An interval between the shale and bed 13 was ascribed correspondingly to A. alternoides Subzone and Zone or to A. glosense Subzone and Zone. In the recent stratigraphic scheme this zone is called as A. alternoides Zone (*Unifitsirovannaya*..., 2012). As for the beds above bed 13, then there are essential disagreements in the dating of beds and schemes of subdivision of the upper part of Upper Oxfordian. Thus, in the recent article (Głowniak et al., 2010), the interval of beds 14–17 includes non-adjacent A. regulare Zone (upper part of bed 14 (top)–lower part of bed 15) and A. rosenkrantzi Zone (upper part of bed 15–lower part of bed 17), whereas in the Guidebook beds 14 and 15 are ascribed to the A. serratum biohorizon of the same-name zone and beds 16–18 to the biohorizon with A. gerassimovi of A. ravni Zone. In terms of stratigraphic subdivision, the Guidebook follows the scheme, proposed by Mesezhnikov (Mesezhnikov et al., 1986; *Sredniy*..., 1989). The existing disagreements in distinguishing the boundaries of A. serratum Zone are due to the fact that Polish researchers did not find index species above bed 13 unlike the authors of the guidebook (oral report of D.N. Kiselev). It is probable that there are no separate beds with *A. regulare* here and this species occurs together with *A. serratum*. This interval in A. serratum Zone is well known for a long time (Sykes and Callomon, 1979). It is overlain unconformably by beds, characterized by ammonites of A. rosenkrantzi Zone. When developing the unified stratigraphic scheme (*Unifitsirovannaya*..., 2012), in which A. serratum Zone and A. regulare Zone were proposed to use as successively replacing each other in the Russian Plate, the results obtained in (Głowniak et al., 2010) was likely taken into consideration. As far as known, this is the only article, where A. regulare Zone was distinguished in the Russian Plate. Here, according to the Guidebook, the interval from bed 14 to bed 15 is attributed to A. serratum Subzone. The boreal scheme with the A. bauhini Zone and A. kitchini Zone previously identified in the section were used for description of the Lower Kimmeridgian (Rogov and Kiselev, 2007; Głowniak et al., 2010). According to Rogov's recommendation, A. subkitchini Subzone was replaced by A. bayi, and the biohorizon with A. zieteni is distinguished in the lower part of A. bauhini Zone. In the author's previous publications, gastropods from the Lower Kimmeridgian interval of the given section were dated in another way: bed $BV_9$ was dated by the bed with Amoeboceras gerassimovi (Upper Oxfordian); the most part of bed $BV_{12}$, by Pictonia baylei Zone, the upper part of bed $BV_{12}$–bed $BV_{14}$; by Rasenia cymodoce Zone.

Figure 1 presents the stratigraphic scheme of the studied section. The description of $BV_0$ beds, made in the whole section, reflects the local character of the section, while the other beds are distinguished according to the principle of consistency and expressivity of lithological features in the accessible part of the outcrop. The section presents only the lithological features with indication of some other characteristic features. This section is considered as the reference one for studying the Oxfordian–Kimmeridgian gastropods of the Russian Plate. The material is mainly represented by high-volume samples (up to 200 kg from the level) due to the dispersion of the material. The preliminary list of 2009 includes 113 identified species of gastropods, including those in the open nomenclature. The most diversity was revealed in C. tenuiserratum Zone and A. alternoides Zone (up to 53 species from the same sampling level).

Bed $BV_{0/5}$. Clay, gray, often greenish, silty, calcareous, with burrows, which disappear in the 0.4–0.6 m interval from the top of the bed. Exposed thickness, 0.95 m.

Bed $BV_{0/4}$. Clay, gray, silty, calcareous, with frequent small phosphorite nodules, ammonites and belemnites *Hemihibolites*, indicating hidden hiatuses in sedimentation. There are greenish interbeds. Thickness, 0.15 m.

Bed $BV_{0/3}$. Clay, usually greenish-gray, calcareous, with rounded phosphorite nodules. Thickness, 0.05 m.

Bed $BV_{0/2}$. Clay, gray, calcareous, silty, with low contrast in shades of gray. There are two levels with green spots. Thickness, 0.67 m.

Bed $BV_{0/1}$. Clay, gray, silty, calcareous, enriched with small detritus and foraminifers, with numerous chaotically arranged green spots, lenses and thin beds. Thickness, 0.1 m.

Bed $BV_1$. Clay, gray, silty, calcareous, enriched with small detritus and foraminifers. There are green spots in the lower 10 cm interval. Thickness, 0.45 m.

Bed $BV_2$. Combustible shale. Clays, black (wet), grayish–black (dry), bituminous with a foliated jointing when weathering. Up section, clays are gradually, but quickly, are followed by gray clays of bed $BV_3$. There are abundant burrows, which are lighter against the background of the bedrock. There are numerous flattened ammonites, fish scales, and small fish bones on the bedding surfaces. Thickness, 0.25 m.

Bed $BV_3$. Clay, gray, calcareous, becoming darker close to the shale. There are abundant burrows, especially close to the top of the underlying shale. In 0.2 m from the lower boundary, a horizon of greenish spots of about 5 cm thick is visible. Thickness, 0.4–0.5 m.

Bed $BV_4$. Clay, dense, calcareous, brownish–gray (dry) in the lower third of the bed, of greenish shades above; the color saturation increases upsection. There are lenses full of faunistical remains, mainly belemnites with *Serpula* worms, also rarely with numerous gastropods. Thickness, about 0.2 m.

Bed $BV_5$. Clay, gray (dry), dark gray (wet), calcareous. Thickness, 0.12 m.

Bed $BV_6$. Clay, calcareous, greenish, with large belemnites and gastropods. There are small nodulous condensed bodies of stromatolites. Thickness, 0.12 m.

