ISSN 0869-5938, Stratigraphy and Geological Correlation, 2023, Vol. 31, No. 2, pp. 71–88. © Pleiades Publishing, Ltd., 2023.
Russian Text © The Author(s), 2023, published in Stratigrafiya, Geologicheskaya Korrelyatsiya, 2023, Vol. 31, No. 2, pp. 82–100.

New Data on the Structure of the Terminal Part of the Volgian Stage of the Upper Jurassic in the Reference Section near the Village of Vasilyevskoye, Yaroslavl Oblast

D. N. Kiselev[a], * and M. A. Rogov[b], **

[a] *Yaroslavl State Pedagogical University, Yaroslavl, 150000 Russia*
[b] *Geological Institute, Russian Academy of Sciences, Moscow, 119017 Russia*
**e-mail: dnkiselev@mail.ru*
***e-mail: russianjurassic@gmail.com*

Received June 24, 2022; revised August 7, 2022; accepted August 26, 2022

Abstract—The study of new sections of the upper part of the Upper Volgian substage near the village of Vasilyevskoye (Rybinsk district, Yaroslavl oblast) made it possible to clarify the position of the lower boundary and the infrazonal division of the Volgidiscus singularis Zone. Until recently, the lower part of the Singularis Zone was not characterized by ammonites, but owing to the study of these sections, it was possible to establish the sequence of craspeditins ammonites (*Volgidiscus* and *Anivanovia*) and to identify a new *Volgidiscus* cf. *lamplughi* biohorizon. The lower boundary of the Singularis Zone in the Chudinovian Formation sections is determined by the first occurrence of *Volgidiscus* above the *Craspedites milkovensis* biohorizon. The infrazonal volume of the Singularis Zone is represented by three biohorizons: *V.* cf. *lamplughi*, *V. pulcher* and *V. singularis*. At present, the Singularis Zone is characterized by the most complete structure in the Panboreal Superrealm, which allows it to be considered as an infrazonal standard for the upper part of the Upper Volgian substage.

Keywords: Jurassic system, biostratigraphy, ammonites, *Volgidiscus*, *Craspedites*
DOI: 10.1134/S086959382302003X

INTRODUCTION

At the present time, the Upper Volgian substage of European Russia is subdivided into Kachpurites fulgens, Garniericeras catenulatum, Craspedites nodiger, and Volgidiscus singularis ammonite zones (Rogov, 2021). The uppermost Singularis Zone was described only in the upper reaches of the Cheremukha River (Rybinsk district, Yaroslavl oblast). Here, the unit of ferruginous sands and sandstones of the Chudinovo Formation was partially ascribed to this zone (Kiselev et al., 2018). In the middle part of the Chudinovo Formation (Seltso-Voskresenskoe section), "Beds with *Volgidiscus singularis*" were distinguished originally (Kiselev, 2003; Kiselev and Rogov, 2012). Later (Rogov et al., 2015), Beds with *V. singularis* were transferred to the rank of zone with the same index species and a variant of its infrazonal subdivision including biohorizons[1] *V. pulcher* and *V. singularis* was suggested. The suggestion to distinguish these biohorizons in Singularis Zone was confirmed after studying the Chudinovo Formation in the section near the village of Vasilyevskoye, where the *V. pulcher* biohorizon was recognized (Kiselev et al., 2018).

The Singularis Zone including two biohorizons occupies the middle part of the Chudinovo Formation (thickness is about 5 m). The *pulcher* biohorizon was distinguished in the lower part of the zone; the stratotype is the section near the village of Vasilyevskoye. In the upper part, the *singularis* biohorizon is actually known in European Russia was distinguished only in the Seltso-Voskresenskoe section. Both biohorizons are geographically widely distributed from England and the North Sea in the west to the Kheta River basin in the east.

Despite the marked progress in the study of the terminal part of the Upper Volgian substage of the Cheremukha River basin, a number of questions concerning its biostratigraphic subdivision remain to be answered. First of all, there is the problem of determining the lower boundary of the Singularis Zone. In the sections of the Chudinovo Formation, the base of this zone has not yet been identified on the basis of changes in ammonite assemblage of Nodiger and Singularis ammonite zones. The occurrence of the Nodiger Zone in the upper reaches of the Cheremukha River was only assumed on the basis of rare findings of

[1] Here and elsewhere, a biohorizon is considered a type of infrazonal units. The essence and principles of distinguishing biohorizons have been previously discussed in detail (Rogov et al., 2012; Rogov, 2021; Kiselev, 2022).

Craspedites ammonites in talus (Kiselev et al., 2018, Plate III, fig. 7). Until recently, the nearest section of the Nodiger Zone was known only from the middle reaches of the Cheremukha River near the village of Mikhalevo, 15 km north of outcrops of the Chudinovian Formation (Kiselev et al., 2018, Fig. 2). The absence of signs of the Nodiger and Singularis zones in a single section raises doubts about the validity of the Singularis Zone and the stratigraphic position of its constituent beds above the Nodiger Zone. According to Mitta (2010), ammonites from the section near the village of Seltso-Voskresenskoe should belong to the genera *Kachpurites* and *Craspedites*, and the beds of the Singularis Zone should be considered as the stratigraphic unit "Beds with *Kachpurites mola*," corresponding to the lower part of Subditus (=Catenulatum) Zone. According to this viewpoint, they should be located below the Nodiger Zone, but not above it.

Ammonites in the Chudinovo Formation were found in three concretion horizons in its middle subformation (after Kiselev et al., 2018). Accordingly, the age of the lower and upper subformations was insufficiently determined.

By the time of the publication of the article describing the Singularis Zone (Kiselev et al., 2018), new observations were done in the section near the village of Vasilyevskoye, which were not included in the publication. They made it possible to specify the age of the lower subformation of the Chudinovo Formation on the basis of ammonites and determine its lower boundary and to partially solve the aforementioned problems.

DESCRIPTION OF SECTIONS

Outcrops of the Chudinovo Formation near the village of Vasilyevskoye are located on the left bank of the Cheremukha River and in two adjacent ravines (Fig. 1). Section no. 7, located in the far ravine (higher up the river), was described in a previous paper (Kiselev et al., 2018). The upper part of the lower subformation and the lower part of the middle subformation with a total thickness of about 12 m crop out here. Ammonites were found only in the middle subformation, while marine bivalves were found in the lower part. Later, as a result of a more careful investigation of the lower part of the section, its lithology and paleontological characteristics were significantly clarified. Therefore, a redescription of the section with other numbering of beds and biostratigraphic subdivision is given below.

Section no. 10 located in the ravine near the village of Vasilyevskoye has been described for the first time.

Section no. 7 is located in the upper and middle parts of the right slope of the ravine (outcrop 7b) and on the bank of the Cheremukha River near the left side of a ravine (outcrop 7a), where the lower part of the section was described. The following succession is observed here (from bottom to top) (Fig. 2).

Bed 1. Sandstone medium-grained, horizontally layered, rusty, weakly cemented, forms a marker horizon in the section. The bed contains abundant *Camptonectes morini* (de Loriol) and *Entolium orbiculare* (Sowerby) and rare *Gresslya alduini* (Fischer de Waldheim). Ammonites are rare and are represented by *Volgidiscus* cf. *lamplughi* (Spath) (Plate I, fig. 10). Apparent thickness is 1–1.2 m.

Bed 2. Sand medium-grained, dark brown to reddish ocher, with frequent pockets of weakly cemented material, changed by limonitized sandstone nodules. In the lower part of the bed, there are numerous mall subrounded iron nodules (2–5 cm), which form a horizon up to 0.2–0.8 m thick above the bottom (horizon 2a). Higher in the section, in the interval of 0.8–2 m (horizon 2b), nodules are less common than in horizon 2a and are represented by ferruginous sandstone, sometimes lenticular (at the base of the horizon) or rounded pancake-shaped (in the upper part of the horizon). The exposed thickness is 2–2.5 m. The top of the bed is covered by talus deposits. Fossils are rare and represented mainly by bivalves *Camptonectes morini* (de Loriol). A single specimen of ammonite *Volgidiscus* cf. *lamplughi* (Spath) was found in horizon 2a (Plate II, fig. 5).

Above, the section is closed by talus of about 2 m thick. The overlying strata are described on the right side of the ravine.

