

Sarmatian Gastropods of the Belaya River Basin (Western Ciscaucasia)

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Abstract—The history of the study of the Sarmatian sections in the basin of the Belaya River is discussed and their lithology is described. The gastropods from beds with *Cryptomacra pesanseris*, except for their lowest part, are described. A description of some species from the Lower Sarmatian rocks embedded in the Middle Sarmatian olistostromes has also been added. As a result, 30 gastropod species from the families Lottiidae, Trochidae, Hydrobiidae, Nassariidae, Pyramidellidae, Cornirostridae, Acteocinidae, and Retusidae were identified. The new genera *Edozeba* and *Pomatiasia* (Hydrobiidae), new species *Edozeba angulata*, *E. caeca*, *E. minuta*, *E. striata*, *Hydrobia neofrauenfeldi*, *Akburunella laminaris*, *A. sinuosa*, *A. spinosa*, *Odostomia caucasica*, and *Brahystomia succineiformis*; new subspecies *Akburunella nefanda archaica* and *Cornirostra anistratenkorum umbilicaris* have been identified. The Middle Sarmatian pyramidellids are reviewed and redescribed. The taxonomy and composition of the genera *Kolesnikoviella* (Trochidae) and *Akburunella* (Nassariidae), origin, morphogenesis, and composition of other described gastropod taxa are discussed. Statistical data on gastropod communities from the lower part of the beds with *C. pesanseris* are presented.

Keywords: Heterobranchia, Trochidae, Hydrobiidae, Nassariidae, Pyramidellidae, *Akburunella*, Middle Sarmatian, Miocene, Ciscaucasia

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INTRODUCTION

This publication opens a series of works on the fauna from the Sarmatian deposits in the Belaya River basin, where they are represented by a sequence of several hundred meters thick, composed mainly of clays and aleurites, with the exception of individual intervals and numerous thin beds formed by sands and sometimes coquinae. Sarmatian deposits are exposed in the banks of the Belaya River and gullies from the town of Tul'skii to the city of Maikop, as well as along its tributaries: the rivers Kurdzhips from the village of Kurdzhipskaia, Fortepianka and Luchka (Fig. 1). Work on its study is still ongoing due to the wide distribution and great thickness of the Sarmatian. Therefore, the paper presents the results of studying a part of the Sarmatian interval based on materials collected in 2014–2017, but at the same time stratigraphic data is included and primary data on the collections of 2018 are taken into account carried out mainly outside the published interval. Here, gastropods from the Belaya River are described from most of the *Cryptomacra* Beds, which are exposed near the upper margin of the village of Groznyi (Beds 25–41, see description of the section below). The outcrop on the Belaya River is extensive and shows an uninterrupted transition from the Lower to the Middle Sarmatian, characterized in the lower part by a variable lithology, which made it

possible not only to localize the occurrences in detail, but also to identify characteristic marker horizons within it. These are outcrops from 1A₀ to 1E₃ on the Kurdzhips River (Fig. 2), which cover a higher interval, including the upper part of the *Cryptomacra* Beds, overlain by the beds with *Atamarcia naviculata*. As the Sarmatian sections are exposed in scattered outcrops, in the absence of marker horizons in it, the localization of material from the Kurdzhips River is based on the numbering of outcrops. The further down the river the outcrop is located, the higher the stratigraphic position is usually occupied by the Sarmatian sequence in it.

MATERIAL

Larger gastropods (*Gibbula*, *Akburunella*, *Duplicatula*) were sampled from the surface or from the wall of outcrops over the course of several years, which made it possible to obtain representative collections in most cases. Smaller gastropods were collected by washing of the samples through sieves, which varied in weight from 1.5 to 5 kg depending on the abundance of shell material. It was impossible to recognize any marker horizons that can be identified on the Kurdzhips and Belaya rivers and in gullies near the town of Tul'skii, due to the high variability of the structure of the sec-

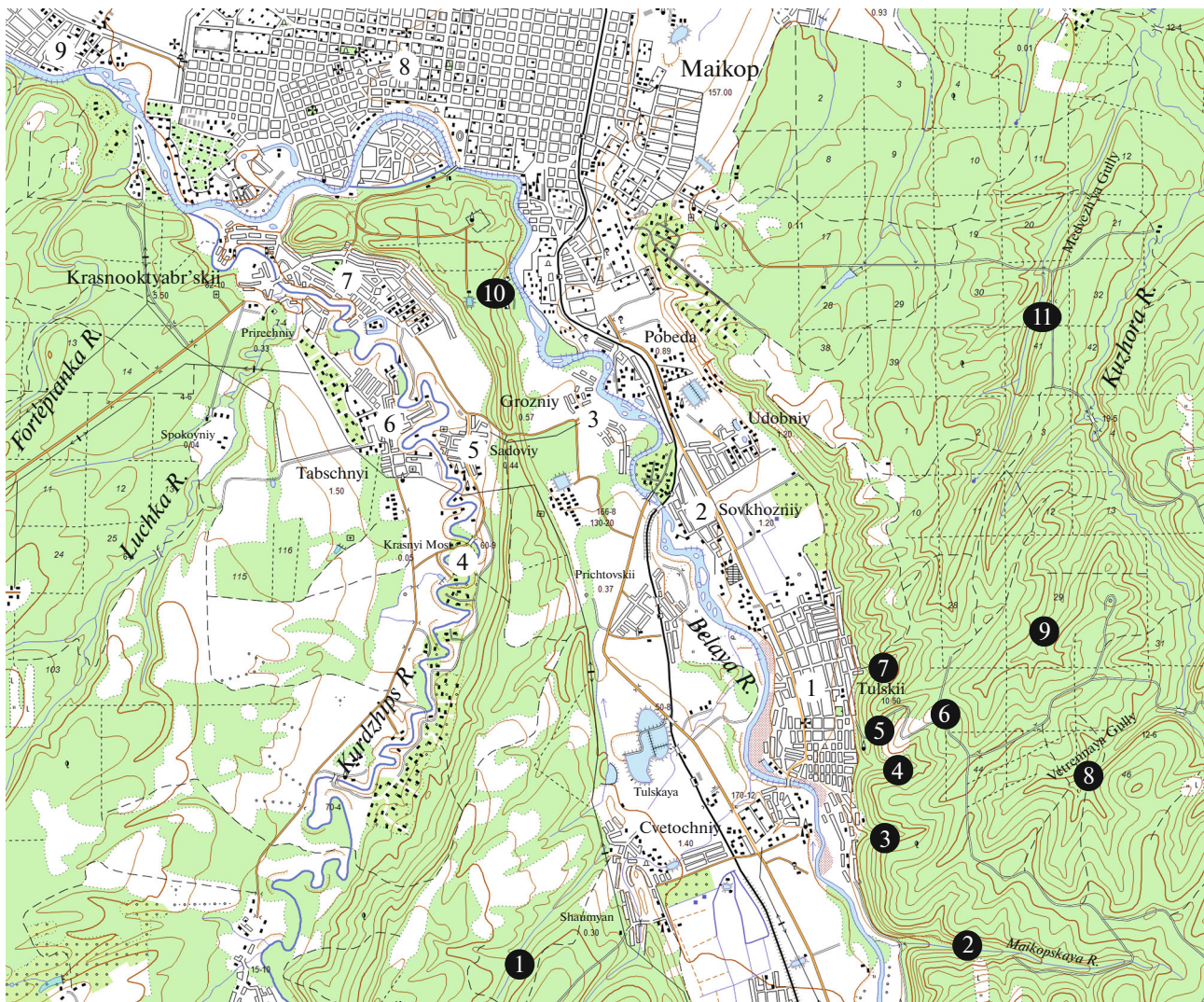


Fig. 1. Toponymic map of the study area. White numbers: (1) Glubokaya Gully, (2) Maikopskaya Gully (aka Maikopka, Podvesnaya), (3) Chumnaya Gully (aka Tul'skaya), (4) Aul Gully, (5) Aul'chik Gully, (6) Makhoshevskoe Forestry, (7) Kladbishchenskaya Gully, (8) Vetrovaya Gully (aka Vertepnaya, Vertepka), (9) Slesareva Levada Gully (aka Slesareva), (10) former farm of Blinov, (11) Medvezh'ya Gully. Black numbers: (1) town of Tul'skii, (2) village of Sovkhoznyi, (3) village of Groznyi, (4) village of Krasnyi Most, (5) village of Sadovy, (6) village of Tabschnyi (in old papers—village of Veselyi), (7) village of Krasnooktyabr'skii (formerly Oktyabr'skii), (8) city of Maikop, (9) village of Gaverdovskii.

tions; therefore, their comparison is based on the nature of the collected assemblages and the existing interpretations of the morphological evolution of the Sarmatian gastropods in the studied interval.

The specimens studied in this paper are housed in the Collection Department of the Paleontological Institute of the Russian Academy of Sciences, Moscow (PIN), coll. no. 5621. Materials from other collections were also used: the Zoological Institute of the Russian Academy of Sciences (ZIN), the F.N. Tchernyshev Central Research Geological Exploration Museum (TsNIGR Museum) and the Paleontological Museum at the Department of Dynamic and Historical Geology of St. Petersburg State University (PM SPbGU).

STATE OF STUDY OF SARMATIAN DEPOSITS IN THE BELAYA RIVER BASIN

When reviewing the works, lists of fossils are given as interpreted by their authors, since it is not always possible to understand which species or even genus were intended. The underlying and overlying deposits are also examined as there are discrepancies in drawing the boundaries of the Sarmatian.

Czarnocki (1911) was the first to publish on this area. He described Neogene deposits along the Belaya River, mainly downstream of the city of Maikop, along the Kurdzhips River, and its left tributaries. He pointed to the transition of the Upper Sarmatian deposits with *Mastra caspia* Eichwald to the overlying sandy-ocher series on the Belaya River. A bed with

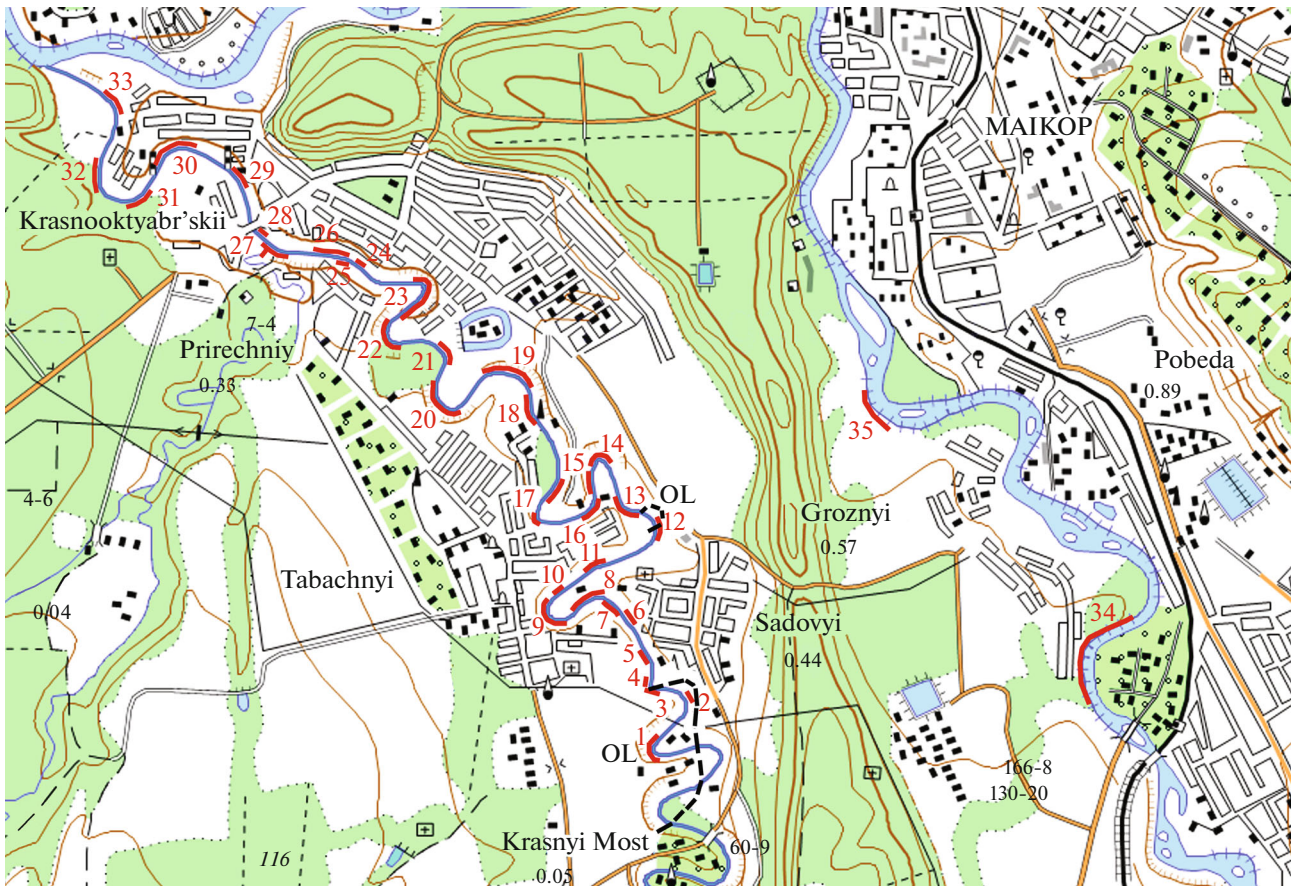


Fig. 2. Scheme of the studied sections on the rivers Belaya and Kurdzhips. Outcrops: (1) 1A₀, (2) 1A_{1a}, (3) 1A₁, (4) 1A₂, (5) 1A₃, (6) 1B₁, (7) 1B₂, (8) 1B₃, (9) 1B₄, (10) 1B₅, (11) 1C₁, (12) 1C₂, (13) 1C₃, (14) 1C₄, (15) 1C₅, (16) 1C₆, (17) 1C₇, (18) 1D₁, (19) 1D₂, (20) 1D₃, (21) 1E₁, (22) 1E₂, (23) 1E₃, (24) 1F₁, (25) 1F₂, (26) 1F₃, (27) 1F₄, (28) 1F₅, (29) 1G₁, (30) 1G₂, (31) 1G₃, (32) 1G₄, (33) 1G₅, (34) section on the Belaya River, (35) first outcrop of the Blinovskaya Formation on the Belaya River. OL—zone of distribution of Middle Sarmatian olistostromes on the Kurdzhips River downstream of the village of Krasnyi Most.

freshwater fauna was found in the section near the Maikop city park (gastropods *Planorbis cornu* Brongniart, *Limnaea*) between beds bearing Middle and Upper Sarmatian faunas. Here, Czarnocki, based on the discovery of molds of *M. caspia* in the lower part of sandy-ocher series, dated it as Upper Sarmatian. It is shown that the upper parts of the Middle Sarmatian and the Upper Sarmatian are composed of sands and sandstones, and the sandy Middle Sarmatian on the Kurdzhips River contains plant imprints. Upstream the Kurdzhips River, the middle Sarmatian sequence is change in clays with interbeds of sands and sandstones, while the Middle Sarmatian fauna, represented in the sands by *Cardium obsoletum* Eichwald, *C. fittoni* Orbigny, *Tapes vitaliana* Orbigny, *Donax dentiger* Eichwald, and *Modiola marginata* Eichwald, is replaced in the clays by *Cryptomacra pesanseris* (Mayer-Eymar) and small *T. vitaliana* (all within the boundaries of a modern village of Krasnooktyabr'skii). Further, the river temporarily goes beyond the mapping sheet, and upstream of the current village of

Krasnyi Most, Czarnocki indicated Lower Sarmatian outcrops with *Syndesmya reflexa* (Eichwald) and the beds with *Pholas hommairei* Orbigny, *P. ustjurtensis* Eichwald, which he attributed to the basal Sarmatian. Czarnocki indicated the presence of an anticline downstream of the village of Krasnyi Most based on the change in the dip direction of the beds. The presence of the anticline was confirmed in subsequent works; the differences concerned only its shape (Shibinsky, 1932; Beluzhenko et al., 2007). A change of the lower Sarmatian to the middle one is established up the Kurdzhips River, upstream the village of Kurdzhipskaya, and clays with *Pholas* and further up with *Spaniodon* are already indicated within the boundaries of the village. Outcrops of the Middle Sarmatian with *T. vitaliana*, *C. obsoletum*, *Macra* were found on the Luchka River, and clays with *Cryptomacra* were found in its upper reaches. As a result, the following structure of the Sarmatian was proposed for the interfluvium of the Pshekha and Belaya rivers (from top to bottom):

Upper Sarmatian: sandy-ocher series, which is followed below by beds with *Macra caspia*;

Middle Sarmatian: beds with typical Middle Sarmatian fauna (i.e., with *C. fittoni*, *C. obsoletum*, *M. vitaliana*, *T. vitaliana*, and others), underlain by the beds with *C. pesanseris*;

Lower Sarmatian: clays with *S. reflexa*, under which beds with *Pholas* were recognized.

Shibinsky (1932) described the upper part of the Neogene deposits, from the Konkian to the Middle Sarmatian, along the Kuzhora and Belaya rivers upstream of Maikop. In his interpretation, the Sarmatian lies on a sandy shell rock (indicated from the Slesareva Levada and Vertepnaya gullies on the Kuzhora River and from the Maikopskaya and Tul'skaya gullies on the Belaya River), named as *Ervilia*-bearing and assigned to the Konkian. This bed contained *Macra eichwaldi* var. *buglovensis* Laskarev, *S. reflexa*, *Ervilia praepodolica* Andrussow, *E. podolica* (Eichwald), *E. trigonula* N. Sokolov, and *Pecten sartaganicus* Andrussow. Fine-grained sands with interbeds of sandstones, with *Ervilia* and *Macra* lie below. The apparent thickness of sands and sandstones is estimated at two meters. Separate outcrops of sandstones with *Pholas* sp. are indicated in the Tul'skaya Gully and described a member of sandstones with shells, with interbeds of sand, 10–12 m thick, and *E. podolica*, *E. trigonula*, *Venus konkensis* Sokolov, *M. cf. eichwaldi* var. *buglovensis*, *Pholas* sp., *Ph. cf. hommairei* Orbigny, *Lucina dentata* Basterot, *Anomia* sp., and *Spaniodontella nitida* (Reuss) in the Maikopskaya Gully. They are assigned to the *Pholas* Beds of the Konkian.

The Lower Sarmatian is described from the Kurdzhips River, Glubokaya, Maikopskaya and Kladbishchenskaya gullies, flowing into the Belaya River, and along Medvezh'ya Gully on the Kuzhora River. A succession from a borehole on the left bank of the Kurdzhips River between the villages of Kurdzhipskaia and Sadovyi is described as a typical and most representative section. Its thickness is estimated at 33.5 m. Sandstone with a mass of *S. reflexa* lies at the base, above there is about a meter of interbedding of gray sandy clays and dolomitized marls. Clays also contain *S. reflexa*. The rest of the succession is composed of gray clays with *Macra eichwaldi* Laskarev. He indicated for the studied area the thickness of clays with *M. eichwaldi* up to 30 m, and with *Syndesmya* up to 35 m. The latter are composed of gray clays with interbeds of clayey sandstones in the Kurdzhips River valley, which are replaced by marls on the Belaya River. Shibinsky drew attention to the presence of marl interbeds at the boundary between the beds with *Macra* and *Syndesma*, which he considered consistent throughout the entire area of work.

Shibinsky united the overlying Sarmatian deposits under the name of *Cryptomacra* Beds and divided them into the lower *Cryptomacra* horizon (125–130 m) and the horizon with *Tapes naviculata* (R. Hörnes) (25 m) at

the top. He attributed gray sandy calcareous clays to *Cryptomacra* Beds, conditionally divided into two parts: in the lower part with interbeds of greenish-yellow clays, gray and brown-yellow fine-grained sandstones; at the top, with interbeds of dolomitized marls. Fossils of *Cryptomacra* Beds: *C. pesanseris*, *Cardium subfittoni*, *Tapes* sp., *Nassa akburunensis* Andrussow, *N. bosporana* Andrussow, *N. leiocochlea* Andrussow, *N. scalaris* Andrussow, *Trochus urupensis* Uspenskaja, and *Hydrobia* sp. The horizon with *T. naviculata* consists at the base of rusty-yellow fine-grained argillaceous sandstones, interbedded with sandy coquinas, at the top—of coarse-grained sands, above which are replaced by gray sandy calcareous clays with frequent interbeds of sand. He listed for the lower part *C. pesanseris*, *T. naviculata*, *Macra vitaliana* Orbigny, *Cardium fittoni*, *C. bajarunasi* Kolesnikov, *Hydrobia pseudocaspia* Sinzow; for the upper part—the same species, as well as *Trochus maginatus* Eichwald, *T. urupensis*, and *N. akburunensis*. He did not recognize the deposits located above the *Cryptomacra* Beds in the studied area.

Kolesnikov (1934) referred several times to sections on the Belaya River, when characterizing the Sarmatian of the Western Ciscaucasia. He followed the Shibinsky speaking about the Lower and Middle Sarmatian, and to Czarnocki writing about the Upper Sarmatian. He recognized Lower Sarmatian sandy deposits with *S. reflexa* using the name Kuzhora Beds, which were later accepted as the basal regional Sarmatian unit (Kojumdgieva, 1971; Iljina et al., 1976; Paramonova, 1994). Later he (1940) briefly mentioned the lithological diversity of the Upper Sarmatian around Maikop, represented by clays with interbeds of argillaceous sand, marls, coquinae and sandstones. He listed *M. caspia*, *M. bulgarica* Toulou, *M. crassicolis* Sinzow, and *M. nalivkini* Kolesnikov as characteristic fossils, as well as finds of remains of fish, cetaceans, plants, and freshwater mollusks in the lower part of the Upper Sarmatian member (according to Grigorovich-Berezovsky, 1935). Probably, it was a horizon with freshwater fauna at the top of the Lower Blinovskaya Subformation (for more details, see Steklov, 1966).

Grigorovich-Berezovsky (1935) subdivided the Sarmatian deposits into four horizons (from bottom to top): Lower Sarmatian, *Cryptomacra* horizon, Middle Sarmatian, and the Upper Sarmatian. He gave a description of the horizons for the territory between the Pshish and Belaya river basins. He gave a brief descriptions of the Sarmatian deposits exposed from the Belaya River and its left tributaries: the Khanka, Fortepianka and Kurdzhips rivers. The Lower Sarmatian deposits lie over the *Pholas* Beds referred to the Lower Konkian in his interpretation. The “Lower Sarmatian” is composed of clays with *S. reflexa*, small *Spaniodontella*, and *N. akburunensis* on the Kurdzhips River. The lower part of the Sarmatian on the Belaya River lithologically varies greatly from outcrop to outcrop, and the fossil fauna is usually not indicated. It is

possible that part of the sections, attributed by the author to the Sarmatian, is older. The *Cryptomacra* horizon is indicated only for the Kurdzhips and Luchka rivers, where it is represented by clays or sandy clays with *C. pesanseris*, *Trochus*, and *Hydrobia*. It is replaced up the section mainly by sandy deposits with the Middle Sarmatian fauna: *Macra vitaliana*, *Cardium fittoni*, *Tapes vitaliana*, *Trochus urupensis*, *Nassa verneuili* (Orbigny), *N. duplicata* (Sowerby), and others. This horizon was established by Grigorovich-Berezovsky on the Belaya, Khanka, Fortepianka, Kurdzhips, and Luchka rivers. There are beds with *M. caspia*, composed of clays and coquinas (the Belaya and Fortepianka rivers) even higher. The author assigned the ocher-sandy series overlying the marine Sarmatian to the Lower Maeotian based on its position in the section above the Sarmatian.