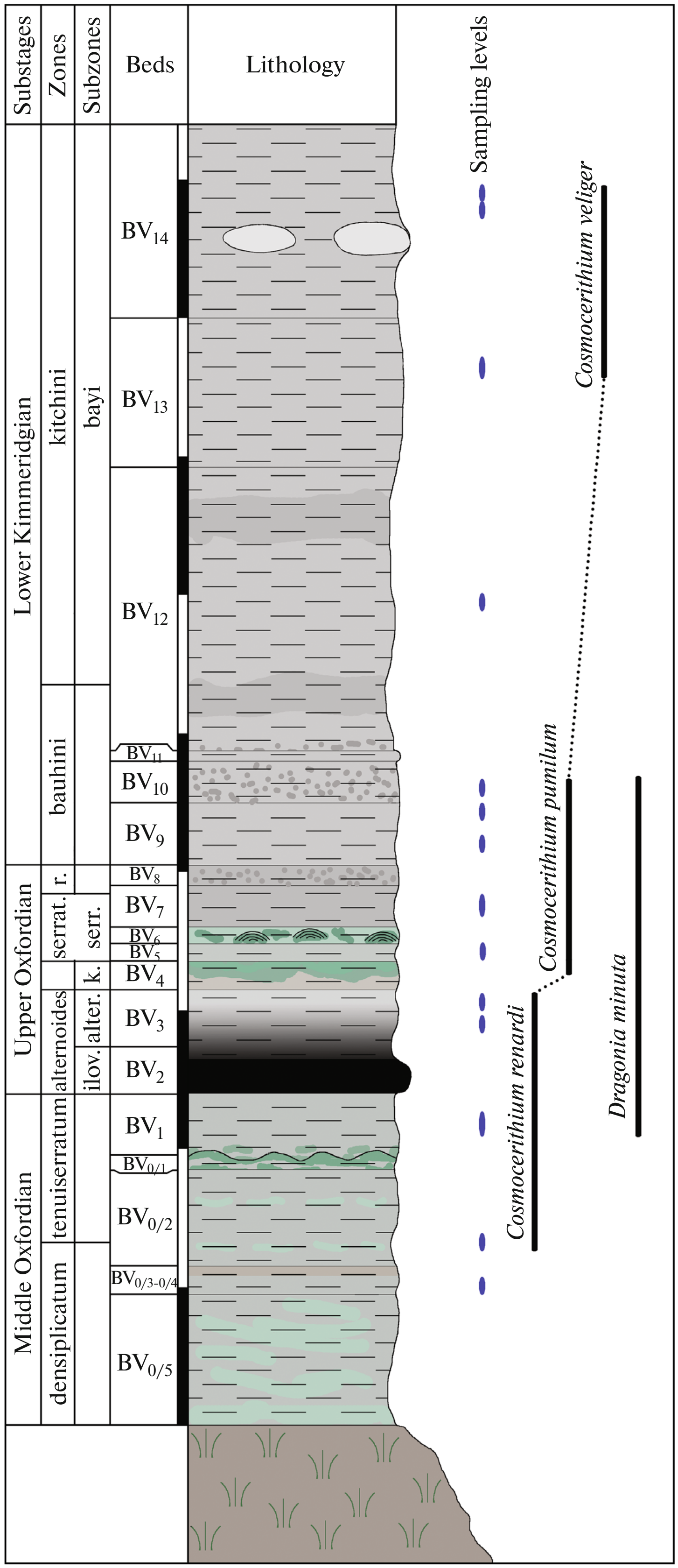



**Fig. 1.** The section near the Mikhalenino village with levels of sampling and distribution intervals of the studied species *Cosmocerithium* and *Dragonia*. Scale bar, 1 m.

Bed $BV_7$. Clay, dark gray (wet), calcareous, with green spots in the middle and at the top of the bed. There are many grains of psammitic-size glauconite. Thickness, 0.3 m.

Bed $BV_8$. Clay, dark gray (wet), calcareous, with numerous burrows darker in color on the background of the bedrock. Thickness, 0.11–0.13 m.

Bed $BV_9$. Clay, gray (wet), pale gray (dry), calcareous. There are large phosphorite nodules. Thickness, 0.45 m.

Bed $BV_{10}$. The same clay, often with numerous burrows and one–two levels of crushed ammonites. Thickness, 0.3 m.

Bed $BV_{11}$. Clay, thinly foliated, calcareous, often with numerous indistinct burrows and numerous crushed ammonites. Thickness, 0.07 m.

Bed $BV_{12}$. Clay, dark gray to black–gray (wet), calcareous, with locally distributed burrows. The 0.1 m lower interval also includes burrows, in the 0.5–0.9 m interval from the lower boundary of the bed are inclusions of loose marcasite. Thickness, 2.05 m.

Bed $BV_{13}$. Clay, gray (wet), calcareous, with a large volume of fine detritus and foraminifers; there are abundant crushed *Amoeboceras* shells. Thickness, 1.05 m.

Bed $BV_{14}$. Clay, dark gray (dry), black–gray (wet), calcareous, with platy jointing. There is a large amount of large detritus and small shells of thin-walled pecten-like bivalve. There are abundant phosphorite nodules, which often replace the living chambers of small ammonites. In 0.45 m from the base of the bed, the horizon of pillow-like nodules of gray calcareous mudstone. Nodules (0.2 m thick, 0.8–1.5 m long) are located in 2–3 m from each other. Thickness, 1.4 m.

Higher in the succession, the section is grass-covered.

## SYSTEMATIC PALEONTOLOGY

### Family Cerithiopsidae Gray, 1847

### Genus *Cosmocerithium* Cossmann, 1906

#### *Cosmocerithium renardi* (Rouillier, 1849)

Plate 4, figs. 1–5

*Cerithium renardi*: Rouillier, 1849, p. 378, pl. L, fig. 96; Lahusen, 1883, p. 37, pl. 3, fig. 7.

*Procerithium (Rhabdocolpus) renardi*: Gerasimov, 1992, p. 71 (pars), pl. 19, fig. 1.

*Cosmocerithium renardi*: Guzhov, 2002a, p. 27, pl. 1, figs. 1–5; Guzhov, 2002b, p. 593, pl. 1, figs. 1–5; Guzhov, 2004, p. 517, pl. 9, fig. 12, pl. 10, figs. 1–4.