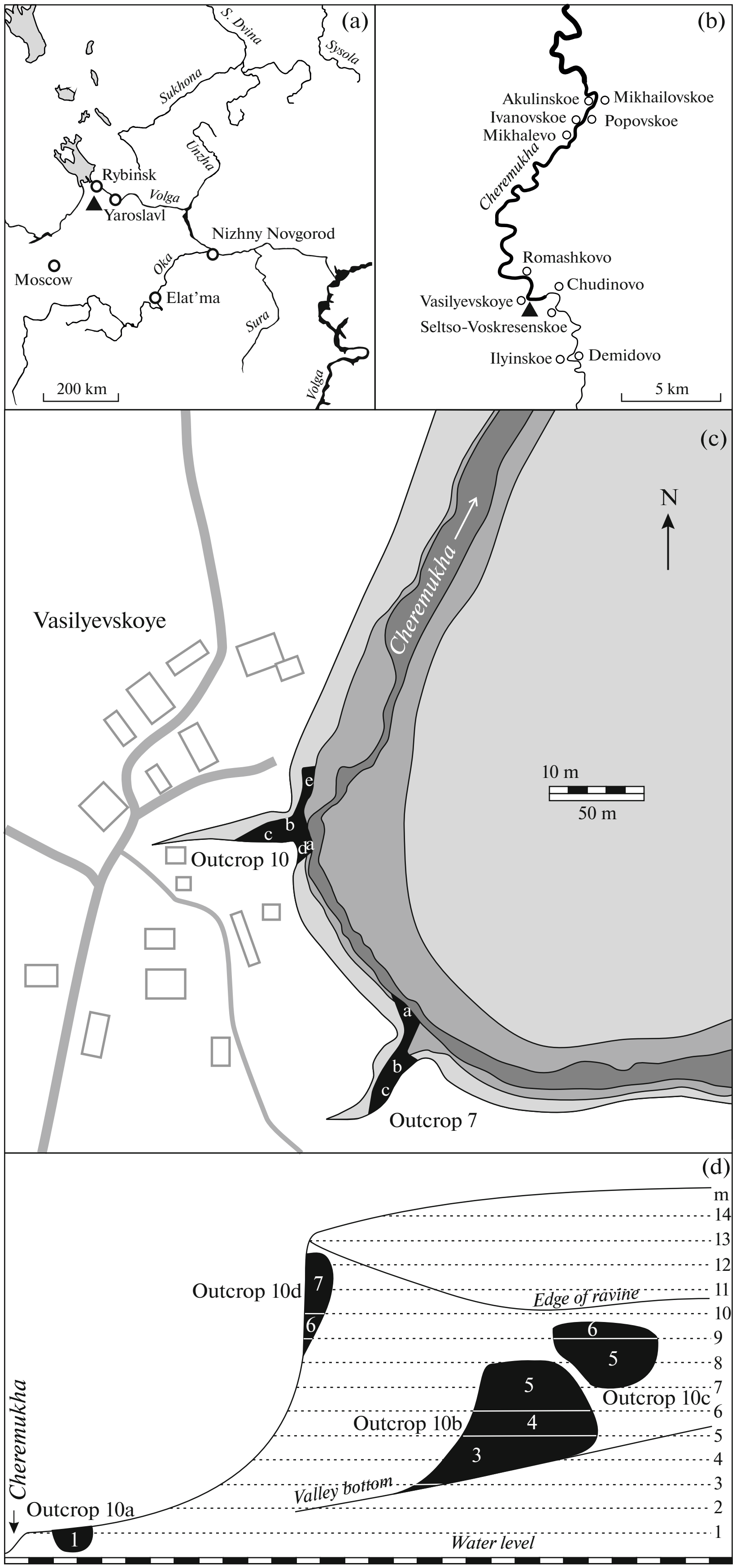
Bed 3. Sand medium-grained, ocherous gray with ocherous spots and thin interlayers of limonitized sandstone. In the upper part of the bed, at about 6.5 m above Bed 1, there is a 1–3 cm horizon of pancake-shaped nodules of ferruginous sandstone. The top of the bed is sharp, located about 7 m above the top of Bed 1.

Bed 4. Sand medium-grained, irregularly horizontally layered, especially in the lower part. The bedding is composed of alternating bright reddish or lemon yellow interlayers 5–10 cm thick with reddish brown lenses of sand of different thickness (Fig. 3d). In the upper 1.5 m, the stratification is indistinct. The thickness is about 4 m.

The description of the overlying beds of the section was published earlier (Kiselev et al., 2018); the renumbered beds are given below:

Bed 5 (formerly Bed 3). Sand medium- to fine-grained, loose, bright ocher, almost orange (Figs. 3b–3d).

Fig. 1. Location scheme of studied sections in the upper reaches of the Cheremukha River. (a, b, c) The different-scale location schemes of the study area; different parts of the Cheremukha River valley (riverbed, floodplain, terraces) in Fig. 1c are shown in different shades of gray; (d) location scheme of outcrops of section no. 10 in the longitudinal profile of the ravine and the succession of beds (numbered); vertical and horizontal scales are the same. Scale bar is 1 m.


(a)
S. Dvina
Sysola
Sukhona
Unzha
Rybinsk
Volga
Yaroslavl
Nizhny Novgorod
Moscow
Oka
Elat'ma
Sura
Volga
200 km
(b)
Akulinskoe
Mikhailovskoe
Ivanovskoe
Popovskoe
Mikhalevo
Cheremukha
Romashkovo
Chudinovo
Vasilyevskoye
Seltso-Voskresenskoe
Ilyinskoe
Demidovo
5 km
(c)
N
Cheremukha
Vasilyevskoye
10 m
50 m
Outcrop 10
Outcrop 7
(d)
m
Outcrop 10d
Edge of ravine
Outcrop 10c
Outcrop 10b
Valley bottom
Cheremukha
Outcrop 10a
Water level

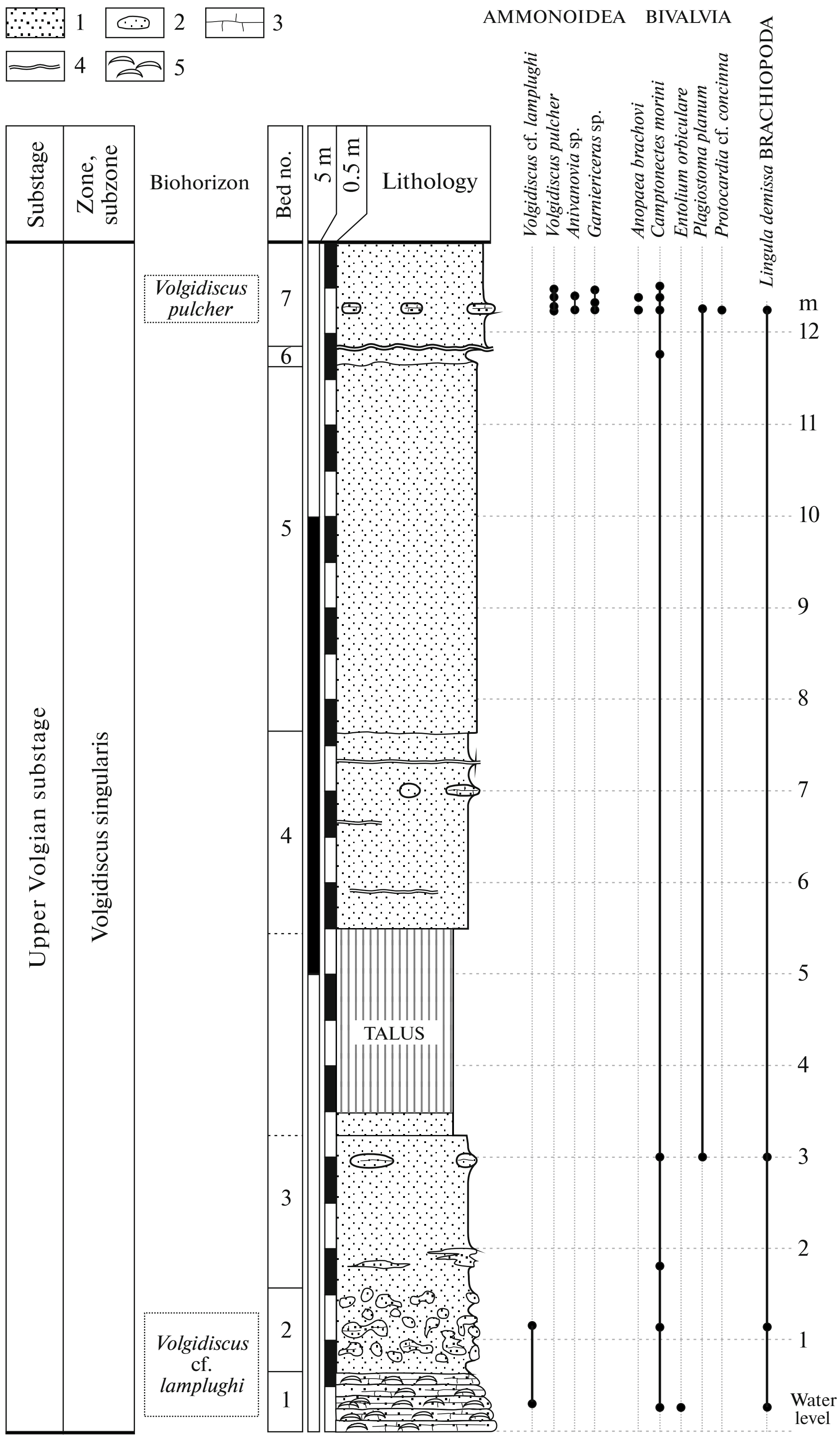


Fig. 2. Geological scheme of the Upper Volgian substage and distribution of fossils throughout section no. 7 near the village of Vasilyevskoye. (1) Sand; (2) sandstone nodules; (3) ferruginous sandstone; (4) foliated interbeds of ferruginous sandstone; (5) horizons of shell deposits.

The bottom and top of the bed are undulating. The top is covered by a thin, up to 5–10 mm, ferruginated horizon, which is followed by foliated interlayers of ferruginous brownish black sandstone (Fig. 3b). It forms an undulating band with distinct boundaries. In places, the nodule horizon forms distinct swellings which enclose *Camptonectes morini* (de Loriol). Thickness is 0.05–0.1 m.

Bed 5 (formerly bed 4). Sand medium-grained, massive, dark reddish brown, rhythmically horizontally layered, passing into weakly cemented sandstone (Fig. 3b). In the middle of the bed, 0.5 m above the bottom, there is a horizon of small potato-shaped nodules of dark brown sandstone. Crushed molds and imprints of ammonites and bivalves, as well as solution cavities after dissolved belemnite rostra, are found in the nodules and host rocks. Ammonites are represented by *Volgidiscus pulcher* (Casey, Mesezhn. et Shulg.) (Kiselev et al., 2018, Plate I, figs. 1–4; Plate II, figs. 1, 2), *Anivanovia* sp., and *Garniericeras* sp. (Kiselev et al., 2018, Plate I, fig. 5). Bivalves are represented by *Anopaea brachovi* (Rouillier) (Kiselev et al., 2018, Plate VII, figs. 1–4), *Camptonectes* (*Camptonectes*) *morini* (de Loriol) (Kiselev et al., 2018, Plate VIII, fig. 3), *Entolium orbiculare* (Sowerby), and *Plagiostoma planum* (Roemer) (Kiselev et al., 2018, Plate VIII, fig. 8). Apparent thickness of the bed is about 1.2 m.

Section no. 10 is represented by several outcrops of the Chudinovo Formation, located on slopes of the ravine near the village of Vasilyevskoye (outcrops 10a–10c) and on the bank of the Cheremukha River (outcrops 10a, 10e; Fig. 1). The base of the section was described in outcrop 10a, in a hole dug for a well to a depth of 1 m below the water level on the left bank of the Cheremukha River, close to the right side of the ravine.

