# Sakmarian Gastropods from the Samarskaya Luka (Lower Permian, Volga-Urals)

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# Sakmarian Gastropods from the Samarskaya Luka (Lower Permian, Volga-Urals)

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**Abstract**—For the first time, a Sakmarian gastropod assemblage from the Samarskaya Luka (Volga-Urals Region) is described. The assemblage includes 18 species: *Apachella noinskyi* sp. nov., *Termihabena pinegensis, Worthenia morovi* sp. nov., *Baylea subpenea, Biarmeaspira verideclinata, Goniasma subangulata, Orthonema frequens, Stegocoelia samaraensis* sp. nov., *Arribazona tschernyschewi, Klavlia minuta* sp. nov., *Anomphalus murankaensis* sp. nov., *Microdoma kulogorae, Anematina permiana, Naticopsis sokensis* sp. nov., *Bulimorpha lavrskyi, Nemdaella usensis* sp. nov., *Donaldina sakmaraensis* sp. nov., *Streptacis volgenesis* sp. nov. Of these, nine species are new. Five species are in common with a synchronous, previously described assemblage from Kulogory (Arkhangelsk Region). The Kulogory assemblage is shown to contain *Baylea subpenea*. The studied assemblage is unusual largely because of its invasive origin and short duration in an isolated basin. It is not known from where the described species had emigrated. At the same time, several species, *Baylea subpenea, Goniasma subangulata*, and *Bulimorpha lavrskyi*, and also some genera (*Nemdaella, Klavlia*) are in common with the gastropod assemblages of the Kazanian basin, which also come from isolated basins.

*Keywords:* Gastropoda, Permian, Sakmarian Stage, East European Craton, Cisuralia, South Urals

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## INTRODUCTION

Our knowledge on the taxonomic diversity of Sakmarian gastropods of the East European Craton has so far been based on data from studies of the Kulogory Formation in the Arkhangelsk Region (Jakowlew, 1899; Kalmykova et al., 1978; Mazaev, 2006). This work describes for the first time an assemblage of Sakmarian gastropods from Samarskaya Luka (Middle Volga Region).

Sakmarian deposits are widespread in the northern and northeastern regions of the East European Craton, but crop out very rarely. Data on the distribution and composition of Sakmarian deposits were obtained from drilling operations (*Geologicheskoe stroenie* ..., 1957).

In the studied region, the Sakmarian Stage is represented by sediments of the epicontinental basin and includes two regional substages: Tastubian and Sterlitamakian. This division is based mainly on rock lithology and does not have a clear biostratigraphic justification. It is important to note that both regional substages were originally established in southern Cisuralia, where the Sakmarian Stage is represented by rather heterogeneous facies: from deep-sea to shallow and/or reef environments. The formation of these facies took place in depositional settings confined to the relatively deep Uralian Strait.

The intervals from which all currently known assemblages of the Sakmarian epicontinental marine gastropods originate belong to the Tastubian Regional Substage.

In the northern and northeastern parts of the East European Craton, the thickness of the Tastubian Regional Substage increases in the north and northeast directions from 0 to 70 m. The deposits are represented by dolomitic limestones with subordinate intercalations of gypsum, less commonly, clay. The overlying undivided Sterlitamak-Artinskian deposits are represented mainly by gypsum and, to a lesser extent, dolomitic limestone (*Geologicheskoe stroenie* ..., 1957).

Due to the specific taxonomic composition of the Sakmarian faunas and the abundance of interbeds of evaporites, it is generally accepted that sedimentation in this epicontinental basin occurred under conditions of increased salinity. The essence of these ideas was formed more than half a century ago, namely: "... the Sakmarian <sea> had an abnormal regime with increased salinity, which increased by the end of the stage, apparently due to its greater isolation from the oceans. Some connection with the latter probably existed only in the north <...>, within the Mezen, Kuloy and Pinega river basins, where the sediments are the least sulfatized and contain abundant fossils"

**Table 1.** Taxonomic diversity of assemblages of Sakmarian gastropods from Kulogory and Samarskaya Luka

| | Kulogory | | | | | Samarskaya Luka | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **4919/1** | **4919/2** | **4919/3** | **4919/4** | **4919/5** | **4919/28** | **4919/35** | **4919/37** | **4919/38** |
| 1. *Globodoma yakovlevi* | | X | | X | | | | | |
| 2. *Apachella noinskyi* sp. nov. | | | | | | X | | | |
| 3. *Glabrocingulum stankovskyi* | | X | | | X | | | | |
| 4. *Termihabena pinegensis* | | X | | | | X | | X | |
| 5. *Worthenia morovi* sp. nov. | | | | | | X | | | |
| 6. *Baylea subpenea* | | X | | X | X | | X | | |
| 7. *Biarmeaspira verideclinata* | X | X | X | X | X | X | X | | |
| 8. *Goniasma subangulata* | | | | | | X | X | | |
| 9. *Orthonema frequens* | | | | | | X | X | | |
| 10. *Stegocoelia samaraensis* sp. nov. | | | | | | X | | | |
| 11. *Arribazona tschernyschewi* | | X | X | X | X | X | X | X | X |
| 12. *Klavlia minuta* sp. nov. | | | | | | | X | | |
| 13. *Anomphalus murankaensis* sp. nov. | | | | | | | X | | |
| 14. *Microdoma kulogorae* | | X | | X | X | | X | | |
| 15. *Anematina permiana* | | | | | | X | X | X | |
| 16. *Naticopsis sokensis* sp. nov. | | | | | | X | | X | |
| 17. *Bulimorpha lavrskyi* | | | | | | X | X | | |
| 18. *Nemdaella usensis* sp. nov. | | | | | | | X | | |
| 19. *Donaldina sakmaraensis* sp. nov. | | | | | | X | X | | |
| 20. *Streptacis volgenesis* sp. nov. | | | | | | X | | | |
| Number of species in each region: | 7 | | | | | 18 | | | |
| Number of shared species: | 5 | | | | | | | | |

(*Geologiya SSSR*, 1963, p. 467–468). This characteristic extends not only to the northern, but also to the remaining parts of the epicontinental basin that existed on this territory in the Sakmarian (*Geologiya SSSR* ..., 1967, 1971). Later, the details of sedimentation in this area in the Sakmarian were not specifically considered anywhere. In the same vein, an explanation was found for the undersaturation (isolation) and low taxonomic diversity of mollusk assemblages of the Kulogory Formation (Mazaev, 2006).

In fact, the history of this basin may be much more complicated. At separate levels, corals, cephalopods, and echinoderms are found. The presence of these groups indicates a salinity regime that was as close as possible to normal marine. Therefore, the impoverishment of taxonomic lists and sharply depleted species composition are associated, primarily, with the isolation of the basin, and only secondarily with the salinity regime.

The origin of the Sakmarian faunas of this basin, as well as the mechanism of its isolation from the relatively deep-water Uralian corridor with such a long shared border between the two water basins, remains unknown. It is also unknown how the taxonomic lists of Asselian and Sakmarian assemblages match (given their facies dependence). Obviously, answers to these questions can only be obtained after a detailed study of the fossil faunas of all adjacent basins (both in time and in space).

The gastropod assemblage described in this work was discovered significantly south of Kulogory. The distance between the occurrences of the Arkhangelsk Region and Samarskaya Luka is approximately 1300 km. The Kulogory assemblage, as shown in this work, includes seven species, and the assemblage from Samarskaya Luka, 18 species, with five species in common (Table 1).

The low diversity and a small number of shared species is associated both with a small number of localities and the rarity of the fossils found in them, and with the undersaturation of the communities.

The undersaturation in the studied assemblages is expressed, firstly, in the “loss” of a large number of large taxa from the taxonomic lists, and secondly, in a high degree of polymorphism of such species as *Apachella noinskyi* sp. nov., *Termihabena pinegensis*, *Worthenia morovi* sp. nov., *Baylea subpenea, Biarmeaspira verideclinata, Arribazona tschernyschewi, Microdoma kulogorae,* and *Anematina permiana*.

The ratio of the number of species to the number of genera, which equals one, most likely indicates either a very low speciation rate, or the absence of speciation as such. The combination of these characteristics indicates the relatively short-term existence of these communities. Therefore, all (or almost all) of the species represented here are most likely migrants from neighboring basins. However, at present, only two species can reliably be classified as immigrants: *Orthonema frequens* and *Anematina permiana*.

Perhaps these data will change after studying the older assemblage from the Asselian Stage of the East European Craton. At the same time, a comparison of the assemblage described here with assemblage from the Asselian/Sakmarian boundary sediments of the reef limestones of Cisuralia (Mazaev, 2019a, 2019b, 2019c, 2019d, 2020) shows that of the common species, only *Orthonema frequens* is present. The morphological similarity of the new species *Apachella noinskyi* and *Termigabena pinegensis* to *A. rugosa* and *T. lirata*, respectively, needs to be mentioned. It is likely that the mismatch of the taxonomic lists of these assemblages is primarily due to differences in facies environments.

On the other hand, the described assemblage contains *Baylea subpenea, Goniasma subangulata,* and *Bulimorpha lavrskyi*, species that, on the contrary, were previously known from the geochronologically younger Kazanian basin.

In addition, the assemblage contains species of such genera as *Klavlia* and *Nemdaella*, which were previously described from the Kazanian basin and were considered monotypic (Mazaev, 2015, 2017, 2018). Most of the remaining species from the assemblage described here should be formally considered endemic. However, given the low degree of knowledge of Sakmarian and earlier faunas, as well as ideas about the pace of morphogenesis, their interpretation as endemic species cannot be considered unambiguous. If this is so, the question arises of where were the refugia from which these forms migrated to this basin? This question is associated with the problem of the origin of later Kazanian faunas. Among the described species, *Worthenia morovi* sp. nov. is of particular interest. This is the first reliable find of a representative of the genus *Worthenia* in the Paleozoic sediments of the East European Craton and the Urals. The reasons for the absence of *Worthenia* at other stratigraphic intervals remain unknown.

## ABBREVIATIONS

The following abbreviations are used in this paper: TSNIGR Museum—F.N. Tshernyshev Central Geological Research Museum; PIN—A.A. Borissiak Paleontological Institute of the Russian Academy of Sciences; KGM—A.A. Stuckenberg Museum of Geology and Mineralogy of Kazan Federal University.

## HISTORY OF STUDY

In 1897, N.N. Jakowlew at the request of A.P. Pavlov identified a small collection of fossils collected on the right bank of the Volga River, near the village of Pecherskoe ("Nadezhda" tunnel). Identifications were published in the field guide of the 7th International Geological Congress. Later, these materials were reidentified (Jakowlew, 1900).

Based on a short list of species, which includes eight species of gastropods, one species of bivalve mollusk, and one species of brachiopods, Jakowlew concluded that this assemblage is similar to the "Permo-Carboniferous" assemblages from the Oka-Tsna Swell of the Moscow basin and the Bakhmut Depression of the Donets Basin. Unfortunately, the list of species indicated by Jakowlew is not accompanied by descriptions or images, and the collection itself is probably lost. In 1900, M.E. Noinsky, passing through Samarskaya Luka, discovered near the Muranka Mill an outcrop of dolomites with numerous imprints of molluskan shells.

The similarity of this assemblage with the "Permo-Carboniferous" assemblage described by Jakowlew prompted Noinsky to begin studying Carboniferous and Perm deposits of Samarskaya Luka. He began their detailed study two years later with the support of the Society of Naturalists of the Imperial Kazanian University. Many years of research were summaries in his extensive monograph on the geological structure of Samarskaya Luka, containing both general conclusions and descriptions of numerous outcrops (Noinsky, 1913).

Noinsky subdivided the Paleozoic deposits of Samarskaya Luka into three large intervals: Carboniferous, "Permian-Carboniferous", and Permian (or "Zechstein"). Noinsky's Carboniferous interval included the Kasimovian, Gzhelian, and most of the Asselian Stage (*Schwagerina* Beds). The Permian-Carboniferous included the terminal parts of the Asselian Stage and Sakmarian Stage, and the Permian interval corresponds to the Kazanian Stage. Each of these intervals was divided by Noinsky into horizons that were designated by indices.

The "Permian-Carboniferous" of Samarskaya Luka was subdivided by Noinsky into three horizons: CPa, CPb, and CPc. This stratigraphy is based on lithology. As was shown in Noinsky's work, the lower horizon is characterized by the greatest diversity of fossils, and in the CPb and CPc horizons, there is not only a decrease in the total number of species, but also a sharp decrease in the number of taxa of higher ranks. The total number of species of gastropods indicated by

Noinsky in the Permo-Carboniferous is 41, of which 26 species were listed as new, and two species, in open nomenclature.

Despite the large number of studied outcrops, the maximum variety of Permo-Carboniferous mollusks was noted by Noinsky just in the outcrop near the Muranka Mill. From this location, Noinsky points out 19 species of gastropods: "*Murchisonia ussensis* n. sp., *Murchisonia tschernyschewi* Jakowlew, *Wortheniopsis kyschertianaeformis* Jakowlew, *Pleurotomaria granuliscincta* n. sp., *Pl. subgranuliscincta* n. sp., *Pl. murankana* n. sp., *Pl. stukenbergi* n. sp., *Pl. parae-Kingi* n. sp., *Pl. Kingi* Jakowlew, *Porcellia minuta*, *Straparollus euomphaloides* n. sp., *Naticopsis parvula* n. sp., *N. volgensis* Stukenberg, *N. netschaewi* Stukenberg, *N. Stukenbergi* n. sp., *Tuberculopleura media* n. sp., *T. densituberculopleura* n. sp., *Omphaloptycha permiana* Jakowlew, *Subulites permocarbonica* n. sp." (original spelling retained, Noinsky, 1913, p. 310).

As a result of research conducted on the Samarskaya Luka, Noinsky developed the paradigm of a "gradual demise of the Carboniferous Sea while preserving relict forms in the isolated Permo-Carboniferous Sea". Following this paradigm, dolomitic limestones of Muranka, as containing the most diverse assemblage, were assigned to the lower horizon CPa.

Despite the presence of only one common species, Noinsky included the assemblage of species identified by Jakowlew from the "Nadezhda" tunnel in the same horizon: *Wortheniopsis kyschertianaeformis* Jakowl., *W. grandicarinata* Jakowl., *Pleurotomaria* n. sp., *Trachydomia wheeleri* Swall., *Portlockia rotundata* var. *densistriata* n. var., *Tuberculopleura anomala* Jakowl., *Bellerophon* cf. *clauses* Gemm., *Bellerophon* sp. (original spelling retained, Jakowlew, 1900). Evidently, this decision was mainly based on the assertion that this assemblage was sampled above the *Schwagerina* Horizon (Jakowlew, 1900).

The mismatch of these lists is probably a result of the assemblage identified by Jakowlew being Asselian, while the assemblage of Muranka is Sakmarian. It is also interesting that Noinsky never mentioned the similarity of the Muranka assemblage to the assemblage from Kulogory, which was previously described by Jakowlew from the Arkhangelsk Region (Jakowlew, 1899).

Unfortunately, the second part of Noinsky's work, which contained paleontological descriptions, remained unpublished. During the fieldwork, Noinsky collected and processed a very representative collection of invertebrates. The whereabouts of this collection is unknown and probably lost. From the entire collection, no more than 10 imprints of gastropods shells and bivalves are left in the KGM collection. The initial scope of this collection can be judged by the number of identifications indicated both in the tables and in the descriptions of sections. Noinsky accompanies the description of the Kazanian interval only with taxa of previously established species, but at the same time notes that the number of species gastropods should be tripled after their study (!). Unfortunately, because Noinsky's manuscripts and collections were lost, all taxa he established are nomina nuda.

Thus, the taxonomic lists cited by Noinsky cannot be checked or used as valid names. However, the quantitative characteristic, regardless of the correctness of the identifications and the validity of taxa, reflects a trend towards a decrease in diversity in the so-called "Permo-Carboniferous". In general, Noinsky's general conclusions about the staged and regular development of the "Russian Sea" in the Carboniferous, Permo-Carboniferous and Permian formed the basis of current ideas and did not undergo any significant changes.

After the work of Noinsky and Stuckenberg from the Carboniferous and Permian deposits of Samarskaya Luka, only two species of Paleozoic gastropods were described (more precisely—revised): *Termihabena pinegensis* from the Sakmarian and *Alanstukella rossica* from the Upper Carboniferous (Mazaev, 2019a, 2020).

## MATERIAL

Occurrences of Sakmarian mollusks in the East European Craton are very rare. This is due both to a relatively small number of outcrops and a strong secondary dolomitization of Sakmarian carbonates. Therefore, finds of single specimens play an important role in the increase of taxonomic lists. However, given the small number of locations and secondary changes in the rocks, the rarity of such specimens are unlikely to indicate rarity of the species themselves.