Pavlinova-Iljina's (1957) paper was dealing with the Konkian–Sarmatian boundary beds. She characterized the *Pholas* Beds as an interbedding of gray micaceous aleurite with brown-yellow sands, sandstones, and shelly sands, with occasional interbeds of pebbles, marls, and clays. The assemblage is dominated by the pholadids *Barnea ustjurtensis*, *B. pseudoustjurtensis* Bogatchew, sometimes containing *Ervilia dissita* (Eichwald) and *E. trigonula*, and small gastropods. She considered *Spaniodontella pulchella* Baily, found in these beds, as re-deposited, like some Tarkhanian and Chokrakian species. In my opinion, the ferruginous sandstones with *Pholas* described by Shibinsky (1932) represent the same deposits. *Pholas* Beds (Pavlinova-Iljina, 1957) are overlain by yellow-brown sands with interbeds of shells and sandstones with the Konkian fauna of the Mediterranean appearance: *Arca noae* Linné, *A. aff. papillifera* M. Hörnes, *Chlamys diaphana* (Dubois de Montpéroux), *Chama gryphoides* Lamarck, *Corbula gibba* (Olivi), *Aporrhais alatus* (Eichwald), *Natica millepunctata* Lamarck, *Columbella scripta* Linné, etc. They are replaced by gray and brown fine-grained clayey sands and aleurites with Early Sarmatian *Abra reflexa* (Eichwald), *Cardium*, *Macra*, and numerous *Hydrobia*. Further in the text, she gives a slightly different lithological description of the beginning of the Sarmatian interval and a more complete list of fossils: brown-yellow sands and sandy coquinas with pebbles, containing abundant *E. dissita*, numerous *Tapes vitaliana*, *Macra eichwaldi*, *Cardium ruthenicum* (Hilber), *Abra reflexa*, *Donax dentiger*, *Ervilia trigonula*, *Modiolus incrassatus* Orbigny, *Trochus subbalatro*? Kolesnikov, *Akburunella* sp., etc. This interval, apparently, corresponds to the *Ervilia* coquina and the underlying sands and sandstones with *Macra* and *Ervilia* of Shibinsky. Thus, he did not observe an interval with the Konkian fauna of the “Mediterranean appearance”. Later, Iljina (2000), when describing the Konkian interval in the same place, in the Chumnaya and Vertepka gullies, indicated that the Konkian is overlain

first by aleurites, and above by sands with the Lower Sarmatian fauna at their base, represented by *Gibbula*, cardiids, *Macra*, and large *Tapes*. She also mentioned a few redeposited *Turritella pythogoraica* Hilber and *N. millepunctata* Lamarck at the base of the Sarmatian.

Buryak (1965) briefly touched on the Sarmatian. He wrote that the Lower Sarmatian deposits with *Cardium pictum* Eichwald and *Macra eichwaldi* lie over the Konkian, and the Lower Sarmatian coquina with Ervilian and with the redeposited Konkian *Turritella atamanica* Bogatchew and *N. millepunctata* are found in the Slesarevaya and Vertepnaya gullies. Somewhat earlier (1960), he pointed out that to the north of the town of Tul'skii, the Konkian deposits pass into sandy clays only with *A. reflexa*, which makes them indistinguishable from similar beds of the lower Sarmatian and proposed to draw the Konkian–Sarmatian boundary within the beds with *A. reflexa*. He proposed in the same paper to recognize beds with *A. reflexa* at the base and beds with *M. eichwaldi* at the top of the Lower Sarmatian, specifying that they are not stratigraphically consistent everywhere. The last led that he (1965) rejected laterly the recognition of these beds. Buryak recognized the Mamai Horizon at the Lower–Middle Sarmatian boundary, in which, he included a member of fine-grained sands 5–6 m thick in the Belaya River area. It remains unclear which part of the sections on the Belaya and Kurdzhips rivers can correspond to this level.

Velikovskaya (1964) believed that the ocher-sandy member with freshwater and terrestrial fauna has Maeotian age based on the identified ostracods *Cypriideis torosa littoralis* Brady, *Loxoconcha maeotica* Voroshilova, *L. trapezoides* Voroshilova, *L. aff. tamarindus* Jones, *Xestoleberis goretskii* Golovko, *X. jatskoi* Golovko, *X. maeotica* Suzin, *Leptocythere maeotica* Livaltal, and *L. sulakensis* Suzin.

Steklov (1966) was the first to describe in detail and characterize the Middle and Upper Sarmatian deposits on the Belaya River in terms of the distribution of terrestrial mollusks. He recognized two intervals in the Sarmatian with such fauna. The lower one is described from sections within the city of Maikop, below the road bridge. The mollusks were collected from marl with sand lenses and interbeds of clay with carbonized remains. Steklov published a list of freshwater and terrestrial gastropods, as well as identifications of ostracods, Characeae, and rare vertebrates. The marl is underlain by gray and ferruginous sands and sandstones with *C. fittoni*, *Macra*; above marl—about 22 meters of interbedding of sands, pebbles and coquinas with *M. caspia*, *M. crassicolis*, *M. anapica* Steklov, *Pseudomacra poroschini* Steklov, and *Hydrobia* sp. The rocks below the marl are assigned to the Middle Sarmatian, above it—to the Upper Sarmatian.

Another interval is confined to the “sandy-ocher” member described from the outcrops near the village of Gaverdovskii. Here, medium-grained sands 20 m thick lie on dark gray clays, and contain *M. caspia* at the base only. They are overlain by dark gray clay (1.5 m) with plant remains, fish scales, and numerous *Hydrobia*. Sands and sandstones with terrestrial fauna follow even higher, with a thickness of about 16 m. Steklov cited an assemblage of gastropods and ostracods from sandstone at the top of the section, but made no conclusions about its most probable age. He adhered to the Upper Sarmatian–Maeotian age of the sequence based on the finds of *M. caspia* in its base, the gradual transition of marine facies to continental ones, and the findings of ostracods indicating the Maeotian age of part of the sequence (following the data of Velikovskaya, see above). He also proposed to expand the age range of the sequence to Pontian; however, he did not substantiate this factually.

Paramonova (1994) published the results of studying Sarmatian sections on the Kuzhora and Belaya rivers and proposed a subdivision of deposits based on bivalve assemblages. In the Kuzhora Horizon, represented by gray fine-grained sands with interbeds of coquinas, more than 20 meters thick, she identified an assemblage characterized by an abundance of *Obsoletiforma lithopodolica ruthenica* and very rare *Plicatiforma praeaplicata praeaplicata* and *Abra alba scythica* (N. Sokolov), which are not found in the Zbruch Horizon located above (the units everywhere are referred to as *beds* in the original paper). The latter is composed of sands with sandstones at the base, clays at the top, and has a thickness of no more than 6 m, are characterized by the appearance of *Obsoletiformes obsoleta obsoleta* (Eichwald) and *Plicatiforma plicata plicata* (Eichwald). Clays with interbeds of sands lie even higher and represent the Novomoskovskian Horizon with *Cryptomacra pesanseris* (25–30 m). Clays of the Dnieper–Vasiljevsk Horizon (at least 12 m) differ from the latter in the appearance of *Plicatiforma fittoni ruslovensis* (Sultanov), *Inaequicostata barboti barboti* (R. Hörnes), *Obsoletiformes venesta* (Kolesnikov), etc.

Beluzhenko (2002a, 2002b) proposed a local stratigraphic scheme for the Middle Miocene–Pliocene deposits of sheet L-37-XXXIV of the State Geological Map with description of sections, distribution, and correlation of stratigraphic units. He identified and characterized the following formations and members in the Sarmatian sequence in the Belaya River basin: the Tsurevskaya Formation, the Krasnomostovskaya Member, the Krasnooktyabrskaya Member, and the Blinovskaya Formation. Subsequently (Beluzhenko, 2004), the Krasnomostovskaya and Krasnooktyabrskaya members were interpreted as formations. Beluzhenko (2004) proposed within the Adygea Uplift a different structure of the lower part of the Sarmatian interval: the Tulsкая, Krasnomostovskaya, Krasnooktyabrskaya, Blinovskaya, and Gaverdovskaya formations

overlie the Adygea Formation of Late Karaganian–Konkian age.

The Tsurevskaya Formation was mapped along the banks of the Kurdzhips River in the village of Kurdzhipsкая and somewhat to south, characterized in the territory of its distribution by a thick series of clays with carbonate interbeds. No data on the structure and fossils of the Tsurevskaya Formation in the Kurdzhips River basin exist in the explanatory notes to the corresponding mapping sheets (Korsakov et al., 2001, 2004). According to Beluzhenko (2002a), the lower part of the Tsurevskaya Formation belongs to the Karaganian, and the upper boundary lies in the Middle Sarmatian, which is suggested by bivalves and foraminifer as findings in the outcrops of the formation along the Pshékha, Pshish, and Psekups rivers. This formation constitutes the lower part of the Sarmatian section just to the west of the Kurdzhips Fault, which crosses the Kurdzhips River downstream of the village of Kurdzhipsкая and follows northeast of the river. According to the explanatory note to sheet L-37-XXXIV and maps of sheets L-37-XXXIV, L-37-XXXV (Korsakov et al., 2001, 2004, as well as Beluzhenko, 2002b), the Krasnomostovskaya Formation overlies the Tsurevskaya Formation to the west of the fault and is replaced up the section by the Krasnooktyabrskaya and further up Blinovskaya formations. However, it remains unclear how the Krasnomostovskaya and Krasnooktyabrskaya formations can be separated from each other, and the Krasnomostovskaya from the Tsurevskaya formations, if their boundary beds do not show lithological or faunal differences. For example, the Upper Tsurevskaya Subformation, according to its description, is composed of clays with clay-carbonate interbeds, characterized at the base by the Lower Sarmatian, at the top—by the Middle Sarmatian faunas. The lower part of the Krasnomostovskaya Formation also has a clay composition, interbeds of marl and the Lower–Middle Sarmatian fauna (Korsakov et al., 2001; Beluzhenko, 2002a, 2002b; Beluzhenko et al., 2007). Moreover, Beluzhenko writes that the Krasnomostovskaya Formation “corresponds to the upper part of Tsurevskaya and lower part of Orlovoerikovskaya formations” (Beluzhenko, 2002b). How can a formation, overlapping the Tsurevskaya Formation (Korsakov et al., 2001), be of the same age as it?

The Lower Sarmatian is described in the most detail (Beluzhenko et al., 2007) on the territory of the Adygea Uplift, basing on sequence in one of the ravines descending to the town of Tul’skii on the right bank of the Belaya River. The latter section was proposed as the stratotype of the Tulsкая Formation (Beluzhenko, 2004). The formation consists of aleuritic member (16 m) below and sands (7 m) above. No fossils are indicated in the lower seven meters of the aleurites. Specimens of *Abra* and *Ervilia* are found higher up in the section. The taxa are cited from sands, basing the papers of Iljina and Buryak. Beluzhenko

points out that section is located in a gully near the building of the Makhoshevskii forestry. This building is located between the upper reaches of two gullies: Aul and Aul'chik, descending to the town of Tul'skii (Fig. 1). A visit to these gullies in 2018 showed that the stratotype was described from the canyon-like Aul'chik Gully.

A thick series (hundreds of meters) lies above and consists of clays at the base, which are replaced by increasingly coarser facies up the section. The lower clayey part of the sequence is proposed to be considered as part of the Krasnomostovskaya Formation (Beluzhenko, 2002b, 2004; Beluzhenko et al., 2007). According to the original description (Beluzhenko, 2002b), it is composed of gray sandy-micaceous laminated clays with interbeds of marls in the lower half and interbeds of clayey sands and sandstones in the upper part. The formation was originally dated as Middle Sarmatian. Later, the dating of the formation was changed (Beluzhenko, 2004): it was divided into the lower subformation, represented by clays and aleuritic clays with thin interbeds of marls and limestones, and with Lower Sarmatian fauna (*Abra reflexa*, *Ervilia dissita*). The upper subformation consists of two members and characterized by the Middle Sarmatian *Cryptomactra pesanseris*. The lower unit is clays with interbeds of "brecciated" limestones (below I refer to such interbeds as "nodules"), the upper one is clays and aleuritic clays. Sections in a gully near the Makhoshevskii forestry for the lower part of the formation and the bank of the Belaya River downstream of the railway bridge near the village of Sovkhoznyi have been proposed as the stratotype (Beluzhenko erroneously indicated the village of Sadovyi, which is on the Kurdzhips River). A description of a section of the formation was also published (Beluzhenko et al., 2007), the thickness of which is estimated at 45 m. He recognized the Krasnooktyabrskaya Formation above the Krasnomostovskaya Formation, which is composed of aleurites with interbeds of aleuritic clays and sands with an estimated thickness of about 210 m and fauna of the Middle Sarmatian age: *C. pesanseris*, *Maetra urupica*, *M. fabreana* Orbigny, *Plicatifformes fittoni*, *Venerupis crenelata*, *Akburunella akburunensis*, and *Gibbula*. Outcrops along the Kurdzhips River from the village of Sadovyi to the upper vicinity of the village of Krasnooktyabr'skii are proposed as the stratotype. Even higher is the Blinovskaya Formation, the lower part of which is described by Beluzhenko based on of an unpublished geological report (Buryak, 1964). Beluzhenko (Beluzhenko et al., 2007) recognized the Lower Blinovskaya Subformation, composed of a sandy series and containing assemblages of Middle Sarmatian mollusks *P. fittoni*, *M. fabreana*, *Obsoletiforma michailowi* (Toula), etc. It terminates at the top by continental sediments, as evidenced by interbeds of dark gray clays and marl lenses with freshwater mol-

lusks *Lymnaea stagnalis* (Linné), *L. cf. glabra* (Müller), *Planorbarius corneus* (Linné) (identifications after Steklov, 1966). The thickness of this subformation is estimated at 50–60 m. A bed of coquina with *Maetra caspia* of the Upper Blinovskaya Subformation unconformably overlies it. There is above about 80 m of sands and 8 meters of clays with *M. caspia*. A section on the Belaya River from the vicinity of the former farm of Blinov (now it is immediately downstream the village of Groznyi, near the hanging bridge) to the mouth of the Fortepianka River is proposed as the stratotype of the Blinovskaya Formation. The Lower Blinovskaya Subformation is dated as Middle Sarmatian, and the Upper Blinovskaya Subformation is dated as Upper Sarmatian, based on the found fauna.

The sequence of Sarmatian deposits is completed by the Gaverdovskaya Formation with a stratotype along the Belaya River from the mouth of the Fortepianka River to the lower vicinity of the village of Gaverdovskii. It was proposed by Beluzhenko (2004) instead of the previously used sandy-ocher member (Beluzhenko and Burova, 2000) and was characterized in detail in 2007 (Beluzhenko et al., 2007). He concluded that Bed 10 may be of Late Sarmatian–Maeotian age, and Bed 11 may be of Maeotian age according to the studied palynassemblages. Thus, the lower part of the formation can be attributed with some degree of uncertainty to the Upper Sarmatian. It includes most of the Lower Gaverdovskaya Subformation, which in the Sarmatian (?) part is composed mainly of sands (Beds 1–7, about 30 m thick), sandstone bed (Bed 8, thickness 5–6 m) and clays (Beds 9–10, apparent thickness 7 m). A probably incorrectly identified *Hydrobia novorossica* Sinzow, which has the Early Pontian age is listed from Bed 2, while terrestrial and freshwater mollusks were found in Beds 4 and 6.

Thus, the total thickness of the Sarmatian deposits in the studied region is estimated (Beluzhenko et al., 2007) at 450 m, of which about 40 m is the Lower Sarmatian (Tul'skaya and lower part of Krasnomostovskaya formations), 280 m is the Middle Sarmatian (the main part of the Krasnomostovskaya, Krasnooktyabrskaya formations and the Lower Blinovskaya Subformation), about 90 m is the Upper Sarmatian (Upper Blinovskaya Subformation) and about 40 m of the supposed continental Upper Sarmatian¹ (most of the Lower Gaverdovskaya Subformation).

More detailed studies of the continental part of the Gaverdovskaya Formation were carried out by a group of researchers led by A.S. Tesakov and V.V. Titov. The sections at the mouth of the Fortepianka River and near the village of Gaverdovskii were studied; and the fossils were collected from the series of bluish-gray

¹ Shells of the Upper Sarmatian *Maetra* found in the Gaverdovskaya Formation are redeposited according to S.V. Popov. Thus, the marine genesis and the Sarmatian age of the enclosing deposits are called into question.

clays (according to Tesakov, it corresponds to Beluzhenko's Bed 6). The first results (Tesakov et al., 2013) showed a rich assemblage of freshwater and terrestrial mollusks, mainly small mammals and turtles. Based on the vertebrate assemblage, this level is dated as the upper part of the MN10 Zone—MN11 Zone, which correspond to the Vallesian—Turolian boundary interval, which confirms the point of view on the Upper Sarmatian—Lower Maeotian interval of this part of the section. The full results were published in a review by Tesakov et al. (2017). In addition to describing the studied sections, vertebrates are described in detail, ostracods and mollusks are illustrated and discussed, palynoassemblages are characterized, and preliminary data of paleomagnetic analysis are given for the first time. The dating of the interval remained the same.

Based on the results of publications, it is possible to reconstruct the structure and occurrence of Sarmatian deposits between the Kuzhora and Kurdzhips rivers as follows. The Sarmatian is underlain by Konkian deposits, which, west of Belaya, are represented by sandy or aleuritic beds with *Barnea* overlain on the eastern bank of the Belaya by the Konkian sandy member with the Veselyanka complex of fauna. At the interfluvium of the Kuzhora and Belaya, the Lower Sarmatian begins with a sandy member with clay interbeds at the top, with *Abra reflexa* and *Macra eichwaldi*, which to the west passes into a predominantly clayey member with separate carbonate interbeds and thin sands at the base. These beds are overlain by clayey and clayey-aleuritic deposits with *Cryptomacra pesanseris*, in which sand interbeds appear up the section, the coarse-grained sediments gradually increase, the number and thickness of sandy beds enlarge. They contain bivalves, mainly represented by *Atamarcia* and *Macra*. The lithology of the upper part of the Middle Sarmatian is also inconsistent. Thus, along the Belaya, this interval is represented by a sandy series, while on the Kurdzhips a deeper-water aleuritic-clayey series overlies a predominantly sandy unit. Numerous remains of terrestrial plants were found on both rivers in the sandy part of the interval, which indicates the proximity of the coastal zone, and at the top of the Middle Sarmatian, continental sediments were found containing both plant remains and terrestrial and freshwater mollusks. Marine deposition resumed in the late Sarmatian, but the sea level was unstable, which is expressed in the variability of the lithological composition of the sediments, which are represented by either sandy or clayey facies, with occasional coquina interbeds. Finally, the second and final retreat of the sea occurs, as a result of which deposits with marine Upper Sarmatian fossils are replaced by a predominantly barren series, in the lower part of which terrestrial and freshwater mollusks and mammals are found, which characterize the Gaverdovskaya fossil assemblage of Late Sarmatian—Early Maeotian age.

SARMATIAN DEPOSITS ON THE BELAYA AND KURDZHIPS RIVERS

Dislocations in the Sarmatian. Bedding is disrupted in the lower part of the Sarmatian on the Belaya and Kurdzhips rivers. These are disruptions in Members 4–7 on the Belaya River, which are dated as uppermost Lower Sarmatian (Fig. 3). They were recorded when the section was first described (Beluzhenko et al., 2007). They can probably be interpreted as underwater landslides accompanied by plastic deformation of bottom sediments. The folds vary greatly in amplitude and morphology. The height of swelling varies from 0.3 to more than 2 meters, which is clearly visible due to the limestone interbeds. In this case, there is a thickening of the clay interbeds between the limestone interbeds, and sometimes the limestone interbeds themselves. With thickening, the sediment is saturated with fossils at the apex of the fold. Fossils were collected from two levels of such accumulations, while shells disappeared as they moved away from the top of the fold. The tops of the folds vary from rounded to pointed (Figs. 4c–4f), sometimes with breaking out of the limestone bed passing through the top (Fig. 4a), suggesting deformation of the already lithified sediment. Occasionally, local horst-like swellings of lithified limestone beds in Member 7 are also encountered, and loop-like fluid textures are observed (Fig. 4b). Members 4 and 5 are characterized by branching, merging, and arbitrary deviating up and down of carbonate interbeds. Member 7 reaches a thickness of 4–5 m in places of swellings, while at the maximum narrowing it decreases to 1.5 m. Sediment above Members 8 and 9 fills in irregularities on the surface of Member 7, retaining the smoothly wavy bedding. In this case, the thickness of Members 8 and 9 decreases over the swelling of Member 7 and vice versa. So, the thickness of Member 8 changes up to two times, and Member 9 by about a third of the maximum thickness.

The disturbed occurrence of Sarmatian deposits on the Kurdzhips River has been recorded for a long time ago. Czarnocki (1911, p. 48) indicated “the fall is rather steep, in some places the beds are set on their heads” for the lower part (lower Sarmatian and *Cryptomacra* Beds) of the Sarmatian section. Later, Shubin (1932, p. 9) expressed himself more specifically: “on the Kurdzhips, the steep dips of the beds are due exclusively to landslides.” On the Kurdzhips River between the road bridge in the village of Krasnyi Most and Outcrop 1A₂ contain a large olistostrome of early Middle Sarmatian age and a younger and smaller one in Outcrop 1C₂. The first olistostrome can be traced in outcrops in the western bends of the river (Figs. 5, 6), while to the east only undisturbed outcrops are visible. In the southern part, it is located on the *Barnea* Beds of the Kartvelian, while in the north it is wedged into the Middle Sarmatian deposits. The boundary of out-



Fig. 3. The Lower Sarmatian part of the section on the Belaya River near the upper vicinity of the village of Groznyi. The water-bearing levels at the top of the cliff run along the surface of nodules interbeds in Beds 11 and 13. They are conformably underlain by beds of Members 8 and 9, from which *Cryptomactra* Beds begin, at the base; folded beds of Member 7 lie at the base.

crops 1A₁ and 1A₂ runs along the northern edge of the olistostrome, which is clearly visible in Fig. 7.