Bed 1. Sand medium-grained, brown, strongly limonitized, with large (up to 0.5 m) loaf-shaped nodules of grayish brown sandstone, which often have phosphatized cores. Nodules are oversaturated with fossil, mainly bivalves *Camptonectes* sp. and rare brachiopods *Lingula demissa* Geras. Rare ammonites are represented by *Craspedites* (*Trautscholdiceras*) *milkovensis* (Strem.) (Plate I, figs. 2–4), *C.* (*T.*) *kaschpuricus* (Traut.) (Plate I, fig. 1), and *Garniericeras* sp. (Plate I, fig. 5). Exposed thickness is about 1 m.

Higher, the section is overlain by talus about 2.5–3 m thick. The overlying beds of the section were studied at the bottom and the left slope of the ravine (outcrop 10b; Figs. 1d, 4a) and the bank of the Cheremukha River downstream from the ravine (outcrop 10e).

Bed 2. Sandstone medium-grained, indistinctly laminated, platy, rusty, highly limonitized. There occur only pectinids. Thickness 0.2–0.5 m.

Bed 3. Sand medium-grained, weakly cemented, followed by loose sandstone in concentrically layered nodules. Near the top, there is a horizon of fossil-bearing massive ferruginous sandstone nodules. Ammonite shell fragments are represented by *Volgidiscus* sp. and *Anivanovia* aff. *mola* Kiselev (Plate I, fig. 8). Bivalves are represented only by pectinids. No fauna remains were found below the nodule horizon. Thickness is about 2 m.

Bed 4. Sandstone weakly cemented, medium-grained, indistinctly laminated, platy, rusty brown, strongly limonitized (Fig. 4c). It forms an overhanging ledge in the section profile. Ammonites were found at the bottom, near the top, and at the top of the bed and are represented by *Volgidiscus* cf. *lamplughi* (Spath) (Plate II, fig. 2) and *Anivanovia* aff. *mola* Kiselev (Plate I, fig. 7). Thickness is about 1 m.

Bed 5. Sand medium- to coarse-grained in the lower part of the bed (about 1.5 m thick) and medium-grained in the upper part (1.5 m), indistinctly laminated, bright reddish gray, strongly ferruginous (Fig. 4b). The upper part of the bed contains three ferruginous interbeds in the form of sheetlike sandstone plates 2–5 mm thick, spaced 0.5–0.6 m apart. The upper plate, the top of the bed, is locally thickened to 2–3 cm. Below each of these three sandstone plates are horizons of massive ferruginous sandstone nodules of different size (up to 0.3 m) and shape (from rounded to chaotic). Three nodule horizons a, b, and c (Fig. 5) include the following faunal remains: ammonites *Volgidiscus* cf. *lamplughi* (Spath) (Plate I, fig. 6; Plate II, figs. 1, 3, 4) and *Anivanovia* aff. *mola* Kiselev (Plate III, fig. 1) and bivalves, mainly *Anopaea brachovi* (Rouillier), *Camptonectes* (*Camptonectes*) *morini* (de Loriol), and *Plagiostoma planum* (Roemer). Thickness is about 3 m. The lower part of the bed crops out on both slopes of the ravine (outcrops 10b and 10c); the upper part crops out only on the right slope (outcrop 10c).

Bed 6. Medium- to coarse-grained sand, in places finely gravel, indistinctly layered at the base, horizontally layered in the middle and upper parts, light ocherous, in places reddish (Figs. 3f, 4b). The bed is crowned by a thin sheetlike sandstone plate, which forms the marker horizon. In the middle of the bed (0.8–1 m above the base) is a horizon of differently shaped (from rounded to flattened) and sized (up to 0.3 m) ferruginous sandstone nodules containing diverse fauna. The following ammonites were recognized: *Volgidiscus* cf./aff. *lamplughi* (Spath) (Plate I, fig. 9; Plate II, fig. 6; Plate III, fig. 2), *Anivanovia* aff. *mola* Kiselev. Bivalves are represented by *Anopaea brachovi* (Rouillier), *Camptonectes* (*Camptonectes*) *morini* (de Loriol), and *Isognomon* sp. Thickness is 1 m. This bed was described in two outcrops: on the right slope of a ravine (10c) and below the bank of the Cheremukha River (10d) (Fig. 1d).

Bed 7. Sand medium- to coarse-grained, rhythmically layered, rusty brown. Rhythmic wavy-horizontal layering is evident in the alternation of brownish red limonitized interlayers with less ferruginous reddish ocher interlayers (Fig. 3f). The thickness of a rhythm is 10–15 cm. The highly limonitized interbeds sometimes include small sandstone nodules, which occasionally contain bivalves. The exposed thickness is 2.5 m. The section terminates higher at the edge of the bedrock coast. This bed is visible only in outcrop 10d.

Most beds of the section no. 10 are well traced laterally in different outcrops, which allow their confident correlation. The exception is Bed 1, described only in outcrop 10a. In spite of the fact that its contact with the overlying beds has not been studied, there are no serious reasons to believe that this bed does not lie at the base of the section. On one hand, no traces of landslides or glaciodislocations, which could have changed the primary bedding, were found in the outcrops. On the other hand, Bed 1 is fundamentally different in the taxonomic composition of ammonites, which characterize an older zone than those of the overlying layers of the section.

In sections 7 and 10, the same intervals of the Chudinovian Formation crop out, but despite insignificant distance of the sections from each other (about 130 m) and similar thickness above the river's edge (about 12 m), they differ significantly in their structure. In both sections, it is impossible to identify any layers and nodule horizons that could be used as marker beds or levels suitable for lithostratigraphic correlation. The discrepancies are especially noticeable when comparing the structure of the sections at the same hypsometric levels. Thus, the interval of 5–10 m above the river's edge in section no. 10 is best characterized paleontologically, while in section no. 7 it is represented by "empty beds." On the contrary, the level of 12 m, represented in section no. 7 by a rich ammonite assemblage, contains no ammonites at all in section no. 10.

The differences considered above do not allow us to correlate even sections located in close proximity according to lithological features. The sections can be correlated biostratigraphically and, in part, by hypsometric levels.

The lower part of the Chudinovo Formation with *Craspedites* (*Trautscholdiceras*) *milkovensis* crops also in the middle reaches of the Cheremukha River near the village of Popovskoe (Kiselev et al., 2018).

AMMONITE ASSEMBLAGES

As evidenced from (Kiselev et al., 2018), ammonites from the section near the village of Vasilyevskoye were found only in the uppermost beds, corresponding in the present paper to the hypsometric mark of 12 m. On the basis of new findings of ammonites from lower horizons, it is possible to characterize biostratigraphically the greater part of the Chudinovo Formation.

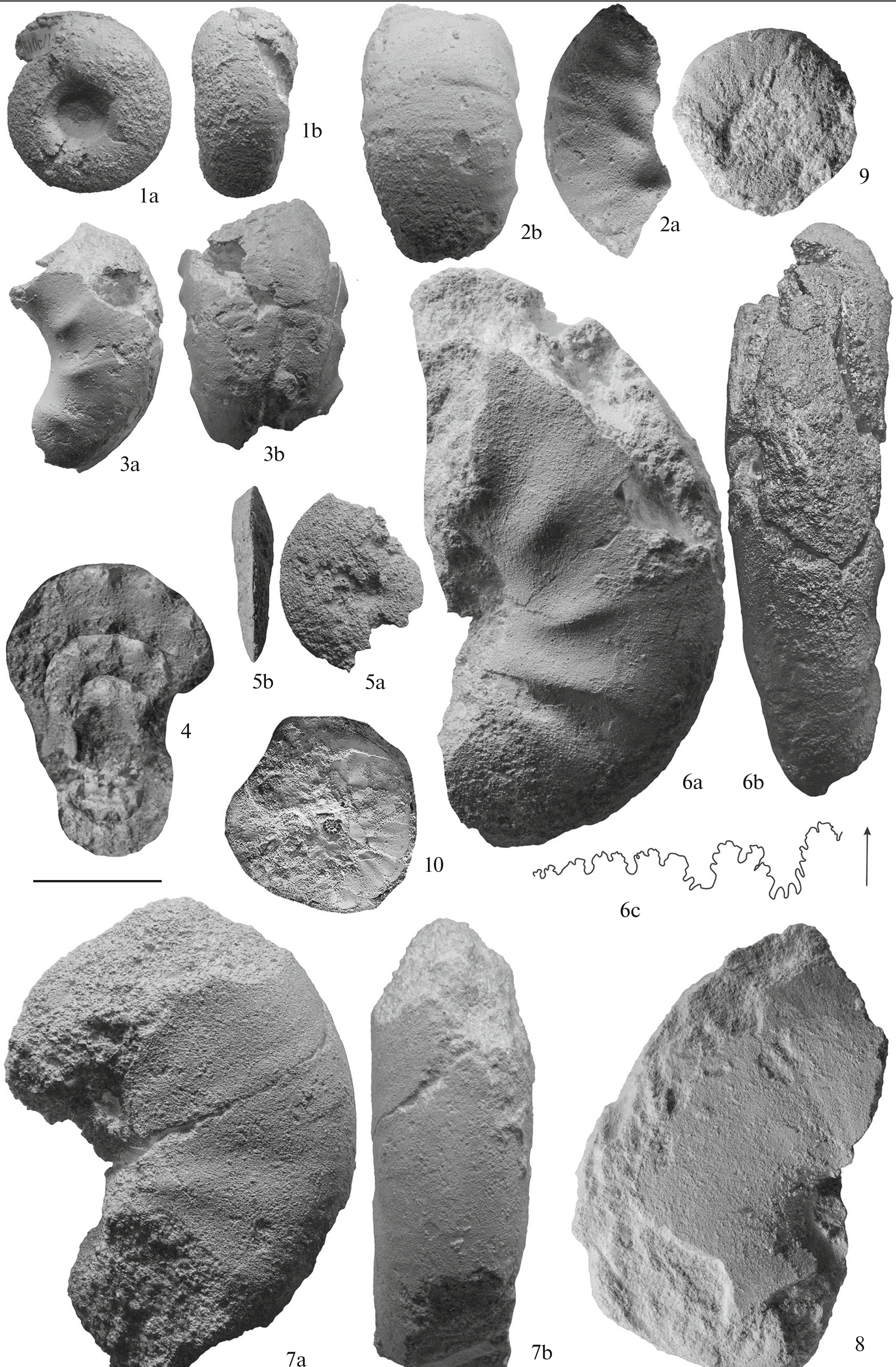
Ammonites are represented by one family Craspeditidae Spath, 1924, including representatives of all its subfamilies—Craspeditinae Spath, 1924, Garniericeratinae Spath, 1952 emend. Rogov, 2017, and Subcraspeditinae Rogov, 2014. In the studied sections they are represented by three assemblages: lower, middle, and upper.