The materials described in this work were collected by the present author from the Soksky Quarry (field season 2013), as well as from a natural outcrop near the village of Muranka (field season 2015) (Figs. 1b, 1c).

The outcrops of Sakmarian Stage rocks were also found in sections of the Bogatyr (field seasons 2015 and 2019) and Yablonevyi Ovrag quarries (field season 2019) (Fig. 1a).

In the Soksky Quarry, despite its size, Sakmarian deposits were only discovered in its southeastern part, in the uppermost carbonate ledge. The length of this outcrop is no more than 20 m. This section of the quarry has not been developed for several decades and is overgrown with small bushes and trees. The occurrence was only discovered thanks to V.P. Morov, who took part in one of the fieldtrips and pointed to it. The material was collected from blocks of limestone that fell out of the ledge.

The lower part of the ledge is covered with scree. Above the scree, the following sequence is observed (bottom to top, Fig. 2a).

Bed 1. Limestones, strongly dolomitized, white, medium-, large-block, strongly cavernous, in some

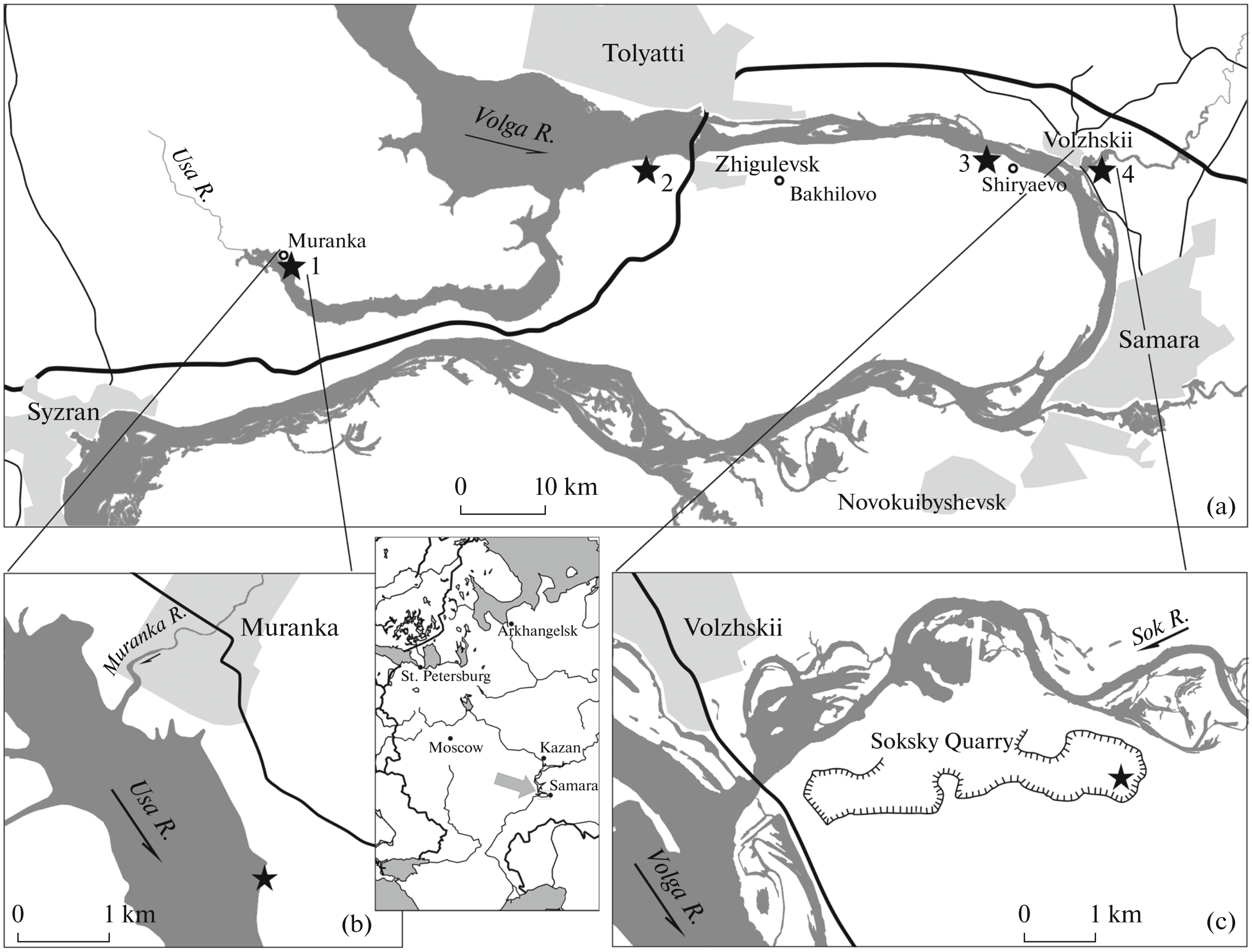


**Fig. 1.** Geographical location of the Sakmarian Stage outcrops on Samarskaya Luka is indicated by asterisks: (1) outcrop near Muranka (locality no. 4919/35), (2) top of the carbonate section in the Yablonevyi Ovrag quarry (locality no. 4919/38), (3) third ledge on top of the carbonate section in the Bogatyr Quarry (locality no. 4919/37), (4) top of the carbonate section in the Soksky Quarry (locality no. 4919/28).

places becoming dolomite powder. Visible thickness up to 5 m.

Bed 2. Limestones clayey, light gray, brownish, dense, sometimes laminated, with finely cubic cleavage 3–7 cm, barren. Thickness 2 m.

Bed 3. Grainstone fine, medium-grained, with a large number of small rounded bioclasts. Thickness 0.2 m.

Bed 4. Limestone strongly dolomitic, gray, very strong, sometimes secondarily silicified, cavernous, medium, large block. Thickness 1.5–2 m. Numerous prints of mollusk shells, as well as uniform brachiopods, bryozoans, sponges, elongated voids (possibly plant roots). Leached bioclasts are randomly located, form unsorted, sporadically occurring clusters.

Bed 5. Limestone breccia. Crushed carbonate from 3 to 7 cm in a brown matrix. Visible thickness 0.5 m.

In Bed 1, one imprint of a large *Bellerophon* was discovered. This is the only find of fossilized residues at this level. Imprints of *Schwagerina* shells, present lower in the section in the horizons of silicified limestone, are absent in this bed. Until now, the finds of bellerophontids in the Sakmarian were not known, but they sporadically occur in horizons with *Schwagerina*. Therefore, Bed 1, most likely, refers to the Asselian. Moreover, the grainstone member (Bed 3) probably terminates a cyclothem. Therefore, only Bed 4 belongs to the Sakmarian stage in this section. Breccia formation (Bed 5) is probably associated with later karst processes.

More than 600 gastropod imprints were collected from Bed 4 (locality no. 4919/28). Unfortunately, the surface of many prints is either partially dissolved or coated with very small crystals of calcite. In addition, dolomitic limestone abundantly contains small pores, so the surface of latex casts, especially small ones, does not always reflect the details of the shell morphology.

The Bogatyr Quarry exposes the most complete of all openings on the Samarskaya Luka. This section

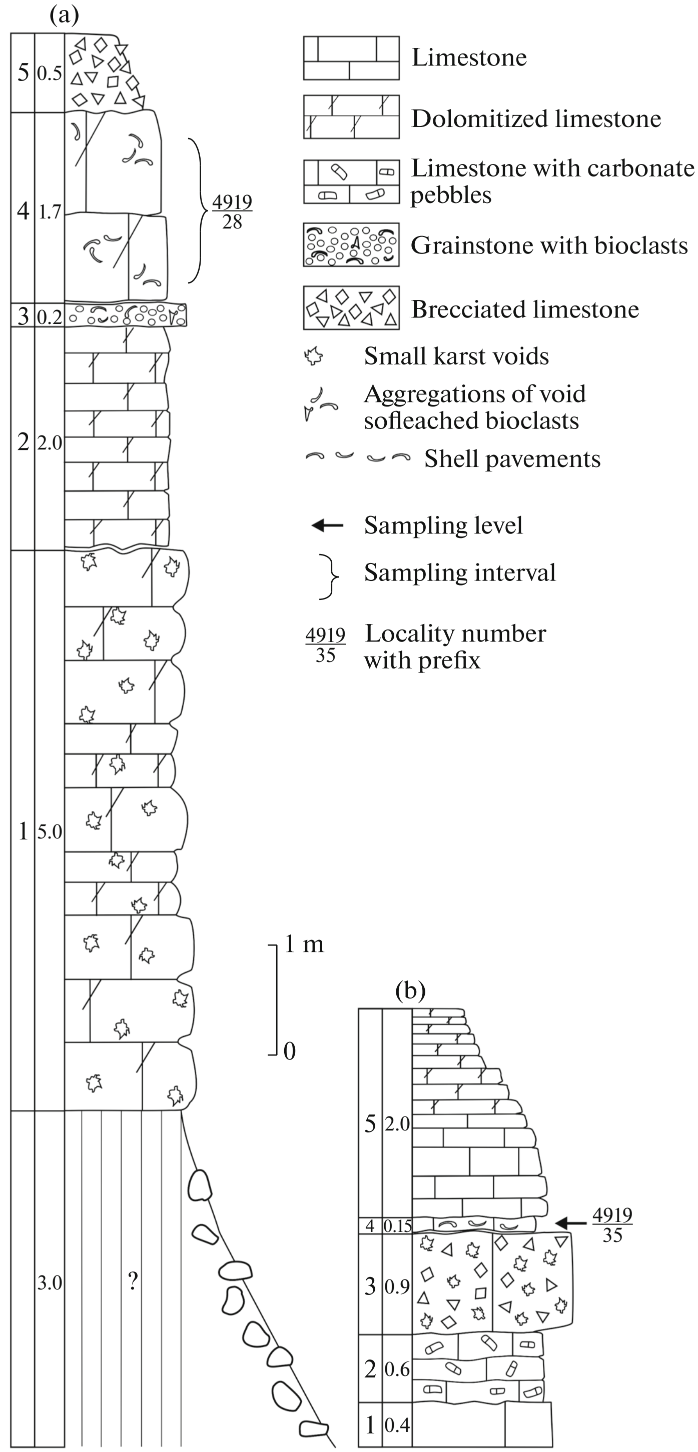


**Fig. 2.** Stratigraphic position of the localities: (a) in Soksky Quarry, no. 4919/28 and (b) on the right bank of the Usa River, 1.3 km downstream of the mouth of the Muranka River, no. 4919/35.

includes the Kasimovian and Gzhelian stages of the Upper Carboniferous, as well as the Asselian, Sakmarian, and Kazanian stages of the Permian. The two upper ledges are composed of Kazanian deposits. The underlying carbonates of the Asselian and Sakmarian stages are strongly dolomitized, often represented by dolomite powder. The Sakmarian Stage interval is mostly reclaimed. In the course of the work, we found numerous aggregations of boulders of dolomitic limestones, identical to dolomitic limestones from locality no. 4919/28. Isolated specimens were selected from the boulders: *Termihabena pinegensis, Arribazona tschernyschewi, Anematina permiana, Naticopsis sokensis* sp. nov. (locality no. 4919/37). The location of Sakmarian gastropods in the area of the village of Muranka was found on the left bank of the Usa River about 2.5 km downstream of the mouth of the Muranka River. It is difficult to say how this location correlates with Noinsky's locality. The Muranka mill, which was located near the mouth of the Muranka river, has long been destroyed and in its place there is a gentle, overgrown slope. In addition, the level of the Usa River has risen dramatically since the construction of a hydroelectric power station in Zhigulevsk.

At present, along the water edge there is a low but steep ledge ca. 0.5 km long composed of carbonate rocks. From the water edge, the following sequence is observed (Fig. 2b).

Bed 1. Limestone white, light yellow, dense, medium-grained, coarse-grained. Visible thickness 0.4 m.

Bed 2. Argillaceous limestone, turning into clayey marl, yellow, brown in the upper part, lumpy, with a large number of white and light green calcareous pebbles, pebble size from 3–5 cm. Bed boundaries are uneven, thickness 0.6 m.

Bed 3. Dolomitic brecciated limestone, yellow, cavernous, caverns from 0.5 to 5 cm. Thickness 0.9 m.

Bed 4. Weakly dolomitized mudstone, yellow or white, very dense, with a large number of leached bioclasts. At the bottom of the horizon there are "shell pavements". Thickness 0.15 m.

Bed 5. Mudstones, white, from coarse-grained below, to thin-plate above, dolomitized in the upper part, sometimes becoming dolomite powder. Visible thickness 2 m.

Material was collected from Bed 4 (locality no. 4919/35). Along with gastropods, there are imprints of shells of uniform brachiopods, large fusulinids, crinoid columnals, and bryozoans.

The described section shows the least degree of dolomitization. Its correlation with the described interval from the Soksky Quarry is difficult. At the same time, the Muranka section can obviously be correlated with the Sakmarian interval in the Yablonevyi Ovrag Quarry. This interval corresponds to the uppermost ledge, which is located on the western side of the quarry. Unfortunately, starting in 2013, access to the Yablonevyi Ovrag Quarry was closed. We managed to get into the quarry only in 2019 for several hours. The top of the upper ledge is composed of limestones similar to the limestones of locality no. 4919/35. Imprints of uniform brachiopods and *Arribazona tschernyschewi* (locality no. 4919/38) were found in the limestones.

All studied material is represented by imprints of shells in the rock. The new collection is housed in the A.A. Borissiak Paleontological Institute of the Russian Academy of Sciences. (PIN, no. 4919).

## SYSTEMATIC PALEONTOLOGY

**Family Eotomariidae Wenz, 1938**

**Subfamily Neilsoniinae Knight, 1956**

**Genus *Apachella* Winters, 1956**

***Apachella noinskyi* Mazaev, sp. nov.**

E t y m o l o g y. In honor of the Russian geologist and paleontologist, Professor of Kazan University M.E. Noinsky.

H o l o t y p e. PIN, no. 4919/28-510, paratypes: nos. 4919/28-503, 4919/28-507, 4919/28-509; shell imprints; Samara Region, Soksky Quarry, locality no. 4919/28.

D e s c r i p t i o n (Fig. 3). The shell is small, turriform, of about six rapidly growing whorls.

The protoconch is formed by at least two smooth and round whorls, the first whorl is planispiral. The initial whorls are almost rounded, ornamented with spiral lirae with equal, relatively wide intercostal spaces. The selenizone is wide, on the second whorl is shifted from the suture by a distance equal to its width.

The upper part of the lateral surface is twice as wide as the lower part of the whorl lateral surface, in the profile from slightly convex to slightly concave, inclined to the shell axis at 25° to 30°. The subsutural ridge is distinct, well developed on the last three whorls. The selenizone lies in line with the upper part of the whorl lateral surface and is 1/4 of its width on the last whorl. The surface between the suture and selenizone is ornamented with three spiral lirae, the thickness of the upper lira is almost equal to the thickness of the selenizone lirae, the thickness of the remaining lirae is less, the upper lira marks the subsutural ridge. A thin filiform lira can be formed and located between the suture and the upper lira. Collabral ribs are short, more massive than spiral lirae, slightly rise above them, sometimes formed as wide ridges, developed between the suture and the second spiral lira of the first order, almost orthocline.

The lower part of the lateral surface in the profile is slightly concave, inclined to the axis of the shell approximately the same as the upper part of the lateral surface whorl; on top it is bounded by the lower lira of the selenizone, below by a cordlike lira of about the same thickness; two more thinner lirae separated by equal spaces are located between them. The lower lira marks a weak angular transition to the basal surface.

The basal surface is moderately convex in profile, drawn down, ornamented with about ten spiral lirae, which are separated by identical, relatively narrow intercostal spaces.

The suture is thin, crisp, located above or below the lower lira of the lower part of the lateral surface.