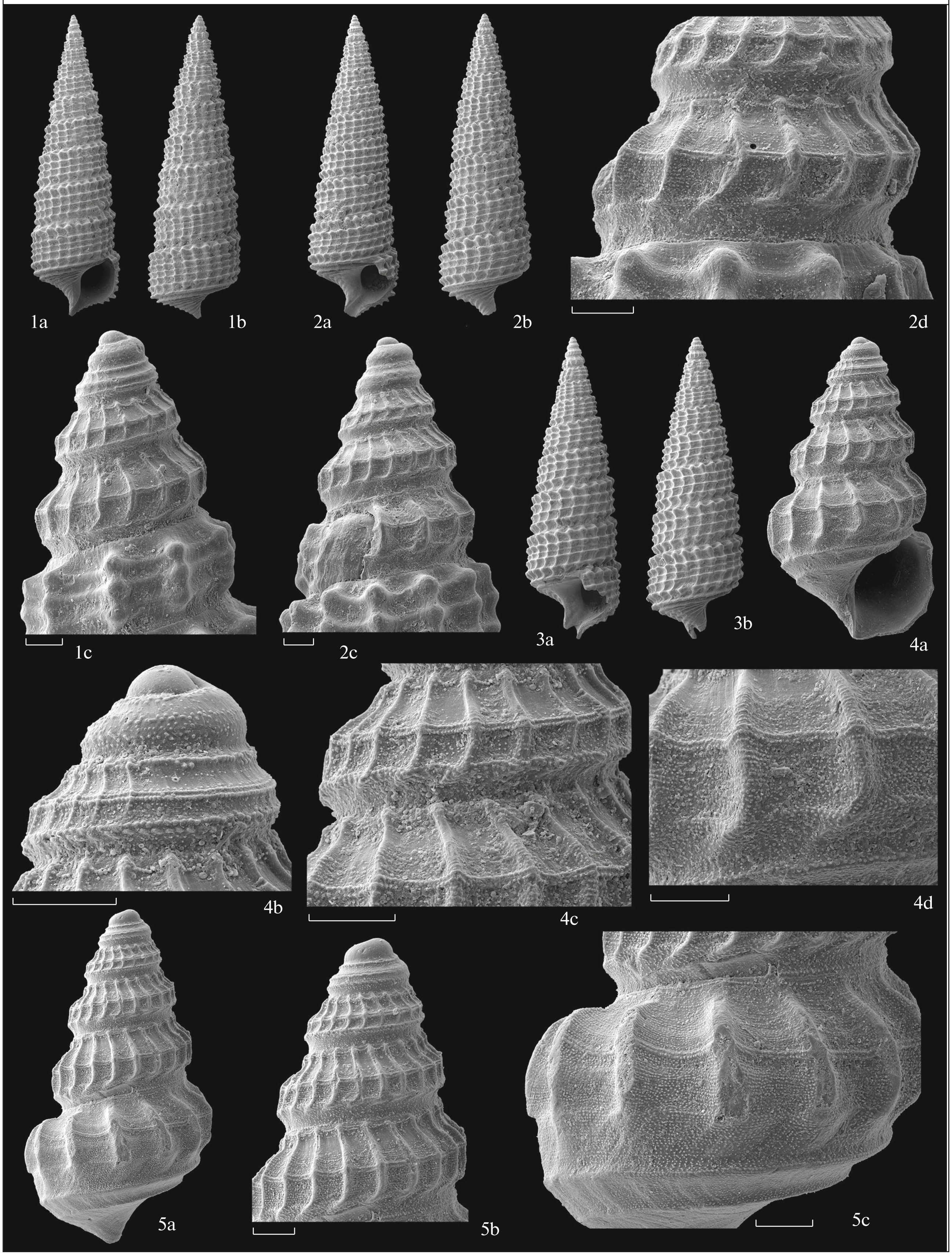
Description. Small orthoconic high-turriculate anomphalous shell, consisting of 5.5 protoconch whorls and up to 12 teleoconch whorls. Shell up to 11 mm in height, up to 3 mm in diameter. Protoconch I has one whorl, ornamented with pustules. Protoconch II consists of four whorls. There are two high ribs on the first whorl; on the subsequent whorls they are crossed by higher collabral folds, 14–16 on the last whorl of the protoconch. An additional thin thread can appear between spiral ribs, or ribs simetimes reduce towards the last whorl. The surface between ribs are densely covered with microscopic pustules. The protoconch–teleoconch boundary is distinct being defined by the line of growth interruption and the change in sculpture pattern. The teleoconch whorls are flattened separated by thin slightly undulating suture and are ornamented with reticulate sculpture of spiral ribs and narrow collabral folds nearly of the same height. From the beginning of the teleoconch are three spiral ribs, between which rare intercalated ribs appear as a shell grows. The fourth primary rib extends slightly at the level of the suture. The first intercalated rib appears in the middle of the teleoconch between the second and third primary ribs; the second intercalated rib appears close to the end of a shell between the primary and secondary second ribs or between the secondary and the third primary ribs. Thus, several early whorls of the teleoconch have three ribs, the most of the subsequent whorls have four ribs; and closer to the shell end—there may be up to five spiral ribs. The largest ribs on the lateral side are the first and third primary ribs. The rounded tubercles are formed at the intersection with folds, the largest ones being on the higher ribs. The folds do not become denser with growth; the increase in their number is proportional to the increase in the circumference of the whorl. The first whorl has 11–13 folds, the eighth has 22–25. Folds are almost orthocline; by the end of the shell they become weakly opistocyrtic, reach the rib bounding the base, but do not form tubercles on it. The first whorls of the teleoconch are also ornamented by the microsculpture made of densely arranged granular striae, which covers the entire surface of the whorl. As the shell grows, they become reduced.

Explanation of Plate 4

Scale bar, 100 μm; shell dimensions for other figures.

**Figs. 1–5.** *Cosmocerithium renardi* (Rouillier, 1849), Mikhalenino. (1–3) population sampling (autochthonous accumulation) at the base of bed $BV_1$, Middle Oxfordian, Cardioceras tenuiserratum Zone; (4, 5) bed $BV_3$, Middle Oxfordian, Amoeboceras alternoides Zone, Amoeboceras alternoides Subzone. (1) spec. PIN, no. 4814/263 (shell height, 9 mm): (1a) apertural view, (1b) abapertural view, (1c) apical part of a shell; (2) spec. PIN, no 4814/264 (shell height, 8.2 mm): (2a) apertural view, (2b) abapertural view, (2c) apical part of the shell, with the visible end of protoconch, (2d) sculpture of protoconch; (3) spec. PIN, no. 4814/265 (shell height, 7.4 mm): (3a) apertural view, (3b) abapertural view; (4) spec. PIN, no 4814/266 (shell height, 1.2 mm), larval shell: (4a) apertural view, (4b, 4c, 4d) sculpture of protoconch; (5) spec. PIN, no 4814/267 (shell height, 1.2 mm), larval shell: (5a) abapertural view, (5b, 5c) sculpture of protoconch.

Plate 4



The lateral side is flattened, roundly passing into the low convex base, on which up to eight narrow, but high, blade-like ribs are located. The aperture is oval, slightly elevated, extended at an angle to the axis of coiling, angular in the posterior part, with a short semicircular–concave channel anteriorly.

C o m p a r i s o n. See descriptions of other species.

O c c u r r e n c e. Middle–Upper Oxfordian, Amoeboceras alternoides Zone of the Russian Plate.

M a t e r i a l. Middle Oxfordian: Mikhalenino (3 spec.), Nikitino (4 spec.); Cardioceras tenuiserratum Zone: Konstantinovo (10 spec.), Mikhalenino, bed $BV_1$ (2183 spec.), section "Northern Makariev" (241 spec.), Shchurovo (28 spec.); Upper Oxfordian, Amoeboceras alternoides Zone, Amoeboceras alternoides Subzone: Mikhalenino, bed $BV_3$ (11 spec. and 12 protoconchs).

***Cosmocerithium pumilum* (Gerasimov, 1992)**

Plate 5, figs. 1–7; Plate 6, fig. 1

*Procerithium renardi*: Gerasimov, 1955, p. 189, pl. 40, figs. 2, 3.

*Procerithium (Rhabdocolpus) renardi*: Gerasimov, 1992, p. 71 (pars), pl. 19, figs. 2–4.