Lower assemblage of craspeditid ammonites was recognized only in Bed 1 of section no. 10. It is represented by subfamilies Craspeditinae and Garniericeratinae, of which Craspeditinae species dominate quantitatively up to 90%. The latter belong to subgenus *Craspedites* (*Trautscholdiceras*), which characterizes Nodiger Zone in European Russia and its analogs in the Arctic. Macroconchs were identified mainly by fragments of body chambers of adult whorls (Plate I, figs. 2, 3), less often by internal whorls (Plate I, fig. 4). They are most similar to the species *C.* (*T.*) *milkovensis* (Strem.), while microconchs can be determined as *C.* (*T.*) *kaschpuricus* (Traut.). In contrast to the typical variety of this species *C.* (*T.*) *milkovensis* (holotype: Stremoukhoff, 1892, figs. 1–3; Mitta and Starodubtseva, 2018, Plate I, text-fig. 8), specimens from the section near the village of Vasilyevskoye have a slightly wider ventral side. In the section near the village of Mikhalevo, typical *C.* (*T.*) *milkovensis* (Rogov et al., 2011, Plate I, fig. 7) and ammonites similar in cross section to specimens from the village of Vasilyevskoye (Rogov et al., 2011, plate, fig. 6) were found. Probably, some originality of the ammonite assemblage of the *milkovensis* biohorizon of the Yaroslavl Volga Region reflects the geographical variability of the species under consideration.

The occurrence of *C.* (*T.*) *milkovensis* in the studied section allows us to establish the *milkovensis* biohorizon for the first time in the upper reaches of the Cher-

Plate I. Here and in Plates II and III, all figures, except for the specially marked ones, are given in full size. Scale bar is 1 cm. Abbreviations: YarGPU—geological museum of the Yaroslavl State Pedagogical University. Figs. 1a, 1b. *Craspedites* (*Trautscholdiceras*) *kaschpuricus* (Trautschold); specimen no. YarGPU Ch10c/1-6; Rybinsk district, Vasilyevskoye village, section no. 10, Bed 1; Upper Volgian, Craspedites nodiger Zone, *C. milkovensis* biohorizon. Figs. 2–4. *Craspedites* (Trautscholdiceras) *milkovensis* (Strem.); Rybinsk district, Vasilyevskoye village, section no. 10, Bed 1; Upper Volgian, Craspedites nodiger Zone, *C. milkovensis* biohorizon. Figs. 2a, 2b. Specimen no. YarGPU Ch10c/1-4. Figs. 3a, 3b. Specimen no. YarGPU Ch10c/1-2. Fig. 4. Specimen no. YarGPU Ch10c/1-7. Figs. 5a, 5b. *Garniericeras* sp; specimen no. YarGPU Ch10c/1-9; Rybinsk district, Vasilyevskoye village, section no. 10, Bed 1; upper substage of the Volgian Stage, Craspedites nodiger Zone, *C. milkovensis* biohorizon. Figs. 6, 9, 10. *Volgidiscus* cf. *lamplughi* (Spath). Figs. 6a–6c. Specimen no. YarGPU Ch10c/5c-2, fig. 6c, ×2; Rybinsk district, Vasilyevskoye village, section no.10, Bed 5, nodule horizon b. Fig. 9. Specimen no. YarGPU Ch10c/6-3; Vasilyevskoye village, section no. 10, Bed 6, nodule horizon. Fig. 10. Specimen no. YarGPU Ch6-36; Vasilyevskoye village, section no. 7, Bed 1. Figs. 7, 8. *Anivanovia* aff. *mola* Kiselev; Upper Volgian, Volgidiscus singularis Zone, *V.* cf. *lamplughi* biohorizon. Figs. 7a, 7b. Specimen no. YarGPU Ch10c/3-5; Rybinsk district, Vasilyevskoye village, section no. 10, Bed 4, top. Fig. 8. Specimen no. YarGPU Ch10c/3-1; Rybinsk district, Vasilyevskoye village, section no. 10, Bed 3, top.

Plate I



emukha River, which was previously known only in the middle course of the Cheremukha River near the village of Mikhalevo (Kiselev et al., 2018; Rogov, 2021).

Microconchs (Plate I, fig. 1) occur less frequently than macroconchs and they make up no more than 20% in the collection of *Craspedites* ammonites. They correspond most closely to the morphotype *C.* (*T.*) *kaschpuricus* (Traut.) (holotype: Trautschold, 1866, pl. 3, fig. 2). This species is typical of the *nodiger* and *milkovensis* biohorizons of the Nodiger Zone in European Russia (Rogov, 2021).

Garniericeratins are represented by a single specimen of *Garniericeras* (Plate I, fig. 5) of poor preservation, which seems to be most closely related to *G. subclypeifome* (Milash.). The latter is common in most of the Nodiger Zone and is not an infrazonal marker. The known published findings of *G.* cf. *subclypeifome* (Milash.) (Rogov, 2021, Plate LXXVI, fig. 5) from the *milkovensis* biohorizon are also poorly preserved, and does not allow us to identify these forms with complete certainty. A similar assemblage with a strong predominance of *Craspedites* (*Trautscholdiceras*) and a single finding of *Garniericeras subclypeiforme* (Milash.) was previously established in the section near the village of Mikhalevo (Rogov et al., 2011). It should be noted that ammonites and lingulid brachiopods predominate in the Mikhalevo section, while bivalves are rare.

Middle assemblage of craspeditid ammonites was described in the lower and middle parts of both described sections near the village of Vasilyevskoye, in the interval of 0–9.5 m above the river level. In section no. 7, this assemblage characterizes Beds 1 and 2; in section no. 10, Beds 2–6. The middle assemblage is represented by a single subfamily Subcraspeditinae and two genera: microconchs belong to the genus *Volgidiscus* Casey, 1973, and macroconchs belong to the genus *Anivanovia* Kiselev, 2003. Both genera have been known from sections in the upper reaches of the Cheremukha River for about 20 years (Kiselev, 2003; Kiselev and Rogov, 2012; Kiselev et al., 2018). Nevertheless, this assemblage includes species that were not previously known in European Russia. They are certainly older than the previously described *Volgidiscus* from the Chudinovian Formation (*V. singularis*, *V. pulcher*). Assignment of the collected specimens to the species rank is complicated because of their poor preservation (mainly, incomplete molds are found). The shell characters can be inferred mainly by adult whorls, since the middle ones are more often destroyed and the inner ones are rarely preserved.

Volgidiscus ammonites of the middle assemblage are characterized by frequent ribbing in the middle whorls (D = 20–40 mm), consisting of smoothed slightly differentiated ribs. On adult whorls of a shell (D = 60–100 mm), ribs become smoother ventrally, and only primary ribs are preserved on the lateral sides, the number of which on an adult half-whorl is usually 7–8 ribs (Plate II, figs. 3–6). Deviations from this morphotype in the sample are probably due to variability in the rate of development. In rapidly developing individuals (tachymorphs), adult whorls become smoother, the density of ribs decreases to 5–6 per half-whorl, and ribs become roller shaped (Plate I, fig. 6). Slowly developing individuals (bradymorphs) on adult whorls retain complete (not modified) primary and secondary ribs (Plate II, figs. 1, 2). The latter are moderately differentiated (branching coefficient of ribs being 3–3.5).

Normal individuals were found at different levels of the lower subformations of the Chudinovian Formation—in the lower (the hypsometric interval of 0–1 m), middle (5–9 m), and upper (9.5–10 m) parts. Bradymorphs and tachymorphs were found only in the middle part (Bed 5 of section 10). This peculiarity of the distribution of different morphs throughout the section is most likely explained by random reasons and is related to the different sample size of ammonites from different intervals.