The development of a small anticline with a core (according to Shibinsky) near the village of Krasnyi Most was established on the Kurdzhips River, starting from Czarnocki. According to Shibinsky, the *Pholas* Beds raise to the surface in the core, and dip again to the south. This anticline is confirmed on sheet L–XXXV of the State Geological Map (Korsakov et al., 2004), and outcrops of the Tuskaya Formation are shown only in the core. Our observations showed that half a kilometer above the road bridge in the village of Krasnyi Most, the bank is already composed of sandy Kartvelian aleurites, which continue within the boundaries of the village up the river. To the north of the anticline, Sarmatian deposits dip with a slight northward slope of 3°–7°, varying from northwest to northeast (Shibinsky, 1932; Korsakov et al., 2004). In Outcrop 1C₄ they dip strictly to the north in outcrop 1C₄. The beds dip roughly in a northeasterly direction. In the outcrop at the village of Groznyi, while Shibinsky (1932) indicated a slight dip of *Cryptomactra* Beds to the north-northeast for the Belaya River bend downstream.

The Kartvelian outcrops on the Kurdzhips River can be traced to the fourth right meander above the road bridge in the village of Krasnyi Most. An extended zone of underwater landslide sediments begins further to the south, with individual remnants of undisturbed deposits. This area has been examined up to the road bridge in the village of Kurdzhipskaya. At least, most of the landslides were formed in the Sarmatian, as evidenced by the widest distribution of blocks with the Sarmatian fauna in the studied area. Blocks with the Lower Karaganian fauna are also found within area of the village of Kurdzhipskaya, while only Lower Sarmatian blocks are found downstream. A landslide was encountered also with the Middle Sarmatian fauna (*Cryptomactra* Beds) closer to

Kurdzhipskaya. Only two remnants of rocks with undisrupted bedding have been preserved at that area: Lower Karaganian (Figs. 8c, 8d) and Lower Sarmatian remnants. The latter is exposed along the river in a series of outcrops (up from the second road bridge above the village of Krasnyi Most) with visible contacts with the surrounding landslide massifs (Figs. 8a, 8b). The remnant is composed of gray clays with interbeds of light gray calcareous mudstones, usually with scattered gastropod fauna, which suggests that these are uppermost Lower Sarmatian. It is noteworthy that the Lower Sarmatian blocks in the landslide massifs surrounding the remnant differ in a faunal content. They are characterized by the presence of interbeds with abundant *Abra reflexa*. A block with an assemblage similar to the remnant was found only within the boundaries of the village of Kurdzhipskaya.

Belaya River. On the Belaya River, the outcrop begins along the left bank, 400 m below the road bridge (Figs. 2, 9). The top of the Lower Sarmatian and lower part of the Middle Sarmatian (beds with *Cryptomactra pseudotellina* and the basal part of the beds with *C. pesanseris*) are exposed in a continuous outcrop. Two terms were used when recognizing the stratigraphic units in the section: bed and member. Lithologically fairly homogeneous intervals are referred to as beds, while thicker series are combined into members, which are interbeddings, the subdivision of which into beds is not useful.

Bed 1. Dark gray (wet) thin-bedded clays are visible in the water at the beginning of the outcrop. Visible thickness 0.5 m.

Bed 2. Gray (dry) calcareous siltstone in the form of a slab, at the top becoming calcareous mudstone or clayey limestone, with *Abra reflexa* (Eichwald), *Retusa truncatula* (Bruguière), rarely *Akburunella* sp. ind., many serpulids. Thickness 0.1–0.15 m.

Bed 3. Gray (dry) aleurite with inclusions of fine-grained sand (thickness 0.4 m), becoming clay up the



Fig. 4. Examples of folds in the Lower Sarmatian Members 6 and 7 in the section on the Belaya River; (a) deformation of flagstone capping Member 7 with a gap at the top. Flagstone protrusion was visible above the left side of the fold a year earlier. It is noteworthy that the rocks of the overlying Member 8 cover the deformation in a compensatory manner with a gradual upward smoothing of the relief irregularities. It can be seen that the flagstone was already broken in the lithified state, and thus Member 8 lies with erosion on the exposed surface of the flagstone; (b) fluid textures in Member 7; (c–e) deformations in Members 4 and 5. The height of the folds in (d) and (e) is about 0.3–0.4 m, the cap diameter is 6.4 cm, and the pickaxe length is 43 cm.



Fig. 5. Large olistostrome on the Kurdzhips River using Outcrop 1A₀ as an example; (a) vertically oriented Lower Sarmatian deformed blocks at the end of outcrop. Sample 19A comes from there. The height of the cliff is about 3 m; (b) crumpled rock of indeterminate age in the middle part of the outcrop.

section. Aleurite contains crushed *A. reflexa*. Thickness 0.7 m.

Member 4. Alternation of clays, aleurites and sandy aleurites (gray clays, gray to brownish-gray (dry) aleurites) with numerous series consisting of several thin beds (1 cm each) of cemented carbonate rocks separated by beds of the same clays or aleurites. The beds are not parallel to each other, but sometimes diverge, sometimes approach each other, sometimes merging into thicker carbonate bodies. The series of carbonate beds follow in 0.15–0.35 m. Clays and aleurites contain many *A. reflexa*, which often form shell interbeds in carbonate series, associating there with rare small cardiids, serpulids, frequent *R. truncatula*, and rare *Gibbula*. Thickness 2.1 m.

Member 5. A thick series of carbonate beds, which consists of clay limestone 0.1–0.2 m thick and several carbonate thin beds above it, separated by gray clays

with *R. truncatula*, *Akburunella*, and *Gibbula*. The thin beds either approach the limestone or move away from it upwards by tens of centimeters. Thickness 0.4–1 m.

Bed 6. Brownish-gray (dry) sandy aleurite with numerous fragments of *Obsoletiforma lithopodolica* (Eichwald) and rare *A. reflexa*. It fills in the unevenness of the roof of Member 5, wedging out in places. Thickness up to 0.4 m.

Member 7. Gray (dry) clays with frequent thin interbeds of light gray clayey limestones containing various fossil assemblages: from relatively scattered *Akburunella* and *Gibbula* to coquina with *Retusa*, *Cornirostra*, with hydrobiids *Edrozeba* and *Pomatiasia*, with *Gibbula*, *Akburunella*, and rare *Duplicatula*. Bivalves: the lower one and a half meters contain *A. reflexa*, getting rarer up the section. The middle part of the member and sample BS12 contain rare *Mactra urupensis* Kolesnikov and juvenile *A. reflexa*.

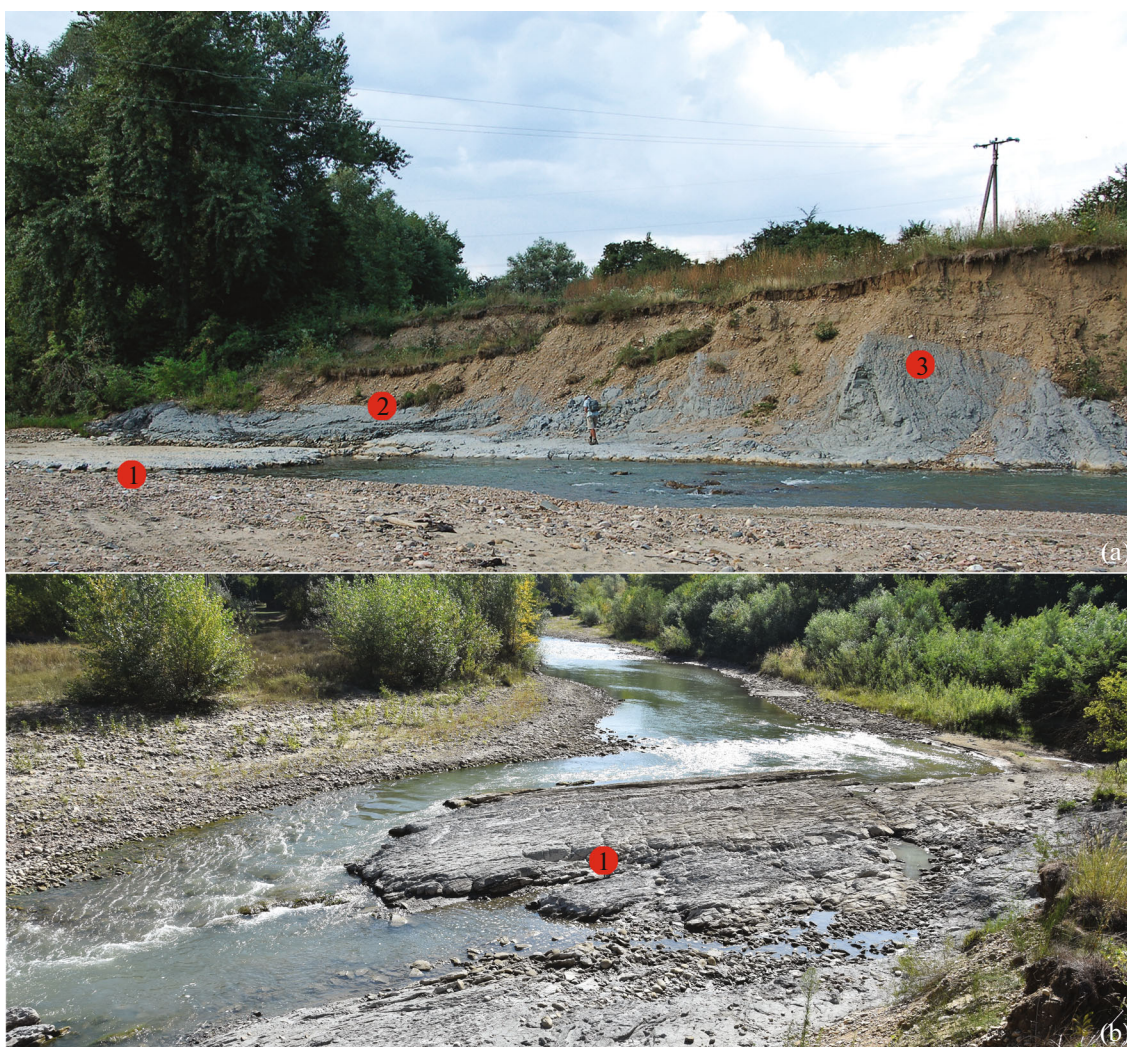


Fig. 6. A large olistostrome on the Kurdzhips River on the example of Outcrop 1A, (a) a vertically lying block with a north–south bed orientation with an apparent length of about 15 m (1) (b), a subhorizontal block with wavy beds due to deformations (2), steeply dipping clays with a north–south orientation west to southeast (3). Fauna: (1) and (2) Middle Sarmatian, *Cryptomactra* Beds (sample 10A and numerous *Akbrunella* originate from block 2), (3) no macrofauna.

Sample BS13—*Obsoletiforma danovi* (Kolesnikov), juvenile *Plicatiforma*, *Musculus*; BS14—juvenile ? *Atamarcia*. Thickness up to 4–5 m.

Member 8. Gray (dry) clays with rare centimeter-size lensing interbeds of loose clayey limestone, which are confined to scattered *C. pseudotellina*. Sample BS11 contains juvenile shells or hinge margins of *Mactra*, *Plicatiforma*, *Obsoletiforma*, ?*Atamarcia*. Gastropods: *Akbrunella*, *Gibbula*, *Cornirostra*, *Retusa*, *Acteocina*, small hydrobiids of the genera *Edrozeba* and *Pomatiasia*, first *Hydrobia*. Thickness up to 1.9 m.

Member 9. Interbedding of gray clays and interbeds (up to 8 cm) of light gray clayey limestones. Interbeds of limestones contain abundant fossils including *C. pesanseris*, *Akbrunella*, *Gibbula*, *Kolesnikovella*, *Cornirostra*, *Acteocina*, *Retusa*, hydrobiids of the gen-

era *Edrozeba*, *Pomatiasia*, *Hydrobia*. A single *Venerupis (Polittapes) ponderosa* (Orbigny) is found, and the sample BS10 contains *Formosulus lucidus* Zhizhchenko. Thickness 1.7 m.

Bed 10. Gray (dry) clay with numerous *Akbrunella*, especially with *A. leiococha* (Andrussow). Thickness 0.4 m.

Bed 11. A bed with calcareous nodules, along strike sometimes with abundant fauna. Thickness 0.1 m.

Bed 12. Gray (dry) clay. Thickness 0.1 m.

Bed 13. Bed with calcareous nodules with abundant fauna, especially in the lower part, similar in composition to the upper part of Member 9. Visually forms a single thick layer with Bed 11, from which the interval with nodules begins. This is a marker horizon that contrastingly separates the lower part of the section without nodules. Fossils: numerous *C. pesanseris*,



Fig. 7. Large olistostrome on the Kurdzhips River showing Outcrop 1A₁ as an example: the line shows the boundary between Outcrop 1A₁ olistostrome and Outcrop 1A₂ (left) with normally occurring Middle Sarmatian *Cryptomacra* Beds.

Akburunella, *Gibbula*, *Retusa*, *Acteocina*, *Edrozeba*, *Pomatiasia*, *Cornirostra*, and *Hydrobia*. Sample BS9 also contains *Odostomia*, *Kolesnikoviella*, and juvenile *Plicatiforma*. Thickness 0.8 m.

Bed 14. Gray (dry) clay. Thickness 0.2–0.3 m.

Bed 15. Interbed with calcareous nodules 0.25–0.3 m thick.

Bed 16. Gray (dry) clay. At 0.15 m from the sole there is a 1 cm thick bed of nodules. Thickness 0.6 m.

Bed 17. Interbed with calcareous nodules 5–7 cm thick.

Bed 18. Gray (dry) clay, interbedded with aleuritic fine-grained sand. Thickness 0.1–0.15 m.

Bed 19. Interbed with calcareous nodules 0.1 m thick.

Bed 20. Gray (dry) clay. Thickness 0.5 m.

Bed 21. Compact cavernous clayey limestone. Thickness 0.1 m.

Bed 22. Interbed with calcareous nodules with a basal layer of clay and silt. Thickness 0.25 m.

Bed 23. Gray (dry) clay. Thickness 0.2 m.

Bed 24. Interbed with calcareous nodules. Thickness 0.2 m.

Interval of Beds 14–24 notable for the absence of visible macrofauna even in interbeds with nodules.

Bed 25. Gray (dry) clay with *Akburunella sinuosa* sp. nov., *A. leioconcha*, *Hydrobia neofrauenfeldi* sp. nov., small hydrobiids. Thickness 0.4 m.

Bed 26. Interbed with calcareous nodules with *A. sinuosa*, *A. caucasica* (Kudriavtzev), *Gibbula urupensis* (Uspenskaja), *H. neofrauenfeldi*, *Pomatiasia cyclostomoides* (Sinzow), *Edrozeba caeca* sp. nov., *Cornirostra anistratenkorum anistratenkorum* (Bandel), *R. truncatula*, *Acteocina lajonkaireana* (Basterot). Thickness 0.15 m.

Bed 27. Gray (dry) clay with *A. sinuosa*, *A. laminaris* sp. nov., small hydrobiids. Thickness 0.25 m.

Bed 28. Interbed with calcareous nodules with *A. bosporana* (Andrussow), *A. sinuosa*, *A. caucasica*, *G. urupensis*. Thickness 0.15 m.

Bed 29. Gray (dry) clay. Thickness 0.6 m.

Bed 30. Interbed with calcareous nodules, divided below by a thin bed of clay. Fossils as in Bed 32. Thickness 0.1–0.15 m.

Bed 31. Gray (dry) clay. Thickness 0.35 m.

Bed 32. Two thin beds with calcareous nodules, separated by clay 0.1 m thick. Fossils: *C. pesanseris*, *A. leioconcha*, *A. bosporana*, *A. akburunensis*, *A. aff. nefanda* (Kolesnikov), *G. urupensis*, *A. lajonkaireana*. Thickness 0.2 m.

Bed 33. Light gray (dry) clays. Thickness 0.6 m.



Fig. 8. (a) An outcrop of the Lower Sarmatian remnant above the village of Krasnyi Most ($44^{\circ}30'07''$ latitude, $40^{\circ}04'34''$ E) with a west-east orientation. The boundary with the olistostrome is 50 m to the south; (b) neighboring outcrop to the south with a north-south orientation. The arrow shows the contact with the landslide massif. The rock deformation of the remnant at the contact is visible; (c) outcrop of the Lower Karaganian ($44^{\circ}28'49''$ N, $40^{\circ}04'15''$ E); (d) *Davidaschvilia (Zhgentiana)* on a mudstone breack (interbed is shown by an arrow in (c)).

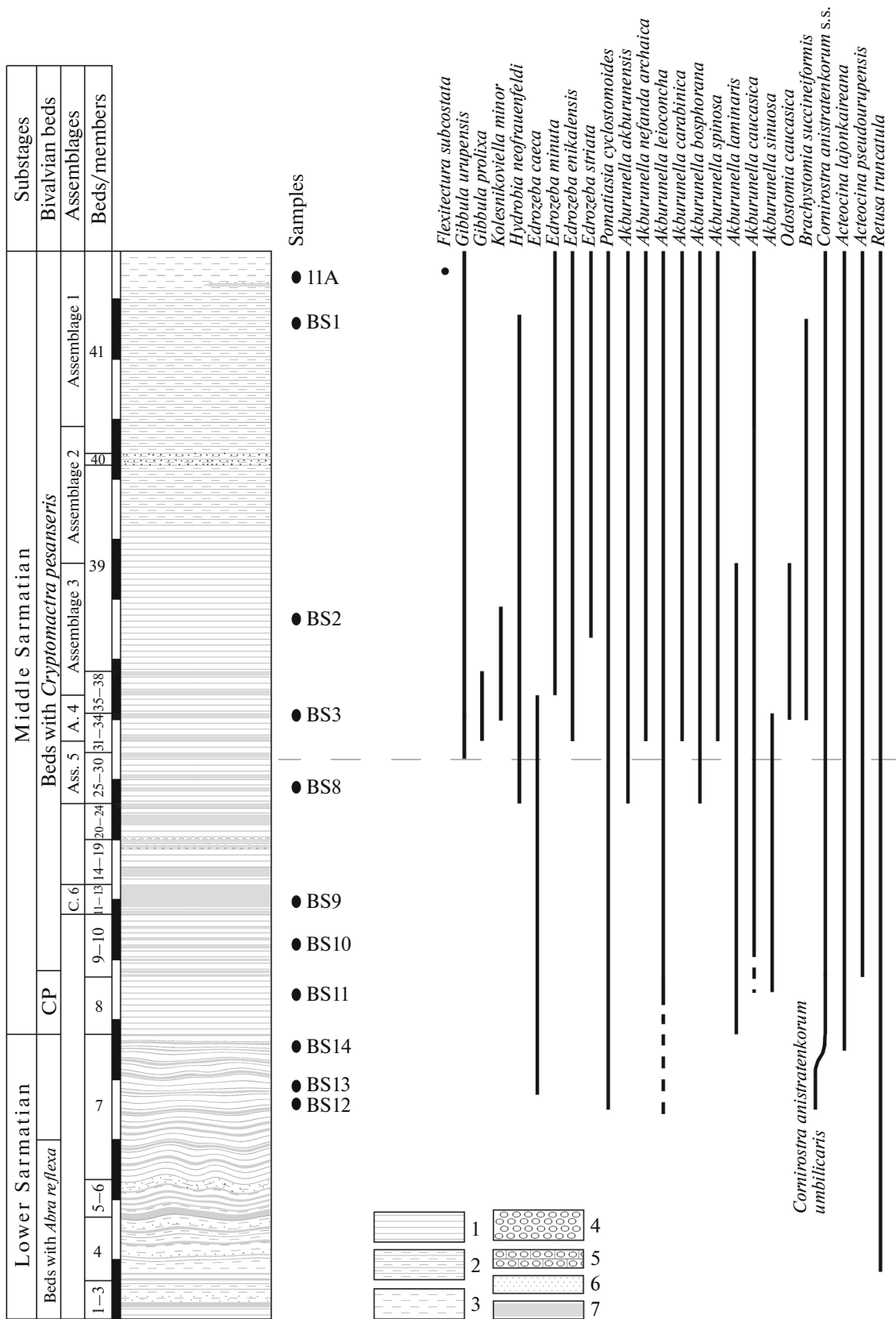


Fig. 9. Schematic section on the Belaya River at the village of Groznyi, revealing the boundary deposits of the Lower and Middle Sarmatian. CP—beds with *Cryptomacra pseudotellina*. Symbols: (1) clay, (2) clayey-aleuritic rock, (3) aleurite, (4) loose nodules, (5) monolithic nodules, (6) sand admixture in the rock or sand, (7) cemented interbeds. The scale bar is 2 m.

Bed 34. Interbed with calcareous nodules with abundant mollusks. A sample BS3 taken from the bed contains: *C. pesanseris*, *Plicatiforma* sp. juv., *A. leioconcha*, *A. bosporana*, *A. caucasica*, *A. carabinica* (Kudriavtzev), *G. urupensis*, *P. cyclostomoides*, *H. neofrauenfeldi*, *C. anistratenkorum anistratenkorum*, *Edrozeba enikalensis* (Kolesnikov), *E. caeca*, *A. lajonkaireana*, *A. pseudourupensis* (Kolesnikov), *R. truncatula*, etc. Thickness 0.15 m.

Bed 35. Light gray (dry) clays. Numerous *H. neofrauenfeldi*. Thickness 0.65 m.

Bed 36. Interbed with calcareous nodules with *C. pesanseris*, *A. leioconcha*, *A. carabinica*, *A. caucasica*, *H. neofrauenfeldi*, *P. cyclostomoides*, *C. anistratenkorum anistratenkorum*, *E. enikalensis*, *A. lajonkaireana*. Thickness 0.15–0.2 m.

Bed 37. Light gray (dry) clays with *A. leioconcha*, *A. caucasica*, *H. neofrauenfeldi* and small hydrobiids. Thickness 0.5 m.

Bed 38. Interbed with calcareous nodules, which is characterized by frequent large gastropods and bivalves *C. pesanseris*, *Akburunella*, *G. urupensis*, huge *A. lajonkaireana*, as well as numerous hydrobiids. Thickness 0.1 m.

Bed 39. Light gray (dry) clays, at the top becoming clayey aleurites. There are thin, ferruginous on the surface, interbeds a few centimeters thick. They are usually found at the top of the bed. A thin bed (2–3 cm) with ferruginous concretions and places with nodules is observed in 0.2 m above the base of the bed. There are numerous specimens of *H. neofrauenfeldi* at 4 meters from the base of the bed and below. Also, *Akburunella* and numerous small hydrobiids are also common. Sample BS2 was collected in the middle part of the bed (below the occurrence of *H. neofrauenfeldi*). Fossils: *A. leioconcha*, *A. caucasica*, *A. bosporana*, *A. akburunensis*, *G. urupensis*, *H. neofrauenfeldi*, *Edrozeba striata* sp. nov., *E. enikalensis*, *P. cyclostomoides*, *A. pseudourupensis*, etc. Bivalves are represented by scattered *C. pesanseris* and very rare *Atamarcia naviculata* (Mayer-Eymar). Thickness 6.5 m.

Bed 40 consists of two interbeds of sand separated by clayey aleurite. Aquifers (without visible cleavage) run through the sand interbeds, which is why they are visible from afar, like dark bands. Thickness 0.45 m.