*Procerithium (Rhabdocolpus) pumilum*: Gerasimov, 1992, p. 74 (pars), pl. 21, figs. 15, 19.

*Cosmocerithium contiae*: Guzhov, 2002a, p. 28, pl. 1, figs. 6–9; Guzhov, 2002b, p. 595, pl. 1, figs. 6–9; Guzhov, 2004, p. 518, pl. 10, figs. 6–9.

H o l o t y p e. State Geological Museum (Moscow), no. IV-222/35: Upper Oxfordian, *Amoeboceras serratum* Zone; Moscow, Mnevniki district, the Moscow River left bank below the Karamyshevo embankment. Images: Gerasimov, 1992, pl. 21, fig. 15; here in Pl. 5, fig. 6.

D e s c r i p t i o n. Small orthoconic, high-turriculate anomphalous shell, consisting of 5.5 protoconch whorls and up to 11 teleoconch whorls. Shell, up to 12 mm in height, up to 3 mm in diameter. The protoconch I consists of one whorl, ornamented with pustules. The protoconch II has four whorls. On the first half-whorl are two high ribs, which become lower further on. The upper one is replaced by two–three thin granulated threads, below which appear several similar threads. The lower rib was transformed into one of threads. Threads intersect with higher collabral folds (about 20 of them on the last whorl of the protoconch). The surface between the threads is densely covered with microscopic pustules. The protoconch–teleoconch boundary is distinct that is expressed by the line of growth interruption and the change in the sculpture pattern. Teleoconch whorls are flattened, separated by a thin even suture line and ornamented with the reticulate sculpture of spiral ribs and narrow collabral folds of approximately the same height. From the beginning of the teleoconch, there are four spiral ribs, between which intercalated ribs may appear as a shell grows. Occasionally, the third primary rib appears a bit later than the others. At the suture level, the fifth primary rib protrudes slightly.

The first intercalated rib appears on the second or third whorl, less often on the fourth whorl between the third and fourth primary ribs; other intercalated ribs usually occur between the third and fourth primary ribs: the second rib appears on the third to seventh whorls, the third rib occurs after the sixth whorl. Thus, the first one to three whorls with four ribs; the main part of the teleoconch with five ribs, and six ribs appear closer to the end of the shell. The ribs are of the same height, or the upper and lower ones are slightly higher than the others. More or less opistocyrt folds cross the ribs, a number of folds increases in proportion to the increase in the circumference of whorls, from 13–17 on the first whorl to 22–30 on the eighth whorl. At the intersection with the ribs there are rounded, often very small, tubercles; the largest of them are located at the intersection with the two upper spiral ribs. At the base, the folds reach the fifth primary tubercle-free rib, which separates the lateral side and the whorl base. On the first whorls of the teleoconch, the microsculpture consisting of densely arranged spiral granulated striae is also developed. The latter cover the entire surface of the whorl. They are reduced with the growth of a shell. The lateral side flattened, roundly passing into a low convex base, having up to seven even ribs. The aperture oval, slightly elevated, extended at an angle to the axis of coiling, angular in the posterior part, with a short semi-circular–concave channel in the anterior part.

The description is given for *C. pumilum* shells, which are common in the upper part of the Amoeboceras serrarum Zone; the morphological norm is slightly different below and above, transitive respec-

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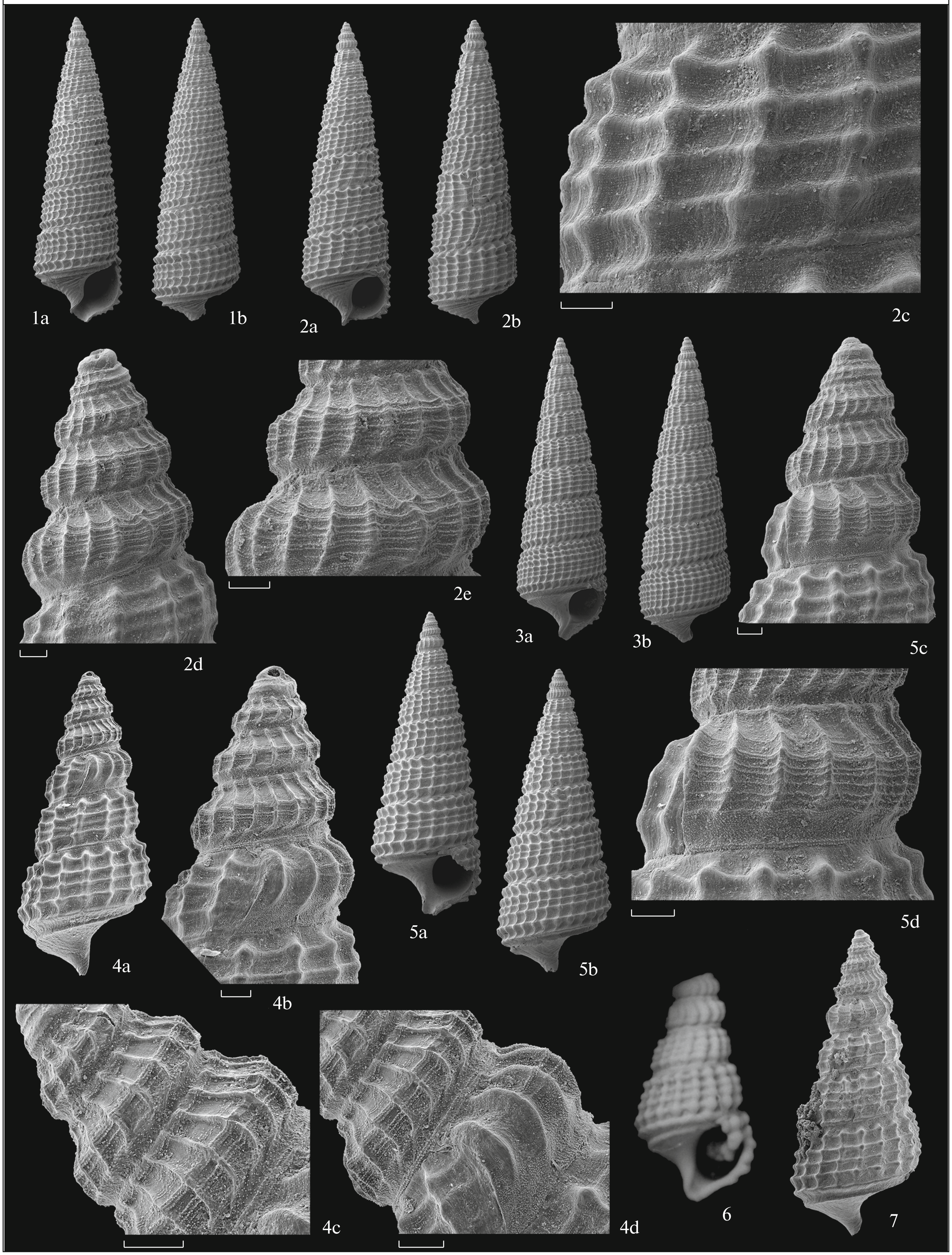
E x p l a n a t i o n o f P l a t e 5

Scale bar, 100 μm; shell dimensions for other figures.