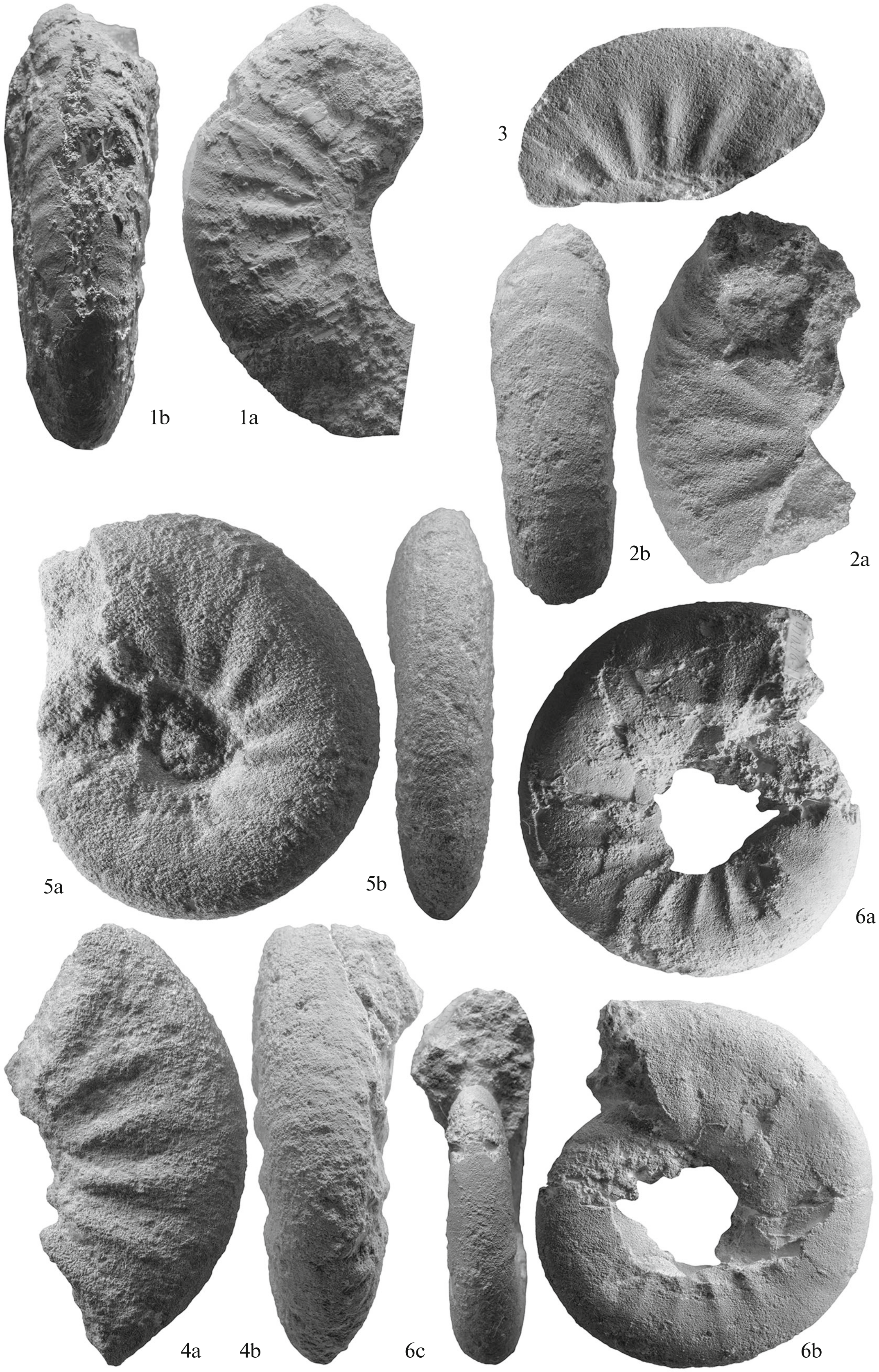
The sculpture of late *Volgidiscus* ammonites of the middle assemblage (Bed 6, section no. 10) on middle whorls is often reduced. This is a sign characteristic of *V. pulcher*, which occurs at a higher interval of the Chudinovo Formation (upper assemblages of craspeditid ammonites). Therefore, there is reason to believe that the ammonite assemblage from Bed 6 has a transitional character.

Such combinations of characters are unknown in other ammonites previously described from the Chudinovo Formation. Thus, the entire available sample of *V. singularis* Kiselev, 2003 (holotype: Kiselev et al., 2018, Plate V, fig. 3) is represented by bradymorphic species. Their primary ribs are more frequent (on average, 12–16 per half-whorl) and thin. Secondary ribs are common and more differentiated (branching coefficient of ribs being 3.5–7.5).

The shell of another species *V. pulcher* (Casey, Mesezhn. et Shulg., 1977) (holotype: Kiselev et al., 2018, Plate II, fig. 3), on the other hand, is more smoothed than in *Volgidiscus* ammonites of the middle assemblage. The shell can completely lose the ribs on

Plate II. Figs. 1–6. *Volgidiscus* cf. *lamplughi* (Spath); Upper Volgian, Volgidiscus singularis Zone, *V.* cf. *lamplughi* biohorizon. Figs. 1a, 1b. Specimen no. YarGPU Ch10c/5c-3; Rybinsk district, Vasilyevskoye village, section no. 10, Bed 5, concretion horizon b. Figs. 2a, 2b. Specimen no. YarGPU Ch10c/5a-3; Rybinsk District, Vasilyevskoye village, section no. 10, Bed 4, top. Fig. 3. Specimen no. YarGPU Ch10c/5b-2; Rybinsk district, Vasilyevskoye village, section no. 10, Bed 5, concretion horizon b. Figs. 4a, 4b. Specimen no. YarGPU Ch10c/5b-1; Rybinsk district, Vasilyevskoye village, section no. 10, Bed 5, nodule horizon b. Figs. 5a, 5b. Specimen no. YarGPU Ch6-36; Rybinsk district, Vasilyevskoye village, section no. 7, Bed 2, 0.5 m above the bottom. Figs. 6a–6c. Specimen no. YarGPU Ch10d/6-1; Rybinsk district, Vasilyevskoye village, section no. 10, Bed 6.

Plate II



adult whorls (Kiselev et al., 2018, Plate I, fig. 1) or preserve rare near-umbilical roller-shaped ribs (Kiselev et al., 2018, Plate I, figs. 2, 3). The last morph sometimes occurs in *Volgidiscus* ammonites of the middle assemblage (Plate III, fig. 6). Nevertheless, specimens with secondary ribs on adult whorls are not characteristic of *V. pulcher*.

The described morphotype is most similar to *Volgidiscus* ammonites from the Lamplughi Zone of England, illustrated in Casey (1973). An adult specimen with bradymorphic morphotype and the most differentiated sculpture (Casey, 1973, pl. 6, fig. 2) was attributed to *V. lamplughi* (Spath) (holotype: Rogov, 2014, plate II, fig. 1). This specimen hardly differs from ammonites of the Chudinovo Formation (Plate II, figs. 1, 2).

Two other adult specimens from the Lamplughi Zone were recognized by Casey as *V.* aff. *lamplughi*. One of them (Casey, 1973; pl. 6, fig. 3) is characterized by dense slightly differentiated ribbing (branching coefficient of ribs being 2). Therefore, it can be attributed to bradymorphic species. Similar specimens were not found in the Chudinovo Formation. The other specimen (Casey, 1973; pl. 5, fig. 3) has a smoothed adult shell with rare roller-shaped ribs. It corresponds to tachymorphic type, which was also found in the studied sections of the Chudinovo Formation.

Thus, *Volgidiscus* ammonites of the middle assemblages are most similar to *V. lamplughi*. In spite of the fact that some morphs of the *Volgidiscus* ammonites belonging to the lower subformation of the Chudinovo Formation are absent in the sample from the Spilsby Sandstone Formation (Lincolnshire), the similarity of these faunas is sufficient to consider them very close or equivalent.

The assemblage of subcraspeditins ammonites of Lamplughi Zone in England shows no indication of the presence of specimens that could be assigned to the genus *Anivanovia*, which constitutes a significant part of the ammonite assemblage of Singularis Zone in the upper reaches of the Cheremukha River. In sections of the Chudinovo Formation near the village of Vasilyevskoye, several specimens of this genus were found in section no. 10 together with *V.* cf. *lamplughi*. The only complete specimen from them (Plate III, fig. 1) meets all characters of the genus, i.e., relatively large size, discoconic shell, smooth last body chamber. In contrast to the type species *Anivanovia mola* Kiselev (holotype: Kiselev et al., 2018, Plate IV, fig. 1), which is characterized by high platyconic whorls with rounded ventral side, this specimen has a wider shell and rounded whorls in section. It should probably be attributed to a new species, but the lack of material does not allow a complete comparison of these two species, especially in terms of sculptural features. Therefore, the older form found together with *V.* cf. *lamplughi* is identified as *A.* aff. *mola*.

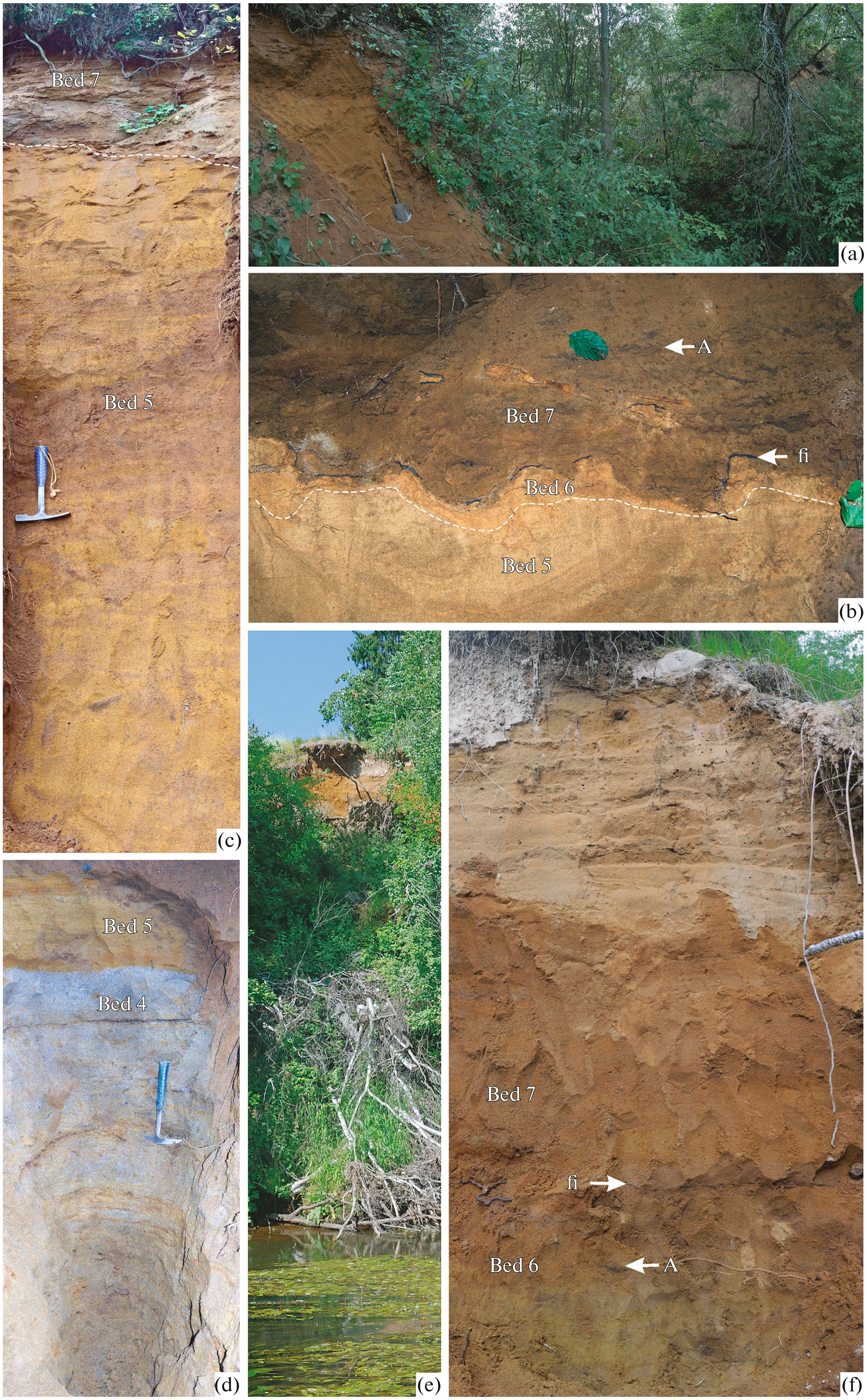
Upper assemblage of *Craspedites* ammonites occurs in the uppermost beds of the section (12–12.5 m above the water level). This assemblage was described only in section no. 7 and is represented by *V. pulcher*, *Anivanovia* sp., and *Garniericeras* sp. characterizing the V. pulcher biohorizon. This fauna was described in detail in a previous article (Kiselev et al., 2018) and is not discussed here. In section no. 10, the pulcher biohorizon should apparently be located above Bed 7. It is probably covered by talus or eroded.