Bed 41. Light gray (dry) clayey aleurites, at the top—about one and a half meters of brownish-light gray (dry) aleurites. The clayey aleurites gradually become aleurites. Two samples were taken in the bed: sample 11A from the lower part of brownish silts and sample BS1 from the upper part of clayey silts. Fossils: *A. akburunensis*, *A. caucasica*, *A. carabinica*, *A. leioconcha*, *G. urupensis*, *E. enikalensis*, *E. striata*, *C. anistratenkorum anistratenkorum*, *P. cyclostomoides*, scattered *C. pesanseris*, rare *A. naviculata* and *Obsoletiforma* sp. juv. Visible thickness is ca. 7 m.

The continuation of the section on the right bank of the next bend indicated by Beluzhenko et al. (2007),

is currently not available for study, since the bank is reinforced by a dam, and a trench filled with water is located between the cliff and the dam. Downstream, both banks are fortified against bank erosion, and there is no outcrop until the sandy section of the Blinovskaya Formation, halfway between the village of Groznyi and former farm of Blinov.

When first describing the section on the Belaya River (Beluzhenko et al., 2007), it was divided into four beds. Their Bed 2 corresponds to the series below the interval with interbeds of calcareous nodules, which Beluzhenko attributed to the lower subformation of the Krasnomostovskaya Formation. These are Beds 1–10 in my description, of which the upper two beds are no longer crumpled into folds (see discussion above). Beluzhenko recognized Bed 3 up the section, which spans an interval with frequent interbeds of calcareous nodules and constitutes the lower member of his upper subformation. Here, it is Beds 11–38. Beluzhenko included Beds 4 and 5 in the upper member, which cannot be distinguished in practice. Also, I did not observe the mentioned lenses with fragments of marls, but I encountered a single lenticular interbed of calcareous nodules at the very top of the section, according to position corresponding to their Bed 5.

The nature of the formation of horizons with calcareous nodules is ambiguous. They can be divided into two types: loosely cemented and monolithic. Loose varieties are represented by horizons overflowing with usually carbonate-argillaceous/aleuritic, rarely sandy nodules, partly intergrown with each other, but usually separate, filled with less carbonate and non-cemented rock of the same or finer (in the case of sandy nodules) grain size (Fig. 10). Sometimes the concretions are very densely packed, resembling nodular phosphorite slabs in the Mesozoic of the Russian Plate. There is usually an increased concentration of mollusk shells in these horizons, which are found both in the body of the nodules and in the host rock. At the same time, they do not bear any traces of roundness and do not taxonomically differ from mollusks outside the horizons of nodules, which contradicts the origin of these horizons due to the removal of clastics by bottom turbidity flows down the slope. The monolithic variety of nodules is represented by strong, highly cavernous limestones, in which individual nodules are no longer distinguished. Such limestones are found on the Belaya River (Bed 21) and Kurdzhips River (Outcrop 1A_{1a}).

The beginning of the section is presented by the Lower Sarmatian, which can be divided into two parts faunistically. The lower part (Beds 1–7) is characterized by the distribution of the bivalves *Abra reflexa* and gastropods *Retusa* and the rarer *Akburunella* and *Gibbula*. *A. reflexa* can be traced to the lower third of Member 7. The upper part corresponds to the rest of the Member 7 interval. Rare *Maetra urupica* Kolesnikov and juvenile *A. reflexa* were found in the middle of the

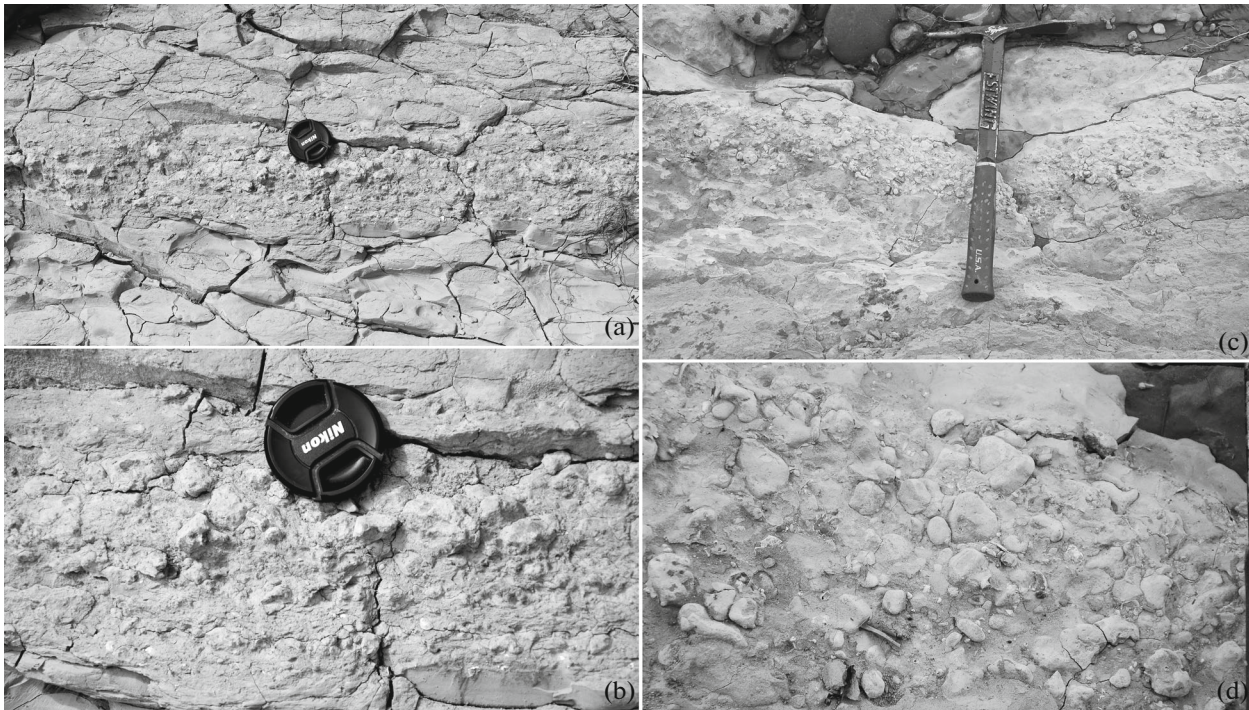


Fig. 10. Nodule horizons from the section on the Belaya River; (a, b) occurrence and texture of the nodules in Bed 36; (c, d) nodule surface in the upper part of Bed 41. Cap diameter 64 mm, pickaxe length 43 cm.

member. However, there is an increase in the diversity of gastropods, which are found only in some carbonate interbeds: *Cornirostra*, hydrobiids of the genera *Edrozeba* and *Pomatiasia* appear, which were absent below, and numerous *Gibbula* and *Akburunella* are encountered in places. *Acteocina* appears at the top of Member 7. The overlying Member 8 and the basal horizon of Member 9 contain *Cryptomactra pseudotellina*. Gastropods become abundant, the genera *Kolesnikovella* and *Hydrobia* appear at this level. Above, to the end of the section, there are *C. pesansensis*, which are concentrated in interbeds of nodules, while only occasionally occurring between them.

Following the available bivalve stratigraphic schemes (Koyumdzhieva et al., 1988; Paramonova, 1994), it was proposed for relatively deeper deposits to recognize beds with *A. reflexa* in the Lower Sarmatian, and beds with *C. pseudotellina* in the lower part and beds with *C. pseudotellina* and beds with *C. pesansensis* above in the Middle Sarmatian. *C. pseudotellina* occurs on the Belaya from the lower calcareous interbeds of Member 8 and also dominates in the lower flagstone of Member 9, while the next limestone contains a significant number of shells that can be attributed to archaic *C. pesansensis*. Therefore, the boundary between the beds with *C. pseudotellina* and with *C. pesansensis* is drawn between the two lower flagstones of Member 9. The boundary between the Lower and Middle Sarmatian is conventionally drawn along the erosional base of Member 8. The absence of finds of bivalves in the upper two to three meters (depending

on the variation of its thickness) in Member 7 leaves uncertainty in such dating.

In the studied area, the thickness of the series with *A. reflexa*, *M. eichwaldi*, and *Obsoletiforma lithopodolica* (=Lower Sarmatian) is about 40 m, the beds with *C. pesansensis* are several times thicker (the upper limit is difficult to establish due to the rare occurrence of *C. pesansensis* at the top of the interval). At the same time, the identified interval with *C. pseudotellina* is about two meters. There is no reason to assume that it accumulated at any different rate than the series below or above (they also have many unconformity levels). It turns out that the Beds with *C. pseudotellina* proposed in the schemes are stratigraphically a very narrow unit. Approximately the same picture was obtained in the study of the clayey Sarmatian along Sauk-Dere Creek (Krymsk District, Krasnodar Krai). The actual beds with *C. pseudotellina* were not found, since they correspond to a gap in the outcrop, but the thickness of this gap is an order of magnitude less than the thickness of the underlying Lower Sarmatian and the overlying clays and aleurites with *C. pesansensis*.

C. pesansensis is a result of morphogenesis of one of the species of the genus *Mactra* (Paramonova (1994) proposed *M. urupica* as its ancestor). *C. pseudotellina* has outlines similar to those of early *C. pesansensis*, but still without radial structures. Beds 9–13 contain very early *C. pesansensis* with rudimentary or slightly developed radial structures. Shells with clear but poorly developed radial structures occur up to the top of the section on the Belaya River. The first *C. pesansensis*

with sharp, well-developed radial structures that take the form of carinae are found only in the outcrop 1B₂ on the Kurdzhips River. Observations over *Cryptomactra* on Sauk-Dere Creek completes this picture. *C. pesansensis* with weakly pronounced radial structures were also found in the lower part of the section, while only shells with sharp radial carinae contained in the upper part of the beds. The latter correspond to the level of the upper part of the Pseudocaspia Member on the Kurdzhips River according to the gastropod assemblage. Thus, there was a gradual transformation of a species of *Mactra* into a late variant of *C. pesansensis*, extended over most of the Middle Sarmatian, and *C. pseudotellina* is a brief initial stage in this transformation. In this regard, it looks promising to distinguish between different intervals of *Cryptomactra* Beds based on the samples of *C. pesansensis* in different morphological states.

Kurdzhips River (Figs. 2, 11). As mentioned above, the Sarmatian deposits above Krasnyi Most are represented by a large massif of underwater landslides and are not suitable for studying fossils. They are replaced by Kartvelian outcrops located at the top of the anticline and be located in Krasnyi Most and to the south, for two kilometers from north to south. The Kartvelian is again replaced by Sarmatian deposits along the northern slope of the anticline, where the last are disturbed by landslides, which can be traced to Outcrop 1A₂.

It is not possible to describe a continuous section for the undisturbed Sarmatian deposits following down the river for a number of reasons. First, despite the large number of outcrops, there are gaps between them, the largest of which are shown in Fig. 11. Most of the section is represented by a monotonous series or a uniform alternation, which does not allow correlating outcrops in adjacent river bends even if the intervals of such outcrops partially overlap. The outcrops are mostly represented by cliffs, often inaccessible from the shore due to deep water. First of all, these are the longest cliffs in large meanders. The situation is complicated by the the Sarmatian beds dipping east and south (the dip to the north is steeper). Therefore, in areas where the river flows from east to west, beds that crop out in the eastern bend are younger than in the western bend. This can be illustrated by the example of outcrops 1B₂–1B₄, which have recognizable interbeds (the position of sections in Fig. 2, interbeds—in Figs. 12 and 13). There is a double interbed of sand in the northern part of outcrop 1B₂. It is not visible in the western half of Outcrop 1B₃ but appears in its eastern part and rises above the water to a height of two meters at the eastern end of 1B₃. The same interbed is located in the middle of the cliff at the beginning of Outcrop 1B₄ but goes under water by the middle of the outcrop. A sand member is observed in the eastern part of 1B₃, which wedges out to the west at the top of the cliff but reappears in the roof from the middle of Outcrop 1B₄. The pack descends to the water's edge by

the end of Outcrop 1B₄. Therefore, the parts of the section that are exposed in the downstream outcrops are usually built on top of each other with a less or more overlap. Outcrops 1C₆ and 1C₇ can completely repeat the intervals uncovered in outcrops 1C₃–1C₅, based on their location of exposures relative to each other and the occurrence of Sarmatian beds. However, their exact comparison is impossible due to the homogeneity of that part of the Sarmatian. A similar situation should be for outcrops 1F₂ and 1F₃–1F₄. Therefore, Fig. 11 shows the sequence of outcrops as they appear along the Kurdzhips River, indicating the characteristic lithology and confined fauna, without attempting to compare the intervals discovered in them.

The first outcrop (1A₀) of this olistostrome with visible fauna is located on the left bank above an abandoned hanging footbridge. Blocks with fauna lie almost vertically under the bridge, they are crumpled in folds in some places and strike from northeast to southwest (Fig. 5a). They are composed of clays with thin interbeds of argillaceous limestones. The clays contain a rewashed horizon with a small lens with abundant gastropods *Gibbula* sp. juv., *Edrozeba caeca*, *Pomatiasia cyclostomoides*, *Cornirostra anistratenkorum umbilicaris* subsp. nov., *Retusa truncatula*, *Acteocina lajonkaireana*, with frequent *Atamarcia naviculata* and a few *Obsoletiforma* sp. juv. (sample 19A). The clay surface of blocks also contains *Akburunella akburunensis*, *A. caucasica*, *A. leioconcha*, *Hydrobia neofrauenfeldi*, *Edrozeba enikalensis*, Lower Sarmatian *Duplicatula* sp. nov. The block with the lens is now correlated with the interval of Members 4 and 5 of the Belaya River section based on the assemblage of sample 19A, and the finds on the surface also indicate the presence of Middle Sarmatian rocks in outcrop.

A block of Sarmatian rocks is exposed in the next outcrop of the olistostrome (1A_{1a}) with a visible length along the bank of about 30 m and a height of 2.5 m. The block consists of an interbedding of cavernous limestones (=“monolithic nodules”) and clays at the base, on which a cross-bedded sandy unit lies containing the bands of clay and thin layer of loose nodules, as well as with a large sandstone lens. *C. pesansensis* was found in clay interbeds. The beds in the block extend subhorizontally without any disturbance. However, it contrasts strongly in lithology and fauna with the undisturbed Sarmatian of the adjacent Outcrop 1A₂, implying that we are dealing with a large olistostrome block. Outcrop 1A₂ is located 300 m northwestwest of 1A_{1a}. The Sarmatian strata dip from northwest to southeast at an angle of a few degrees, as we can see in the further sequence on the river with a similar disposition of outcrops (beginning of Outcrop 1B₃ and end of Outcrop 1B₄). Thus, the interval should be several meters higher in Outcrop 1A₂ than in Outcrop 1A_{1a}. However, rocks in Outcrop 1A₂ are much younger

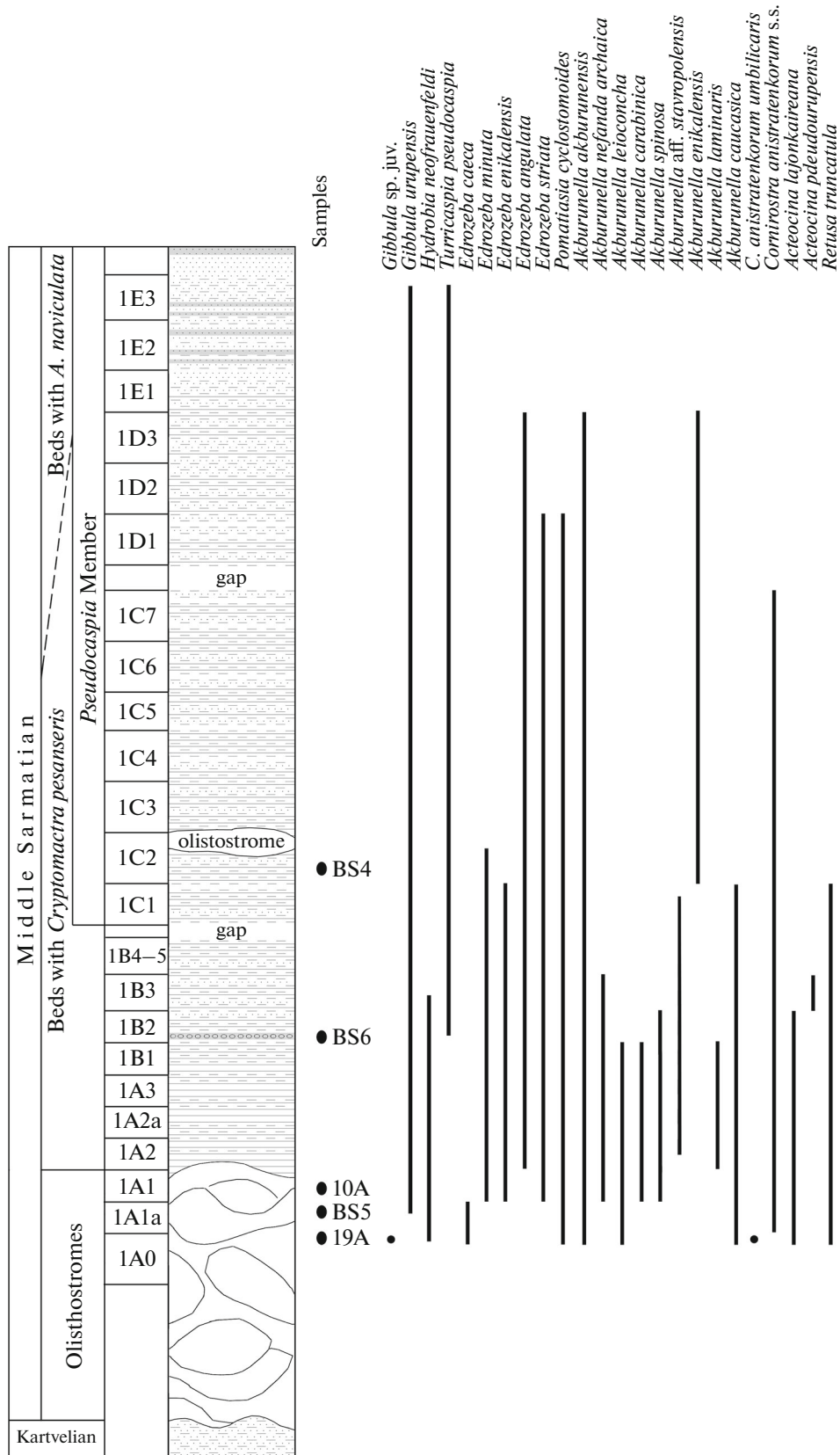


Fig. 11. Schematic section of the Kurdzhips River showing the distribution of gastropods in its outcrops. Column with outcrop numbers as they go down the river is near the lithological column. The outcrops are divided by length into three groups, depending on which their segment is longer according to their length along bank. The lithological column reflects the general character of the lithology in corresponding outcrops. Explanation of symbols is given in text-fig. 9.

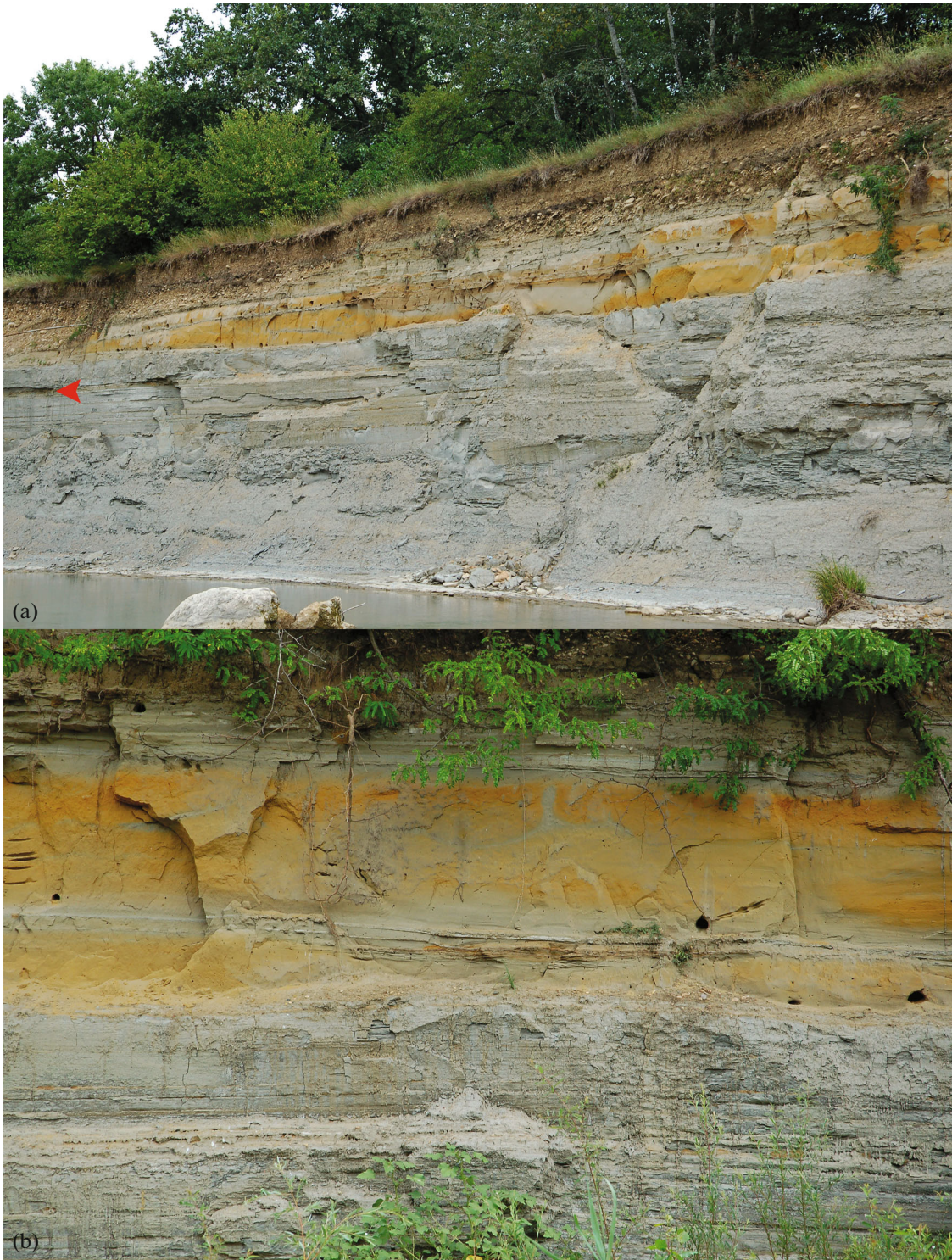


Fig. 12. (a) Sand member in the eastern part of Outcrop 1B₃ (red arrow shows the same interbed of sand as marked in Text-fig. 13); (b) upper part of the member. A strong change in the thickness of separate interbeds is visible even in a small section of outcrop.

than Outcrop 1A_{1a}. Interval of outcrop 1A₂ is located somewhere above Bed 41 of the section on the Belaya River in terms of fauna, while 1A_{1a}, corresponds to the interval between Beds 13–26 of the same section in

terms of morphology and gastropod composition, and lithology. That is, there is a much greater hiatus between the outcrops than could be allowed, if the dip of the undisturbed Sarmatian beds have place. A sample taken



Fig. 13. (a) Western part of Outcrop 1B₃ with a double sand bed at the base. The red arrow indicates the sand interbed at the base of the upper sand member, the blue arrow indicates the position of the double sand bed; (b–d) accumulations of fauna in erosion washouts of the lower sand interbed. Lid diameter 64 mm.

below the sandy member of 1A_{1a} contains *A. leioconcha*, *A. caucasica*, *A. akburunensis*, *A. bosporana*, *A. sinuosa*, *G. urupensis*, *Kolesnikoviella minor*, *H. neofrauenfeldi*, *P. cyclostomoides*, *E. caeca*, a form of *Edrozeba*, preceding *E. enikalensis*, and *Retusa truncatula*.