**Figs. 1–7.** *Cosmocerithium pumilum* (Gerasimov, 1992). (1, 2, 4, 5, 7) Mikhalenino, bed $BV_7$, Upper Oxfordian, Amoeboceras serratum Zone, Amoeboceras serratum Subzone. (1) spec. PIN, no 4814/268 (shell height, 8.8 mm): (1a) apertural view, (1b) abapertural view; (2) spec. PIN, no 4814/269 (shell height, 7.1 mm): (2a) apertural view, (2b) abapertural view, (2c) microsculpture at the beginning of teleoconch, (2d) protoconch, (2e) sculpture of protoconch; (3) spec. PIN, no. 4814/270 (shell height, 7.4 mm), Mikhalenino, the upper part of bed $BV_9$, Lower Kimmeridgian, Amoeboceas bauhini Zone, Amoeboceas zieteni biohorizon: (3a) apertural view, (3b) abapertural view; (4) spec. PIN, no 4814/271 (shell height, 2.3 mm): (4a) general view, (4b) protoconch, (4c, 4d) sculpture of the protoconch; (5) spec. PIN, no 4814/272 (shell height, 6.6 mm): (5a) apertural view, (5b) abapertural view, (5c) protoconch, (5d) sculpture of the protoconch; (6) holotype, SGM, IV-222/35 (shell height, 2.3 mm), from P.A. Gerasimov's negative, Moscow, the Moscow River left bank near the Karamyshevo embankment, Amoeboceras serratum Zone; (7) spec. PIN, no 4814/273 (shell height, 3 mm).

Plate 5



tively to *C. renardi* and *C. veliger*. This situation is discussed below.

V a r i a b i l i t y. In sampling from Amoeboceras serratum Zone are shells with the transition morphology between *C. renardi* and *C. pumilum*. They are characterized by coarser and rare spiral sculpture on the collabrally folded stage of the protoconch II, than in later *C. pumilum*. This is combined with the presence of the very short three-rib stage on the teleoconch; then the latter is followed by elongated four-rib stage or the development of whorls with four primary ribs without appearing intercalated ribs for a long time. Tubercles are larger, as in *C. renardi*. In contrast to this, the sculpture of late *C. pumilum* from the upper part of Amoeboceras bauhini Zone becomes more frequent reaching up to 7–9 spiral ribs on the last whorl, and a number of ridges increase up to the maximum values (about 30). At this, the initiation of intercalated ribs is shifted in time at the earlier stages of ontogenesis. The spiral sculpture on the protoconch is narrowing to the state, characteristic of *C. veliger*.

Material from the *Amoeboceras koldweyense* Subzone (outcrops in environs of the Mikhalenino village) is characterized by the presence of giant shells of many gastropod assemblages. *Cosmocerithium* reaches a height of 13.5 mm and a diameter of 3.7 mm.

C o m p a r i s o n. It differs from *C. renardi* in the morphology of teleoconch by more dense and slender sculpture on the lateral side, low ribs at the basal part, with slightly convex profile of whorls; in the morphology of a protoconch by the change of two spiral ribs by thin granulated threads at the stage with collabral sculpture. The comparison with *C. veliger* is given at the description of the latter.

O c c u r r e n c e. Upper Oxfordian Amoeboceras serratum Zone–Lower Kimmeridgian Amoeboceras bauhini Zone of the Russian Plate.

M a t e r i a l. Upper Oxfordian, Amoeboceras serratum Zone, Amoeboceras koldeweyense Subzone: Mikhalenino, bed $BV_4$ (73 spec.), Amoeboceras serratum Subzone: Yegoryevsk Phosphorite Mine, quarries no. 7-bis (1284 spec.) and no. 10 (1 spec.), Mikhalenino, beds $BV_5$ (1 spec.), $BV_5$–$BV_6$ (51 spec.) and $BV_7$ (2553 spec.); Amoeboceras serratum–Amoeboceras rosenkrantzi Zone: Moscow, Brateevo district (333 spec.); Lower Kimmeridgian, *Amoeboceras bauhini* Zone, Amoeboceras zieteni biohorizon: Mikhalenino (2 spec.), beds $BV_9$ (55 spec.) and $BV_{10}$ (4 spec.).

### *Cosmocerithium veliger* Guzhov, sp. nov.

Plate 6, figs. 2–5

*Cosmocerithium pumilum*: Guzhov, 2002a, pl. 1, fig. 11; Guzhov, 2002b, p. 596, pl. 1, fig. 11; Guzhov, 2004, pl. 10, fig. 12.

E t y m o l o g y. Named after planktonic larvae of gastropods, as this species is known predominantly on the basis of studying larval shells.

H o l o t y p e. PIN, no. 4814/274: Lower Kimmeridgian, Amoeboceras kitchini Zone, Amoeboceras bayi Subzone; Kostroma Region, Makariev district, the Unzha River right bank above the village of Mikhalenino (bed $BV_{14}$). Image: Pl. 6, fig. 2.

D e s c r i p t i o n. Small orthoconic, high-spired, anomphalous shell. Post-lavral shells are known from single juvenile and fragmentary specimens; being adult they have to be similar in length and size to *C. pumilum* and *C. renardi*. Protoconch I consists of almost one whorl, ornamented with pustules. Protoconch II consists of four whorls: on the first half a whorl are two ribs. Subsequently, the upper rib is replaced by two thin granulated threads; below, there appear some more similar threads, and the lower rib is transformed into one of them. On the last four whorls, rib/threads intersect with high collabral folds, 16–18 being on the last whorl. The surface between the threads is densely covered with microscopic pustules. At the base of the last protoconch whorl are two carinas; the rest of the surface is covered with several rows of spiral pustules. The protoconch–teleoconch boundary is distinct, being defined by the line in growth interruption and the change in the sculpture pattern. Teleoconch whorls are convex, separated by the fine even suture and covered with the reticulate sculpture of spiral ribs and narrow collabral folds of approximately the same height. From the beginning of the teleoconch are four spiral ribs, between which intercalated ribs appear as a shell grows. At the suture level, the fifth primary rib protrudes slightly. On the holotype, secondary ribs appear on each whorl, reaching, therefore, seven ribs already on the fourth volution. More or less opistocyrt folds (they are almost

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E x p l a n a t i o n o f P l a t e 6