SINGULARIS ZONE AND ITS PALEONTOLOGICAL SUBSTANTIATION

New data on distribution of ammonites in the Chudinovo Formation allow us to significantly clarify the boundaries of the Singularis Zone and its internal structure. The lower boundary of the zone is well defined in the lower part of the lower subformation by the first occurrence of *Volgidiscus* species above the Craspedites nodiger Zone represented by the terminal *milkovensis* biohorizon. At the base of the Singularis Zone, a new biohorizon, preliminary identified as *Volgidiscus* cf. *lamplughi*, may be proposed. This gives a good fit of boundaries of these zones in the section and allows us to consider the boundary between them as biostratigraphically continuous. The latter is due to the fact that sections with a continuous boundary between these two zones are not known in European Russia, which at present gives grounds to consider the studied sections as the most complete. Nevertheless, there is a good chance of finding an interval with a transition *Craspedites* fauna in the Chudinovian Formation. This is evidenced by the finding of *Craspedites* (?*Taimyroceras*) sp. (Kiselev et al., 2018, Plate III, fig. 7) in the upper reaches of the Cheremukha River (environs of the village of Seltso-Voskresenskoe), the position of which in the section is unfortunately unknown. It is assumed (Kiselev et al., 2018, p. 92) that this form should be found in the top of the Nodiger Zone, above the *milkovensis* biohorizon. However, it is possible that it can originate from the Singularis Zone, since *Craspedites* (*Taimyroceras*) in sections of eastern Siberia occur as far as the upper part of the Lower Ryazanian substage (Hectoroceras kochi Zone; see Rogov, 2020).

The results of studying the sections near the village of Vasilyevskoye allowed us to characterize most of the Chudinovo Formation for the first time by the distribution of ammonites. First of all, this refers to the lower subformation, where the *V.* cf. *lamplughi* biohorizon was identified. According to this, the infrazonal

Fig. 3. Outcrops of Singularis Zone near the village of Vasilyevskoye. (a–d) Section no. 7 ((a) upper part, outcrop 7c; (b, c) Beds 5–7, outcrop 7c; (d) Beds 4, 5, outcrop 7b); (e, f) outcrop 10d ((e) a general view of the outcrop from the Cheremukha River; (f) Beds 6, 7). Designations: A—findings of ammonites, fi—foliated interbeds of ferruginous sandstone.


Bed 7
Bed 5
(c)
(a)
A
Bed 7
fi
Bed 6
Bed 5
(b)
Bed 5
Bed 4
(d)
(e)
Bed 7
fi
Bed 6
A
(f)

scale of the Singularis Zone becomes more complex and includes three biohorizons: *V.* cf. *lamplughi*, *V. pulcher*, and *V. singularis* (Fig. 6). On the basis of this sequence, the correlation of the Singularis Zone with the Lamplughi Zone of England can be clarified at the infrazonal level. The position of *V.* cf. *lamplughi* (and, apparently, *V. lamplughi*) at the base of the chronological sequence of *Volgidiscus* ammonites turned out to be quite unexpected, since it was previously assumed that this species occupied an intermediate position among *Volgidiscus* species (Kiselev et al., 2018, plate I), and the *lamplughi* biohorizon should have occupied the gap between the *pulcher* and *singularis* biohorizons in the infrazonal scale or be partially correlated with the latter (Rogov, 2021).

In view of the new data, the evolution of *Volgidiscus* ammonites also appears to be more complex than previously supposed. The ancient species *V. lamplughi* had a developed sculpture on adult whorls, which is noticeable in specimens with bradymorphic morphotype. At the next stage of phylogenesis (*V. pulcher*), the sculpture on the adult whorls was reduced, indicating that the species norm is transferred to specimens of tachymorphic morphotype. Consequently, the origin of *V. pulcher* is associated with tachygenesis, or phylogenetically determined acceleration of individual development. At the next phylogenetic stage, the species norm is transferred again toward bradymorphic specimens, resulting in the appearance of *V. singularis* by bradygenesis. Thus, the evolution of *Volgidiscus* ammonites had no directional development, occurring recurrently or according to the principle of "oscillatory trends" that were characteristic of many genera of Volgian ammonites (Rogov, 2021).

Zone Volgidiscus singularis Kiselev, 2003

Nomenclature description of zone and V. pulcher and *V. singularis* biohorizons see in (Kiselev et al., 2018). Description of a new *V.* cf. *lamplughi* biohorizon is given below.

Biohorizon Volgidiscus cf. lamplughi nov.

Index species: *Volgidiscus* cf. *lamplughi* (Spath, 1936).

Stratotype: village of Vasilyevskoye, section no. 10, Beds 2–6.

Ammonites: index species (Plate I, figs. 6, 9, 10; Plate II, figs. 1–6; Plate III, fig. 2), *Anivanovia* sp. aff. *mola* Kiselev (Plate I, figs. 7, 8; Plate III, fig. 1).

Distribution: Yaroslavl Volga Region, the lower part of the Chudinovo Formation, Rybinsk district (upper reaches of the Cheremukha River).

Correlation: equivalent of *Volgidiscus lamplughi* biohorizon of England and Subpolar Urals (Table 1).

Remarks. The new data obtained when studying the section near the village of Vasilyevskoye allow us to clarify the previously proposed infrazonal correlation schemes for the terminal part of the Upper Volgian of European Russia (Singularis Zone), England and Subpolar Urals (Lamplughi Zone), and Northern Siberia (Chetae Zone). In particular, the relative position of two biohorizons of the Lamplughi Zone, *V. lamplughi* and *V. pulcher*, should be revised. In the previous version of the infrazonal scale of the Lamplughi Zone of England (Kiselev et al., 2018, Table 1), the *lamplughi* biohorizon is located above the *pulcher* biohorizon. Subsequently, the same sequence was assumed for the Lamplughi Zone of the Subpolar Urals (Rogov, 2021). Taking into account the new data obtained, it must be admitted that both biohorizons correlate in the opposite way: the *lamplughi* biohorizon should be located at the base of the zone and the *pulcher* biohorizon above it. Unfortunately, the currently available data from the sections of the Lamplughi Zone of England do not allow us to establish the sequence of *Volgidiscus* ammonites, because most specimens of this genus originate from condensed nodules not only in the Lamplughi Zone itself but also in the above-lying Runctoni Zone, where they were redeposited (Casey, 1973). The sequence of *Volgidiscus* ammonites is not reliably described in these sections. There are only suppositions about the possible existence of two levels with different species in the sections. According to this, an infrazonal subdivision can be made only theoretically. The lower *lamplughi* biohorizon can be distinguished in the Lamplughi Zone of the sections described by R. Casey (Casey, 1973): North Runcton (Runcton Beds, Bed 4); Spilsby, two wells (Spilsby, Lower Spilsby Sandstone, Bed 7). According to Casey, the *Volgidiscus* assemblage is represented here by the index species *Volgidiscus* spp. and *V.* aff. *lamplughi*.

The upper biohorizon can be distinguished only in Bed 6 of the Manor Farm section (lower part of Lower Mintlyn Beds), in which, according to Casey, three types of nodules are found. Some of the nodules originated from the underlying beds. *Volgidiscus* ammonites are present in this bed in two types of nodules: black phosphorite ones where no other ammonite species were found and black phosphorite ones with fragments of nacreous coating, where, along with *Volgidis-*

Plate III. Figs. 1a–1c. *Anivanovia* aff. *mola* Kiselev, specimen no. YarGPU Ch10c/5c-1; Rybinsk district, Vasilyevskoye village, section no. 10, Bed 5, nodule horizon b; Upper Volgian, Volgidiscus singularis Zone, *V.* cf. *lamplughi* biohorizon. Figs. 2a, 2b. *Volgidiscus* cf. *lamplughi* (Spath), specimen no. YarGPU Ch10d/6-2; Rybinsk district, Vasilyevskoye village, section no. 10, Bed 6; Upper Volgian, Volgidiscus singularis Zone, *V.* cf. *lamplughi* biohorizon.