The olistostrome ends with Outcrop 1A₁, composed of large blocks of clay, laying from almost vertical to subhorizontal, with different orientations of the planes, partially crushed with the formation of low-amplitude folds (Fig. 6). Blocks with abundant fauna

of *Cryptomactra* Beds found in the olistostrome: rare *C. pesanseris*, many nassarids (mainly *A. akburunensis* and *A. caucasica* with rare *A. carabinica* and *A. spinosa*), trochids *G. urupensis*, small hydrobiids, rarely *H. neofrauenfeldi*. The sample 10A comes from there: *A. akburunensis*, *A. carabinica*, *P. cyclostomoides*, *G. urupensis*, *E. enikalensis*, *E. striata*, *C. anistratenkorum anistratenkorum*, rare bivalves are a few *A. naviculata*.

The boundary of the olistostrome runs approximately in the middle of the river bend (Fig. 7), and Outcrop 1A₂ is composed of normally laying clays. There is a slightly different complex here: *A. caucasica*, *A. akburunensis*, *A. leioconcha*, and *A. carabinica* are dominate between *Akburunella*, and *H. neofrauenfeldi*, *Edrozeba minuta*, and *E. angulata* are numerous among the hydrobiids.

There is a straight section down the river, hence the exposure is poor. It begins with Outcrop 1A_{2a} with a horizon rich in gastropods *A. akburunensis*, *A. leioconcha*, *A. caucasica*, *E. angulata*, *E. striata*, *E. minuta*, *P. cyclostomoides*, and *C. anistratenkorum* s.s. Outcrop 1B₁ contains numerous *A. akburunensis*, *A. caucasica*, *G. urupensis*, *H. neofrauenfeldi*, small hydrobiids. The first changes in lithology begin from Outcrop 1B₂ a thin interbed with calcareous nodules passes over gray (dry) clay with poor diversity of macrofauna, from which sample BS₆ was taken: *A. caucasica*, *A. akburunensis*, *A. spinosa*, *A. nefanda archaica* subsp. nov., *G. urupensis*, *H. neofrauenfeldi*, *E. angulata*, *E. minuta*, *E. striata*, *P. cyclostomoides*, *C. anistratenkorum anistratenkorum*, and rare *R. truncatula*. Bivalves are represented by *C. pesanseris*. There is a double interbed of dirty-yellow sand without fossils about a meter above the nodules. Numerous *A. akburunensis*, small hydrobiids, *H. neofrauenfeldi*, and also *A. spinosa*, *A. caucasica*, *G. urupensis*, a few *A. naviculata* occur in the clays under and above the sands.

The next outcrops, 1B₃ and 1B₄, are primarily of interest from a lithological point of view, as they have the first major series of sandy interbeds. Outcrop 1B₃ is elongated approximately from the northeast to the southwest and there is a slight rise of the beds in the same direction. Therefore, a double bed of sand is observed at the southwestern end of the section, while the following series of sandy interbeds is visible in the eastern part of the section. There is a member of aleuritic clays 5–6 meters thick with rare *Akburunella* between them. The sandy unit has here a thickness of about one and a half meters and consists of a lower half meter, where aleuritic clays alternate with thin interbeds of sands, and an upper meter part, consisting of two thick interbeds of yellow sand separated by gray aleurite. The thicknesses of the upper sand interbeds vary greatly, reaching 0.5 m each (Fig. 12). They contain numerous small bivalves, gastropods *T. pseudocaspia*, small hydrobiids, fragments of *Sinzowia*. There are about a meter of silty clay with centimeter-thick interbeds of sand under the sand unit. The lower double bed of sand is accessible for studying in the western

part of 1B₃, where erosion washouts are often found in the lower interbed (Fig. 13), either empty or filled with diverse shallow-water Middle Sarmatian fauna. Large-sized fauna is found in larger washouts and represented by archaic *Akburunella enikalensis* (Kolesnikov), ? *A. nefanda* (fragments), as well as *Duplicatula daveluina* (Orbigny), heavily rounded *Barbotella*, numerous large cardiids and *Mactra*. Smaller washouts contain only smaller cardiids. Bivalves were identified from both sand levels: *Obsoletiforma bajarunasi bajarunasi* (Kolesnikov), *O. bajarunasi urupensis* (Kolesnikov), *O. pseudofischeriana pseudofischeriana* (Sinzow), *O. pseudofischeriana vasoevichi* (Kolesnikov), *O. obsoleta obsoleta* (Eichwald), *O. obsoleta nefanda* (Kolesnikov), *Plicatiforma plicata subfittoni* (Sinzow), *Musculus sarmaticus* (Gatuev), *Donax dentiger* (Eichwald), *Venerupis vitaliana vitaliana* (Orbigny), *Atamarcia naviculata* (R. Hörnes), *Mactra fabreana* (Orbigny), *Solen subfragilis* (Eichwald), ? *Abra reflexa*. Both levels with sands are well exposed in Outcrop 1B₄, but due to local conditions they are difficult to study. *A. akburunensis* was found in a small Outcrop 1B₅ (gray clays).

Outcrop 1C₁ follows after some gap. It is composed mainly of gray clayey aleurites with two sandy interbeds. Numerous *Akburunella* and other hydrobiids are found below the sands. The following taxa were collected at the western end of the outcrop: *Akburunella akburunensis*, *A. caucasica*, *A. aff. stavropolensis* (Kudriavtzev), *Turricaspia pseudocaspia*, *Edrozeba angulata*, *E. minuta*, *Pomatiasia cyclostomoides*, *Cornirostra anistratenkorum anistratenkorum*, *Retusa truncatula*. A thick member begins with the outcrop, which I named “*Pseudocaspia* Member” because of the abundance of *T. pseudocaspia* with the rare occurrence of relatively large gastropods (nassarids and trochids) and the impoverishment of the assemblage of small hydrobiids is characteristic for it. There are frequent beds characterized only by *T. pseudocaspia*. It is poorly studied member in samples, while the main data were obtained by collecting gastropods from outcrops. The only processed sample taken from the member comes from the lower part of Outcrop 1C₂ from the level where *E. angulata*, in addition to *T. pseudocaspia* was often observed visually. The following assemblage was identified: *E. angulata*, *E. minuta*, *P. cyclostomoides*, *T. pseudocaspia*, and *C. anistratenkorum anistratenkorum*.

Subsequent outcrops can be grouped as the lithological composition changes. Thus, the Sarmatian in outcrops 1C₃ to 1E₁ is predominantly represented by clayey aleurites and aleurites with numerous intercalations or thin bands of sand (nowhere such thick beds are found as in outcrops 1B₃ and 1B₄). Examples of intercalations with sand for this group of outcrops are shown in Fig. 14. Shells of *A. naviculata* become more common up the section, with rare *O. bajarunasi bajarunasi* admixed in outcrops of group 1D, concentrated mainly in sandy interbeds. *T. pseudocaspia*



Fig. 14. Sandy interbeds and inclusions by example: (a) Outcrop 1C₅, (b) Outcrop 1D₃.

dominates among the gastropods, in addition to which the very rare *Akburunella* (*A. akburunensis*, *A. enikalensis*) and sometimes *E. angulata* can be found in the talus. A sample of an increased volume (35 kg) was taken from Outcrop 1C₇ in 2019 taking into account the dispersal of the fauna. The level was chosen by analogy with the sample BS2, where *E. angulata* was encountered in addition to *T. pseudocaspia*. As a result, the sample confirmed the extreme impoverishment and dispersal of the fossils. It contained only a few *T. pseudocaspia* and even fewer *E. angulata*. Sandy interbeds of Outcrop 1D₁ contained: *Obsoletiforma incurvata* (Kolesnikov), large *O. bajarunasi bajarunasi*,

O. praefischeriana (Koles.), *Plicatiforma fittoni* (Orbigny), *A. naviculata*, *Maetra* sp. The aleurites of 1D₁ and 1D₃ contain common *A. naviculata*, a few *O. bajarunasi bajarunasi* and *O. obsoleta obsoleta*. *C. pesansensis* is only rarely found in the *pseudocaspia* Series. It is known from single finds of arches of the anterior margins, usually in taluses. The topmost find is the interval of outcrop 1D₃.

A 1.5-m bed of yellow sand appears at the top of outcrop 1E₁, overlain by interbedding of aleurites, sandy aleurites, sands, and thin-platy sandstone (from Outcrop 1E₁ to the beginning of Outcrop 1E₃,



Fig. 15. (a) Interbedding in Outcrop 1E₂, (b) sandstone on the Kurdzhips River downstream of Outcrop 1E₃.

Fig. 15a). The alternation is replaced in Outcrop 1E₃ by a series of gray clayey-aleuritic sands, which are overlain downstream by a rusty-yellow bed of sand one to two meters thick, capped by bed of sandstone up to half a meter thick (Fig. 15b). Numerous *Turricaspia pseudocaspia* and occasionally *Gibbula urupen-*

sis were found in outcrops 1E₁–1E₃. Gray sandy aleurites and aleuritic sands with flagstone interbeds emerge with a gap of 100 m downstream after the sandstone bed. A similar series continues to the road bridge, and contains sandy interbeds, with abundant bivalves including *Atamarcia naviculata*, *Donax denti-*

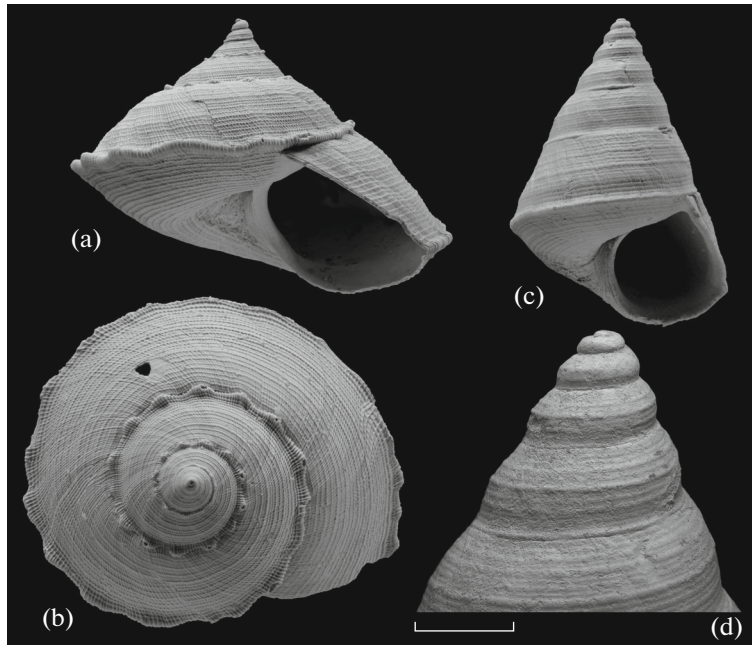


Fig. 16. Morphology of *Kolesnikoviella blainvillei* (Orbigny, 1844) (a, b) and *Jujubinus anceps* (Eichwald, 1851) (c, d) from the Middle Sarmatian of Chişinău; (a, b) specimen PM SPbGU, no. 3/418 (height 8.8 mm, diameter 19.2 mm); (c, d) specimen TsNIGR Museum, no. 205/11126 (height 10.5 mm).

ger and small cardiids. Gastropods are rare and poorly preserved here: a late *G. urupensis* was identified. The composition of the assemblage changes downstream of the bridge, now it is with more diverse gastropods and bivalves. The Sarmatian is still composed of gray aleurites, rarely sandy to one degree or another; true sands become rare. The molluscan assemblage is dominated by abundant *A. naviculata* and *T. pseudocaspia*. Bivalves: *Plicatiforma fittoni*, *Obsoletiforma bajarunasi bajarunasi*, *O. pseudofischeriana pseudofischeriana*, *Venerupis panderosa*, *Maetra fabreana*, etc. Gastropods are represented by *Edrozeba angulata*, *Kolesnikoviella minor*, late *Akburunella enikalensis*, *A. multicostata* (Kolesnikov), *Akburunella* sp. nov., *Gibbula kichinevae* (Orbigny), diverse *Acteocina*, rarely *Barbottella* (along the erosion horizons) and other species, mostly of the genera *Gibbula* and *Duplicatula*. That is the assemblage combines the elements of a “typical” Middle Sarmatian fauna and a fauna of the upper part of the *Cryptomactra* Beds.

SYSTEMATIC PALEONTOLOGY

Family Lottiidae Gray, 1840

Subfamily Tecturinae Gray, 1847

Genus *Flexitectura* O. Anistratenko, 2000

Type species. *Flexitectura (Acmaea) tenuissima* (Sinzow, 1892). The type material of the species comes from the Middle Sarmatian deposits of Moldavia (Dniester River).

Remarks. According to the images (Anistratenko O. and Anistratenko V., 2007), the protoconch is located on the apex of representatives of the genus in the form of a smooth rounded or oval plate separated by a groove from the postlarval shell. The shell from an earlier paper (Anistratenko O. et al., 2006, text-fig. 5D), erroneously attributed to *Blinia* sp., has the same feature. In this respect, *Flexitectura* differs from the species *Blinia* O. Anistratenko, Bandel et V. Anistratenko, 2006, in which the protoconchs are represented by hemispherical or flattened rounded formations, smooth or covered with concentric wrinkles, usually without a sharp demarcation of the postlarval shell. There is a possibility that the “protoconchs” of *Flexitectura* are in fact a secondary formation: a filling formed after the dissolution of the larval shell. Cases of dissolution of larval shells and juvenile parts of the postlarval shell in gastropods are known, for example, in Caecidae, Subulinidae (*Rumina* Risso, 1826), Pomatiopsidae (*Bourmyia* Cossmann, 1888), and Clausillidae (*Oospira* Blanford, 1872).

Flexitectura subcostata (Sinzow, 1892)

Plate 11, fig. 1

Acmaea subcostata: Sinzow, 1897, p. 61, pl. 3, figs. 6, 7; Kolesnikov, 1934, p. 130, pl. 19, figs. 22–25.

Acmaea striato-costata: Sinzow, 1897, p. 62, pl. 3, figs. 8–10.

Tectura (Flexitectura) subcostata: Anistratenko O., 2000b, text-fig. 2, fig. 7.

Tectura (Flexitectura) striatocostata: Anistratenko O., 2000b, text-fig. 2, fig. 11.

Tectura (Flexitectura) matvei: Anistratenko O., 2000c, p. 85, text-figs. a–c.

Flexitectura subcostata: Anistratenko O. and Anistratenko V., 2007, p. 363, figs. 4D, 9A, 9B.

Description. The shell is cap-shaped oval, 1.8 mm long, 1.1 mm wide and 1.1 mm high. Apex has a smooth, slightly convex plate elongated across the shell, 0.13×0.15 mm in size, surrounded by a furrow. The cap is elongated, with a high apex slightly shifted from the longitudinal line of the shell. The cap surface is covered with concentric growth lines and radial sculptural elements. The latter are more numerous, thin and embossed closer to the apex, while they are replaced closer to the edge by more widely spaced, wide and smoothed ones. The surface of the shell is permeated with micropores.

Occurrence. Middle Sarmatian, western and central parts of the sea basin (Ukraine, Moldova, Crimea, Ciscaucasia).

Material. Belaya River; Bed 4I, sample 11A (1 specimen).

Family Trochidae Rafinesque, 1815

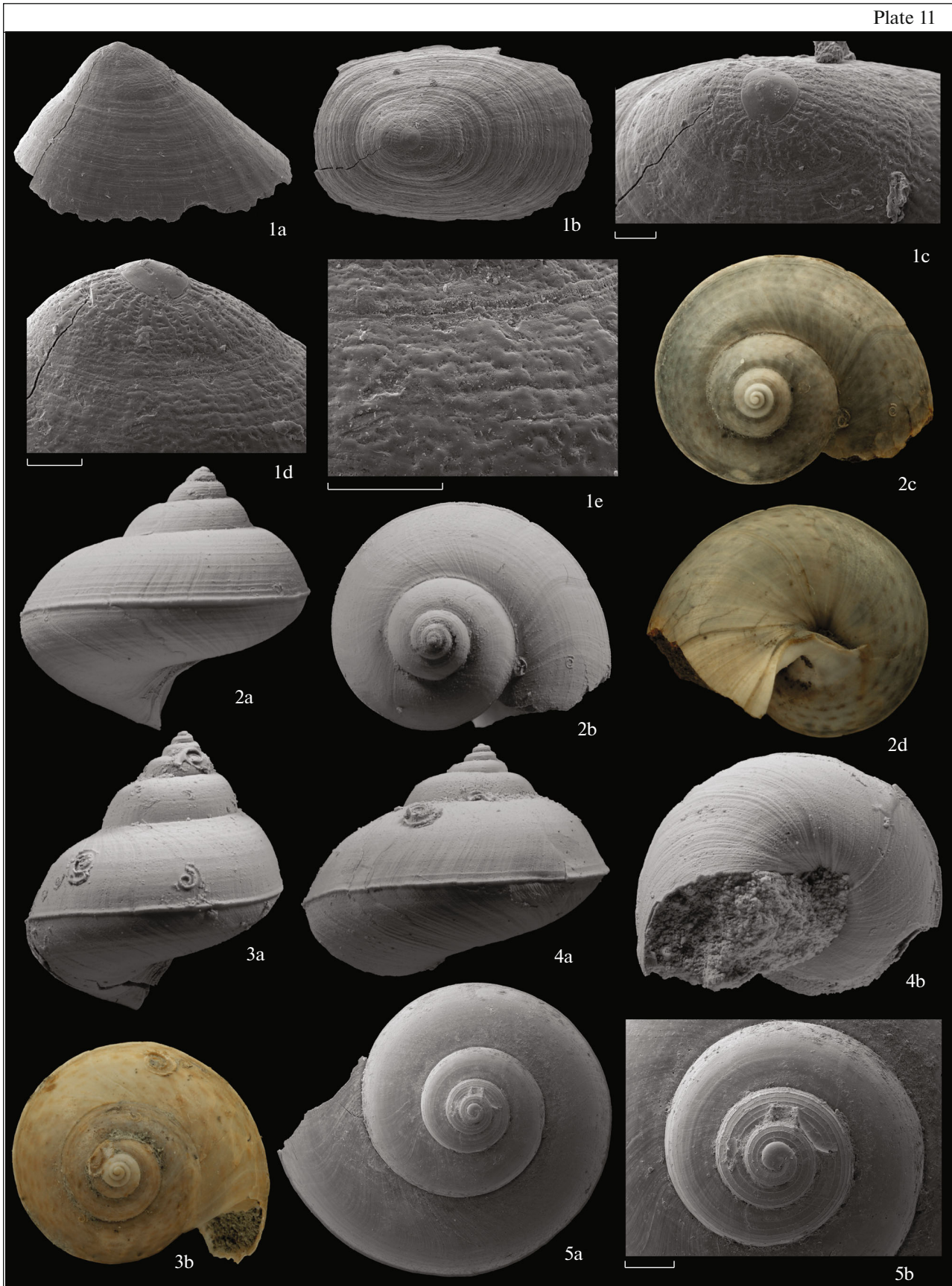
Beds with *Cryptomactra pesanseris* contained an impoverished trochid assemblage, of which three forms were identified to species: *Gibbula urupensis* (Uspenskaja), *G. prolixa* Volkova, 1955, and *Kolesnikoviella minor* (Uspenskaja, 1927). A description of juvenile *Gibbula* from the Lower Sarmatian sample 19A is also given. Two more forms, extracted from sample BS3, are represented by single very juvenile shells, differing in the morphology of the corresponding whorls from the species listed above. Their description is not given, in the hope of finding better preserved material.

There are different points of view on the systematic position of the Sarmatian trochids. *Kolesnikoviella blainvillei* (Orbigny, 1844) (with *K. minor* as a variety) and *Gibbula urupensis* were assigned to the genus *Trochus* before the work of V.P. Kolesnikov. Kolesnikov was the first to subdivide trochids into several phylogenetic groups (Kolesnikov, 1934): *K. blainvillei* was included in the 8th group, in which *Trochus subblainvillei* (Sinzow, 1897) is listed as its descendant, and *G. urupensis* was included in the 2nd group, where it considered one of the descendants of *Trochus angulatus* Eichwald, 1851. Subsequently (Kolesnikov, 1939), they were assigned to different genera: *K. blainvillei* to the section *Sarmates* Kolesnikov, 1939 (species of the 7th and 8th groups from the book of 1934) of the genus *Calliostoma*, and *G. urupensis* into the section *Robur* Kolesnikov, 1939 (species of the 2nd group) of the genus *Gibbula*. Koyumdzhieva (1969a) interpreted *K. blainvillei* as a species of the genus *Gibbula*. There have been several attempts to rework the Sarmatian trochid system in recent decades. O.Yu. Anistratenko (2000a) proposed to assign the species *K. blainvillei*

and *T. subblainvillei* to the genus *Microamberleya*. She did not find potential ancestors among modern trochoid mollusks, but pointed out a great similarity with fossil Eucyclidae, in which the genus was included within the new subfamily Microamberleyinae (Anistratenko O., 2000a; Anistratenko O. and Anistratenko V., 2007). However, *Microamberleya* was moved to the subfamily Gibbulinae Stolicka, 1868 of the family Trochidae in a later review (Anistratenko O. and Anistratenko V., 2012). Neither the subfamily nor the genus have ever been validly published in accordance with the ICZN rules, and therefore names are not available for use.

A different point of view is stated by Sladkovskaya (2017). She proposed the recognition of the subgenus *Gibbula (Kolesnikoviella)* including seven species: *G. (K.) adela* (Orbigny, 1844), *G. (K.) anceps* (Eichwald, 1851), *G. (K.) blainvillei* (type species), *G. (K.) papilla* (Eichwald, 1851), *G. (K.) pageana* (Orbigny, 1844), *G. (K.) subblainvillei* (Sinzow, 1897), *G. (K.) urupensis* (Uspenskaja, 1927). It is suggested that *G. (K.) urupensis* is derived from *G. (K.) papilla* in the second half of the Early Sarmatian, and *G. (K.) blainvillei* derived from it by the end of the first half of the Middle Sarmatian. Unfortunately, the Lower Sarmatian species *papilla* is not illustrated in that work. There is no indication of the origin of this find in the descriptive part. There is only record of a single find of *papilla* in the Zbruch Beds section near the village of Bursuk in the stratigraphic part (Sladkovskaya, 2017, p. 1479). However, there is a possibility that this may be another species with a similar shell. Similar material was collected on the Belaya River in Member 7 (uppermost Lower Sarmatian, collected in 2018). This form, indeed, has adult whorls very similar to those of the Middle Sarmatian *T. papilla*, but is clearly distinguished in the initial whorls of the teleoconch. Judging by our materials, the “twin” of *papilla* is one of the descendants of the polymorphic species, which also gave rise to the species *K. minor*. These and other data on the prehistory of *Kolesnikoviella* will be presented factually in the next paper as new material is processed.