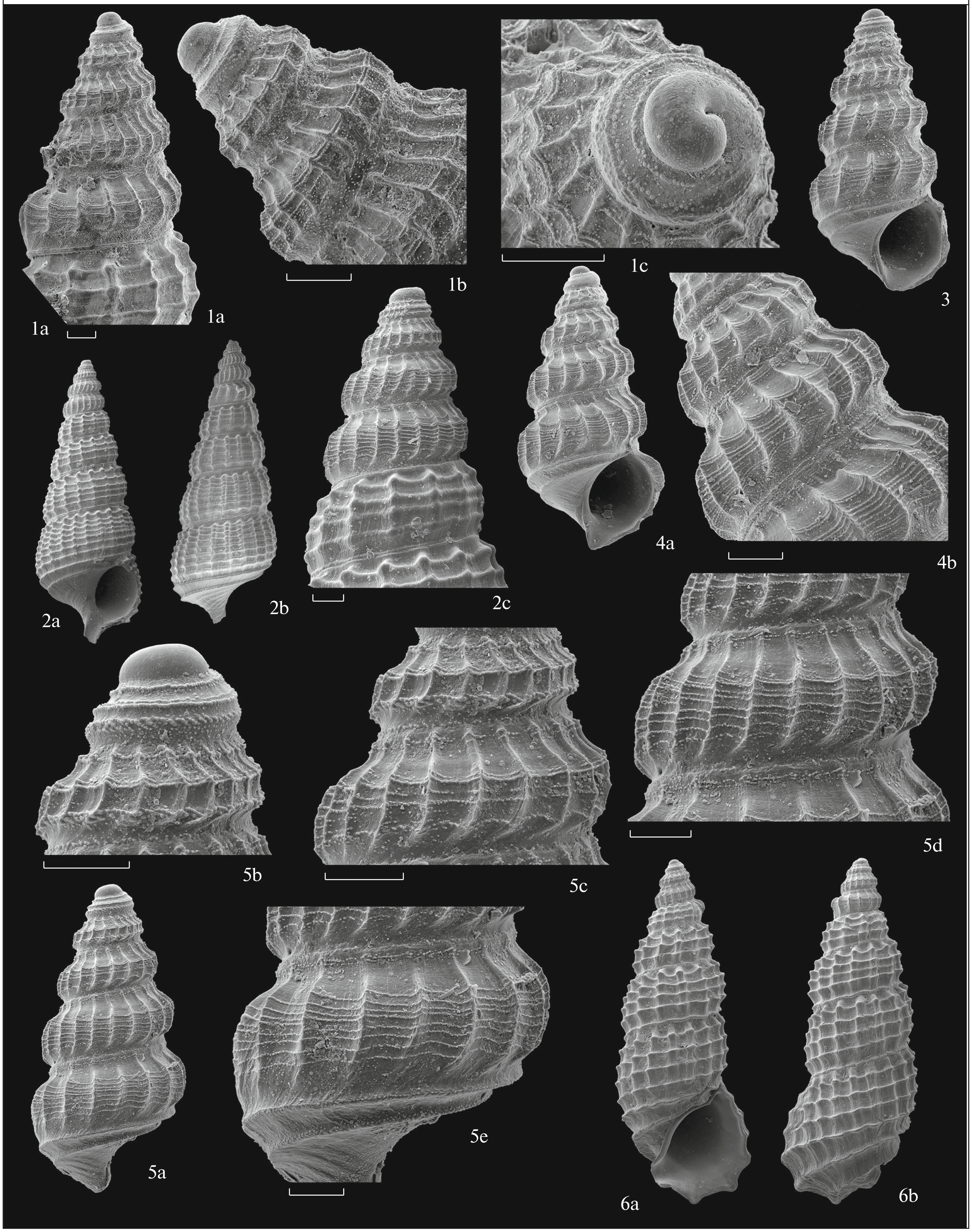
Scale bar, 100 μm; shell dimensions for other figures.

**Fig. 1.** *Cosmocerithium pumilum* (Gerasimov, 1992). spec. PIN, no №4814/273, Mikhalenino, bed $BV_7$, Upper Oxfordian, Amoeboceras serratum Zone, Amoeboceras serratum Subzone: (1a) protoconch, (1b, 1c) sculpture of protoconch.

**Figs. 2–5.** *Cosmocerithium veliger* Guzhov, sp. nov., Mikhalenino, the upper part of bed $BV_{14}$, Lower Kimmeridgian, Amoeboceras kitchini Zone, Amoeboceras bayi Subzone. (2) holotype, spec. PIN, no 4814/274 (shell height, 4 mm): (2a) apertural view, (2b) abapertural view, (2c) apical part of a shell; (3) spec. PIN, no 4814/275 (shell height, 1.1 mm), larval shell; (4) spec. PIN, no. 4814/276 (shell height, 1.1 mm), larval shell: (4a) apertural view, (4b) sculpture; (5) spec. PIN, no 4814/277 (shell height, 1.1 mm), larval shell: (5a) abapertural view, (5b, 5c, 5d, 5e) successive development of the sculpture of the protoconch from the apex towards the base of the last whorl.

**Fig. 6.** *Dragonia minuta* Guzhov, sp. nov. Holotype, spec. PIN, no. 4814/278 (shell height, 3.1 mm), Mikhalenino, bed $BV_7$, Upper Oxfordian, Amoeboceras serratum Zone, Amoeboceras serratum Subzone: (6a) apertural view, (6b) abapertural view.

Plate 6



orthocline in early whorls) cross the ribs. A number of folds increases in proportion to the increase in the circumference of whorls. Rounded tubercles are formed at the intersection with ribs. The folds reach the primary fifth tubercle-free rib, separating the lateral side and the base. The lateral side is slightly convex, merges roundly into a low convex base, with up to seven even ribs. Inner whorl section oval, slightly elevated.

D i s t r i b u t i o n. Lower Kimmeridgian, *Amoeboceras kitchini* Zone of the Russian Plate.

C o m p a r i s o n. It differs from *C. renardi* in the teleoconch morphology by denser and slender sculpture on the lateral side, low ribs at the base, the convexity of the whorls; in the protoconch morphology by the change of two spiral ribs in several thin granulated threads at the stage with collabral sculpture. It differs from *C. pumilum* in the teleoconch morphology by more slender and dense spiral sculpture, convex whorls; in the protoconch morphology by an increased number of spiral threads at the collabral–sculptured stage.

M a t e r i a l. Lower Kimmeridgian: Amoeboceras kitchini Zone, Amoeboceras bayi Subzone: Mikhalenino, bed $BV_{14}$ above horizon with nodules (10 juvenile shells and 203 protoconchs).

### Genus *Dragonia* Guzhov, gen. nov.

E t y m o l o g y. Named after the shape of the mouth, resembling the wing of a mythical dragon. Feminine gender.

T y p e s p e c i e s. *D. minuta* sp. nov.