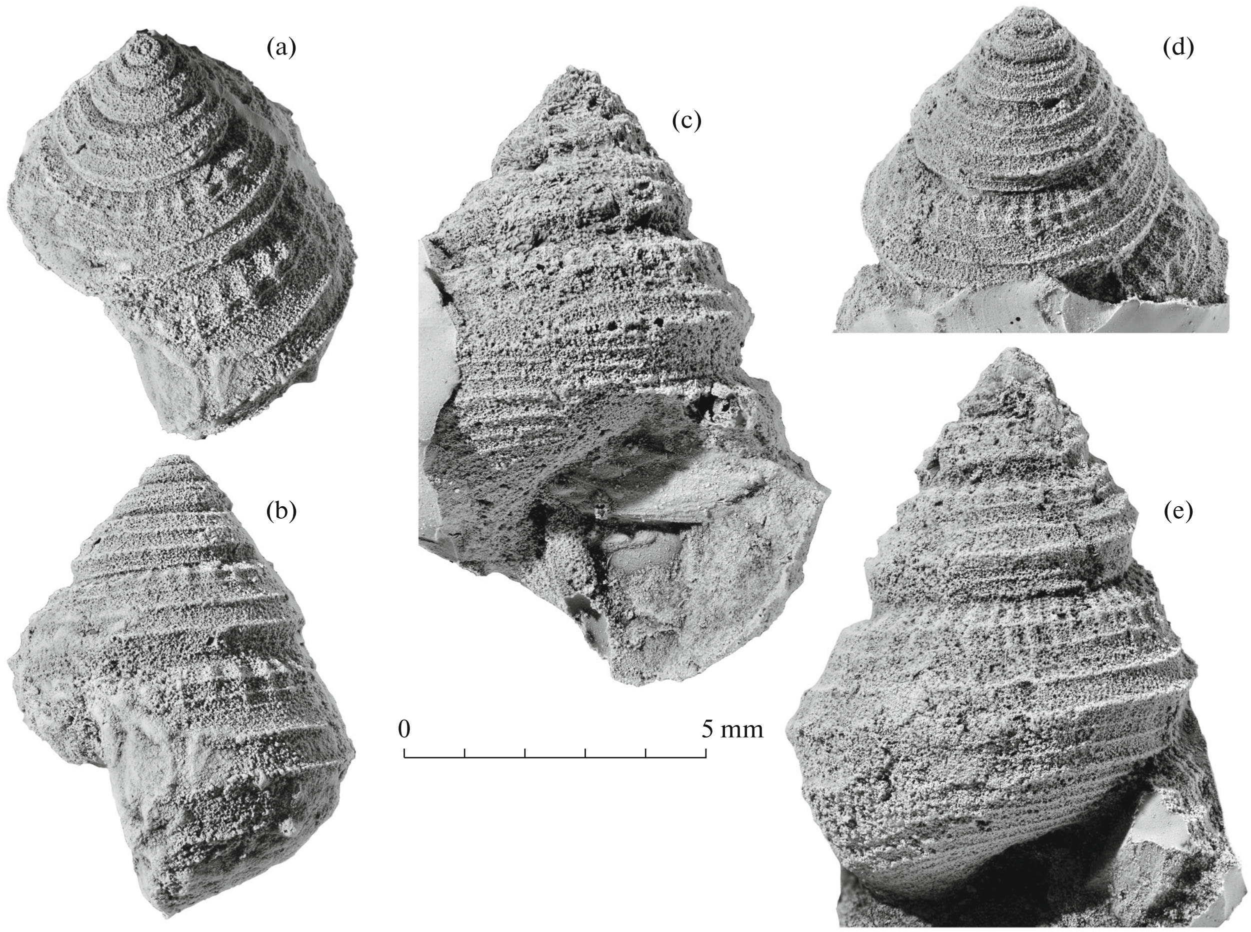


**Fig. 3.** *Apachella noinskyi* Mazaev, sp. nov.; latex casts, all ×8: (a, c) paratype no. 4919/28-503: oblique top view, lateral view; (c) paratype no. 4919/28-510, apertural view; (d, e) paratype no. 4919/28-509, oblique top view, apertural view.

The height of the aperture is approximately equal to its width. The columellar lip is massive, flattened, slightly arched, and slightly inclined to the axis of the shell. The apertural margin is thin. The notch is not preserved. The umbilicus, if present, is very narrow, slit-like. No growth lines were observed.

D i m e n s i o n s i n m m:

| Specimen no. | Max. diameter | Shell height |
|---|---|---|
| 4919/28-503 (paratype) | 6.2 | 7.7 |
| 4919/28-509 (paratype) | >7.3 | >10.2 |
| 4919/28-510 (holotype) | >7.5 | 10.3 |

C o m p a r i s o n. The new species is very similar to *A. rugosa* Mazaev, 2019, which differs from it by a more elongated shell and a wider surface above the selenizone in the first two adult whorls. The new species differs from *A. nodosa* Batten, 1989, in the straight section of the upper surface of the whorl between the subsutural ramp and selenizone. From *A. huecoensis* Batten, 1989, the new species differs in the wider whorl surface over the selenizone

R e m a r k s. In Noinsky's collection several samples have imprints, but not all of their identifications are written on the labels. Most likely, Noinsky's species described here referred to as "*Pleurotomaria muranka*".

O c c u r r e n c e. Type locality.

M a t e r i a l. Altogether six specimens from the type locality, also two specimens in Noinsky's collection (KGM, coll. no. 17, specimens nos. 339, 379; Muranka Mill).

### Family Phymatopleuridae Batten, 1956

### Genus *Termihabena* Mazaev, 2019.

#### *Termihabena pinegensis* Mazaev, 2019

*Euconospira? pinegensis*: Mazaev, 2006, p. 48, pl. 5, fig. 3, 4.

*Termihabena pinegensis*: Mazaev, 2019c, p. 31, fig. 4.

H o l o t y p e. PIN, no. 4919/1-14, shell imprint; Russia, Arkhangelsk region, Pinega River, Lower Permian, Sakmarian Stage, Kulogory Formation.

D e s c r i p t i o n. See description of *Termihabena pinegensis* in Mazaev, 2019c, p. 31.

R e m a r k s. The genus, in addition to the six species mentioned earlier (Mazaev, 2019), should include another species that was described by Jakowlew as *Pleurotomaria kingii* (Jakowlew, 1899, p. 26, pl. 4, fig. 21). The only specimen of this species is represented by the imprint of a shell in compact yellow limestone (TsNIGR Museum, specimen no. 76/325). Jakowlew pointed out that in his collection "there is a fairly significant number of imprints of this form at Vyksa, ..., there are several imprints from Spas-Ivanovo and the Tara River...". Specially, the descriptions of the morphology of the aperture and umbilicus were made by Jakowlew based on the study of these imprints, because these shell characters are missing from the print of the original. Unfortunately, all duplicate material is lost. It is impossible to determine the exact age of the specimens collected in the Monastyrski Mine, because this location no longer exists.

Jakowlew's species is very close to *T. pinegensis*, from which it differs in the more convex basal whorl surface.

O c c u r r e n c e. Arkhangelsk and Samara regions, Lower Permian, Sakmarian Stage.

M a t e r i a l. Two specimens from the Arkhangelsk Region and 63 specimens from Samarskaya Luka: 61 specimens from locality no. 4919/28, two specimens from locality no. 4919/37, and also one imprint in Noinsky's collection (KGM, coll. no. 17, specimen no. 379; Muranka Mill).

**Family Lophospiridae Wenz, 1838**

**Genus *Worthenia* Koninck, 1883**

***Worthenia morovi* Mazaev, sp. nov.**

E t y m o l o g y. In honor of V.P. Morov who discovered this locality.

H o l o t y p e. PIN, no. 4919/28-522, paratype no. 4919/28-525, shell imprints; Samara Region, Soksky Quarry, locality no. 4919/28.

D e s c r i p t i o n (Fig. 4). A trochiform medium-sized shell of 6–7 whorls with a sharp carina. The embryonic shell consists of at least two and a half evenly rounded smooth whorls. The first one and a half to two whorls are planispiral; subsequent whorls are offset along the axis. The maximum diameter is about 0.9 mm.

The first adult whorl carries a wide selenizone. The selenizone separates the relatively narrow subsurface ramp and the slightly concave side surface of the whorl, which is almost parallel to the shell axis. A weak subsutural ridge is present on the subsutural ramp. The selenizone in the profile is sharply concave, bounded by two spiral lirae, the lower ridge marks a sharp shoulder.

The morphology of subsequent adult whorls is different: the width of the subsutural ramp increases, its profile, like the profile of the lateral surface whorl, becomes distinctly concave, the lower edge of selenizone shifts to the side surface of whorl, the profile of the selenizone becomes sharply convex, angular, its central part marks the shoulder. The basal whorl surface is convex in profile, separated from the lateral and umbilical surfaces by a distinct shoulder. The umbilical surface is convex. The umbilicus is very narrow. The suture on the initial whorls is thin, on the last whorls narrow and deep.

The shell surface is ornamented with cordlike spiral lirae. The subsutural ridge impressed to the suture, on the first whorl smooth, on subsequent whorls marked by a cordlike lira, sharply tuberculate. The subsutural area between the subsutural ridge and selenizone on the last whorls is ornamented with two or three spiral lirae, the thickness of which is less than the thickness of the ribs bounding selenizone. The selenizone is sharply wavy, in the central part it is ornamented with thin spiral lirae, the number of which varies from one to two, the lunulae, if any, are weak. The lateral surface is ornamented with spiral lirae, the number of which on the last whorl reaches eight, the upper lirae are thinner than the lower ones, the latter are comparable in thickness to the ribs bounding the selenizone. The lower lira marks the relatively sharp inflection of the lateral surface into the basal. The basal surface carries about eight relatively massive spiral lirae. Intercostal spaces between them, especially in the upper part, can carry thinner spiral lirae of the second order. The umbilical surface has no spiral lirae but carries coarse collabral wrinkles.

The aperture is almost round in plan, sharply elongated from the axis in the notch area. The palatal and columellar lips are sharply brought together, smoothly passing into a very short parietal edge. The columellar lip is massive, flattened in the lower part, evenly curved, smoothly passing into the basal lip.

The growth lines on the subsutural ramp are prosocyrtic, generally inclined prosoclinally, adjoin the suture at right angles, form sharp lunulae on the selenizone, sharply opistocline, sharply inclined directly under the selenizone, form a sharp arch on the lateral surface, and prosocyrtic on the basal surface.

The aperture is almost round in plan, in the area of the notch sharply elongated from the axis.

D i m e n s i o n s i n m m:

| Specimen no. | Shell height | Max. diameter |
|---|---|---|
| 4919/28-522 (holotype) | >10.0 | ≈8.5 |
| 4919/28-525 (paratype) | >10.6 | 8.1 |

C o m p a r i s o n. The new species is similar to *W. tabulata* (Conrad, 1835) and *W. kingi* Batten, 1989, from which it is distinguished by the prominent subsutural ramp and slit-like umbilicus.

R e m a r k s. Growth lines were observed only on shell imprints with an eroded surface.

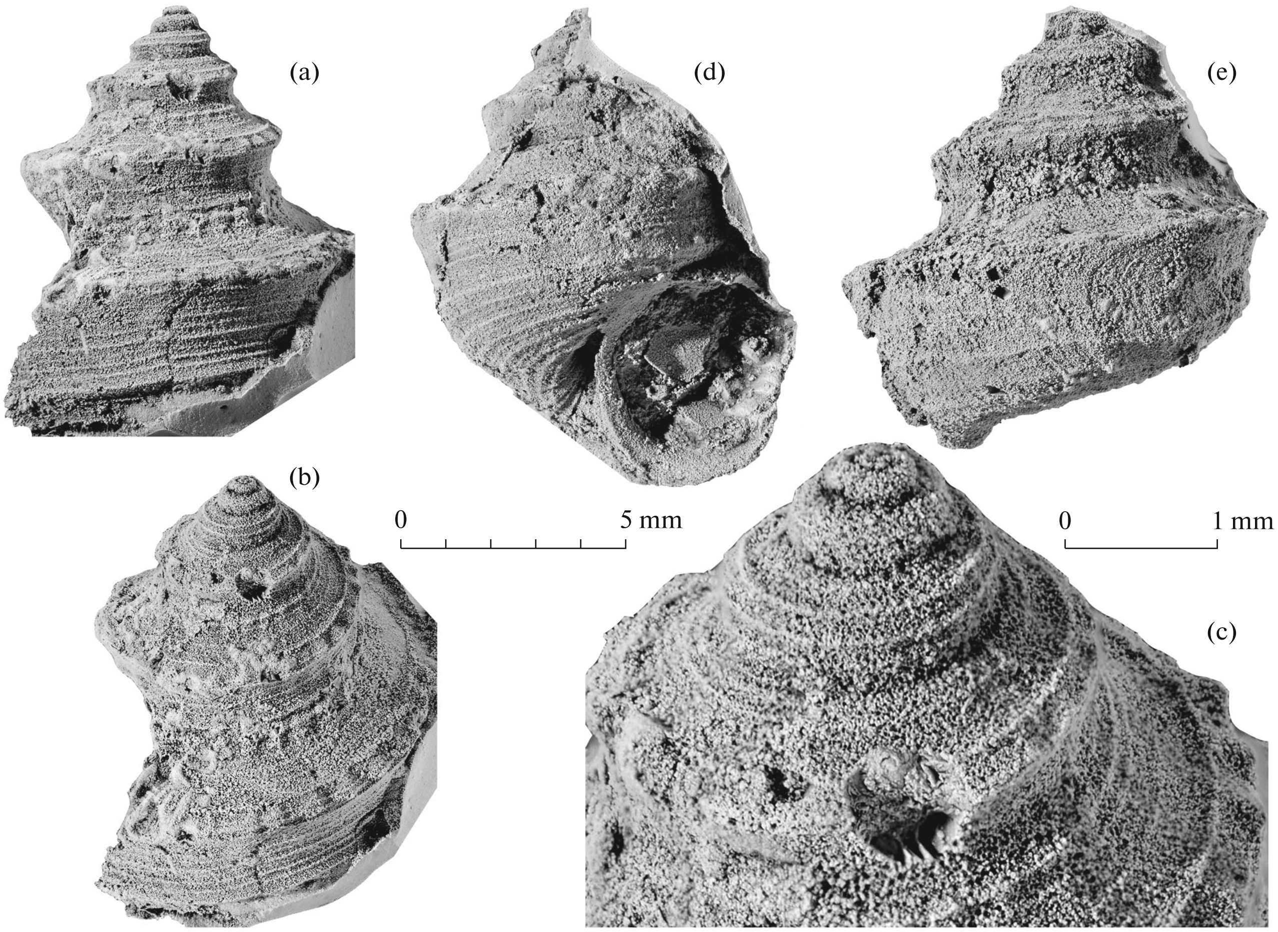


**Fig. 4.** *Worthenia morovi* Mazaev, sp. nov.; latex casts, all ×6, except for (c): (a–c) holotype no. 4919/28-522: (a) lateral view, (b) oblique top view, apertural view; (c) protoconch and initial whorls, ×20; (d) paratype no. 4919/28-525, apertural view; (e) specimen no. 4919/28-526, lateral view.

In Noinsky's collection, there is one imprint of poor state of preservation, which may belong to the shell of the species described here (however, it might be *Biarmeaspira verideclinata*) (KGM, coll. no. 17, specimen no. 214; Muranka Mill). Judging by the label, Noinsky defined it as "*Pleurotomaria subgranuliscincta*".

M a t e r i a l. Altogether 13 specimens from the type locality.

## Genus *Baylea* Koninck, 1883

### *Baylea subpenea* (Netschaev, 1894)

*Pleurotomaria subpenea*: Netschaev, 1894, p. 329, pl. 11, fig. 14.

*Baylea subpenea*: Mazaev, 2015, p. 906, pl. 10, figs. 4–12; pl. 11, figs. 1–4; text-fig. 11d; Mazaev, 2016, p. 598, pl. 6, fig. 6.

non *Biarmeaspira verideclinata*: Mazaev, 2006, pl. 4, fig. 18 (part).

D e s c r i p t i o n (Fig. 5). See Mazaev, 2015, p. 906.