An interesting fact is associated with *Kolesnikoviella* in the proposed composition (Sladkovskaya, 2017): it includes the species *Trochus anceps*, which is the type species of an available and valid subgenus *Anceps* Kolesnikov, 1939, proposed for the genus *Calliostoma* (Kolesnikov, 1939). That is *Kolesnikoviella* in Sladkovskaya’s interpretation should be considered formally a junior synonym of *Anceps*, unless it is shown that *T. anceps* cannot be attributed to *Kolesnikoviella*. At present, it can be argued that *T. anceps* does not come from the same ancestor as *Kolesnikoviella minor* and *K. blainvillei*. There are also large differences in shell morphology between these species (i.e., *Kolesnikoviella* s.s.) and *T. anceps* starting from early whorls



(text-fig. 16; pl. 14, figs. 1–3). Therefore, it is proposed to classify *T. anceps* in the genus *Jujubinus*, while *Kolesnikoviella* is accepted with fewer species.

It should be noted that *Kolesnikoviella*, even with very few species (i.e., *K. blainvillei* and *K. minor*) is not limited to *Cryptomactra* facies. *K. minor* is limited in distribution to fine-grained argillaceous or aleuritic sediments, occurring in the *Cryptomactra* Beds or similar facies above them. *K. blainvillei*, on the contrary, is widely distributed in shallower and coarse-grained sediments, being one of the elements of the “typical” Middle Sarmatian fauna. But the species found rarely in the same fine-grained sediments as *K. minor*. The area of habitat of *K. blainvillei* is extensive, probably, the entire water area of the Sarmatian basin. Therefore, most likely, the ancestor from which both species are descended was a stenobiont and gave rise to several species with different and narrower ecological niches.

Subfamily Trochinae Rafinesque, 1815

Genus *Gibbula* Risso, 1826

Gibbula urupensis (Uspenskaja, 1927)

Plate 11, figs. 2–5; Plate 12, figs. 1–4

Trochus urupensis: Uspenskaja, 1927, p. 637, pl. 34, figs. 11–14; Davidaschvili, 1932, p. 52, pl. 9, figs. 25–27; Kolesnikov, 1934, p. 146, pl. 20, figs. 23–26; Zhizhchenko, 1934, p. 74, pl. 8, figs. 8–10.

Gibbula urupensis: Volkova, 1955, p. 25, pl. 12, figs. 15, 16; Steklov, 1955, pl. 6, fig. 13; Zelinskaya et al., 1968, p. 112, pl. 30, fig. 11; Volkova, 1974, p. 81, pl. 19, figs. 8, 9; Lukeneder et al., 2011, fig. 4C.

Gibbula (*Gibbula*, sect. *Robur*) *urupensis*: Korobkov, 1955, pl. 5, figs. 25, 26.

Gibbula (*Kolesnikoviella*) *urupensis*: Sladkovskaya, 2017, p. 1555, pl. 6, figs. 18–20.

?*Calliostoma pachulanensis*: Muskhelishvili, 1964, p. 339, figs. 1–3; 1980, p. 33, pl. 3, figs. 8, 9.

Lectotype. TsNIGR Museum, no. 34/1815, here designated: Crimea, Kerch Peninsula, village of Volkovo (before 1945—Katerlez); Middle Sarmatian. The specimen is indicated from Katerlez, Mount Shipshin is indicated in the paper on the label. Figured: Uspenskaja, 1927, pl. 34, fig. 12; here: Pl. 12, fig. 4.

Description. Conical and low-conical shells with five rapidly growing teleoconch whorls reach a height of 9.5 mm and a diameter of 12.5 mm. At the

same time, the height of the spire varies significantly (Pl. 11, figs. 2a, 3a, 4a). The protoconch is about a whorl long, densely covered with irregularly tubercular chaotically arranged microsculpture, and has a distinct boundary with the teleoconch. The first whorl of the teleoconch has four well-defined spiral ribs. Intercalated ribs appear between them on the second whorl. Simultaneously, the ribs become smoothened, and they are strongly reduced after 2–2.5 whorls to weakly expressed spiral band-like elements or poorly visible spiral striae. The first two whorls of the teleoconch are covered with densely arranged rows of microscopic pustules. Late whorls have convex whorl side and bases separated by a sharp keel, usually with numerous thin spiral striae on the surface. Whorls in cross section are rounded to dorsoventrally flattened, thin-walled, with a maximum width at the level of the keel. The last whorl is large, more than half the height of the shell, with a convex base covered with poorly visible spiral striae, which become more prominent closer to the umbilicus (up to the threads). The growth lines are prosocline-opisthocyrt at the base. Their direction becomes almost orthocline above the keel, which changes to prosocline in the upper half of the whorl side. Their bend on the whorl side is peculiar, at first the lines have a slightly or weakly opisthocline direction, and above the middle of the whorl side they become strongly prosocline. The umbilicus is widely slit-like to nearly absent. The aperture and margins of the lips were not observed in intact condition. The whorls are rounded from below in cross section, with an adapical angular junction of lips. Pattern on the shell of several spiral rows of spots on the whorl side and on the base.

Variability. Within samples from samples and assemblages, variability is expressed in a strong variation in the height of the spire and sharpness of the keel. Occasionally there is a shell with a delayed development of the keel, so that even at the end of the third whorl there is only a rounded shoulder. The length of the sculptured stage is significantly varies. In shells with a short stage, it takes about two whorls, and the secondary ribs only begin to appear, as a sharp reduction in sculpture occurs and a transition to a smooth keeled stage. Shells with elongation of the ribbed stage up to 2.5 or slightly more whorls have numerous spiral

Explanation of Plate 11

The scale bar 100 μm, except for (5b)—500 μm. The dimensions of other shells are given in explanation.

Fig. 1. *Flexitectura subcostata* (Sinzow, 1892): specimen PIN, no. 5621/1, height 1.8 mm, Belaya River, Bed 41, sample 11A, lower part of the beds with *C. pesanseris*: (1a) lateral view, (1b) apical view, (1c) apex in apical view, (1d) apex in lateral view, (1e) sculpture and micropores.

Fig. 2–5. *Gibbula urupensis* (Uspenskaja, 1927): (2) specimen PIN, no. 5621/9, height 9.5 mm, diameter 10 mm, Belaya River, Bed 41, lower part of the beds with *C. pesanseris*: (2a) abapertural view, (2b) apical view, (2c) apical view, pattern on the shell, (2d) abapical view, pattern on the shell; (3) specimen PIN, no. 5621/11, height 10 mm, diameter 10.5 mm, the same locality: (3a) abapertural view, (3b) apical view, pattern on the shell; (4) specimen PIN, no. 5621/10, height 9.5, diameter 12.4 mm, Belaya River, assemblage 2, lower part of the beds with *C. pesanseris*: (4a) abapertural view, (4b) abapical view; (5) specimen PIN, no. 5621/13, diameter 7.2 mm, Belaya River, assemblage 1, lower part of the beds with *C. pesanseris*: (5a) apical view, (5b) ribbed stage.

threads covering the whorl, which are then rapidly reduced. The degree of reduction also varies greatly: from a weaker one, when smoothed threads remain on the surface of the whorl, and well-defined ones near the umbilicus (the lectotype of the species and the specimen on Pl. 12, fig. 2 belong to this variant), to a strong reduction, when it is impossible to see striae even near the umbilicus. The pattern on the shell, while retaining the appearance of spiral rows of spots, is otherwise variable. A pattern usually consists of five rows of well-pigmented spots on the base, which are better visible and larger than those on the whorl side. The shape of the spots varies from rounded to elongated along the whorl. The rows consist of small and pale spots on the whorl side, infrequently dividing into rows of two size orders. Sometimes, there are specimens in which the size and clarity of the spots are the same as on the base, but usually the rows of small spots are poorly distinguishable even when look under magnification due to weak pigmentation.

Comparison. This species differs from *G. prolixia* in strongly keeled whorls, a strong reduction in spiral sculpture after the ornamented stage, and a different pattern on the shell. From *Gibbula* sp. juv. differs in the shorter *Gibbula*-like stage with an initial rough sculpture, after which the sculpture is rapidly reduced; by early appearing and well-defined keel, the direction of growth lines.

Remarks. The species was recorded from the Lower Sarmatian of Podolia (Kolesnikov, 1934) and the Middle Sarmatian of Chisinau (Simionescu and Barbu, 1940), which has not yet been confirmed, but was relayed in subsequent surveys (Iljina, 1998; Anistratenko O. and Anistratenko V., 2007; Sladkovskaya, 2017) and it raises strong doubts. The appearance of the species in the Middle Sarmatian is confirmed by new materials from the Belaya River in 2018 (discussed after the section on systematic paleontology).

The identification of *G. urupensis* from the Sarmatians near the village of Ordu, south of Sinop (Özsayar, 1977, p. 53, pl. 6, fig. 10), also raises serious doubts. The description is very short and does not give an idea of the described find, the illustration is very poor. It shows a poorly preserved keeled shell with a high spire and with a seeming spiral sculpture on the whorl side. However, the find is indicated from calcar-

eous sandstones with a “typical” Middle Sarmatian assemblage of mollusks (ibid.: pp. 28–29 and assemblage in Table 3), while the species has so far been undoubtedly confirmed only from more deep-water clayey and aleuritic facies. Most likely, Özsayar dealt with a weathered shell of another trochid species.

Based on the author’s materials, it can be stated that *G. urupensis* occurs in the Middle Sarmatian in argillaceous and aleuritic (including sandy aleurites) facies not only in the *Cryptomactra*-bearing part of the section, but also in the higher laying beds with *A. naviculata*.

Occurrence. Middle Sarmatian of Crimea, Ciscaucasia, western part of the Caspian Region (Kalmykia), Transcaucasia (Georgia): mainly in beds with *Cryptomactra pesansensis*.

Material. Belaya River: assemblages 5 (1 specimen), 4 (12 specimens), 3 (11 specimen), assemblage 2 (7 specimens), 1 (128 specimens), upper part of the assemblage 1 (45 specimens), samples BS3 (23 specimens) and BS2 (1 specimen); Kurdzhips River: 1A₁ (79 specimens), 1A₂ (9 specimens), 1B₁ (4 specimens), 1B₂ (10 specimens), 1C₁ (1 specimen), 1D₁ (4 specimens), 1D₃ (5 specimens), 1E₂ (1 specimen), 1E₃, beginning of the outcrop (4 specimens).

***Gibbula prolixia* Volkova, 1955**

Plate 12, fig. 5; Plate 13, figs. 1, 2

Gibbula prolixia: Volkova, 1955, p. 25, pl. 12, figs. 12–14; 1974, p. 82, pl. 19, figs. 12–14.

Lectotype. I designate a specimen figured by Volkova (1955, pl. 12, figs. 13, 14; 1974, pl. 19, figs. 13, 14) as the lectotype. The type series is lost. Syntypes were not originally in the collection of Volkova’s identification keys (TsNIGR Museum, no. 10623).

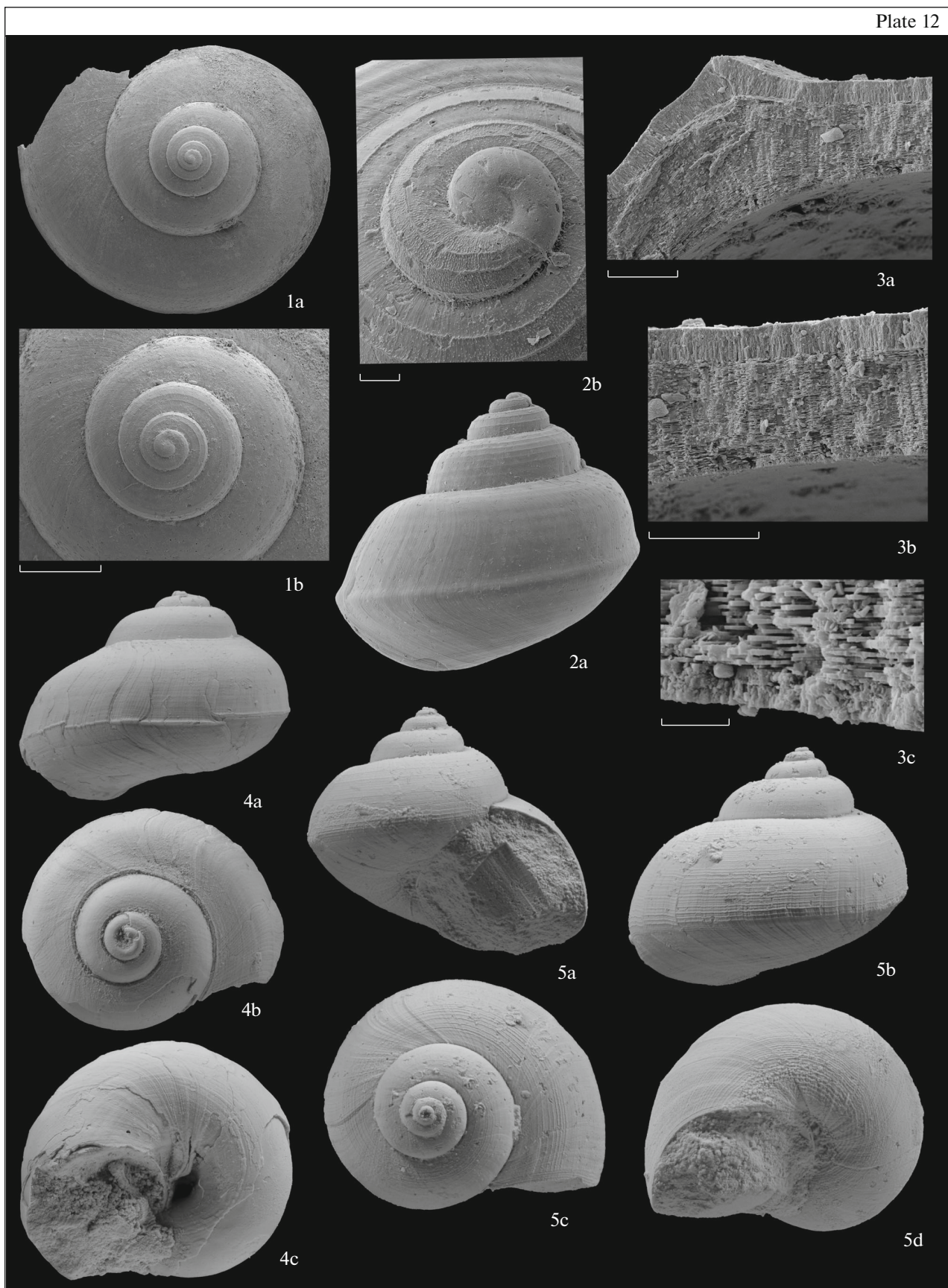
Description. Low-conical shell with five rapidly growing teleoconch whorls, reaching a height of 9.4 mm and a width of 11–11.5 mm. The whorls have a trapezoid-rounded section, expanding downward. The suture is quite deep so the spire has a gradate profile. The first two whorls of the teleoconch bear several spiral threads (about 5–6), to which later intercalated threads are added. Reduction of sculpture does not always develop at late whorls. Therefore, the whorl side of the last whorl is usually covered with numerous

Explanation of Plate 12

Scale bar (1b) 1 mm, (2a, 3b) 100 μm, (3c) 10 μm. The dimensions of other shells are given in explanation.

Figs. 1–4. *Gibbula urupensis* (Uspenskaja, 1927): (1) specimen PIN, no. 5621/14, diameter 7.9 mm, Kurdzhips River, Outcrop 1E₃, beds with *A. naviculata*: (1a) apical view, (1b) ribbed stage; (2) specimen PIN, no. 5621/12, height 3 mm, Kurdzhips River, Outcrop 1A₁, olistostrome, block with Middle Sarmatian fauna, beds with *C. pesansensis*: (2a) lateral view, (2b) protoconch; (3) specimen PIN, no. 5621/15, Belaya River, Bed 41, lower part of the beds with *C. pesansensis*: (3a) structure of the shell wall in the keel area, (3b) structure of the shell wall in the palatal part of the outer lip, (3c) myostracum; (4) lectotype TsNIGR Museum, no. 34/1815, diameter 13 mm, height 10.5 mm, village of Volkovo, Middle Sarmatian: (4a) abapertural view, (4b) apical view, (4c) abapical view.

Fig. 5. *Gibbula prolixia* (Volkova, 1955): (5) specimen PIN, no. 5621/16, height 9.4 mm, diameter 11 mm, Belaya River, assemblage 4, lower part of beds with *C. pesansensis*: (5a) apertural view, (5b) abapertural view, (5c) apical view, (5d) abapical view.



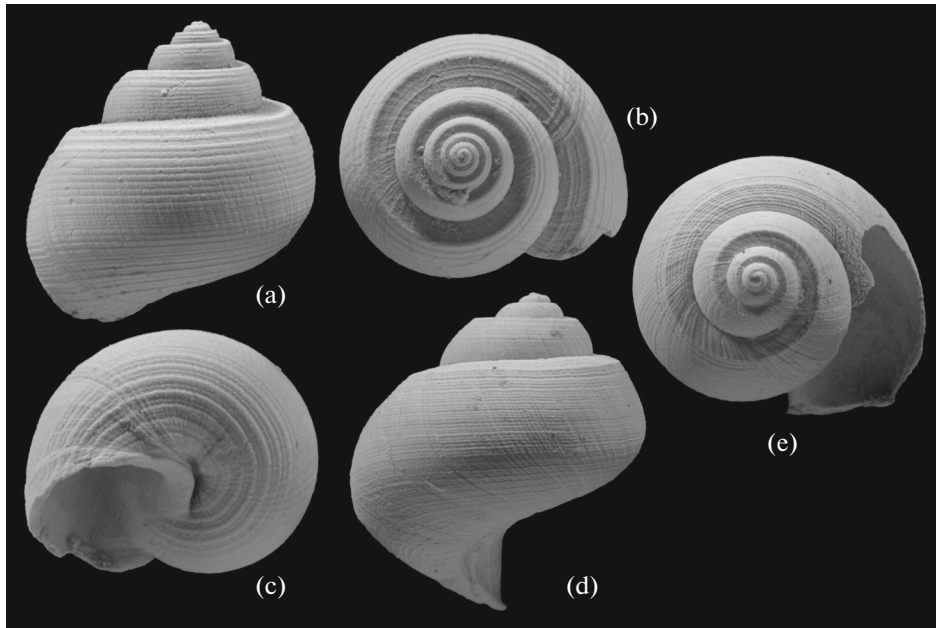


Fig. 17. Syntypes of *Turbo pictus* Eichwald, 1830: (a–c) specimen PM SPbGU, no. 3/440a (height 6.5 mm, diameter 6 mm), Khmelnytski Region, Gorodok District, village of Zavadyntsi, Lower Sarmatian; (d, e) specimen 3/441 (height 8.5 mm, diameter 7.5 mm), Khmelnytski Region, Letychiv District, village of Novokonstyantyniv, Middle Sarmatian².

threads and striae of varying prominence: from well-defined to strongly smoothed. The base has the same sculpture, which is better expressed near the umbilicus. The last whorl is very high, more than 80% of the height of the shell, rounded, with a relative pronounced rounded bend at the border between the whorl side and the base. Growth lines are prosocline-opisthocyrt on the base. Their direction becomes almost orthocline above the basal-palatal bend, which in the upper half of the whorl side changes to prosocline. The umbilical zone is covered with rock matrix in all specimens; probably, the umbilicus was narrowly slit-like. The aperture is oval, slightly flattened, abapically rounded, with adapical angular lip junction. The pattern on the shell surface varies from a combination of spiral rows of small spots and larger irregularly shaped spots elongated across the whorl. Spiral rows are observed on the lower half of the whorl side and in the upper part of the base; transversely elongated spots are observed near the umbilicus and in the upper part of the whorl side.

Comparison. This species differs from *G. urupensis* in the rounded whorls without a keel, more developed spiral sculpture on the whorl side and base, and a pattern on the shell of randomly arranged pigmented areas of different sizes and shapes.

Remarks. N.S. Volkova dates the description of the species to 1938 in her books, but the original description of the species was published in 1955. She

² Dating of the material is according to data from V.D. Laskarev (1914, pp. 398, 468).

probably indicated the date of recognition of the species in one of her unpublished geological survey reports.

Sladkovskaya (2017) included *G. proluxa* in the synonymy list of *G. picta picta* (Eichwald, 1830) due to the “insignificance” of differences, interpreting it as an ecomorph. Indeed, they are similar in the roundness of whorls and indistinct spiral sculpture, but this is where the similarity ends. *G. proluxa* are distinguished by a low spire, rapidly growing whorls of different outlines, a rounded bend between the base and whorl side, more delicate sculpture, and the absence of a ramp at the top of the whorl, which is well developed, at least on the early whorls of the teleoconch of *G. picta*. I present photographs of syntypes of *G. picta* (Fig. 17) for visual comparison. In my opinion, here there is some external similarity of independently emerged species.

Occurrence. Middle Sarmatian, beds with *C. pesansensis*; Ciscaucasia.

Material. Belaya River: assemblage 4 (1 specimen), assemblage 3 (3 specimens).

Gibbula sp. juv.

Plate 13, figs. 3–5

Description. A conical anomphalous juvenile shell with spirally ornamented whorls. The first 2–2.5 whorls of the teleoconch are convex, with four narrow and widely spaced ribs. The whorl surface, including the ribs, is densely punctated with microscopic pustules. Many intercalary threads appear subsequently, due to which subsequent whorls are densely

covered with flattened spiral threads of various orders. The pustules disappear. A rounded bend develops at the level of the suture. It intensifies in some shells to a low keel topped with a more prominent thread. The maximum width of the whorl at the level of the bend. The base is covered with frequent, but more widely spaced threads. The growth lines are slightly prosocline.

Comparison. This species is distinguished from *G. urupensis* by a longer ornamented teleoconch stage with well-pronounced sculpture, weak development of the peripheral keel; from *G. proluxa*, also by the character of the ornamented stage, higher spire, sharper angularity, or even development of a keel in the whorl periphery.

Remarks. Adult shells of the same shape were collected in Members 4 and 5 from outcrops on the Belaya River in 2018. However, even adult shells could not be identified due to the lack of similar images in the literature.

Occurrence. Uppermost Lower Sarmatian of Ciscaucasia (present author's material).

Material. Kurdzhips River: 1A₀, sample 19A (80 specimens).

Genus *Kolesnikoviella* Sladkovskaya, 2017

Microamberleya: Anistratenko O., 2000a, p. 7; Anistratenko O. and Anistratenko V., 2007, p. 316, 317; Anistratenko O. and Anistratenko V., 2012, p. 119 (nomen nudum).

Gibbula (*Kolesnikoviella*): Iljina, 1998, p. 24 (nomen nudum).

Gibbula (*Kolesnikoviella*): Sladkovskaya, 2017, p. 1549.