D e s c r i p t i o n. Small cyrtoconoid turriculate anomphalous shell. The protoconch consists of one whorl of the protoconch I and several complex sculptured whorls of the protoconch II. The teleoconch consists of several whorls, covered with a rough reticulate sculpture. At first, whorls are convex, slowly increasing in width. Then, they become flattened and extension in width stops. Spiral ribs become higher abapically. As a result, ribs at the base are blade-like in shape. The lateral side roundly bends the low convex base. The aperture is oval, oblique relative to the axis of the coiling, sharply angular in the posterior part, has a short and shallow siphonal notch in the anterior part. The outer lip in the basal part is turned back, with angular outgrowths that increase as approaching the notch.

C o m p o s i t i o n. Type species, *D. longa* sp. nov.

C o m p a r i s o n. This genus differs from other genera in a specific morphology of the teleoconch and the aperture.

O c c u r r e n c e. Oxfordian and Kimmeridgian of the Russian Plate.

#### *Dragonia minuta* Guzhov, sp. nov.

Plate 6, fig. 6; Plate 7, figs. 1–6

*Procerithium (Rhabdocolpus) pumilum*: Gerasimov, 1992, p. 74 (pars), pl. 21, figs. 17, 18.

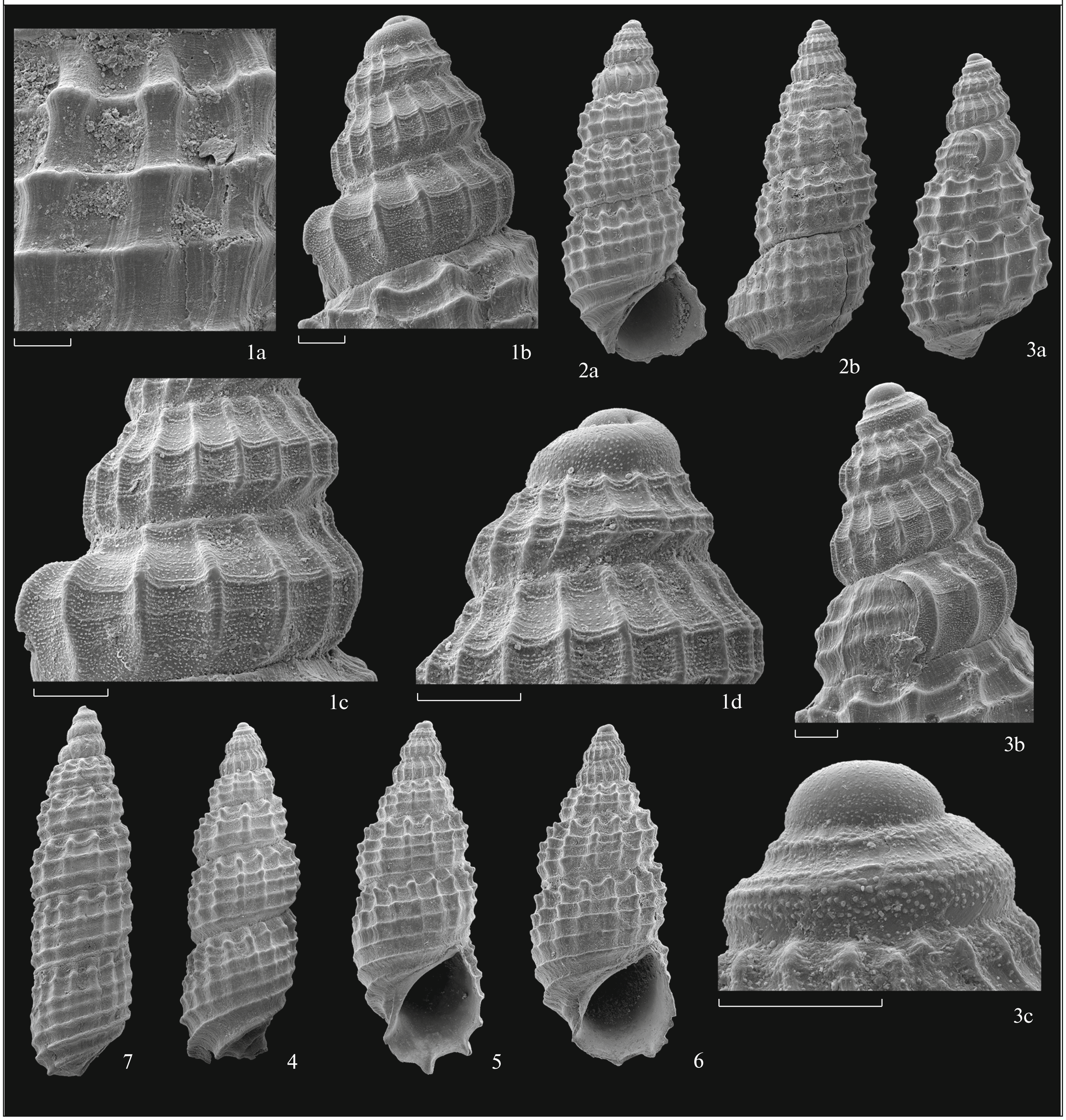
*Cosmocerithium pumilum*: Guzhov, 2002a, p. 28 (pars), pl. 1, figs. 10, 12; Guzhov, 2002b, p. 596 (pars), pl. 1, figs. 10, 12; Guzhov, 2004, p. 518 (pars), pl. 10, figs. 10, 11.

E t y m o l o g y. From Latin *minutus* (small).

H o l o t y p e PIN, no. 4814/28: Upper Oxfordian, Amoeboceras serratum Zone, Amoeboceras serratum Subzone; Kostroma Region, Makariev district, the Unzha River right bank above the Mikhalenino village (bed $BV_7$). Image: Pl. 6, fig. 6 and Pl. 7, fig. 1.

D e s c r i p t i o n. Small high-turricate cyrtoconoid anomphalous shell, consisting of four protoconch whorls and four teleoconch whorls. A shell height is up to 3.5 mm, diameter is up to 1.3 mm. The protoconch consists of two stages: the first protoconch I whorl, ornamented with pustules and terminated by the line of growth interruption, and comlex sculptured protoconch II, consisting of three whorls. From the beginning of the protoconch II, three ribs appear: one at the top and two very closely located at the base of the lateral side. Already in half a whorl, they greatly decrease, and other spiral elements appear between them. The protoconch II whorls are asymmetrically convex, of a trapezoidal profile with a maximum width in the lower half of the lateral side and a gradual narrowing adapically. Whorls are densely covered with spiral striae, with pronounced primary ribs on their background. The surface between the ribs and striae is densely covered with microscopic pustules. Opistocyrt folds cross the spiral elements; with a growth of the protoconch folds become gradually sparsely distributed, elevated, reaching 20 of them on the last whorl. The protoconch–teleoconch boundary is distinct, expressed by the line of growth interruption and the change in the pattern of the sculpture. Teleoconch whorls are convex at the beginning, becoming flat later. On the last whorl, a growth of the shell in diameter terminates. The suture is slightly undulating, shallow, becomes shallower with the growth of the shell. From the beginning of the teleoconch there appear four spiral ribs, the lower of which is half, less often completely, hidden under the suture. A number of ribs increase to the end of the shell due to development of the intercalated rib between the second and third primary ribs. On the last turn, the second intercalated rib appears between the first and second primary ribs. The moment of the first occurrence of the first intercalated rib varies greatly. The ribs intersect almost orthocline narrow ridges, which become narrower and more frequent with the growth of a shell (11 folds on the first whorl, 17 folds on the last whorl). Together with ribs they form the reticulate sculpture with small rounded tubercles at the intersections. The highest tubercles occur on the first spiral rib, where they can look like spines. Ribs and folds are almost equal in height: on the first whorl the folds are noticeably

Plate 7




Explanation of Plate 7

Scale bar, 100 µm; shell dimensions for other figures.