D i m e n s i o n s i n m m:

| Specimen no. | Shell height | Max. diameter |
|---|---|---|
| 4919/35-20 | 3.85 | 3.44 |
| 4919/35-23 | >6.20 | >5.30 |
| 4919/35-24 | 7.45 | 6.45 |
| 4919/35-25 | 4.30 | 3.70 |
| 4919/35-35 | 3.31 | 3.00 |
| 4919/35-34 | 2.07 | 2.04 |

C o m p a r i s o n. This species has a clear resemblance to *B. kuesi* Batten, 1995, from which it differs by a noticeable increase in the distance between suture and subsutural ridge during shell growth. From *B. nemdaensis* Mazaev, 2015, this species differs in the angular profile of the last whorls, a slightly convex or almost flat subsutural ramp, and in most cases in the slenderer shell. In differs from *B. vjatkensis* Mazaev, 2015 in the absence of a thin selenizone stage, simultaneous appearance of spiral lirae restricting the selenizone, and their equal thickness on the first teleo-

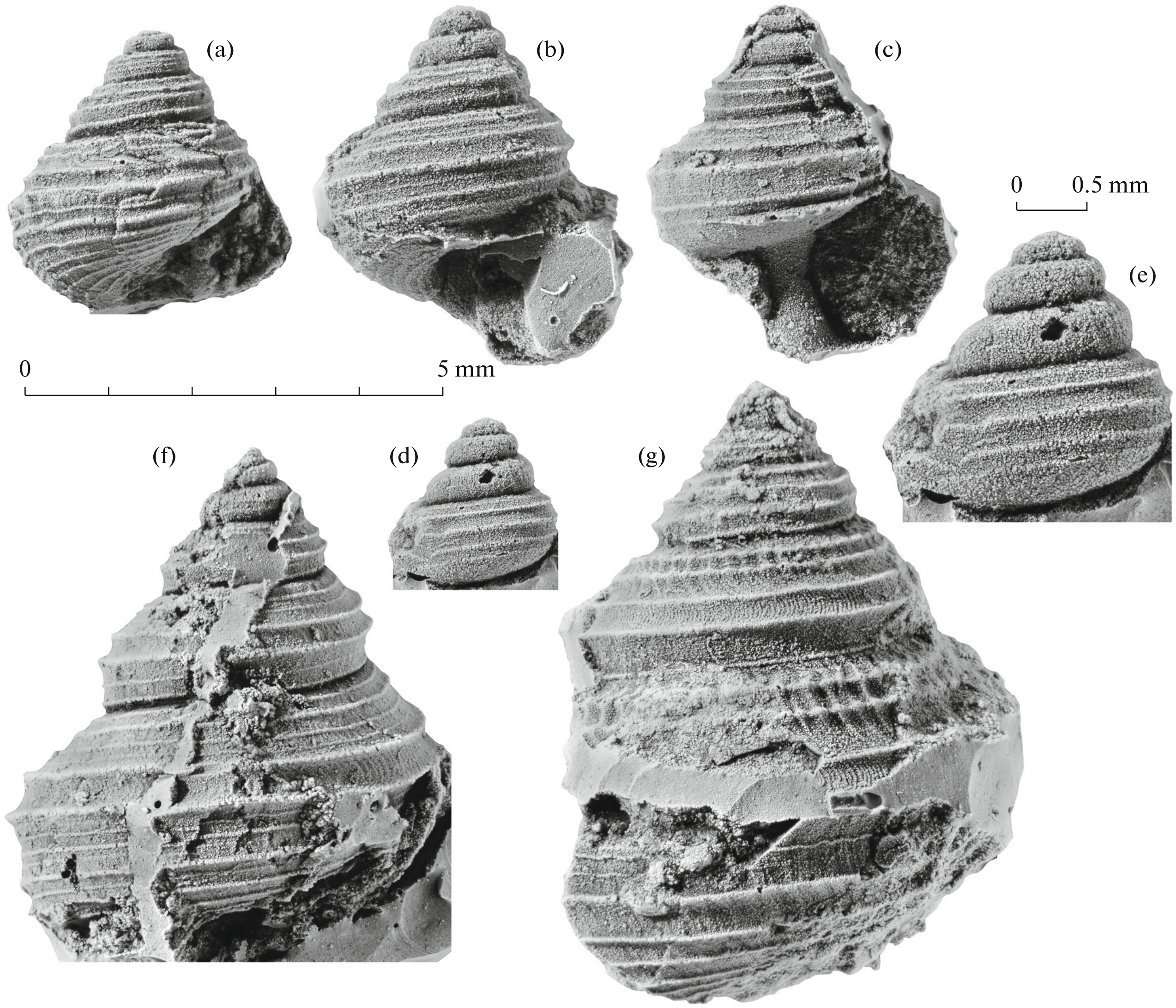


**Fig. 5.** *Baylea subpenea* (Netschaev, 1894); latex casts, all ×12, except fig. (d): (a) specimen no. 4919/35-31; (b) specimen no. 4919/35-20; (c) specimen no. 4919/35-25; (d) specimen no. 4919/35-34; (e) the same specimen, ×20; (f) specimen no. 4919/35-23; (g) specimen no. 4919/35-24.

conch whorl, as well as the larger and rounded first teleoconch whorls, lower and wider first angular whorl, and the wider selenizone on adult whorls.

Remarks. This species is found for the first time in the Sakmarian Stage. Previously seven specimens of this species found in the Arkhangelsk Region were erroneously assigned to *Biarmeaspira verideclinata* (Mazaev, 2006, pl. 4, fig. 18).

In the sample from locality no. 4919/35 many signs of shells vary widely. New observations allow some changes to be made to the diagnosis of the species that was proposed previously (Mazaev, 2015).

The number of whorls of the embryonic shell varies from three to four, while its diameter varies from 0.6 to 1.3 mm. Based on the profile of the first two adult whorls, the studied sample is divided into approximately two parts. On some shells, whorls are almost rounded, the lirae are divided by equal intercostal spaces, their differentiation and the formation of a relatively wide area under the lower selenizone lira begins at about the third adult whorl (Fig. 5g). On the shells of the second group, the differentiation of intercostal spaces and the formation of a flattened area under the lower selenizone lira can begin already on the first whorl (Figs. 5a–5f). The number of shells of the second group is much larger than the number of shells of the first group. In samples from Kazanian locations, this ratio is the opposite. The number of multilirate specimens in the studied sample is significantly larger than in samples from the Kazanian Stage locations.

The degree of development of auxiliary second-order lirae in different specimens is not the same and may be mistaken for independent species characters.

So, in some specimens, additional lirae of the second order can be developed one at a time in all intercostal spaces, including those between the suture and subsutural lirae, while their thickness significantly differs from the thickness of the main lirae (Fig. 5f).

In other specimens, auxiliary second-order lirae can be developed only on one or more intercostal spaces (Figs. 5a, 5b, 5g). In some specimens from Kazanian samples, the thickness of the auxiliary lirae below the suture is equal to the thickness of the subsutural ridge (Mazaev, 2015, pl. 11, figs. 1, 3). In the studied sample there is an instance with the same set of features (Fig. 5g). In addition, it is distinguished by a developed collabral ornamentation on the subsutural ridge of the last two whorls. Nodes are present in the intersections of the collabral and spiral elements of the shell ornamentation. A similar combination of characters in this species is observed for the first time and only in one specimen.

In Noinsky's collection there is one imprint of this species (KGM, coll. no. 17, specimen no. 292; Muranka Mill). As indicated on the label, Noinsky identified it as "*Pleurotomaria kyschertianaeformis* Jakow. var. *lata*".

O c c u r r e n c e. Volga-Urals Region; Lower Permian, Sakmarian Stage; Middle Permian, Kazanian Stage; Arkhangelsk Region; Lower Permian, Sakmarian Stage.

M a t e r i a l. Altogether 68 specimens. Sakmarian Stage: Samarskaya Luka—18 specimens from locality no. 4919/35, Arkhangelsk Region—three specimens from locality no. 4919/2, two specimens from locality no. 4919/4, two specimens from locality no. 4919/5. Kazanian Stage, Volga-Urals Region: nine specimens from the Lower Kazanian Substage and 33 specimens from the Upper Kazanian Substage.

### Genus *Biarmeaspira* Mazaev, 2006

#### *Biarmeaspira verideclinata* Mazaev, 2006

*Biarmeaspira verideclinata* (part): Mazaev, 2006, p. 45, pl. 4, figs. 1–17, 19–22; text-fig. 2; non pl. 4, fig. 18.

D e s c r i p t i o n (Fig. 6). See Mazaev, 2006, p. 45.

D i m e n s i o n s i n m m:

| Specimen no. | Shell height | Max. diameter |
|---|---|---|
| 4919/28-511 | 5.7 | 5.3 |
| 4919/28-512 | 7.7 | 6.7 |
| 4919/28-514 | 6.4 | >6.0 |
| 4919/28-530 | 11.8 | 10.1 |

C o m p a r i s o n. This species differs from other *Biarmeaspira* species in the very late (only on the third whorl of the teleoconch) shift of lower lira of the selenizone to the lateral surface of whorl.

R e m a r k s. In the Sakmarian sediments of the Arkhangelsk Region, this species is represented by diverse morphotypes, which probably show all possible variants of species variability. In Samarskaya Luka samples, variability is expressed only in a slight change in the apical angle, in the appearance of wrinkles near the subsutural ridge, and also in the development of a weak keel in most specimens. In general, the morphology of shells from Samarskaya Luka is probably consistent with the norm. A few deformed imprints of this species from Samarskaya Luka, as well as some of the specimens from Arkhangelsk Region with strongly developed carinae (Mazaev, 2006, pl. 4; figs. 4, 5, 9, 10, 13, 14, 17, 21, 22), resemble imprints of *Worthenia morovi* sp. nov. The difference between the species is minimal, lies mainly in the structure of selenizone and the subsutural ridge on adult whorls.

Since the selenizone profile on the initial whorls is concave and becomes convex only after the third adult whorl, the juvenile shell of *Biarmeaspira verideclinata* may be erroneously assigned to some *Baylea* species. An additional spiral lira appears on the selenizone only in the third whorl of the teleoconch directly above the lower selenizone lira; in adult whorls it is central and mark the shoulder (Figs. 6a–6c). In the studied samples, the characters of the selenizone development was very stable. In poorly preserved specimens, the appearance of an additional lira above the lower selenizone lira is poorly distinguishable (Mazaev, 2006, pl. 4, figs. 19–21). Juvenile specimens of *Biarmeaspira verideclinata* can hardly be distinguished from specimens of *Baylea subpenea* (Netschaev, 1894). The latter, as it turned out, are also present in the studied samples. So, among the previously studied specimens from the Arkhangelsk Region identified as *B. verideclinata*, seven specimens belong to *Baylea subpenea* (Mazaev, 2006, pl. 4, fig. 18).

O c c u r r e n c e. Sakmarian Stage, Samara and Arkhangelsk regions.

M a t e r i a l. Altogether 168 specimens, Samara Region: seven specimens from locality no. 4919/28 and one specimen from locality no. 4919/35, and also 160 specimens from localities of the Arkhangelsk Region.

### Family Goniasmatidae Nützel et Bandel, 2000

### Genus *Goniasma* Tomlin, 1930

#### *Goniasma subangulata* (Verneuil, 1845)

*Murchisonia subangulata*: Verneuil, 1845, p. 340, pl. 22, fig. 6; Golovkinsky, 1868, p. 108, pl. 5, fig. 7, 8; Netschaev, 1894, p. 333, pl. 12, figs. 1, 2, Jakowlew, 1899, p. 31, pl. 4, fig. 25.

*Goniasma subangulata*: Mazaev, 2015, p. 936, pl. 24, figs. 2–7, Mazaev, 2018, p. 815, pl. 17, figs. 3–8.

*Murchisonia biarmica*: Netschaev, 1894, p. 335, pl. 12, fig. 3; Jakowlew, 1899, p. 35, pl. 4, fig. 28 (non *Murchisoni abiarmica* Kutorga, 1842).

*Murchisonia golowkinskii*: Jakowlew, 1899, p. 33, pl. 4, figs. 26, 27.

*Goniasma golowkinskii*: Mazaev, 2015, p. 939, pl. 24, fig. 1; pl. 25, figs. 1–11; pl. 38, fig. 5.

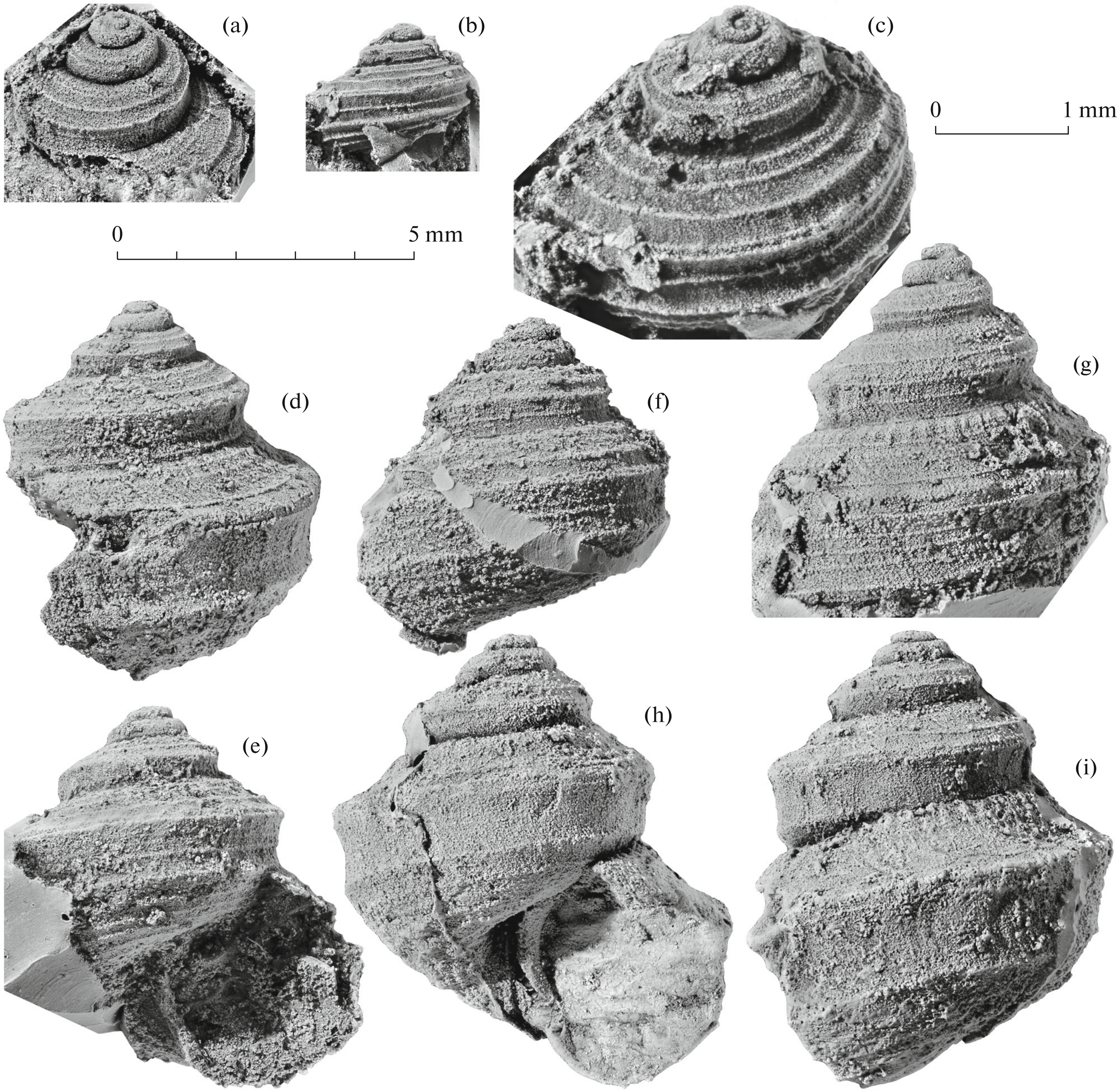


**Fig. 6.** *Biarmeaspira verideclinata* Mazaev, 2006; latex casts, all ×9, except fig. c: (a) specimen no. 4919/28-519; (b) specimen no. 4919/35-36; (c) the same specimen, oblique top view, ×20; (d, e) specimen no. 4919/28-514: lateral view, showing the depth of the notch and apertural view; (f) specimen no. 4919/28-511; (g) specimen no. 4919/28-528; (h, i) specimen no. 4919/35-24: apertural view and lateral view.

D e s c r i p t i o n (Fig. 7). See a description of *G. golowkinskii*: Mazaev, 2015, p. 939; and also remarks in Mazaev, 2018, p. 815.

D i m e n s i o n s i n m m:

| Specimen no. | Shell height | Max. diameter |
|---|---|---|
| 4919/28-433 | >9.2 | 3.6 |
| 4919/28-457 | 6.9 | 2.6 |
| 4919/28-460 | 7.5 | 2.9 |

R e m a r k s. Previously, the stratigraphic distribution of this species was limited to the Kazanian. The specimens of this species found in the Soksky Quarry are represented by shells of small and medium sizes. All of them belong to the morphotype, which is most often found in the facies of the shallow submarine plains of the Kazanian basin.

Judging by the label, Noinsky called this species "*Murchisonia ussensis*". One of the imprints with the label is kept in KGM (coll. no. 232). On the same

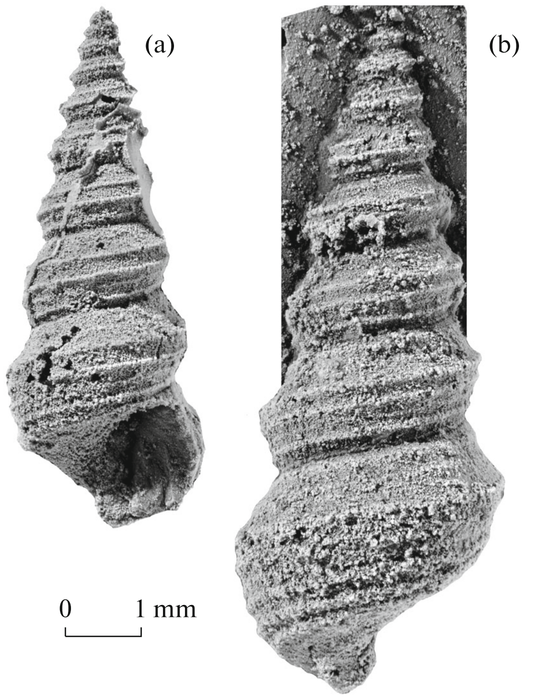


**Fig. 7.** *Goniasma subangulata* (Verneuil, 1845); latex casts, all×10: (a) specimen no. 4919/28-457; (b) specimen no. 4919/28-433.

specimen there is a shell imprint of *Bulimorpha lavrskyi*.