***Kolesnikoviella minor* (Uspenskaja, 1927)**

Plate 13, fig. 6; Plate 14, figs. 1–3

Trochus blainvillei var. *minor*: Uspenskaya, 1927, p. 638, pl. 34, figs. 15–17; Kolesnikov, 1930, p. 136, pl. 1, figs. 19–23; Kolesnikov, 1934, p. 186, pl. 24, figs. 25, 26.

Gibbula (*Kolesnikoviella*) *blainvillei minor*: Sladkovskaya, 2017, p. 1553, pl. 6, figs. 6–8.

? *Calliostoma* sp.: Steklov, 1955, pl. 6, fig. 14.

Lectotype. TsNIGR Museum, no. 43/1815, here designated: Crimea, Kerch Peninsula, village of Volkovo (before 1945—Katerlez); Middle Sarmatian. The specimen is indicated as from Katerlez in the paper, Mount Shipshin is indicated on the label. Figured: Uspenskaya, 1927, pl. 34, figs. 16, 17; here: text-fig. 18.

Description. Juvenile anomphalous shells 3–3.5 mm high with 3.5–4 whorls of the teleoconch. The protoconch is short, slightly more than a whorl long, and probably smooth. The demarcation with the teleoconch is sharp. The first whorl of the teleoconch has four spiral ribs. A sharp keel develops from the third whorl at the level of the lower rib. The three ribs located above are partly reduced to threads or striae with the growth of the shell. As the surface of the whorl above the keel expands, intercalated threads appear on it. The keel gradually approaches the lower suture as

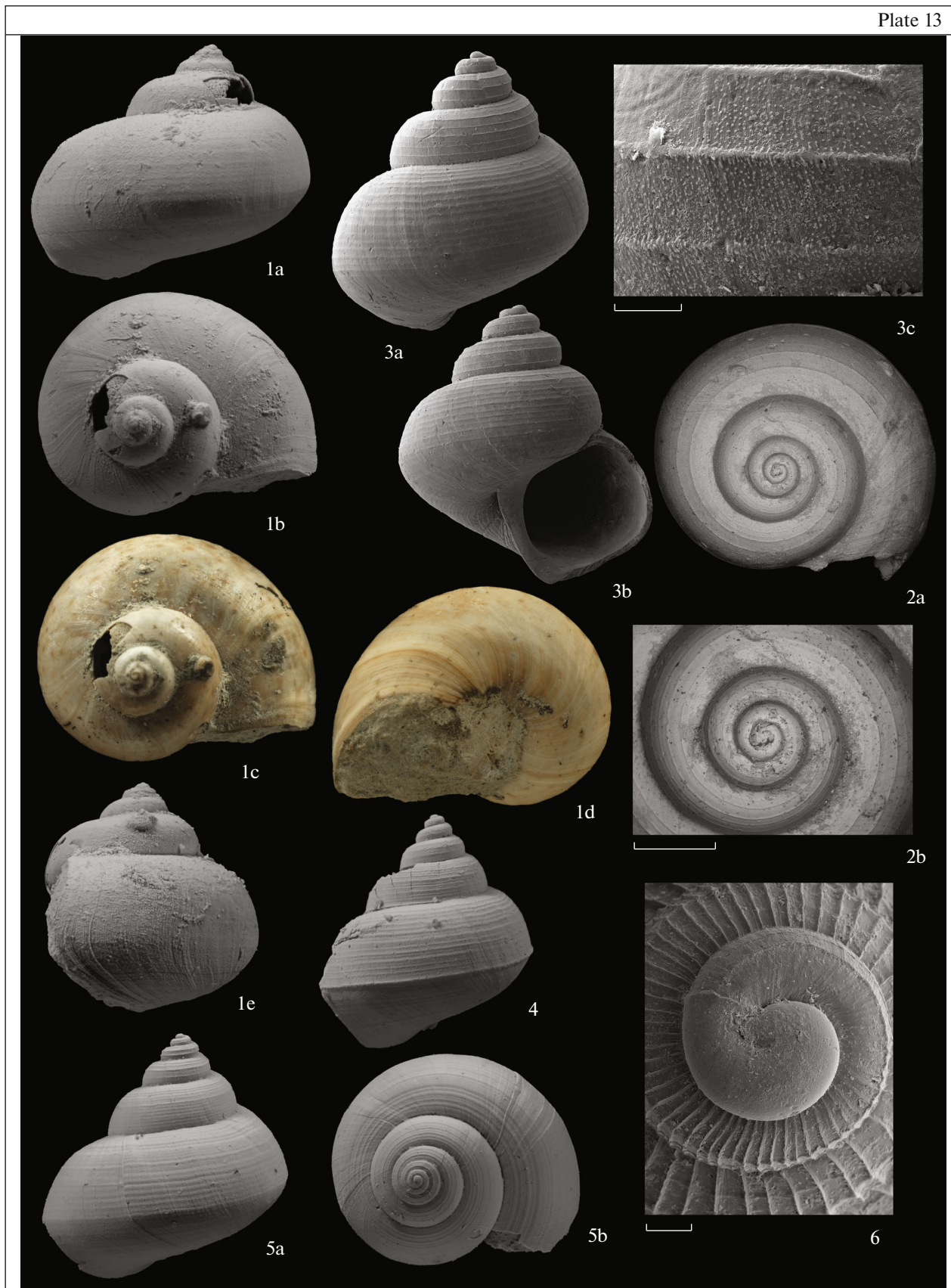
the shell grows. Frequent collabral threads follow across whorl, which, as the keel develops, when it is crossed, form curved liriate protrusions inclined in the direction of shell growth. There are about 50 threads on the third whorl. They are prosocline-opisthocyrt above keel and straight-prosocline below keel. They continue at the base, where are crossed by several spiral threads (up to six on the fourth whorl).

Comparison. *K. minor* differs in juvenile whorls from *K. blainvillei* in having a high spire, as in *K. blainvillei*, the transition to rapidly growing whorls begins early, so the apical angle greatly increases, and the adult shell acquires a distinct cyrtoconoid outline. Therefore, the shell of *K. blainvillei* has a wider shell already at the third whorl.

Remarks. The type series is represented by poorly preserved juvenile shells; in addition to the lectotype, these are 42/1815 (Uspenskaya, 1927, pl. 34, fig. 15) and unfigured 44/1815–46/1815. All with the same locality details as the lectotype.

Sladkovskaya (2017) considered *K. minor* as a subspecies of *K. blainvillei* (Orbigny, 1844). *K. minor* is distinguished by smaller shells and fine sculpture, and the absence of nodes on the keel. Sladkovskaya believes that this is an ecological subspecies of *K. blainvillei*, because *blainvillei* s.s. is confined to shallow-water and coarser-grained facies, while *minor* occurs in deeper-water facies. This is also related to the difference in the geographical distribution of *blainvillei* and *minor*: the former is found throughout the entire area of the Sarmatian Sea, while the range of the latter is confined to the development of *Cryptomacra* facies. The morphological proximity of both taxa, as well as the lithological discreteness of distribution, quite logically leads to the conclusion that *blainvillei* is a dimorphic species. However, the material collected in 2018 gave the possibility to trace the descendant and the process of formation of *K. minor*. It suggests that the taxonomy of the two forms can be interpreted another from the point of view of phylogeny. It has been recorded that *K. minor* does not originate from *K. blainvillei* s.s., but from another as yet undescribed species. This occurs in the interval of Beds 9–13. *K. blainvillei* s.s. was not found in this interval or above, but some morphs of the ancestral species are very similar in morphology to *blainvillei* s.s. It is quite possible that *blainvillei* s.s. is the result of diversification of the same species, but in shallow water facies. Thus, it appears that *minor* and *blainvillei* originated independently and, most likely, originally differed as forms with different ecological niches. Therefore, it is more correct to use them in the status of independent species according to phylogenetic taxonomy.

The description of the species is based on a few juvenile shells originating from the base of the *Cryptomacra* Beds. These shells should be considered as early *minor*, which differ from late forms (at the same juvenile stage) from the upper part of the Middle Sar-



Explanation of Plate 13

Scale bar 100 μm , except for (2b) 1 mm. The dimensions of other shells are given in explanation.

Figs. 1–2. *Gibbula prolixa* (Volkova, 1955), Belaya River, assemblage 3, lower part of the beds with *C. pesansensis*: (1) specimen PIN, no. 5621/17, height 9.3 mm, diameter 11.5 mm: (1a) abapertural view, (1b) apical view, (1c) apical view, pattern on the shell, (1d) abapical view, pattern on the shell, (1e) apertural margin profile; (2) specimen PIN, no. 5621/18, diameter 7.4 mm: (2a) apical view, (2b) initial whorls.

Figs. 3–5. *Gibbula* sp. juv., Kurdzhips River, Outcrop 1A₀, sample 19A, olistostrome, block of the Lower Sarmatian: (3) specimen PIN, no. 5621/7, height 3.5 mm: (3a) abapertural view, (3b) apertural view, (3c) microsculpture on teleoconch; (4) specimen PIN, no. 5621/8, height shell 7 mm; (5) specimen PIN, no. 5621/6, height 6.5 mm, diameter 7 mm: (5a) abapertural view, (5b) apical view.

Fig. 6. *Kolesnikoviella minor* (Uspenskaja, 1927): specimen PIN, no. 5621/4, Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesansensis*; protoconch.

matian in a number of morphological features: more frequent and less high spiral sculpture, low position of the keel, which is adjacent to the suture. Because of the last, the keel is not so pronounced on the spire.

Occurrence. Middle Sarmatian, usually beds with *C. pesansensis*, Crimea and Ciscaucasia.

Material. Belaya River: samples BS3 (20 specimens) and BS2 (4 specimens).

Family Hydrobiidae Stimpson, 1865

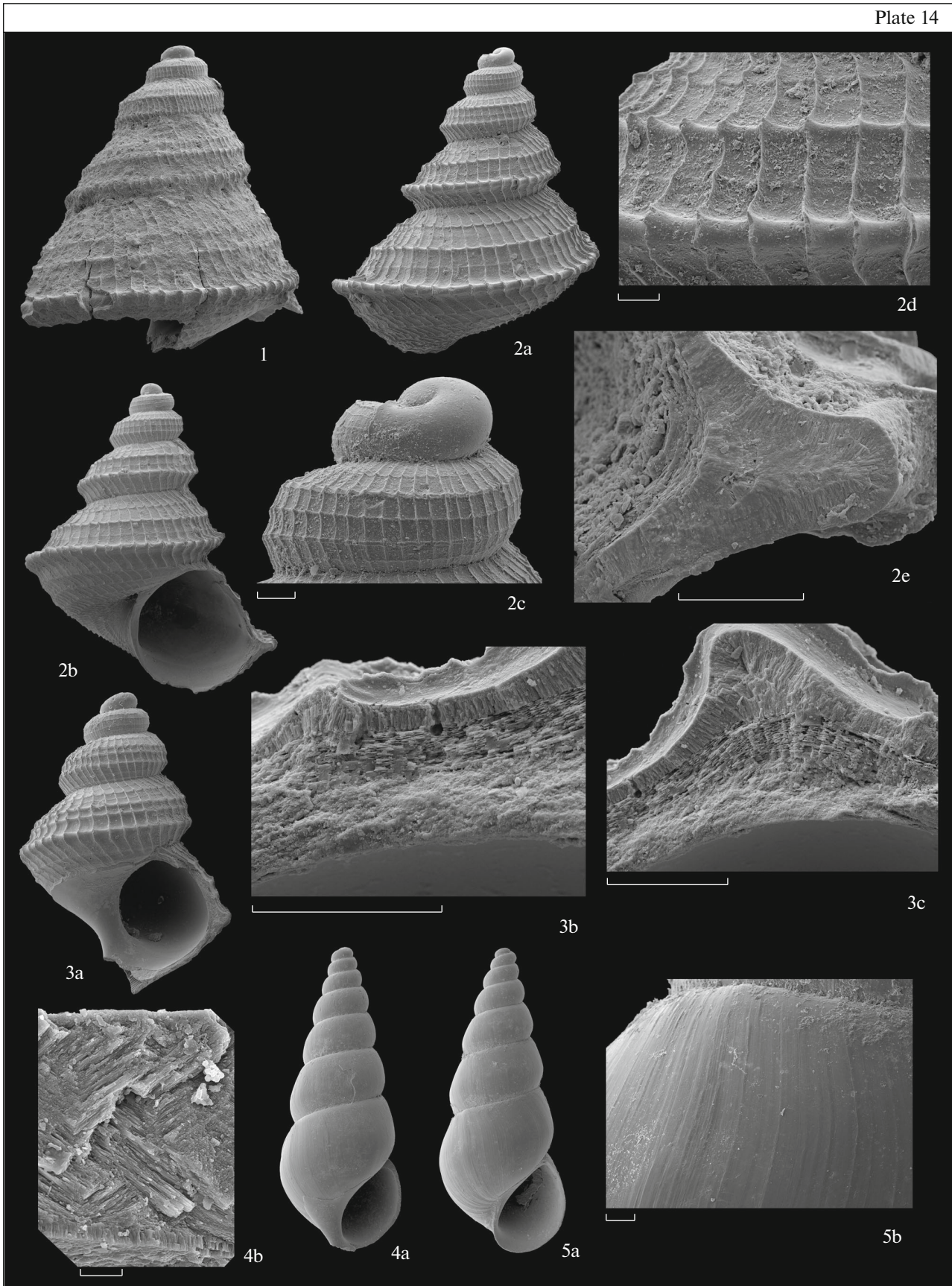
The collected hydrobiids can be divided into two groups: “large” and “small”. The former includes *Hydrobia* and *Turricaspia*, the latter *Pomatiasia* and *Edrozeba*. They differ not only in size, but also in origin.

“Large” hydrobiids, in my opinion, originate from the early Sarmatian *Hydrobia*, the species taxonomy of which is debatable. Three works can be distinguished in which there were attempts to systematize hydrobiid (Jekelius, 1944, Papp, 1954, and Švagrovský, 1971). Jekelius recognized species using small differences, which led to the description of several poorly distinguishable taxa. A. Papp divided large hydrobiids into two variable species *H. stagnalis* (Baster, 1765)³ and *H. frauenfeldi* (M. Hörnes, 1856), subdivided into the subspecies *H. stagnalis stagnalis*, *H. stagnalis andrussowi* Hilber, 1897, *H. frauenfeldi frauenfeldi*, and *H. frauenfeldi suturata* (Fuchs, 1873). In addition, two forms have been described in open nomenclature. *H. frauenfeldi* aff. *subsuturata* Jekelius, 1944 has interest among them, which differs in the reduction of keel from *H. frauenfeldi suturata* and is related to the *Rissoa* Beds of the Vienna Basin. Papp arranged the figures on the plate in a certain way so that the upper row was made up of forms from *Rissoa* Beds (Rissoenschichten (R)),

and the next row was made up of shells from higher beds (Ervilienschichten (E), Mactraschichten (M)). It appears that hydrobiids found in the *Rissoa* Beds (*H. stagnalis stagnalis*, *H. frauenfeldi suturata*, and *H. frauenfeldi* aff. *subsuturata*) are shorter and smaller than those occurring stratigraphically higher (*H. stagnalis andrussowi*, *H. frauenfeldi frauenfeldi*). The lineages *H. stagnalis andrussowi*–*H. stagnalis* s.s. and *H. frauenfeldi suturata*–*H. frauenfeldi* s.s. shows the shell increase and disappearance of morphs with angular whorls from samples.⁴ Hence, a certain trend can be suggested, which based on the materials on the Vienna Basin that he had at that time. Other data were presented by J. Švagrovský. He divided *Hydrobia* into 11 species, of which he only synonymized *H. stagnalis stagnalis* and *H. suturata* with the corresponding subspecies proposed by Papp. Other images of Papp do not appear in his synonyms. This is probably due to an accidental omission, since the comments on the species contain indications of the complete correspondence of shells of *H. elongata* (Eichwald, 1830) and *H. stagnalis andrussowi* in opinion of Švagrovský to the shell illustrated by Papp. I can only assume that Švagrovský synonymized them respectively with *H. frauenfeldi frauenfeldi* and *H. stagnalis andrussowi* in opinion of Papp. He also characterized the Sarmatian beds of the Vienna Basin with lists in which he presented a different distribution of species: *H. elongata* (R, E, M), *H. suturata* (R, E), *H. stagnalis stagnalis* (R, E, M), and *H. stagnalis andrussowi* (E). There was no trend in the change in the morphology of large hydrobiids according to his data, as it appeared in Papp’s paper, and throughout the entire Lower Sarmatian of the Vienna Basin, approximately the same set of morphotypes existed. The species *H. elongata* was the most abundant and widespread according to Švagrovský’s materials. It is noteworthy that his point of view was later adopted by Papp (Papp, 1974). That is, the conclusion is that during the Early Sarmatian in the Vienna Basin, there was no visible morphological

³ Papp erroneously indicated Basterot as the author. At present, the name *Turbo stagnalis* Basterot, 1765 is considered unavailable, and the form described under it is synonymized with *Helix stagnorum* Gmelin, 1791, which has recently been usually included in the genus *Heleobia* Stimpson, 1865 (Hydrobiidae) (Holthuis, 1945; Bank et al., 1979; Giusti and Pezzoli, 1984). The forms described under this name by Papp and Švagrovský readily differ from *H. stagnorum* in the shell shape and cannot be considered conspecific even by conchological criteria. It seems more reasonable to use the specific name *Hydrobia andrussowi* Hilber, 1897.

⁴ It is noteworthy that Papp gives drawings of these hydrobiids on the same scale. The drawings contradict his measurements of the height of the shells in the text, according to which the height, on the contrary, did not change. These measurements are given below in the text.



Explanation of Plate 14

Scale bar 100 μm , except (4b) 10 μm . The dimensions of other shells are given in explanation.

Figs. 1–3. *Kolesnikoviella minor* (Uspenskaja, 1927), Belaya River: (1) specimen PIN, no. 5621/2, height 3 mm, Bed 39, sample BS2, lower part of the beds with *C. pesansensis*; (2) specimen PIN, no. 5621/3, height 3.4 mm, Bed 34, sample BS3, lower part of the beds with *C. pesansensis*: (2a) abapertural view, (2b) apertural view, (2c) protoconch, (2d) sculpture, (2e) structure of the shell wall in the keel area; (3) specimen PIN, no. 5621/5, height 2.6 mm, the same locality: (3a) shell, (3b) structure of the shell wall above the keel, (3c) structure of the shell wall in the keel area.

Figs. 4–5. *Hydrobia neofrauenfeldi* sp. nov., Kurdzhips River, Outcrop 1A₀, olistostrome, block of the Middle Sarmatian, lower part of the beds with *C. pesansensis*: (4) specimen PIN, no. 5621/19, height 5.4 mm: (4a) apertural view, (4b) shell wall structure; (5) specimen PIN, no. 5621/24, height 5.8 mm: (5a) apertural view, (5b) whorl surface.

evolution of large hydrobiids. Other reviews on the Lower Sarmatian of that region (Jekelius, 1944; Boda, 1959) do not provide data with a comparable stratigraphic reference within the substage. Jekelius's paper only shows a greater morphological diversity within the Lower Sarmatian "large" hydrobiids than is evident from the materials of other researchers.

In the review by Kolesnikov (1934) the following species assigned to *Hydrobia* are described: *H. uiratamensis* Kolesnikov, 1934, *H. elongata*, *H. substriatula* Sinzow, 1880, *H. enikalensis* Kolesnikov, 1934, and *H. pseudocaspia* Sinzow, 1892. The type material of *H. uiratamensis*, indicated from the Lower Sarmatian, represented by heavily worn shells (text-fig. 19) and does not differ from *H. elongata* with the same shell length. The main part of the extant type material of *H. elongata* comes from the Lower Sarmatian of Podolia (Figs. 20c–20f). The illustrated specimens do not differ from the Middle Sarmatian material figured by Kolesnikov (1934, pl. 27, figs. 18–21).

H. uiratamensis and listed shells of *H. elongata* correspond to shortened non-carinate *H. elongata* and *H. frauenfeldi* in opinion of Švagrovský and Papp, respectively. Another portion of the shells from Kuncha and a single specimen of *H. elongata* from the Middle Sarmatian of Chişinău in the collection of Eichwald (text-figs. 20a–20b) correspond to their understanding of *H. stagnalis stagnalis*, part of the shells from Kuncha and the only specimen of *H. elongata* from the Middle Sarmatian of Kishinev in the collection of Eichwald (Figs. 20a–20b) corresponds to their interpretation of *H. stagnalis stagnalis*. *H. elongata*, listed by Kolesnikov from the *Cryptomactra* Beds, belongs to another species, that I described as *H. neofrauenfeldi*. I found in large numbers (Krasnodar Krai, Krymsk District) *H. elongata*⁵, indicated by Kolesnikov for the Middle Sarmatian of the Scythian Shelf, and it corresponds to *H. frauenfeldi* from the Vienna Basin, moreover, with an admixture of a morph that has a rounded angularity near the lower suture. *H. substriatula* from the Middle Sarmatian of the Galician Gulf is a specific form with a well-developed spiral sculpture. *H. pseudocaspia* and *H. enikalensis* are

described here as *T. pseudocaspia* and *Edrozeba enikalensis*, and they are not known below the Middle Sarmatian according to our data.

H. neofrauenfeldi and *T. pseudocaspia* clearly differ from coeval samples of the species "*H. elongata*". *H. neofrauenfeldi* is distinguished by longer slenderer shell, often with a rounded angularity that appears higher than in similar morphs of "*H. elongata*" and is usually more pronounced. Non-angular specimens of *H. neofrauenfeldi* are very similar to the most elongated *H. frauenfeldi*/*H. elongata* in the papers of Švagrovský and Papp. *T. pseudocaspia*, which in the Sarmatian of the Belaya River is always found separately from *H. neofrauenfeldi*, has early representatives that are closest to the most elongated non-angular "*H. stagnalis*". I have at my disposal more ancient *T. pseudocaspia* from a borehole in the Stavropol Krai near the village of Krasnogvardeiskii, showing further shortening and size decrease of the shell (Pl. 16, figs. 6, 7: the variability of the species in the samples is showed). This material on the assemblage of accompanying small hydrobiids is correlated by me with the interval of beds 11–24 of the section on the Belaya River. Here the question arises about the distinction between *T. pseudocaspia* and "*H. stagnalis*". Two lineages may be proposed, considering "*H. stagnalis*" and *H. frauenfeldi* as independent species: the first is "conservative", in which the species slightly changed over time, and the second is "progressive", in which the shell increased in size and whorl number. Thus, the following ratios of shell length and height were indicated for *H. frauenfeldi*: eight whorls at 6 mm in height (Hörnes, 1856; Jekelius, 1944; Papp, 1954), six–seven whorls at a height of about 5 mm, rarely up to 6.5 mm (Švagrovský, 1971). For *H. suturata*: eight–nine whorls and 5–5.5 mm in height (Fuchs, 1873), eight whorls and 5 mm in height (Jekelius, 1944), 4–5 mm in height (Papp, 1954), six–seven whorls and 4.5–5.5 mm in height (Švagrovský, 1971). For *H. stagnalis* s.s.—5 mm in height (Papp, 1954), six–seven whorls and up to 5.5 mm in height (Švagrovský, 1971); for *H. stagnalis andrussowi*, seven whorls and 4–5 mm in height (Papp, 1954), seven whorls and 5 mm in height (Hilber, 1897), six whorls (Švagrovský, 1971). *H. neofrauenfeldi* and *T. pseudocaspia* elongate and enlarge in our material to eight whorls and 8 mm in height and to 10.5 whorls and more than 16 mm in height, respectively. A similar cleavage with lines of

⁵ I consider *H. elongata* as a junior synonym of *H. frauenfeldi*. The priority of *H. frauenfeldi* is due to the fact that *Rissoa elongata* Eichwald, 1830 is a junior homonym of *R. elongata* DeFrance, 1827.