**Figs. 1–6.** *Dragonia minuta* Guzhov, sp. nov. (1) holotype, spec. PIN, no 4814/278 (shell height, 3.1 mm), Mikhalenino, bed $BV_7$, Upper Oxfordian, Amoeboceras serratum Zone, Amoeboceras serratum Subzone: (1a) microstriation on the teleoconch, (1b) protoconch, (1c,1d) sculpture of the protoconch; (2) spec. PIN, no. 4814/279 (shell height, 2.4 mm), Moscow, Brateevo district, Upper Oxfordian, Amoeboceras serratum–Amoeboceras rosenkrantzi Zone: (2a) apertural view, (2b) abapertural view; (3) spec. PIN, no. 4814/280 (shell height, 1.7 mm), bed $BV_7$, Upper Oxfordian, Amoeboceras serratum Zone, Amoeboceras serratum Subzone: (3a) general view, (3b) protoconch, (3c) early whorls of the protoconch; (4) spec. PIN, no. 4814/281 (shell height, 2.7 mm), Mikhalenino, bed $BV_9$, Lower Kimmeridgian, Amoeboceas bauhini Zone, Amoeboceas *zieteni* biohorizon; (5) spec. PIN, no. 4814/282 (shell height, 2.6 mm), the same locality and age; (6) spec. PIN, no. 4814/283 (shell height, 2.5 mm), the same locality and age.

**Fig. 7.** *Dragonia longa* Guzhov, sp. nov. Holotype, spec. PIN, no. 4814/284 (shell height, 2.9 mm), ravine near the dacha village of Novoselki, Middle Oxfordian, Cardioceras densiplicatum Zone (Infacerithium level).

higher than the ribs, whereas they become equal by the end of the shell. Folds are traced to a high blade-shaped rib, which separates the lateral side and the basal part. The surface of whorls, including ribs, is densely ornamented with numerous microscopic striae. The lateral side merges roundly into the low convex base. At the base is a high blade-shaped rib, below which there is sometimes the second very low, semicircular in cross section rib. Growth lines vary from almost orthoclinal to slightly opistocyrt by the end of the shell. The whorl section oval, elevated. The aperture oval, elongated obliquely to the shell axis, with thin lips. The anterior part of the peristome is bent, with angular grooved outgrowths corresponding to the ends of the ribs on the shell surface. The lips converge posteriorly at an acute angle; a weakly protruding groove is formed anteriorly at the junction, having the form of a semicircle notch. Such apeture forms both in adult and subadult individuals.

Holotype (shell height, 3.2; diameter, 1.2 mm).

O c c u r r e n c e. Middle Oxfordian Cardioceras tenuiserratum Zone—Lower Kimmeridgian Amoeboceras bauhini Zone of the Russian Plate.

C o m p a r i s o n. It differs from D. *longa* in shorter shell, only the last whorl of which does not increase in diameter.

M a t e r i a l. Middle Oxfordian, Cardioceras tenuiserratum Zone: Mikhalenino, bed $BV_1$ (1 spec.); Upper Oxfordian, Amoeboceras alternoides Zone, Amoeboceras alternoides Subzone: Mikhalenino, bed $BV_3$ (one adult and two juvenile specimens); Amoeboceras serratum Zone, Amoeboceras serratum Subzone: Mikhalenino, beds $BV_5$–$BV_6$ (14 spec.), $BV_7$ (156 spec.); Amoeboceras serratum–Amoeboceras rosenkrantzi zones: Moscow, Brateevo district (275 spec.); Lower Kimmeridgian, Amoeboceas bauhini Zone, Amoeboceas zieteni biohorizon: Mikhalenino, bed $BV_9$ (94 spec.).

***Dragonia longa* Guzhov, sp. nov.**

Plate 7, fig. 7

E t y m o l o g y. From Latin *longus* (long).

H o l o t y p e. PIN, no. 4814/284: Middle Oxfordian, *Cardioceras densiplicatum* Zone; Ryazan Region, Ryazan district, Oka River right bank (Dyat'kovo backwater), a ravine near the dacha village of Novoselki.

D e s c r i p t i o n. Small subcylindrical cyrtoconoid anomphalous shell, consisting of several whorls of the protoconch and 5.5 whorls of the teleoconch. The protoconch is greatly worn and incomplete. Based on the preserved part of a shell, one can see that it has as much as 3.5 whorls; its morphology is similar to that to *D. minuta*: protoconch II consisting of several whorls, covered by high collabral folds (18 ones at the last whorl) and, probably, thin spiral sculpture. The protoconch–teleoconch boundary is distinct and is defined by the line of growth interruption and the change in the pattern of sculpture. A spire at the two first whorls of the teleoconch increases in a diameter, then this grows terminates; the shell becomes cylindrical and whorls are flat, separated by the suture line. From the beginning of the teleoconch there appear four spiral ribs, the lower one of which is half hidden beneath the suture. Towards the end of a shell, a number of ribs increases up to 5 due to the appearance of a intercalated rib between the second and third primary ribs at the beginning of the fifth whorl. Ribs cross straight opistocline narrow folds, narrowing and increasing in a number with the growth of shell (11 folds on the first whorl, 14 folds on the last one). Together with ribs they form the reticulate sculpture with small rounded tubercles at the intersections. The highest tubercles occur on the first spiral rib. Ribs and folds are almost the same in height: folds on two first whorls are higher than ribs, but towards the end of a shell they become of the same height. Folds do not reach the rib, which separates the lateral side and the base. The lateral side merges roundly into the low convex base. At the base is the sole high blade-shaped rib. Growth lines are straight prosocline. Whorl crossection oval, elevated. An aperture is unknown.

Holotype (a shell height, 2.95 mm, diameter 0.8 mm).

O c c u r r e n c e. Middle Oxfordian, Cardioceras densiplicatum Zone of the Russian Plate.

M a t e r i a l. Holotype.

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