Plate III

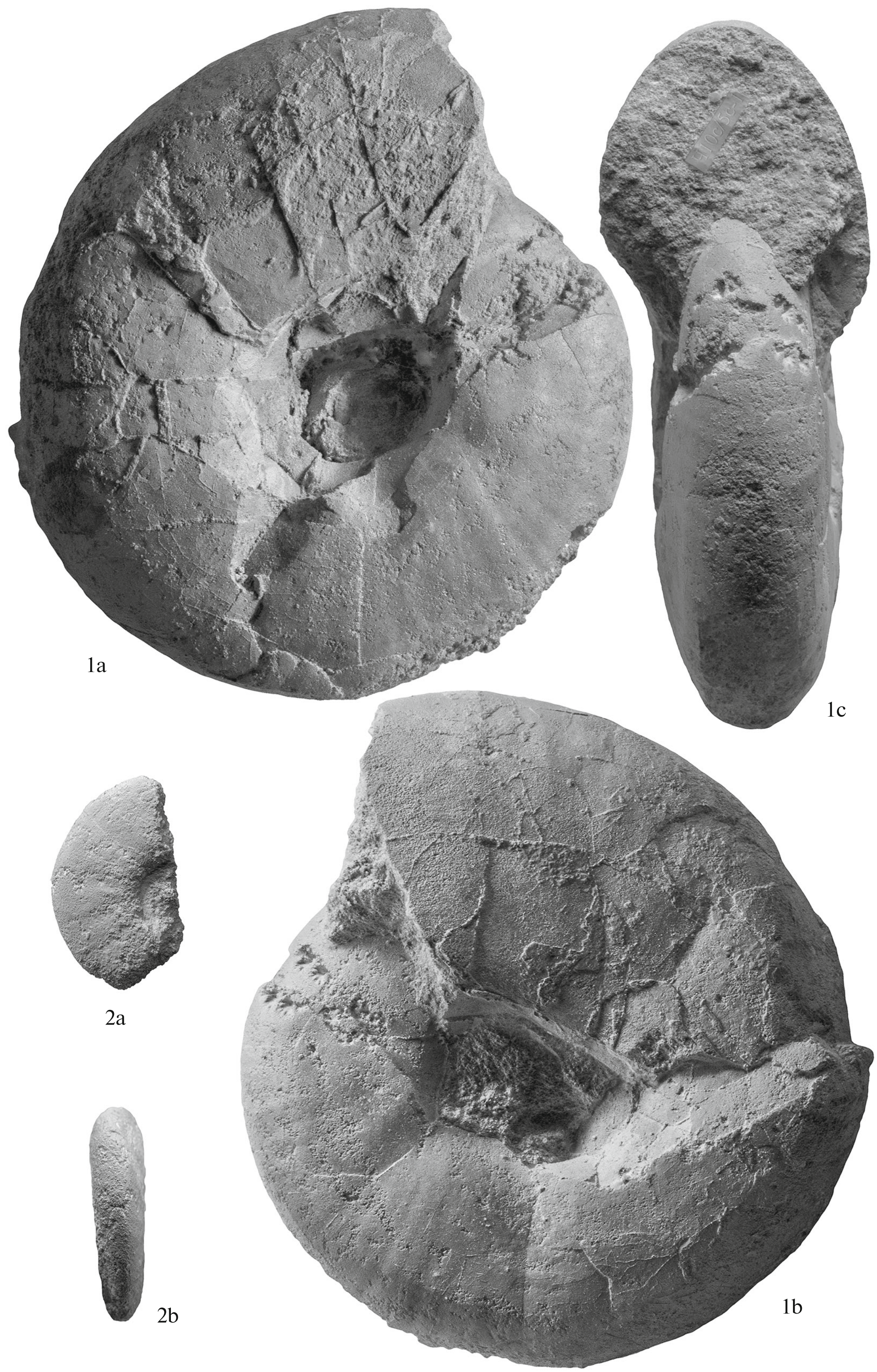


Table 1. Correlation scheme of the upper part of Upper Volgian deposits of European Russia, England, North Sea, Subpolar Urals, and Northern Siberia (modified after Kiselev et al., 2018; Rogov, 2021)

European Russia			North Sea	England	Subpolar Urals	Northern Siberia	
Zone, subzone		biohorizon	biohorizon			biohorizon	Zone
Singularis		*V. singularis*	*V. singularis*			*V. singularis*	Chetae
		V. pulcher		Lamplughi; *V. pulcher*	*V. pulcher*	*V. pulcher*	
		V. cf. *lamplughi*		*V. lamplughi*	*V. lamplughi*		
Nodiger	Milkovensis	*C. milkovensis*					Taimyrensis
	Nodiger	*C. nodiger*				*C. discoides*	
		C..transitionis					

cus ammonites, *Praetollia* (*Runctonia*) are found. The *Volgidiscus* ammonites found here were assigned by Casey to *Volgidiscus* sp. nov. The same name is assigned to a specimen from another section (Caistor); a cross-section of its shell is shown in (Casey, 1973, fig. 5i). Later (Casey et al., 1977), it was established that this specimen is similar to species *V. pulcher* and is now considered its paratype (Kiselev et al., 2018, Plate III, fig. 1). It is possible that specimens from Bed 6 of the North Runcton section can also be attributed to *V. pulcher*, but this conclusion cannot be verified before studying R. Casey's collection. The above data allow us to outline the sequence of biohorizons in England: *lamplughi* (lower) and *pulcher* (upper).

CONCLUSIONS

After the Chudinovo Formation and Singularis Zone in the Cheremukha River basin (Kiselev et al., 2018), which constitute the uppermost part of the Upper Volgian substage in European Russia, were distinguished, several questions of infrazonal subdivision of the Singularis Zone and paleontological substantiation of its lower boundary remained unsolved. The study of new outcrops in the reference section near the village of Vasilyevskoye has generally solved these problems. The position of the Singularis Zone above the Nodiger Zone was finally proved not by indirect evidence in several sections containing fragments of a unified sequence, but directly in a unified section. This has resolved the doubts about the validity of this zone and its position in the top of the Upper Volgian substage and has allowed us to abandon alternative hypotheses about the age of the Chudinovian Formation.

The new studies made it possible to paleontologically comprehensively characterize the entire Chudinovo Formation, including its lower part, in which ammonites were not found until recently. This made it possible to distinguish the *Volgidiscus* cf. *lamplughi* biohorizon at the base of the formation above the *Milkovensis* biohorizon and at the base of the Singularis Zone. Thus, the infrazonal contents of the Singularis Zone increased to three biohorizons (cf. *lamplughi*, *pulcher*, and *singularis*), which constitutes the most complete sequence of species of the genus *Volgidiscus* in the Panboreal Superrealm. In other regions of the same superrealm where *Volgidiscus* is known, namely, in England, North Sea, Subpolar Urals, and Northern Siberia, only its fragments are observed. This gives grounds to consider the sequence of biohorizons of the Singularis Zone of the Chudinovo Formation as an infrazonal standard of the upper part of the Upper Volgian substage for the entire Panboreal Superrealm.

Despite the progress in the study of the beds under consideration, there are a number of unresolved questions related to the quality of the paleontological substantiation of the lower part of the Chudinovo Forma-

Fig. 4. Outcrops of section no. 10 near the village of Vasilyevskoye. (a) General view of outcrops in the middle part of the ravine, outcrop 10b (in the background) and outcrop 10c (in the foreground); (b) Beds 5 and 6, outcrop 10c; (c) Beds 4, 5, outcrop 10b. Designations: A—findings of ammonites, fi—foliated interbeds of ferruginous sandstone, hor.—horizon.


Outcrop 10b
Outcrop 10c
(a)
Bed 5
A
Bed 4
A
A
Bed 3
(c)
Bed 6
fi
Hor. 5c
A
fi
Hor. 5b
A
fi
A
Hor. 5a
fi
Bed 5
(b)

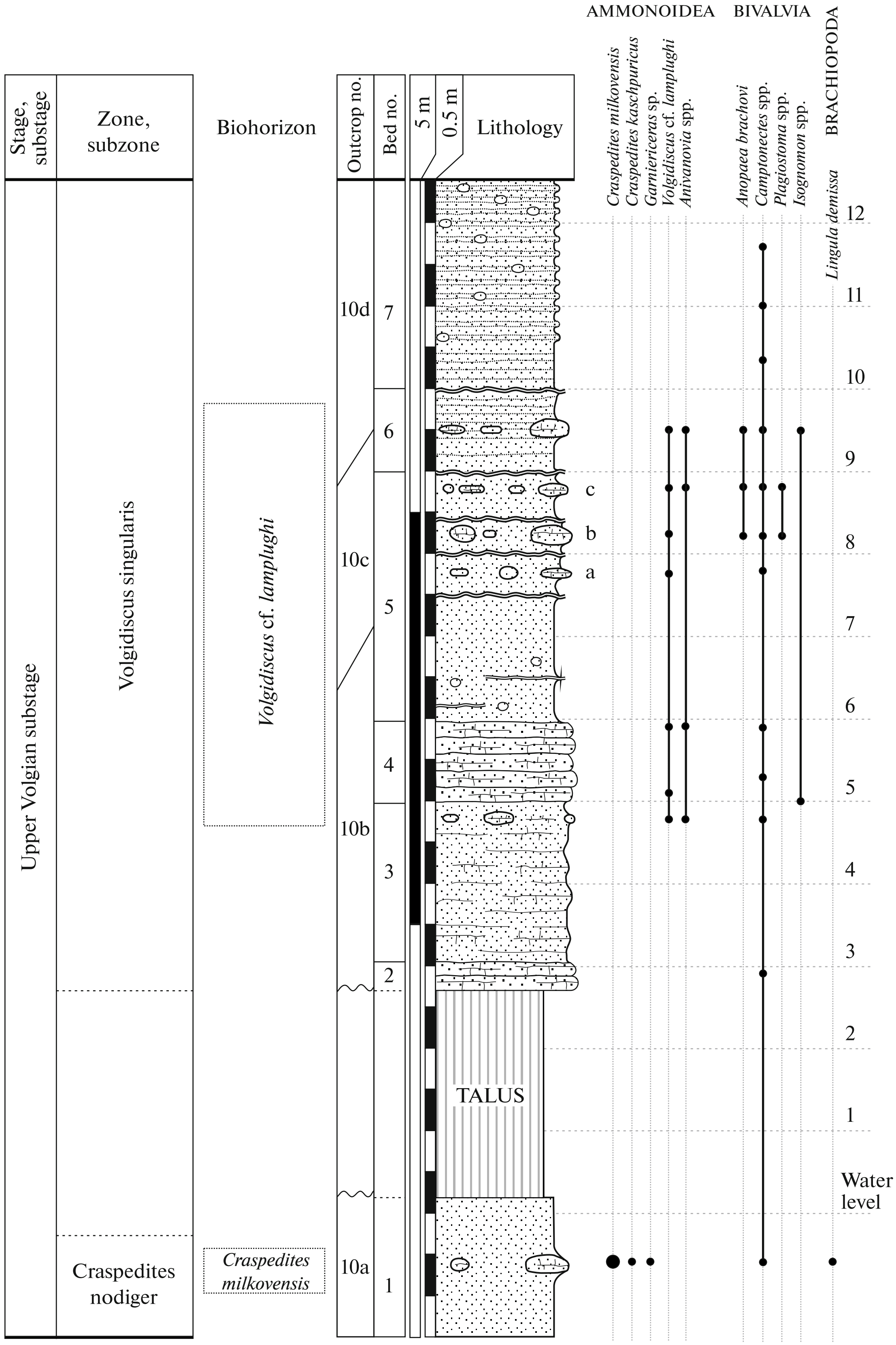


Fig. 5. Geological scheme of the Upper Volgian substage and distribution of fossils throughout section no. 10 near the village of Vasilyevskoye. See legend in Fig. 2.