O c c u r r e n c e. Volga-Urals Region; Sakmarian and Kazanian stage.

M a t e r i a l. 23 specimens from the Sakmarian Stage: locality no. 4919/28—22 specimens, locality no. 4919/35—one specimen, and also more than 150 specimens from the Kazanian Stage.

### Family Orthonematidae Nützel et Bandel, 2000

### Genus *Orthonema* Meek et Worthen, 1862

#### *Orthonema frequens* Licharew, 1968

*Orthonema frequens*: Licharew, 1968, p. 42, pl. 12, figs. 1–7, text-fig. 13, 14;

Mazaev, 2002, p. 97, text-figs. 1A, 2A, 4A–4F (non *Orthonema frequens* Licharew, 1968).

Mazaev, 2019d, p. 1301, figs. 50a–50e.

H o l o t y p e. TsNIGR Museum, coll. no. 8336, specimen no. 369; Central Asia, South Fergana, Kara-Chatyr Range; Lower Permian, Kara-Chatyr Stage.

D e s c r i p t i o n (Fig. 8). See the description of *Orthonema frequens*: Mazaev, 2019d, p. 1301.

D i m e n s i o n s i n m m:

| Specimen no. | Shell height | Max. diameter |
|---|---|---|
| 4919/35-4 | 6.9 | >2.8 |

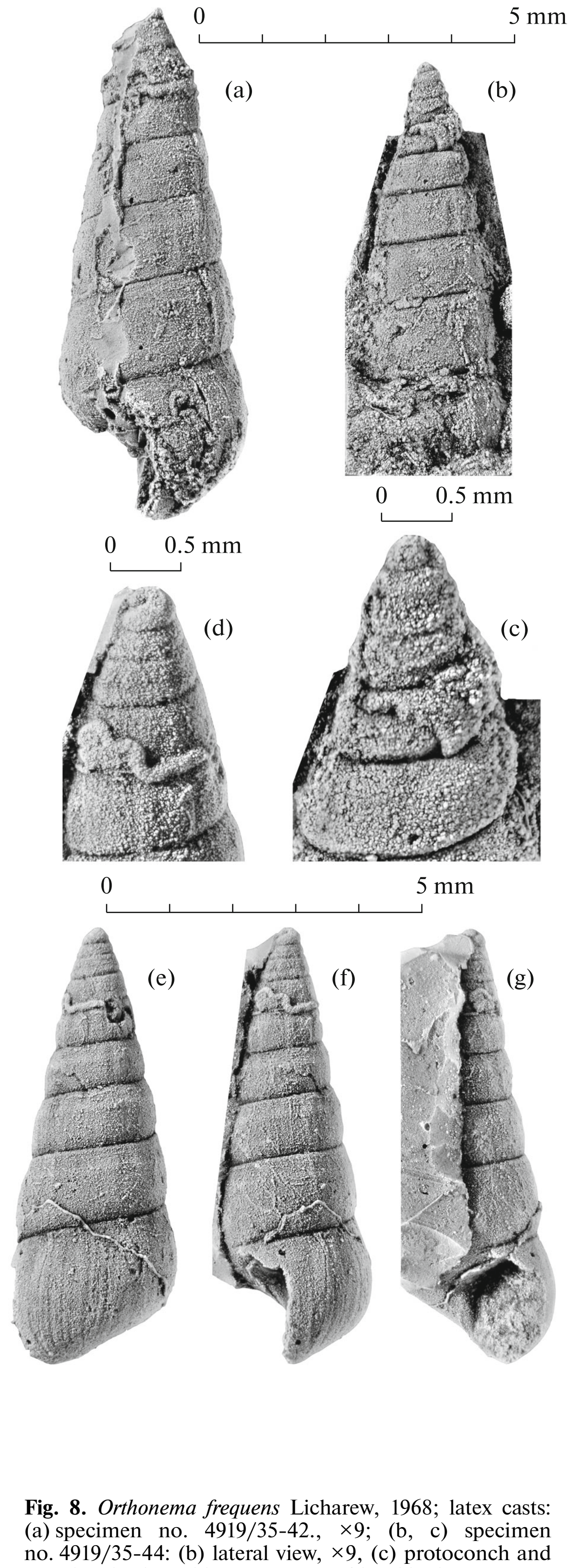


**Fig. 8.** *Orthonema frequens* Licharew, 1968; latex casts: (a) specimen no. 4919/35-42., ×9; (b, c) specimen no. 4919/35-44: (b) lateral view, ×9, (c) protoconch and initial whorls, oblique view, ×20; (d–g) specimen no. 4919/35-4: (d) protoconch and initial whorls, ×20, (e–g) view opposite to aperture, (f) lateral,(g) apertural view, ×9.

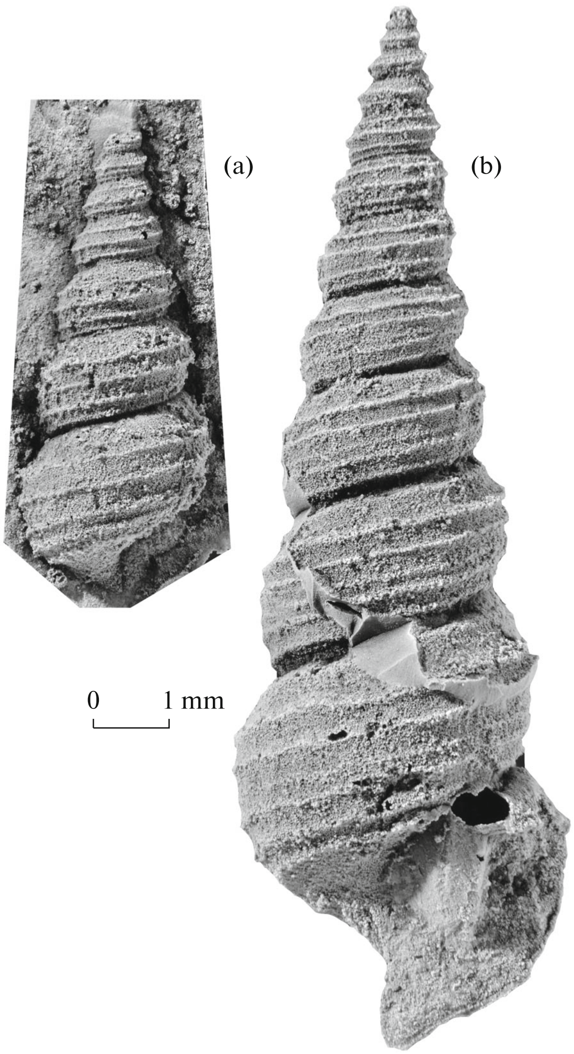


**Fig. 9.** *Stegocoelia samaraensis* Mazaev, sp. nov.; latex casts, all ×10: (a) paratype no. 4919/28-448; (b) holotype no. 4919/28-466.

C o m p a r i s o n. This species differs from *O. salteri* (Meek et Worthen, 1860) in the higher whorls, and also in the less scalate whorl profile.

R e m a r k s. In the Sakmarian limestones of Samarskaya Luka, this species was found only in locality no. 4919/35. All specimens are represented by the morphotype, which B.K. Licharew named as var. *laevis* in the original description of the species (Licharew, 1968, p. 43, pl. 12, figs. 13–17). Due to the large geographical and temporal hiatus, this variety can hardly be considered as a subspecies. A characteristic feature of the shells of this morphotype is the tendency to complete loss of the elements of spiral ornamentation. Due to the disappearance of the ribs, the lateral surface whorl profile becomes uniformly convex, while in forms with a developed spiral sculpture it is almost straight or slightly concave. The whorls profile of this morphotype coincides with the profile of the last whorls of adult forms in which the spiral sculpture is developed in the primary and secondary whorls, but is reduced in the latter (Mazaev, 2019d, text-figs. 50b, 50e). In all the studied specimens, either the lower edge of the upper pair, which marks a weak shoulder, or the lower edge of the lower pair is very weakly pronounced. On one of the specimens, of all the ribs, only one lira of the lower pair was developed. The lateral surface profile of this specimen is almost straight.

O c c u r r e n c e. Asselian Stage, Central Asia, South Cisuralia; Sakmarian Stage, Samarskaya Luka.

M a t e r i a l. Altogether 13 specimens: two specimens from locality no. 4919/28; five specimens from locality no. 4919/35, and six specimens from the Asselian-Sakmarian boundary beds of Shakh-Tau (Mazaev, 2019d).

### Genus *Stegocoelia* Donald, 1889

#### *Stegocoelia samaraensis* Mazaev, sp. nov.

E t y m o l o g y. From the city of Samara.

H o l o t y p e. PIN, no. 4919/28-466, paratype 4919/28-448; shell imprints. Samara Region, Soksky Quarry, locality no. 4919/28.

D e s c r i p t i o n (Fig. 9). A high medium-sized shell consisting of numerous, rapidly growing whorls. The structure of the protoconch is unknown, probably consisting of two smooth whorls. The first four or five teleoconch whorls possess a sharp keel that marks the lower lira of the selenizone. The subsutural ridge is of moderate width, the upper selenizone lira lies almost in the middle. The gap between the suture and the upper lira is slightly convex, the selenizone surface is sharply concave. The lateral surface is sharply inclined to the axis of the shell, with an almost straight profile, on the fourth and fifth whorl is ornamented with a lower pair of primary spiral lirae. The width of the intercostal space of the lower pair is two times less than the width of selenizone. The gap between the lower selenizone lira and the upper lira of the lower pair is equal to the width of selenizone. In adult whorls, the lateral surface profile, as well as the number and position of the ribs, changes. The subsutural ramp is bounded by the upper selenizone lira, its width is equal to or slightly greater than the selenizone width. Near the suture, a weak subsutural ridge is formed. The sharp keel disappears, the surface of the selenizone occupies an almost subvertical position. The selenizone lies in line with the side surface, the whorl peripheral point is marked by the upper and/or lower margin of the selenizone. The lateral surface of adult whorls in the profile is slightly convex, occupies an almost subvertical position. The width of the intercostal space of the lower pair is equal to the width of the selenizone. An additional second-order lira may appear on the intercostal space between pairs of main lirae. The thickness of the additional lira is less than or comparable with the thickness of the main lirae. The whorl basal surface is moderately convex; its border with the lateral surface is marked by the lower lira of the lower pair of main spiral lirae. The basal surface on the last whorl is ornamented with one massive and two very weak spiral lirae. The intercostal space between the massive lira and the lower lira of the lower pair is less than the width of the selenizone, the remaining intercostal spaces are slightly concave, their width is comparable to the width of the selenizone. The suture is clear, impressed, lies under the lower lira of the lower pair. The umbilicus is absent. The columella is corkscrew-shaped, formed by a narrow and long lapel of the columellar lip. Growth lines are not preserved.

D i m e n s i o n s  i n  m m:

| Specimen no. | Shell height | Max. diameter |
|---|---|---|
| 4919/28-448 (paratype) | >6.20 | 2.65 |
| 4919/28-466 (holotype) | 13.90 | 4.50 |

C o m p a r i s o n. The new species is very similar to *S. gzheliensis* Mazaev, 2001, from which it differs by the almost subvertical position of the selenizone on the last whorls, as well as by a smaller gap between the lower selenizone lira and the upper lira of the lower pair. From *Stegocoelia acuta* Mazaev, 2001, the new species is distinguished by the presence of a subsutural ridge, and a wider, flattened whorl lateral surface.

R e m a r k s. On photographs of the holotype and paratype, the basal part of aperture is significantly extended downward. It seems that the aperture had a siphon groove. However, a similar form of aperture can occur in shells with broken basal and palatal edges, which, evidently, is observed in the illustrated material.

O c c u r r e n c e. Type locality.

M a t e r i a l. Altogether 12 specimens from locality no. 54919/28.

### Genus *Arribazona* Kues, 1990

#### *Arribazona tschernyschewi* (Jakowlew, 1899)

*Murchisonia (Glyphodeta?) tschernyschewi*: Jakowlew, 1899, p. 39, pl. 5, fig. 1;

*Murchisonia (Hormotoma?) tschernyschewi*: non Licharew, 1967, p. 49, pl. 12, figs. 10–12; Nelzina, 1978 (in Kalmykova et al., 1978), p. 22, pl. 1, figs. 29–31;

*Arribazona tschernyschewi*: Mazaev, 2003, p. 97; Mazaev, 2006, p. 50, pl. 5, figs. 6–13.

L e c t o t y p e. TsNIGR Museum, no. 126/325, paralectotypes: nos. 107/325, 122/325, Arkhangelsk Region, eastern part of an outcrop near the village of Kulogory, grainstone of the second cyclite; Lower Permian, Sakmarian Stage, Kulogory Formation.

D e s c r i p t i o n (Fig. 10). See the description of *Arribazona tschernyschewi*: Mazaev, 2006, p. 400, pl. 5, figs. 6–13.

D i m e n s i o n s  i n  m m:

| Specimen no. | Shell height | Max. diameter |
|---|---|---|
| 4919/28-298 | 11.1 | 5.7 |
| 4919/28-302 | 15.2 | 5.6 |
| 4919/28-303 | 18.0 | 7.3 |
| 4919/28-304 | 10.9 | 5.7 |
| 4919/28-308 | 11.3 | 4.9 |
| 4919/28-317 | 13.2 | 6.1 |
| 4919/28-320 | 12.6 | 5.6 |

C o m p a r i s o n. This species is very similar to *A. lata* (Netschaev, 1894), from which it differs by lower whorls and the absence of a tendency to form a carinate inflection between the selenizone and the basal surface on adult whorls; from *A. longispira* Mazaev, 2015 differs in the lower whorls.

R e m a r k s. The species is exceptionally polymorphic. In samples from localities of the Samara Region, variability is manifested approximately in the same way as was noted for samples from the Arkhangelsk Region (Mazaev, 2006, p. 401).

Judging from the label, this species was named by Noinsky as "*Murchisonia jakowlewi*" (KGM, coll. no. 17, specimen no. 366; bank of the Volga River, behind the "Plitnyi" tunnel/quarry).

O c c u r r e n c e. Sakmarian Stage of the Samara and Arkhangelsk regions.

M a t e r i a l. In total 181 specimens. Samara Region: locality no. 4919/28—70 specimens, locality no. 4919/35—11, locality no. 4919/37—three specimens, locality no. 4919/38—four specimens, and also 93 specimens from localities in the Arkhangelsk Region.

### Family Holopeidae Wenz, 1938

### Subfamily Gyronematinae Knight, 1956

### Genus *Klavlia* Mazaev, 2018

#### *Klavlia minuta* Mazaev, sp. nov.

E t y m o l o g y. From the Latin *minuta* (minute, small).

H o l o t y p e. PIN, no. 4919/35-14, shell imprint; Sakmarian Stage, Samarskaya Luka, left bank of the Usa River, 2.5 km downstream of the aperture of the Muranka (locality no. 4919/35).

D e s c r i p t i o n (Figs. 11a–11d). A very small turbiniform shell of at least four rounded whorls. The protoconch is probably smooth, from one whorl, with a diameter of about 0.2 mm. The first and subsequent definitive whorls are uniformly rounded. The suture is sharp, depressed. The coil is distinctly raised above the last whorl, the ratio of its height to the height of the shell is approximately 1/2. The pleural angle is 80°–90°. The surface of the whorls is covered with numerous very thin, barely visible spiral striae. The umbilicus is deep. The aperture is oval in plan, slightly

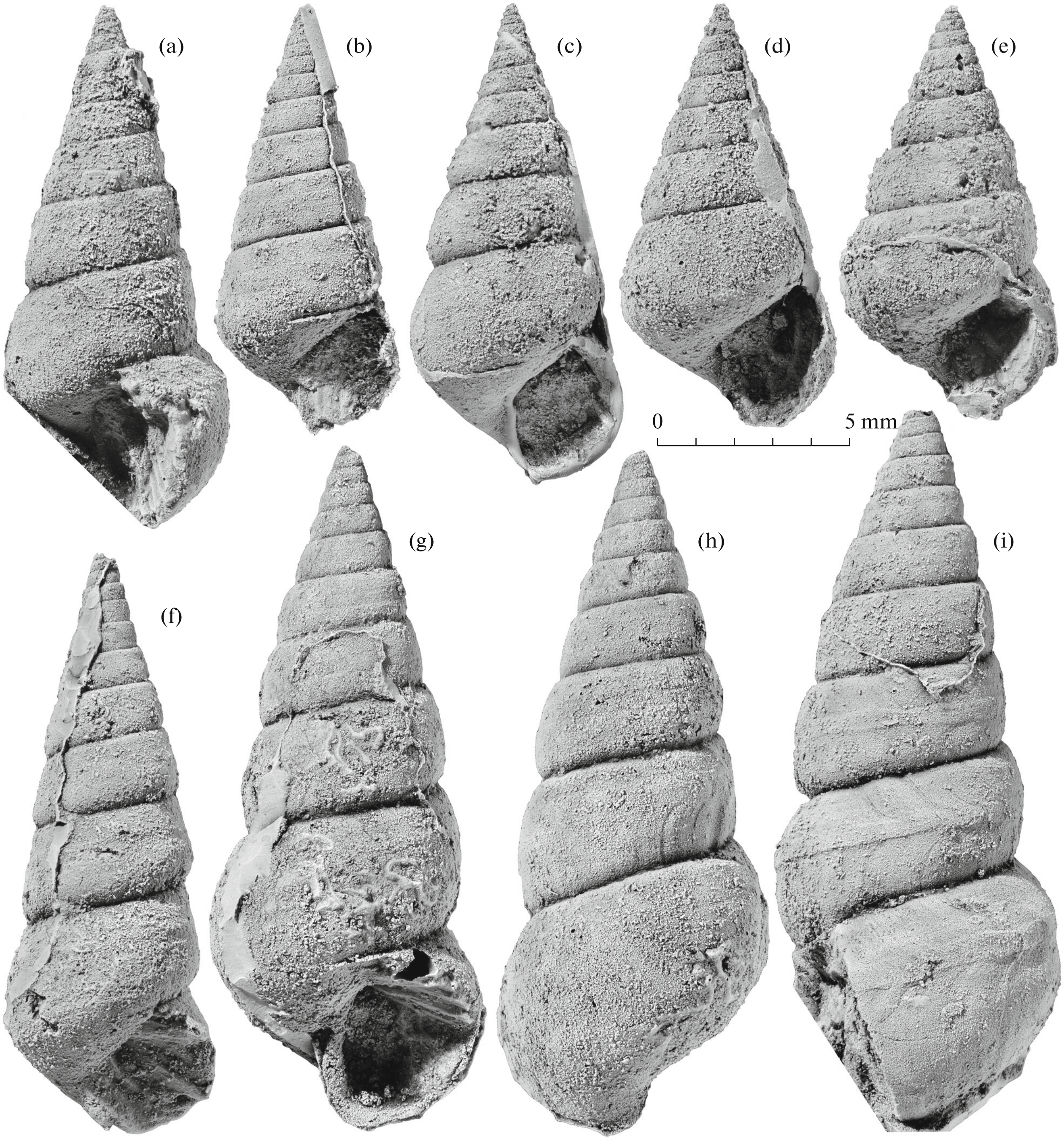


**Fig. 10.** *Arribazona tschernyschewi* (Jakowlew, 1899); latex casts, ×6: (a) specimen no. 4919/28-334; (b) specimen no. 4919/28-308; (c) specimen no. 4919/28-320; (d) specimen no. 4919/28-298; (e) specimen no. 4919/28-304: (f) specimen no. 4919/28-302; (g, h) specimen no. 4919/28-303: apertural view and lateral view; (i) specimen no. 4919/28-357.

tilted down. The growth lines are slightly prosocyrtic; they are inclined prozoclinally from the seam at an angle of about 30° to the axis of the shell.

Dimensions in mm:

| Specimen no. | Shell height | Max. diameter |
|---|---|---|
| 4919/35-3 (paratype) | ≈1.90 | ≈1.70 |
| 4919/35-14 (holotype) | 1.75 | 2.15 |

Comparison. The new species differs from *Klavlia klavlia* Mazaev, 2018 in the smaller sizes, a higher growth rate of whorls, as well as a smaller width and height of the section of whorls, with the same shell size.

Remarks. This is the second species of the genus. Perhaps, due to the small size, the cross section of its last whorl is more uniform and does not have car-

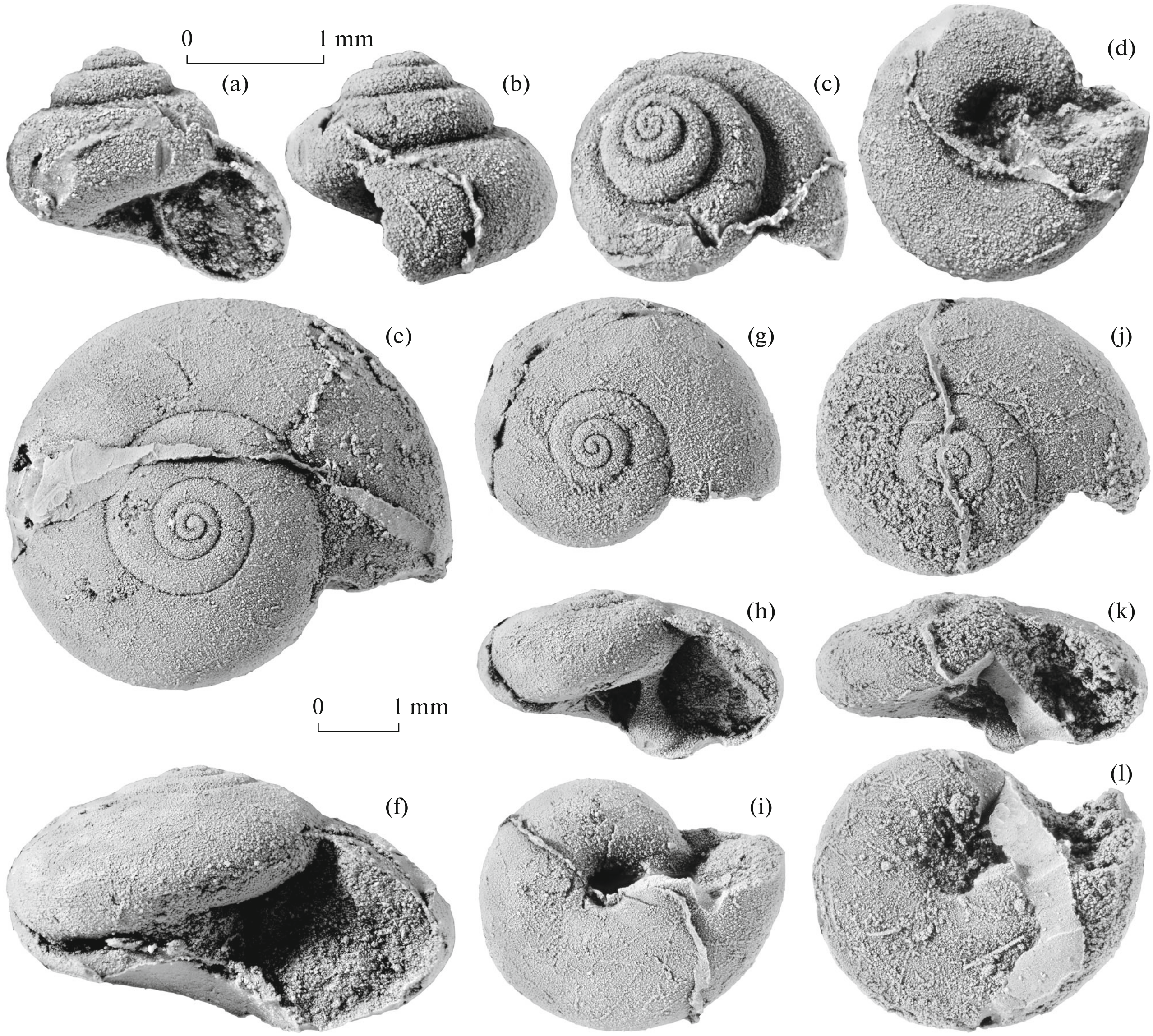


**Fig. 11.** (a–d) *Klavlia minuta* Mazaev, sp. nov.; latex cast, ×20, holotype no. 4919/35-14: (a) apertural view, (b) lateral view; (c) oblique top view, (d) bottom view; (e–l) *Anomphalus murankaensis* Mazaev, sp. nov.; latex casts, ×12: (e, f) paratype no. 4919/35-15: (e) top view, (f) apertural view; (g–i) holotype no. 4919/35-16: (g) top view, (h) apertural view,(i) bottom view; (j–l) paratype no. 4919/35-17: (j) top view, (k) apertural view, (l) bottom view.

inated inflections, as in the last whorl of the type species, *K. klavlia*. Otherwise, the characteristics of the new species undoubtedly bring it closer to the type species of the genus *Klavlia*. Growth lines are only observed on the paratype.

M a t e r i a l. Holotype and paratype.

**Family Anomphalidae Wenz, 1938**

**Genus *Anomphalus* Meek et Worthen, 1867**

***Anomphalus murankaensis* Mazaev, sp. nov.**

E t y m o l o g y. From the village of Muranka.

H o l o t y p e. PIN, no. 4919/35-16, paratypes: nos. 4919/35-15, 4919/35-17; shell imprints. Sakmarian Stage, Samarskaya Luka, left bank of the Usa River, 2.5 km downstream of the mouth of the Muranka River (locality no. 4919/35).

D e s c r i p t i o n (Figs. 11e–11l). A small, very low turbiniform shell of about five smooth, slightly compressed rounded whorls. The suture is distinct, thin, located above the periphery of whorl. The coil of most specimens rises slightly above the last whorl. The surface of the whorls between the sutures is moderately convex. The upper surface is slightly inclined, moderately convex in profile. The whorl lateral surface is evenly rounded in profile. The basal surface is almost

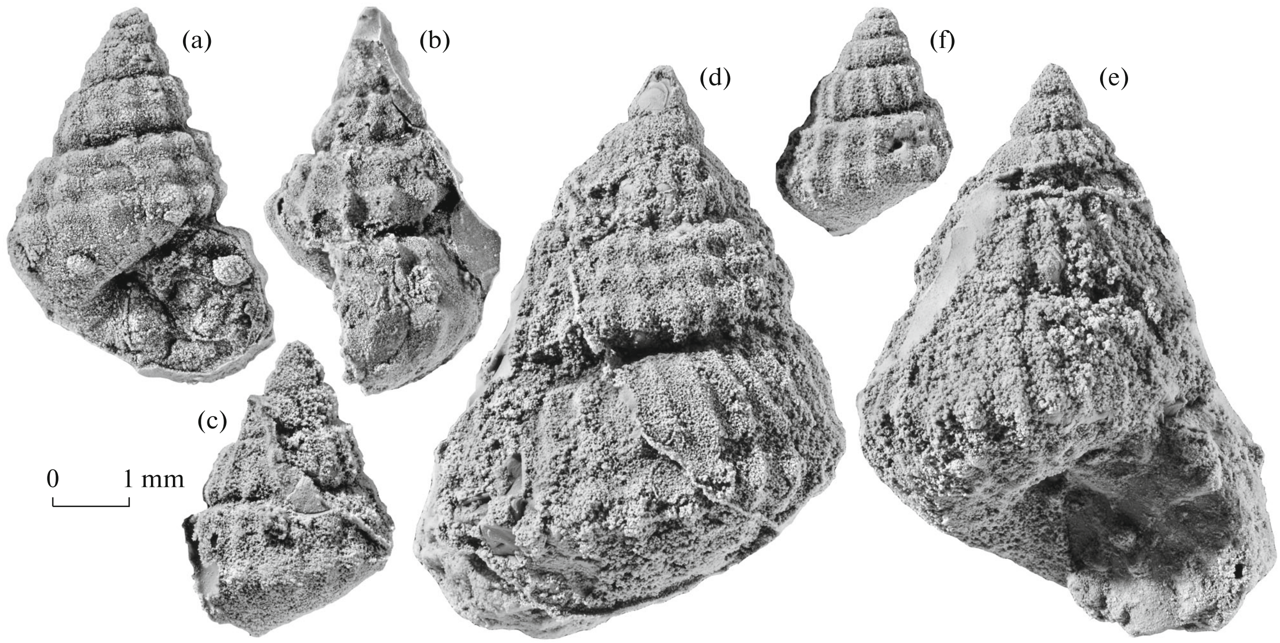


**Fig. 12.** *Microdoma kulogorae* (Jakowlew, 1899); latex casts, ×10: (a) specimen no. 4919/35-62; (b) specimen no. 4919/35-61; (c) specimen no. 4919/28-495; (d, e) specimen no. 4919/28-497: (d) view opposite to aperture, (e) apertural view; (f) specimen no. 4919/28-494.

flat, bounded by a sharp umbonal crest. The umbilicus is deep and narrow; its diameter is approximately 7.5 times smaller than the maximum diameter of the shell. The umbilical walls are cylindrical. The aperture width is always slightly larger than its height. The columellar apertural margin is slightly arched. The columellar ramp is strongly expanded in the lower part, its lower margin extends downward to form an arch. Inside the aperture, the columellar and basal lips are separated by a narrow and short canal. The basal lip is straight or slightly concave. The parietal aperture wall is formed by the shell wall of the previous whorl. Growth lines are indistinguishable.

D i m e n s i o n s i n m m:

| Specimen no. | Shell height | Max. diameter |
|---|---|---|
| 4919/35-15 (paratype) | ≈3.30 | 5.50 |
| 4919/35-16 (holotype) | 2.11 | 3.75 |
| 4919/35-17 (paratype) | 2.00 | 4.10 |

C o m p a r i s o n. The new species is primarily distinguished from *A. striatus* Mazaev, 1997 and *A. planus* Licharew, 1967 by the cylindrical structure of the umbilical walls and the wide columellar ramp; from *A. japonicus* Nützel, 2012, differs in the wide parietal part of aperture, which is represented by the shell wall of the previous whorl.

M a t e r i a l. In total five specimens from the type locality.

### Family Microdomatidae Wenz, 1938

### Genus *Microdoma* Meek et Worthen, 1867

#### *Microdoma kulogorae* (Jakowlew, 1899)

*Tuberculopleura kulogorae*: Jakowlew, 1899, p. 59, pl. 5, fig. 24;

*Microdomakulogorae*: Nelzina, 1978 (in Kalmykova et al., 1978), p. 21, pl. 1, fig. 22, 27, 28; Mazaev, 2006, p. 401, pl. 5, figs. 14–18.

L e c t o t y p e. TsNIGR Museum, no. 188/325, paralectotype no. 191/325; Arkhangelsk Region, eastern part of an outcrop near the village of Kulogory, grainstone of the second cyclite; Lower Permian, Sakmarian Stage, Kulogory Formation.

D e s c r i p t i o n (Fig. 12). See the description of *Microdoma kulogorae* in (Mazaev, 2006, p. 401).