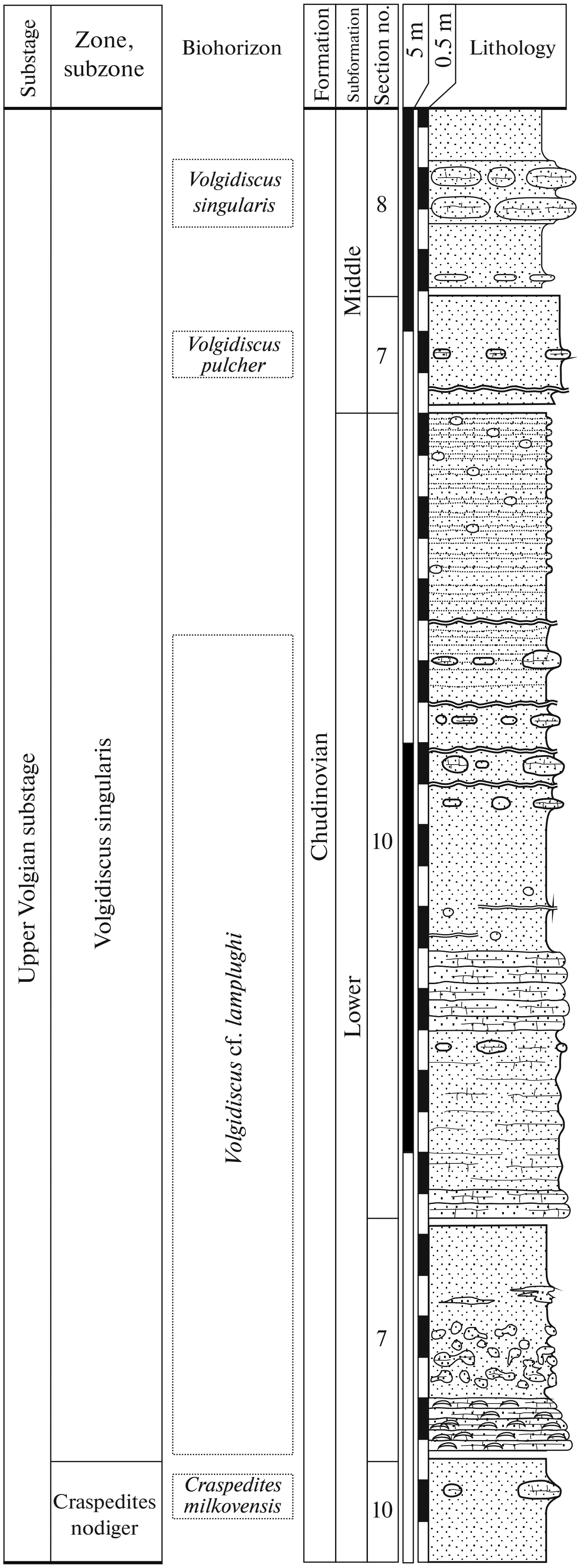


Fig. 6. Generalized section of the Upper Volgian substage in the upper reaches of Cheremukha River. See legend in Fig. 2.

tion. The poor preservation of ammonites and their occasional occurrence do not allow us to reliably identify the *Craspedites* ammonites of the *Volgidiscus* cf. *lamplughi* biohorizon. Therefore, their definitions are given in open nomenclature. It is possible that the subsequent infrazonal subdivision of the Singularis Zone may become more complex owing to the identification of new biohorizons. However, at present, we can assume that it is close to completion.

ACKNOWLEDGMENTS

We are grateful to L.M. Kiseleva (Yaroslavl) for the help in studying the sections near the village of Vasilyevskoye, and are also grateful to the reviewers for their comments.

FUNDING

This work was performed within the framework of a state assignment of the Geological Institute of the Russian Academy of Sciences (project no. 0135-2018-0035).

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

Reviewers E.Yu. Baraboshkin, V.A. Zakharov, and A.E. Igolnikov

REFERENCES

Casey, R., The ammonite succession at the Jurassic–Cretaceous boundary in eastern England, in *The Boreal Lower Cretaceous*, Casey, R. and Rawson, P.F., Eds., *Geol. J.*, 1973, Spec. Iss. 5, pp. 193–226.

Casey, R., Mesezhnikov, M.S., and Shul'gina, N.I., Correlation of the Jurassic–Cretaceous boundary deposits of England, Russian Platform, Subpolar Urals, and Siberia, *Izv. Akad. Nauk SSSR, Ser. Geol.*, 1977, no. 7, pp. 14–33.

Kiselev, D.N., Sel'tso-Voskresenskoe, in *Atlas geologicheskikh pamyatnikov prirody Yaroslavskoi oblasti* (Atlas of Geological Monuments in the Yaroslavl Region), Yaroslavl: Yaroslavl. Gos. Ped. Univ., 2003, pp. 58–62.

Kiselev, D.N., Ammonites and infrazonal stratigraphy of the boreal and subboreal Bathonian and Callovian, in *Tr. GIN RAS, vyp. 628* (Trans. Geol. Inst. Russ. Acad. Sci., Vol. 628), Moscow: GEOS, 2022.

Kiselev, D.N. and Rogov, M.A., Sel'tso-Voskresenskoe, in *Ob"ekty geologicheskogo naslediya Yaroslavskoi oblasti: stratigrafiya, paleontologiya i paleogeografiya* (Objects of Geological Heritage of the Yaroslavl Region: Stratigraphy, Paleontology, and Paleogeography), Moscow: ZAO Izd. Dom Yustitsinform, 2012, pp. 126–130.

Kiselev, D.N., Rogov, M.A., and Zakharov, V.A., The Volgidiscus Singularis Zone of the terminal horizons of the Volgian Stage of European Russia and its significance for interregional correlation and paleogeography, *Stratigr. Geol. Correl.*, 2018, vol. 26, no. 2, pp. 206–233. https://doi.org/10.1134/S0869593818020053

Mitta, V.V., Late Volgian *Kachpurites* Spath (Craspeditidae, Ammonoidea) of the Russian platform, *Paleontol. J.*, 2010, vol. 44, no. 6, pp. 622–631.

Mitta, V.V. and Starodubtseva, I.A., On some Volgian ammonites and their nomenclatural types, *Paleontol. J.*, 2018, vol. 52, pp. 469–480. https://doi.org/10.1134/S0031030118050076

Rogov, M.A., *Khetoceras* (Craspeditidae, ammonoidea)—A new genus from the Volgian stage of northern Middle Siberia, and parallel evolution of Late Volgian boreal ammonites, *Paleontol. J.*, 2014, vol. 48, no. 5 pp. 457–464. https://doi.org/10.1134/S0031030114050086

Rogov, M.A., Infrazonal ammonite biostratigraphy, paleobiogeography and evolution of Volgian craspeditid ammonites, *Paleontol. J.*, 2020, vol. 54, no. 10, pp. 1189–1219. https://doi.org/10.1134/S0031030120100068

Rogov, M.A., Ammonites and infrazonal stratigraphy of the Kimmeridgian and Volgian stages of Panboreal Superrealm, in *Tr. GIN RAN* (Trans. Geol. Inst. Russ. Acad. Sci.), 2021. Vyp. 627. https://doi.org/10.54896/00023272_2021_627_1

Rogov, M.A., Kiselev, D.N., Gulyaev, D.B., and Okhapkina, E.A., New data on Craspedites nodiger Zone (Upper Volgian sub-Stage) of the Yaroslavl Region, in *Yurskaya sistema Rossii: problemy stratigrafii i paleogeografii. Chetvertoe Vseross. Soveshch., 26–30 sentyabrya 2011 g, St. Petersburg: Nauchn. mater.* (Jurassic of Russia: Problems of Stratigraphy and Paleogeography. Proc. Fourth All-Russ. Conf., St. Petersburg, September 26–30, 2011), St. Petersburg: Izd. LEMA, 2011, pp. 184–186.

Rogov, M.A., Gulyaev, D.B., and Kiselev, D.N., Biohorizons as infrazonal biostratigraphic units: An attempt to refine the Jurassic stratigraphy based on ammonites, *Stratigr. Geol. Correl.*, 2012, vol. 20, no. 2, pp. 211–229.

Rogov, M.A., Baraboshkin, E.Yu., Guzhikov, A.Yu., Efimov, V.M., Kiselev, D.N., Morov, V.P., and Gusev, V.V., *Granitsa yury i mela v Srednem Povolzh'e. Putevoditel' ekskursii "Mezhdunarodnaya nauchnaya konferentsiya po probleme granitsy yurskoi i melovoi sistem, 7–13 sentyabrya 2015 g., g. Samara* (Jurassic-Cretaceous Boundary in the Middle Volga Region. Guidebook of Excursion "International Scientific Conference on the Jurassic-Cretaceous Boundary, September 7–13, 2015 (Samara, Russia)), Samara, Samarsk. Gos. Tekh. Univ., 2015 [in Russian].

Stremoukhow, D., Note sur la zone á *Olcostephanus nodiger* près du village Milkovo, du district de Podolsk, gouv. de Mocsou, *Bull. Soc. Impér. Nat. Moscou. N.S.*, 1892, vol. VI, no. 3, pp. 432–436.

Trautschold, H., Zur Fauna Des Russischen Jura, *Bulletin de la Société Impériale des naturalistes de Moscou*, 1866, vol. 39, no. 1, pp. 1–24.

Translated by D. Voroshchuk