D i m e n s i o n s i n m m:

| Specimen no. | Shell height | Max. diameter |
|---|---|---|
| 4919/28-497 | 7.6 | 5.5 |
| 4919/35-61 | 5.1 | 3.5 |
| 4919/35-62 | 5.0 | 3.5 |

V a r i a b i l i t y. The species is polymorphic. The apical angle varies from 50° to 60°. The number of collabral ribs on the fifth and sixth whorls can vary from 12 to 26, while the thickness of the ribs is always approximately equal to the width of the intercostal spaces. The collabral ornamentation on different specimens and/or on different whorls of the same specimen can be expressed either in the type of ribs (from thin to almost cordlike), or in a species of three,

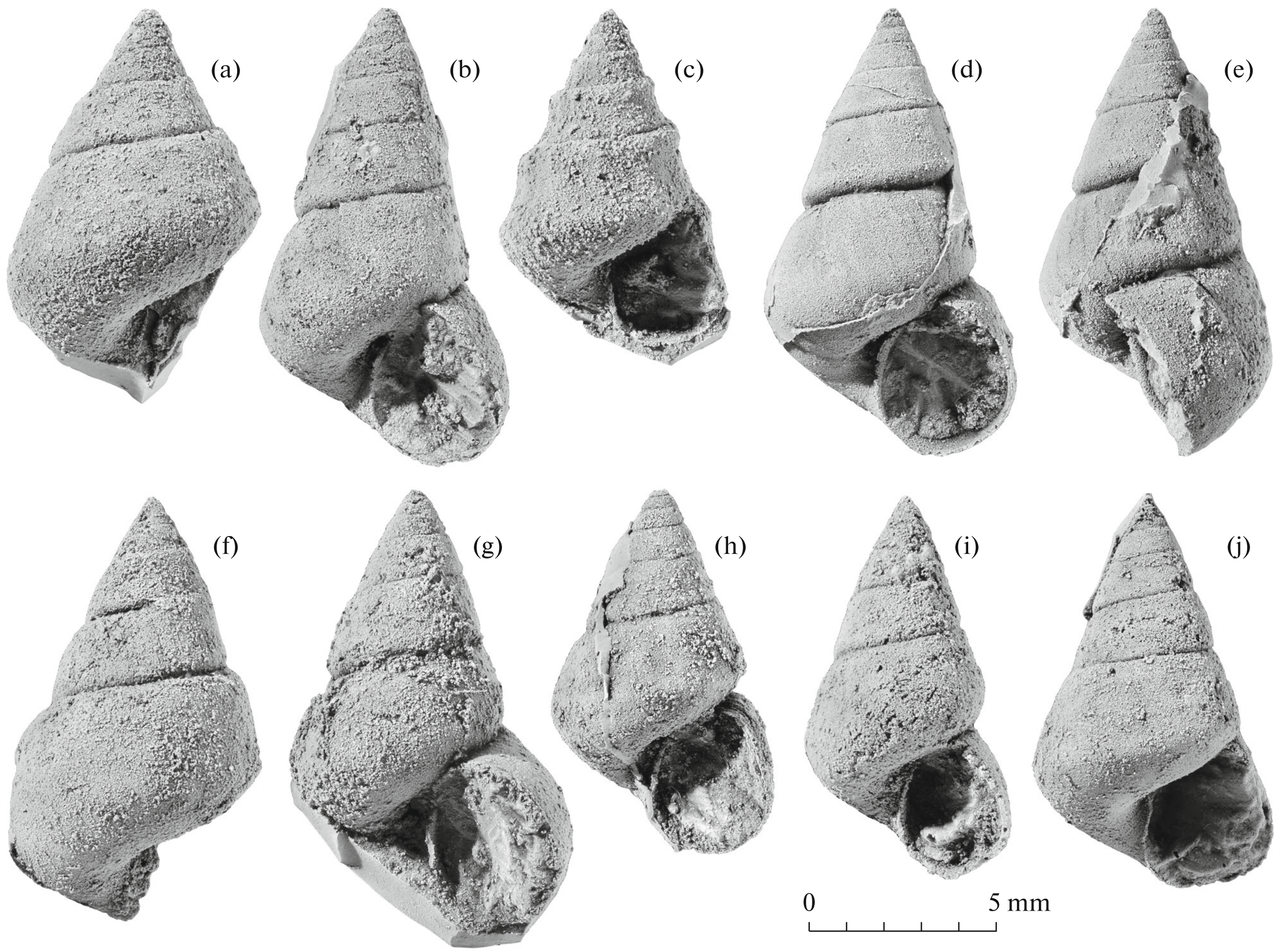


**Fig. 13.** *Anematina permiana* (Jakowlew, 1899); latex casts, ×5: (a) specimen no. 4919/28-123; (b) specimen no. 4919/28-289; (c) specimen no. 4919/28-203; (d, e) specimen no. 4919/28-45: (d) apertural view, (e) lateral view; (f) specimen no. 4919/28-157; (g) specimen no. 4919/28-281; (h) specimen no. 4919/28-62; (i) specimen no. 4919/28-217; (j) specimen no. 4919/28-231.

less often, two collabrally elongated nodes. On numerous specimens, the nodes are well developed, distinctly separated from one another, always lined up in a collabral direction, following the direction of the growth lines. Some specimens at the gerontic stage are characterized by the disappearance of ornamentation, with whorls becoming almost smooth.

O c c u r r e n c e. Sakmarian Stage, Samara and Arkhangelsk regions.

M a t e r i a l. Altogether 43 specimens, Samara Region: locality no. 4919/28—four specimens, locality no. 4919/35—nine specimens, and 30 specimens from localities in the Arkhangelsk Region.

### Family Elasmonematidae Knight, 1956

### Genus *Anematina* Knight, 1933

#### *Anematina permiana* (Jakowlew, 1899)

*Omphaloptycha permiana*: Jakowlew, 1899, pp. 69, 124, pl. 5, fig. 19; *Anematina permiana*: Mazaev, 1997, p. 101, figs. 6I–6R.

L e c t o t y p e. TSNIGR Museum, no. 207/325; Vladimir Region, Monastyrsky Mine Near the town of Vyksa; terminal part of the Gzhelian Stage or Asselian Stage.

D e s c r i p t i o n (Fig. 13). A tall turbiniform medium-sized shell consisting of seven smooth whorls. The umbilicus is deep, very thin, slitlike. The suture is clear, impressed, located just below the point of the whorl periphery. The lateral surface in the profile varies from slightly concave to slightly convex, tilted to the shell axis at about 20°. The transition of the lateral surface to the basal in the middle whorls is sharp, with the formation of a sharp and round shoulder, while in the last whorls it is relatively smooth and evenly rounded. The basal surface in the profile is straight or slightly convex. The growth lines on the lateral and basal surfaces are clear, thin, straight; on the lateral surface inclined opistoclinally to the shell axis at 20°. The aperture height slightly exceeds its width. The aperture margins are thin. The parietal part of the aperture is formed by the surface of the last whorl. The columellar margin is long, almost straight or slightly arched, slightly inclined to the shell axis, smoothly passes into the basal margin.

D i m e n s i o n s  i n  m m:

| Specimen no. | Shell height | Max. diameter |
|---|---|---|
| 4919/28-45 | 11.9 | 6.7 |
| 4919/28-62 | 9.7 | 6.0 |
| 4919/28-123 | ≈9.9 | ≈6.7 |
| 4919/28-157 | 11.3 | 6.7 |
| 4919/28-203 | 9.0 | 6.0 |
| 4919/28-217 | 10.2 | 5.8 |
| 4919/28-231 | 10.6 | 6.5 |
| 4919/28-281 | 12.0 | 7.5 |
| 4919/28-289 | 12.2 | 6.7 |
| 4919/28-290 | 8.2 | 5.7 |

V a r i a b i l i t y. A polymorphic species. Usually, the apical angle varies from 50° to 60°. An insignificant number of specimens has low conical shells; apical angle values reach 50° (Fig. 13a). Approximately 30% of the studied specimens, conversely, have turriform shells; the apical angle reaches 50° (Fig. 13b). The profile of the whorl lateral surface varies widely, but in most specimens it varies from slightly concave to slightly convex. Often these changes can be traced in different whorls of one shell (Figs. 13d, 13e). In some specimens, the profile of the whorl lateral surface is either concave (Fig. 13c), or convex (Fig. 13g). Such deviations are especially pronounced on the last whorl. On some specimens on the last whorl, a displacement of the suture closer to the shell axis is observed. In such cases, the parietal part of the aperture decreases in size, while either the angle of inclination of the lateral surface to the axis of the shell increases (Fig. 13g), or the last whorl shifts downward with increasing suture depth (Figs. 13b, 13d, 13e, 13h, 13i).

C o m p a r i s o n. *Anematina permiana* differs from *A. proutana* (Hall, 1856) in the flattened lateral surface of the whorls (see also Knight, 1941, pl. 52, fig. 4). From *A. rockymontanum* (Shimer, 1926), the new species differs in a smoother inflexion between the lateral and basal surface of the whorl, as well as a smaller angle of inclination of the growth lines to the shell axis (see also Yochelson and Saunders, 1967, pl. 14, figs. 10–16).

R e m a r k s. Among the studied specimens, it is conditionally possible to distinguish several morphotypes that deviate from the norm according to individual characteristics. Similar morphotypes are observed in a sample of the Noginsk Substage of the Gzhelian Stage in the Moscow Region (Mazaev, 1997). Thus, despite such a long temporary lag and the absence of good morphological characters, the studied materials, with a very high probability, belong to one species.

O c c u r r e n c e. Gzhelian Stage of the Moscow Basin, Sakmarian Stage of Samarskaya Luka.

M a t e r i a l. Altogether 292 specimens; 289 specimens from locality no. 4919/28, and three specimens from locality no. 4919/37.

**Family Naticopsidae Waagen, 1880**

**Genus *Naticopsis* McCoy, 1844**

***Naticopsis sokensis* Mazaev, sp. nov.**

E t y m o l o g y. From the Sok River.

H o l o t y p e. PIN, no. 4919/28-470, paratypes: nos. 4919/28-468, 4919/28-471, 4919/28-473 shell imprints; Samara Region, Soksky Quarry, locality no. 4919/28.

D e s c r i p t i o n (Fig. 14). The shell is medium-sized; its height is equal to the maximum diameter or slightly exceeds it. The coil clearly rises above the last whorl. The ratio of the shell height to aperture height is 1.44–1.54. The suture is sharp, impressed. The whorls profile is evenly rounded; in adult whorls, the whorl upper surface is slightly flattened. The whorl periphery point is just below the middle of the lateral surface. The angle of inclination of the tangent to the shell surface near the suture to the shell axis is from 124° to 138°. The surface of the shell is probably smooth. The transition of the lateral surface to the basal is very smooth. The aperture is auriculate; the aperture plane is oblique.

The height and width of the aperture are approximately equal. The inducture is moderately developed along the columellar margin, as a massive ridge, in rare cases slightly expanding downward. The surface of the inducture is probably smooth. The columellar lip, which forms the inducture, is straight, the angle of inclination to the axis is 40° to 45°; it passes into the basal lip very sharply. The basal lip is massive, roll-shaped near the axis, on the rest of it is formed as a crescentic area with a concave surface. The palatal lip is thin. The parieto-palatal canal is well developed. The growth lines are either thin, or (on the last whorl) sharp, straight, or slightly prosocyrtic, inclined prosoclinically to the shell axis at about 20°.

D i m e n s i o n s  i n  m m:

| Specimen no. | Shell height | Max. diameter | Aperture height |
|---|---|---|---|
| 4919/28-468 | 15.1 | 14.2 | 9.8 |
| 4919/28-470 (holotype) | 16.0 | 14.5 | 10.1 |
| 4919/28-471 (paratype) | 12.7 | 12.8 | 8.8 |
| 4919/28-473 (paratype) | 15.2 | 13.7 | 10.2 |

C o m p a r i s o n. Due to the high coil, the new species is similar to *N. retusa* Wanner, 1922, *N. spallanzanii* Gemmellaro, 1889, *N. mediterranea* Gemmellaro, 1889, and *N. wagneri* Gemmellaro, 1889, from which it differs in shell proportions, as well as an

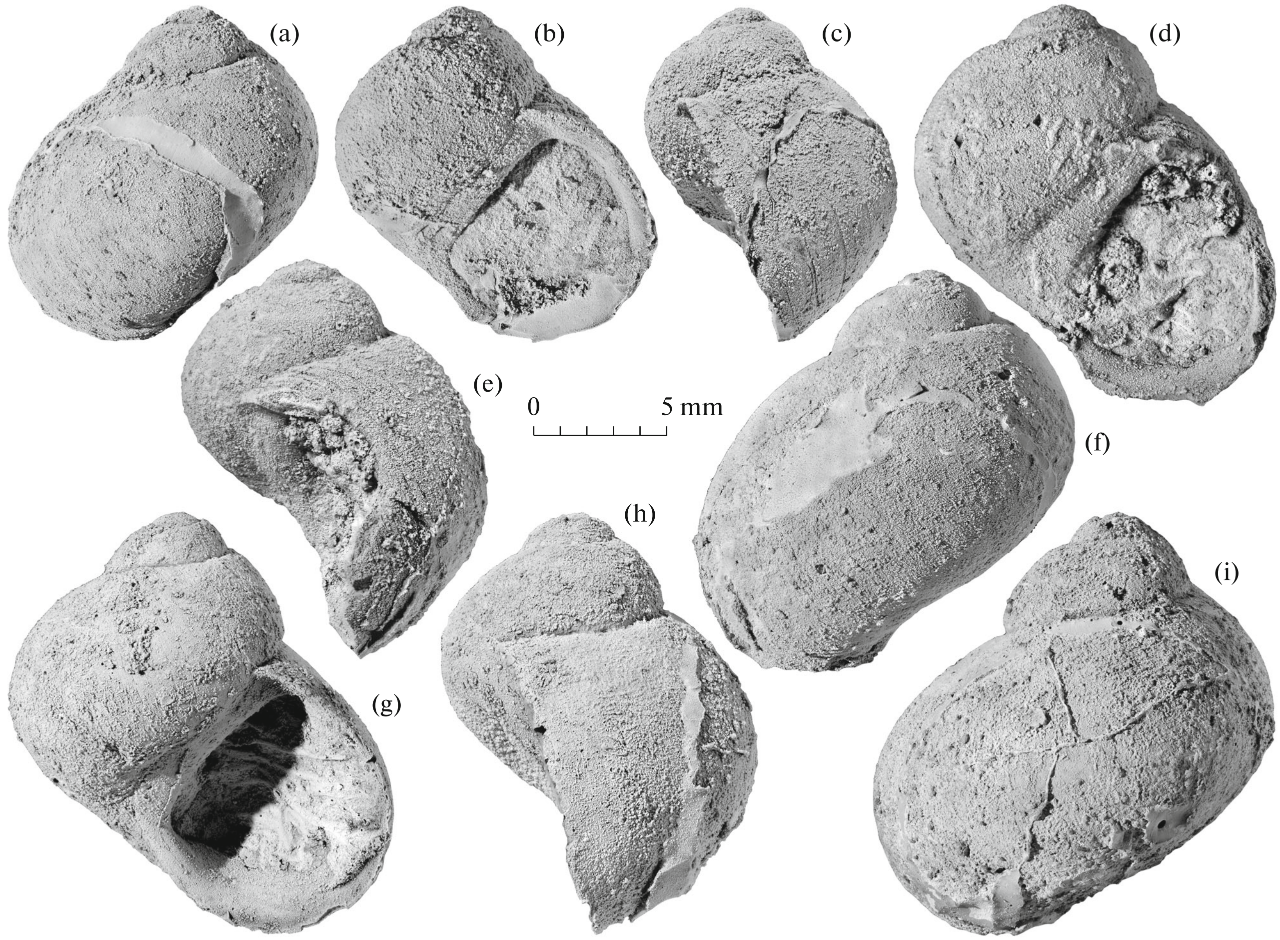


**Fig. 14.** *Naticopsis sokensis* Mazaev, sp. nov.; latex casts, all ×3.5: (a–c) paratype no. 4919/28-471: view opposite to aperture, apertural view, lateral view; (d–f) paratype no. 4919/28-473: apertural view, lateral view, view opposite to aperture; (g–i) holotype no. 4919/28-470: apertural view, lateral view, view opposite to aperture.

almost straight columellar edge, which sharply transits into the basal edge.

R e m a r k s. In the list of species from the "Muranka Mill" locality Noinsky listed four species of the genus *Naticopsis*. He identified two of them as new species, the rest as *N. volgensis* Stuckenberg, 1905 and *N. netschaewi* Stuckenberg, 1905. In the studied material, this genus is represented by only one species described here. Therefore, Noinsky's reference to the existence of three more species, regardless of the accuracy of the definitions, seems an intriguing mystery. Perhaps his collection included specimens of the genus *Globodoma*. Noinsky's collection contained only one imprint of the genus *Naticopsis*, which, as indicated on the label, was identified as *N. volgensis* Stuckenberg, 1905 (KGM, collection no. 17, specimen no. 379). This imprint belongs to the species described here. The shapes of the coil of *Naticopsis sokensis* sp. nov. and of the specimen illustrated by Stuckenberg are indeed very similar (Stuckenberg, 1905, pl. 8, fig. 6). However, such important diagnostic features of *N. volgensis* as the morphology of the aperture, the basal part of the shell, and the last whorl remain unknown. In addition, in the description, Stuckenberg indicated the presence of spiral ornamentation that is completely indistinguishable in a pencil drawing of the original. In that case, the species described by Stuckenberg should not be assigned to the genus *Naticopsis*.

O c c u r r e n c e. Sakmarian Stage of the Samara Region.

M a t e r i a l. In total eight specimens: six specimens from locality no. 4919/28; one specimen from locality no. 4919/37, and one specimen in Noinsky's collection (KGM).

### Family Soleniscidae Knight, 1931

### Genus *Bulimorpha* Whitfield, 1882

#### *Bulimorpha lavrskyi* Mazaev, 2015

*Bulimorpha lavrskyi*: Mazaev, 2015, p. 968, pl. 36, figs. 8, 9; pl. 37, fig. 3; Mazaev, 2018, p. 822, pl. 20, fig. 3.

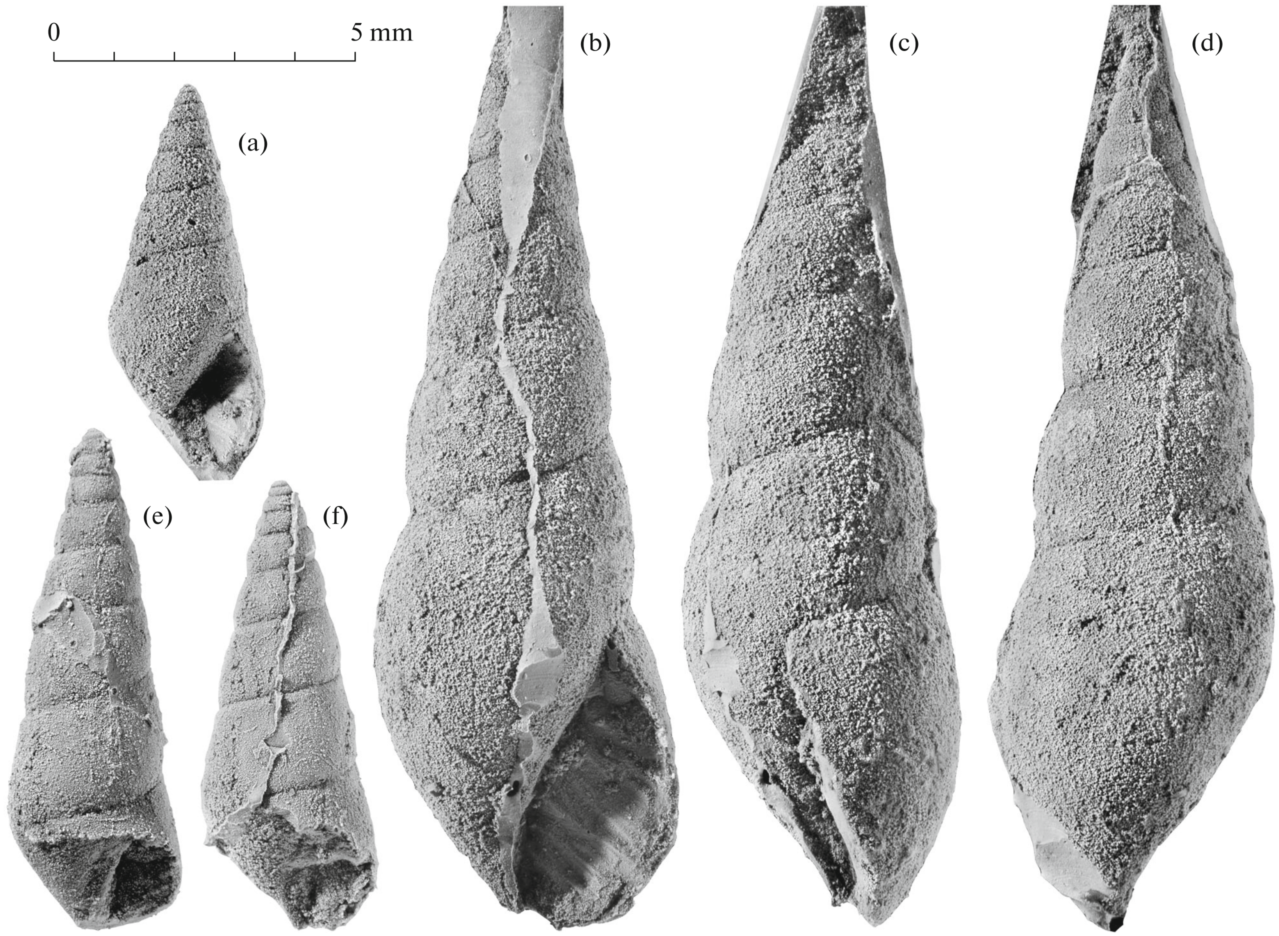


**Fig. 15.** *Bulimorpha lavrskyi* Mazaev, 2015; latex casts, all ×8: (a) specimen no. 4919/28-499; (b–d) specimen no. 4919/28-498: apertural view, lateral view, view opposite to aperture; (e) specimen no. 4919/35-40; (f) specimen no. 4919/28-39.

Description (Fig. 15). See Mazaev, 2015, p. 968.

Dimensions in mm:

| Specimen no. | Shell height | Max. diameter |
|---|---|---|
| 4919/28-498 | 15.1 | 5.2 |
| 4919/28-499 | ≈6.6 | ≈2.7 |

Remarks. Due to the poor preservation of imprints, details of the shell surface are not observed. The apical angle in different specimens varies from 20° to 30°. Specimens from locality no. 4919/35 are slightly deformed because of an insignificant compaction of the sediment at the beginning of its lithification. Despite variations in the apical angle and profile of the whorl lateral surface, all studied specimens belong to the same species. The ratio of the whorl width to its height varies within the same limits as in the specimens from the Kazanian Stage.

Noinsky identified this species as "*Sobulites permocarbonica*". Noinsky's collection contains three imprints in two samples (KGM, collection no. 17, specimen nos. 232, 332).

Occurrence. Volga-Ural Anteclise, Sakmarian and Kazanian stages.

Material. Altogether 22 specimens: four specimens from locality no. 4919/28, three specimens from locality no. 4919/35, and 15 specimens from the Kazanian Stage.

### Family Meekospiridae Knight, 1956

### Genus *Nemdaella* Mazaev, 2015

Remarks. To date, only a typical species, *N. leonovae* Mazaev, 2015 was included in this genus. Inclusion of a new species, *N. usensis* sp. nov., in the composition of *Nemdaella* expands the previously proposed diagnosis of genus. Probably the main difference between *Nemdaella* and *Meekospira* is the very large size of the first planispiral whorls.

#### *Nemdaella usensis* Mazaev, sp. nov.

Etymology. From the Usa River.

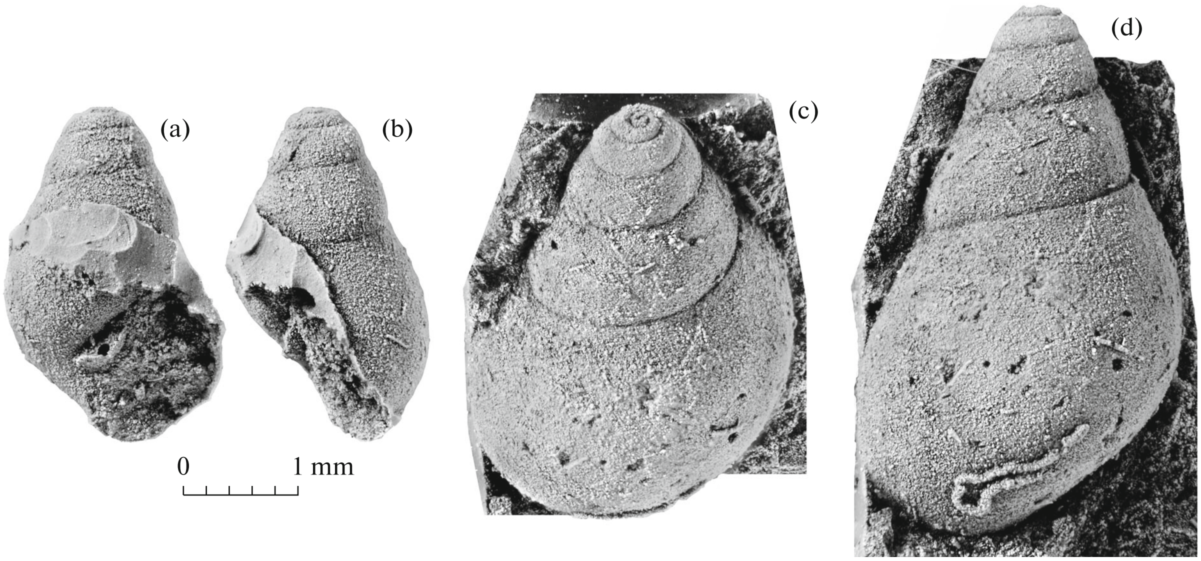


**Fig. 16.** *Nemdaella usensis* Mazaev, sp. nov.; latex casts, ×15: (a, b) paratype no. 4919/35-58: (a) apertural view, (b) lateral view; (c, d) holotype no. 4919/35-1: (c) oblique top view, (d) view opposite to aperture.

H o l o t y p e. PIN, no. 4919/35-1; shell imprint, Sakmarian Stage, Samarskaya Luka, left bank of the Usa River, 2.5 km downstream of the mouth of the Muranka River (locality no. 4919/35).

D e s c r i p t i o n (Fig. 16). The shell is small, sobulitid, consisting of five rapidly expanding whorls. The contours of the coil are almost straight. The suture in all whorls is sharp, thin, impressed. The diameter of the protoconch first whorl is 0.12–0.18 mm; the diameter of the first, almost planispiral whorl is 0.45 mm. The following whorls shift sharply along the axis. The surface of the teleoconch first whorl is uniformly convex, the lateral surface of the remaining whorls is moderately convex. The transition to the basal surface is very smooth. The ornamentation and growth lines are not observed on the shell surface. The structure of the aperture is unknown.

D i m e n s i o n s i n m m:

| Specimen no. | Shell height | Max. diameter |
|---|---|---|
| 4919/35-58 (holotype) | 4.7 | 2.9 |
| 4919/35-59 (paratype) | 4.2 | 2.7 |

C o m p a r i s o n. The new species is distinguished from *N. leonovae* Mazaev, 2015 by the uniform growth of the teleoconch whorl sand the absence of spiral ornamentation.

M a t e r i a l. Holotype and two paratypes.

**Family Donaldinidae Bandel, 1994**

**Genus *Donaldina* Knight, 1933**

***Donaldina sakmaraensis* Mazaev, sp. nov.**

E t y m o l o g y. From the Sakmara River.

H o l o t y p e. PIN, no. 4919/35-51, paratype no. 4919/35-55; shell imprints. Sakmarian Stage, Samarskaya Luka, left bank of the Usa River, 2.5 km downstream of the aperture of the Muranka River (locality no. 4919/35).

D e s c r i p t i o n (Figs. 17a–17d). The shell is small, very elongated, turriform, of at least 10 very slowly expanding whorls. The protoconch, as far as can be observed in the existing material, is planispiral, of about one or one and a half rounded whorls, its axis coincides with the teleoconch axis. There is no clear boundary between the protoconch and the teleoconch. The suture on all teleoconch whorls is deep, impressed. The lateral surface of the whorls in section is almost rounded. The whorls are ornamented with five or six spiral lirae, intercostal spaces are wide, of equal size. The upper lira is clearly offset from the suture by 1.5 times the width of the intercostal spaces. On the third, fourth and fifth whorls, the upper lira marks a very weak keeled bend of the lateral surface of the whorl. The suture adjoins between the fifth and sixth lira. The basal surface is almost straight, strongly pulled down. The columellar lip is straight, long, relatively massive. The parietal part of aperture is wide, relatively massive. The palatal lip is thin. The growth lines are thin, clear, form a wide labral sinus, generally opistocyrtic, sharply opistocline from the upper lira.

D i m e n s i o n s i n m m:

| Specimen no. | Shell height | Max. diameter |
|---|---|---|
| 4919/35-51 (holotype) | 7.60 | 2.20 |
| 4919/35-52 | 3.20 | 1.25 |
| 4919/35-55 (paratype) | 4.00 | >1.30 |
| 4919/35-56 | ≈3.80 | ≈1.50 |

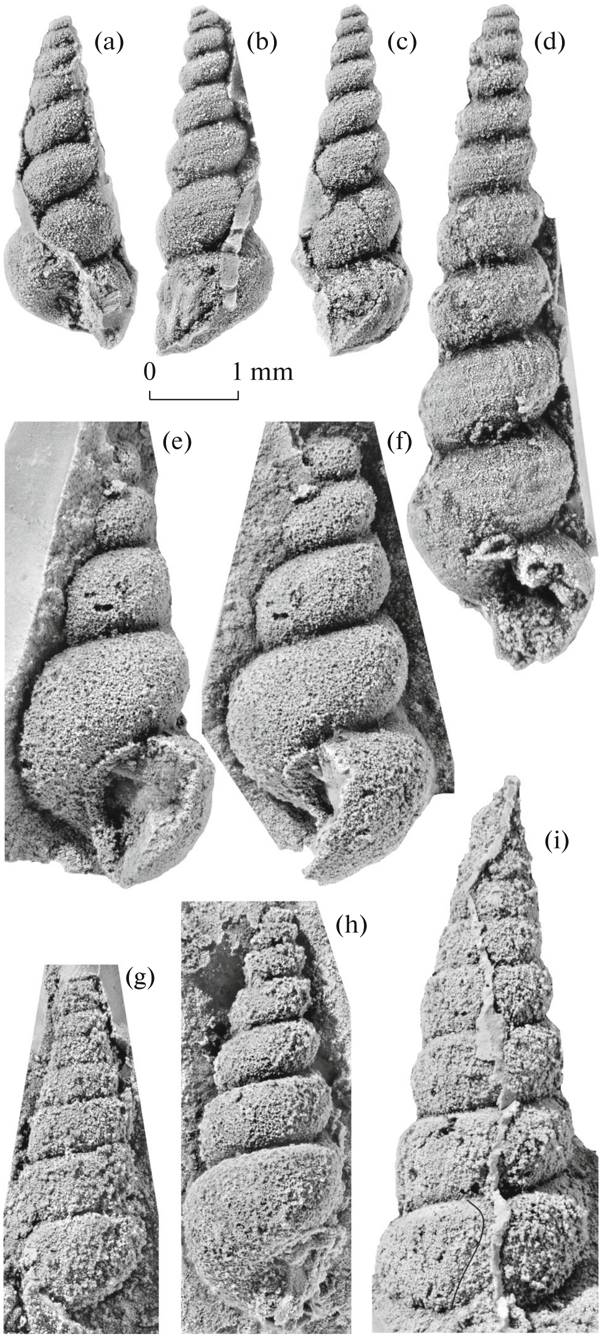


**Fig. 17.** (a–d) *Donaldina sakmaraensis* Mazaev, sp. nov.; latex casts, ×12: (a) paratype no. 4919/35-56; (b, c) paratype no. 4919/35-55; (d) holotype no. 4919/35-51; (f–i) *Streptacis volgenesis* Mazaev, sp. nov.; latex casts, ×12: (e, f) specimen no. 4919/28-484: (e) apertural view, (f) lateral view; (g) specimen no. 4919/28-477; (h) specimen no. 4919/28-486; (i) holotype no. 4919/28-474.

C o m p a r i s o n. The new species is very close to *D. stevensana* (Meek et Worthen, 1866) and *D. quinquecarinata* Pan and Erwin, 2002, from which it differs by a narrower gap between the upper lira and suture, wider intercostal spaces and a more elongated shell.

O c c u r r e n c e. Sakmarian Stage of the Samara Region.

M a t e r i a l. In total eight specimens: four specimens from locality no. 4919/28 and four specimens from locality no. 4919/35.

### Family Streptacididae Knight, 1931

### Genus *Streptacis* Meek, 1872

#### *Streptacis volgenesis* Mazaev, sp. nov.

E t y m o l o g y. From the Volga River.

H o l o t y p e. PIN, no. 4919/28-474, shell imprint; Samara Region, Soksky Quarry, locality no. 4919/28.

D e s c r i p t i o n (Figs. 17e–17i). The shell small, slender, turriform, consisting of 8–10 very slowly expanding whorls. The contours of the whorls are almost straight. The ratio of the width to the height of the teleoconch whorls as the shell grows varies from 2.1 to 1.93. The suture is crisp, impressed. The whorl lateral surface is smooth, moderately convex in the profile, sometimes slightly flattened, smoothly transforms into a slightly convex basal surface. The umbilicus is absent. The aperture is probably drop-shaped, slightly elongated. The columellar lip is long, almost straight. The growth lines are thin, form a sharp labral sinus.

D i m e n s i o n s i n m m:

| Specimen no. | Shell height | Max. diameter |
|---|---|---|
| 4919/28-468 (holotype) | 4.8 | >2.0 |
| 4919/28-477 | ≈4.1 | ≈1.6 |
| 4919/28-493 | >4.9 | ≈1.7 |

C o m p a r i s o n. The new species is very close to *S. subgracilis* (Netschaev, 1894), from which it differs by slightly smaller sizes and lower whorls with respect to their height.

R e m a r k s. On the available material, there is wide variability of the whorl profile and the suture depth. Possibly, such wide variations, from almost flat whorls (Fig. 17g) to sharply convex (Figs. 17e, 17f, 17h) are not so much forms of variability as forms of conservation, because almost all imprints are covered with thin crusts of small calcite crystals. Depending on the change in the thickness of these crusts on the prints in the seam area, the suture depth and the whorl profile may look different. The holotype (Fig. 17i) occupies an intermediate position in this series of specimens.

Imprints of *Streptacis volgenesis* sp. nov. are very similar to the imprints of *Donaldina sakmaraensis* sp. nov., especially when you consider that the imprints of spiral lirae are not always preserved on the latter. The only difference is often only the ratio of the whorl width to its height, which in these species is very distinct.

M a t e r i a l. In total 14 specimens from the type locality.

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