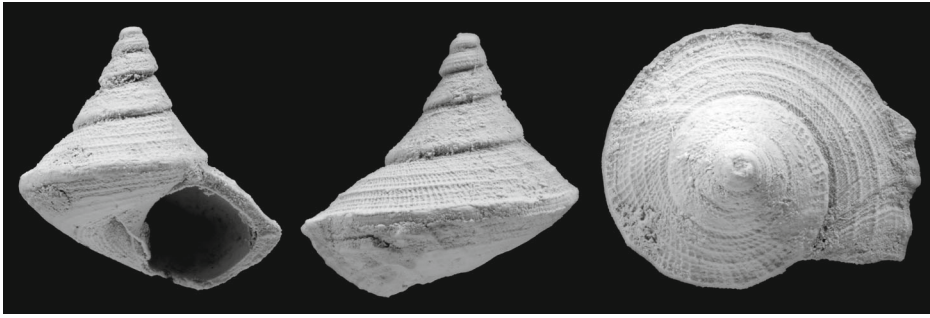


Fig. 18. *Kolesnikoviella minor* (Uspenskaja, 1927), lectotype TsNIGR Museum, no. 43/1815, height 6 mm and diameter 6.5 mm, Crimea, Kerch Peninsula, Mount Shipshin (now within the city of Kerch), Middle Sarmatian.

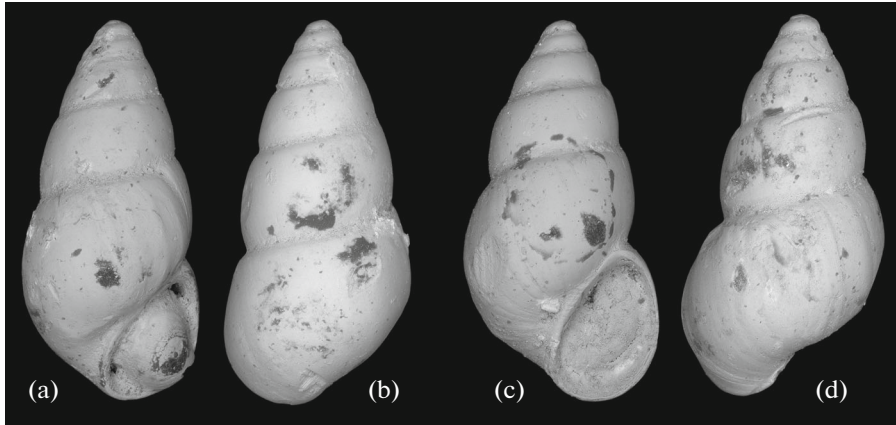


Fig. 19. *Hydrobia uiratamensis* Kolesnikov, 1934, Kazakhstan, Tyub-Karagan Peninsula, Uiratam section, Lower Sarmatian: (a, b) paralectotype TsNIGR Museum, no. 275/11126, height 3.4 mm; (c, d) lectotype (designated by Kojumdgieva, 1969, p. 89) TsNIGR Museum, no. 276/11126, height 2.7 mm.

giants is also seen in the Sarmatian genera *Acteocina* and *Retusa* (see discussion of families below).

H. neofrauenfeldi and *T. pseudocaspia* were already isolated by the beginning of the Middle Sarmatian, showing that their formation occurred in the Early Sarmatian. We do not have evidence of any trend of morphological divergence within this group of hydrobiids up to the Middle Sarmatian (except for the discussed data of Papp (1954)). It simply may not yet have been observed.

In conclusion, it is noteworthy to mention the subgenus *Robicia* (*Annulifer*) Cossmann, 1921 with the type species *Paludina protracta* Eichwald, 1851. Unfortunately, the type material of the species, listed in the inventory of collection no. 3 of the Paleontological Museum of St. Petersburg State University, compiled in the 1930s, was not found. It was probably lost while extinguishing the fire that broke out in the nearby rooms in 2001. The hall with the collections was flooded by firemen to prevent the spread of fire. The diagnosis of *Annulifer* is based on material of N.A. Sokolov, who gave M. Cossmann a shell with the definition of *P. protracta* (Cossmann, 1921, p. 119). This is *T. pseudocaspia* judging by the image of one of the shells (*ibid.*, pl. 5, figs. 17, 18), which, based on the indicated scale, has a height of about 13 mm.

Eichwald, when describing *P. protracta*, mentioned a shell of 8–9 whorls, as well as a height of three lines (Eichwald, 1853). It is not clear what system of measures he used, so we have a range of 6–7.5 mm in the decimal system. Drawing in the Eichwald's atlas (1851, 1853, pl. 10, fig. 25) is rather sketchy. Therefore, it can equally fit for *T. pseudocaspia*, *H. neofrauenfeldi* and the most multispiral *H. frauenfeldi*. *H. neofrauenfeldi* can be excluded, since its distribution is limited to the lower part of the *Cryptomactra* Beds. Both late *H. frauenfeldi* and early *T. pseudocaspia* can be suitable for the length and height of the shell (see above). During the original description, two locations were indicated in the original description: the villages of Novokonstantyniv and Zalistsi, and later the village of Bilozirka was added to the location list (Eichwald, 1853). Only the Lower Sarmatian emerges at Zalistsi and Bilozirka, while the material from Novokonstantyniv was collected in quarries of Middle Sarmatian limestone (Laskarev, 1914). The list of localities confirms that both *H. frauenfeldi* and *T. pseudocaspia* may correspond to *P. protracta*. As far as is known, the recognition of *Annulifer* went unnoticed by subsequent Sarmatian mollusk researchers. Its practical value for the systematization of Sarmatian hydrobiids seems

doubtful, especially with the problem in the interpretation of the type species.

“Small” hydrobiids in *Cryptomactra* Beds are represented by two basic groups for which new genera are proposed: *Edrozeba* and *Pomatiasia*. Based on the species described from the Lower Sarmatian of the Vienna Basin, it is most likely that the genus *Edrozeba* evolved from the forms described in the genera *Pseudoamnicola* (*Staja*) and *Valvata* (*Turrivalvata*) in Papp (1954), *Pseudoamnicola* in Švagróvský (1971), *Pseudoamnicola* (most species) and *Valvata* (*V. politioanei*) Jekelius, 1944) in Jekelius (1944). All of these species are characterized by tiny smooth shells with a few whorls varying in whorl and shell geometry. Similar forms were described from the Lower and Middle Sarmatian by Eichwald (1851, 1853) in the genus *Paludina*. Some of them were not included in the monograph by Kolesnikov (1934: described in the genus *Amnicola*), although he worked with the Eichwald collection, and the type material of many Eichwald species is still available for study. These are unsculpted species, in many respects resembling those of the Lower Sarmatian of the Dacian Gulf. At present it is impossible to say from which particular form *E. caeca* (described below) originated, but shells, previously identified by the author as “*Pseudoamnicola sarmatica* Jekelius, 1944”, were found in the Lower Sarmatian of the Aulchik Gully (collected in 2018), below the distribution of *E. caeca*. The Sarmatian history of the genus *Pomatiasia* looks more unambiguous. The only species *P. cyclostomoides* (Sinow, 1880), with type material from the Middle Sarmatian of Moldova (Pl. 24, fig. 2), can be traced from the lower part of the Lower Sarmatian. In the latter, it is described as *Valvata* (*Cincinnati*) *carasiensis* Jekelius, 1944 and does not differ morphologically from the type material of *P. cyclostomoides*. This species can be traced on the Belaya River from the upper part of the Lower Sarmatian to the middle part of the *Pseudocaspia* Member in the Middle Sarmatian. However, while it occurs in abundance on the Belaya River below the *Pseudocaspia* Member, then only five shells of *V. carasiensis* are indicated in the huge collections of Jekelius, and this is the only publication on the Lower Sarmatian of the Dacian Gulf, where there is data on *Pomatiasia*. The origin of the genus with such an unusual morphology remains unclear.

The assignment of Sarmatian hydrobiids to the genera *Hydrobia* and *Turricaspia* is tentative and does not necessarily show a close relationship with modern representatives of these genera. These names were used only because of the great similarity in appearance of the shell and the absence of contradictions in salt ecology between the Sarmatian and modern representatives of these genera. Modern taxonomy of hydrobioid mollusks is based primarily on peculiarities of the reproductive system. At the same time, shells of different genera and even families identified on this principle often do not differ in any way. That is, the concho-

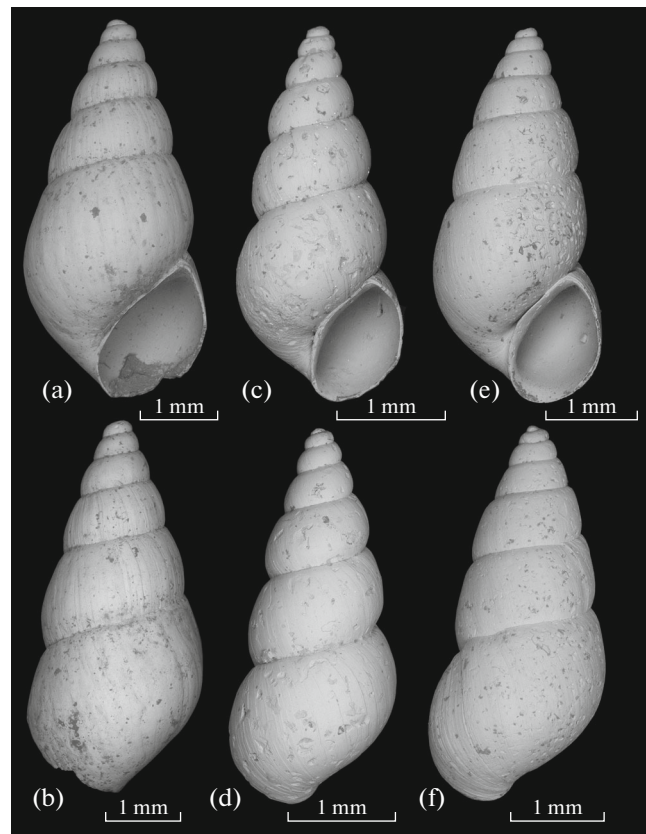


Fig. 20. Syntypes of *Rissoa elongata* Eichwald, 1830: (a, b) specimen PM SPbGU, no. 3/492a, height 4.8 mm, Moldova, Chişinău, Middle Sarmatian; (c, d) specimen ZIN, no. 62502, height 3.4 mm, Khmelnitskyi Region, Teofipol' District, village of Kuncha, Lower Sarmatian⁶; (e, f) specimen ZIN, no. 62503, height 4 mm, the same locality.

logical taxonomy of fossil Hydrobioidea does not correlate with the zoological one.

Genus *Hydrobia* Hartmann, 1821

Hydrobia neofrauenfeldi sp. nov.

Plate 14, figs. 4, 5; Plate 15, figs. 1–4

Hydrobia pseudocaspia: Volkova, 1955, p. 27, pl. 13, figs. 10–13 (figs. 10, 12—juvenile); Volkova, 1974, p. 86, pl. 20, figs. 10–13.

Etymology. To indicate the origin from the species *H. frauenfeldi* (M. Hörnes).

Holotype. PIN, no. 5621/22: Middle Sarmatian, lower part of the beds with *Cryptomactra pesanseris*; Republic of Adygea, Maikop District, outcrop on the Belaya River downstream the upper outskirts of the village of Grozny, Bed 39; figured in Pl. 15, fig. 3.

⁶ Dating is given according to V.D. Laskarev (1914, pp. 210–211), who described only the Lower Sarmatian outcrops in the vicinity of the village of Kuncha.

Description. Anomphalous high-spined shells, as adults with 7 to 8.5 whorls and 6.5–7 to 8 mm high, respectively. The protoconch is short, about a whorl long, smoothly passing into the teleoconch. The protoconch is has a distinct wrinkled microsculpture, against which four thin spiral “threads” stand out. Only orthocline growth lines are visible on the surface of the teleoconch. The whorls are convex, rounded, usually have an angular-rounded peryphery, separated by a rather deep suture. Angularity develops approximately in the middle of the whorl side or somewhat lower. The whorl side smoothly passes into a rounded-convex base. The aperture is oval, dorsoventrally elongated, rounded-angular adapically and rounded abapically. The lips are thin.

The wall of the shell consists of a cross-lamellar ostracum and a thin prismatic myostracum. The ostracum plates, bending, come out almost vertically to the surface of the whorl, forming an external thin subprismatic layer.

Variability. The shells from sample BS3 are 6.4–7 mm in height with a length of seven whorls and 4.6–5 mm with a length of six and a half whorls. Thus, the maximum shell length is seven whorls and 7 mm in height. The situation is similar in sample BS2: the height is 6.8–7.5 mm at seven and a half whorls; larger shells are very rare (for example, eight whorls and 8 mm high). The length of the shell slightly increases in the sample from Outcrop 1B₂ while maintaining its dimensions: the length of the shell is from 7.3 to eight whorls at a height of 7 mm; it is usually eight whorls at a height of 7.5 mm, with range from seven and a half to eight and a half whorls. Extreme specimens from 1B₂: from the most slender (6.8 mm and 8.3 whorls, elongation 2.67) to the lowest-spined (6.6 mm and 7.5 whorls, elongation 2.06).

A significant, usually predominant (rarely totally) part of the shells collected in the lower part of *Cryptomactra* Beds has a whorl side with a varying degree of angular-rounded bend, the position of which varies from the middle to the lower quarter of the height of the whorl side. Thus, there are approximately equal numbers of shells without angularity and with weak angularity in the sample from Outcrop 1A₀. Shells with a weak development of angularity dominate in BS3, less often without it. Shells with angularity sharply predominate in all stratigraphically higher samples, and shells with better pronounced angularity become enough numerous. The slenderness of the shell also varies, although low-spined specimens are few. The illustrated shells arranged: by degree in angularity: without angularity (Pl. 14, fig. 4a; Pl. 15, fig. 3) and with maximum angularity (Pl. 15, fig. 2); by slenderness: lower-spined (Pl. 15, fig. 1) and especially slender (Pl. 15, fig. 2).

Comparison. In general, the distinguishing features of the species are indicated in the discussion of the family above. The species differs from other Sarmatian forms in having more multispiral and slen-

der shells, which are characterized by a highly located, rounded angularity.

Remarks. The olistostrome shells in Outcrop 1A₀ were collected from an area that exposed several blocks and may be Middle Sarmatian, judging from other fauna collected from the surface.

Occurrence. Middle Sarmatian, lower part of beds with *Cryptomactra pesansensis* of Ciscaucasia.

Material. Belaya River: samples BS3 (293 specimens) and BS2 (62 specimens), assemblages 4 (63 specimens), 3 (316 specimens) and 1 (2 specimens); Kurdzhips River: outcrops 1A₀ (8 specimens), 1A₁ (15 specimens), 1A₂ (17 specimens), 1B₁ (55 specimens), 1B₂ (121 specimens), 1B₃ (19 specimens), 1A₂–1B₃ (14 specimens).

Genus *Turricaspia* B. Dybowski et Grochmalicki, 1917

Turricaspia pseudocaspia (Sinzow, 1912)

Plate 15, figs. 5–7; Plate 16, figs. 1–9

Hydrobia pseudocaspia: Sinzow, 1912, p. 308, pl. 13, figs. 98–105; Davitdashvili, 1932, p. 70, pl. 10, figs. 28–30; Kolesnikov, 1934, p. 216, pl. 27, figs. 27–29; Zhizhchenko, 1934, p. 75, pl. 9, figs. 24, 25; Simionescu and Barbu, 1940, p. 70, pl. 6, fig. 27; Volkova, 1955, p. 27, pl. 13, figs. 10–13; Steklov, 1955, pl. 6, fig. 33; Volkova, 1974, p. 86, pl. 20, figs. 10–13; Ali-Zade, 1974, p. 108, pl. 35, figs. 1–5.

Hydrobia enikalensis: Volkova, 1955, pl. 13, fig. 14; Volkova, 1974, pl. 20, fig. 14.

Hydrobia aff. *pseudocaspia*: Steklov, 1955, pl. 6, figs. 34, 35.

Hydrobia (*Hydrobia*) *pseudocaspia*: Kojumdgieva, 1969a, p. 88, pl. 31, figs. 14–18.

Transitional forms from *Hydrobia* (*Hydrobia*) *frauenfeldi* to *H.* (*H.*) *pseudocaspia*: Kojumdgieva, 1969a, p. 87, pl. 31, figs. 12, 13.

Hydrobia stagnalis stagnalis: Özsayar, 1977, p. 56, pl. 7, fig. 7.

Lectotype. TsNIGR Museum, no. 290/11126: Middle Sarmatian; Stavropol Krai, Izobil’nyi District, village of Tishchenskoe. Proposed by E. Kojumdgieva (1969a, p. 88). Figured: Kolesnikov, 1934, pl. 27, figs. 28, 29; here: pl. 16, fig. 5. Although the selected specimen is not illustrated in Sinzow’s work, it was taken by Kolesnikov from the Sinzow collection and comes from the type locality, thus referring to the type material of the species. It must be admitted that the choice of such fragmentary specimen as a type of species was unsuccessful and only makes it difficult to compare with other hydrobiids.

Description. Anomphalous high-spined shells, as adults have, seven to nine whorls long and 6.5 to 11 mm high in the *Cryptomactra* Beds and *Pseudocaspia* Member, and above reach 10.5 whorls in length and 14–16 mm in height, and sometimes even more. The morphology of the larval stage is unknown due to the pitting or rubbing of the initial whorls. The whorls are convex, rounded, separated by a rather deep suture, covered with prosocline growth lines. Often, spiral elements of endosculpture are visible on the whorl surface of, from barely visible to quite clear, but at the same time very low (extreme as in Pl. 16, fig. 6) or thin spiral striation (Pl. 16, fig. 3). The aperture is oval, dorsoventrally elongated, angular dorsally and

rounded ventrally. The lips are thin. The wall of the shell consists of a cross-lamellar ostracum and a thin prismatic myostracum. The ostracum plates, bending, come out almost vertically to the outer surface of the whorl, forming an outer narrow subprismatic layer.

Variability. There is a certain trend in the change of the length and size of the shells of *T. pseudocaspia*: gradual elongation and enlargement of the shells up the section. Shells from Outcrop 1C₁ are 7–7.5 mm high and have seven whorls, with rare specimens with eight whorls. The situation begins to change up the section. Shells in Outcrop 1C₃ with 7–7.5 whorls are already 8–9.5 mm high; with 8.5–9 whorls and 10–11 mm high in Outcrop 1D₁; with 8–9 whorls and 9–10.5 mm high in Outcrop 1D₃, the material is usually fragmentary in Outcrop 1E₃, due to greater fragility, but a picture is obtained as in 1D₁, with a length of 8.5–9 whorls shell and a 10–11 mm high. Outcrop 1G₄ contains specimens with 10–10.5 whorls and 13–16 mm high. This is not associated with a change in the lithology of the enclosing deposits, as the lowest and upper finds are confined to gray aleurites and clayey aleurites. At the same time it is clear that shells from rocks of different lithology differ each other in the same stratigraphic interval.⁷ Numerous much larger *T. pseudocaspia* were found in the sandy interbeds of Outcrop 1B₃ (the same size as in assemblages of outcrops 1D₁, 1E₃), collected from aleuritic clays in the same place. However, shells from the highly arenaceous rock of Outcrop 1E₃ do not differ in shell size and length from those of the clayey aleurites of Outcrop 1D₁. *T. pseudocaspia* from coarse-grained calcarenites of the Novokrymskaya Formation of Miroshnikova Shchel' Creek (Krymsk District of the Krasnodar Krai, Middle Sarmatian: Pl. 16, figs. 8, 9) are the same size as in the largest specimens from the *Pseudocaspia* Member of the Kurdzhips River Sequence, but with shorter shell (7–7.5 whorls). If both of them are compared with the type material, then the shells from the limestones of Miroshnikova Shchel' are distinguished by a faster growth of whorls in diameter, which is resulted in slightly less slender shell with a partly more convex periphery of the early whorls.

There is also variability in the slenderness of the shell, the convexity of the whorls, the presence, character or absence of the above-mentioned spiral sculpture. These variants, were shown in the photo plates, where possible. Shells close to the prevailing norm are specimens in Pl. 15, fig. 7 and Pl. 16, fig. 2.

Remarks. *T. pseudocaspia* differs from other Sarmatian hydrobiids in the long, large and usually slender shell with rounded and more or less convex whorls.

The presence of *T. pseudocaspia* in the Middle Sarmatian of the western part of the Sarmatian Sea can be

demonstrated by the material of Kojumdgieva (1969a), who shows shells a length of 9–10 whorls at a height of 10–15 mm, I. Simionescu (Simionescu and Barbu, 1940) wrote about 8 whorls at a height of 11.5 mm.

Occurrence. Middle Sarmatian of Bulgaria, Moldova, Crimea, Ciscaucasia and Transcaucasia (Abkhazia).

Material. Kurdzhips River: sample BS4 (4 specimens); outcrops 1B₃ (6 specimens), 1B₅ (1 specimen), 1C₁ (43 specimens), 1C₂ (53 specimens), 1C₃ (147 specimens), 1C₅ (51 specimen), 1C₇ (89 specimens), 1D₁ (585 specimens), 1D₂ (30 specimens), 1D₃ (210 specimens), 1E₂ (35 specimens), 1E₃ (50 specimens).

Genus *Edrozeba* Guzhov, gen. nov.

Etymology. Arbitrary combination of letters. Feminine.

Type species. *Edrozeba caeca* sp. nov.

Description. Small, low-spined, with a few whorls, narrowly umbilicated shells. The protoconch has about one whorl, richly ornamented with pustules, striae, spiral lines, or nodular sculpture. The teleoconch is smooth or covered with a thin spiral sculpture, consists of convex rounded whorls. The growth lines are slightly sigmoidal, with an opisthocyrt bend at the top of the whorl. The aperture is rounded, with thin lips, round anteriorly, rounded or rounded-angular posteriorly.

Composition. Type species *E. angulata* sp. nov., *E. enikalensis* (Kolesnikov, 1934), *E. minuta* sp. nov., and *E. striata* sp. nov.

Comparison. It differs from other genera in small, low-spined shells and in ecology due the distribution in mesohaline basins.

Occurrence. Lower and Middle Sarmatian.

Edrozeba caeca Guzhov, sp. nov.

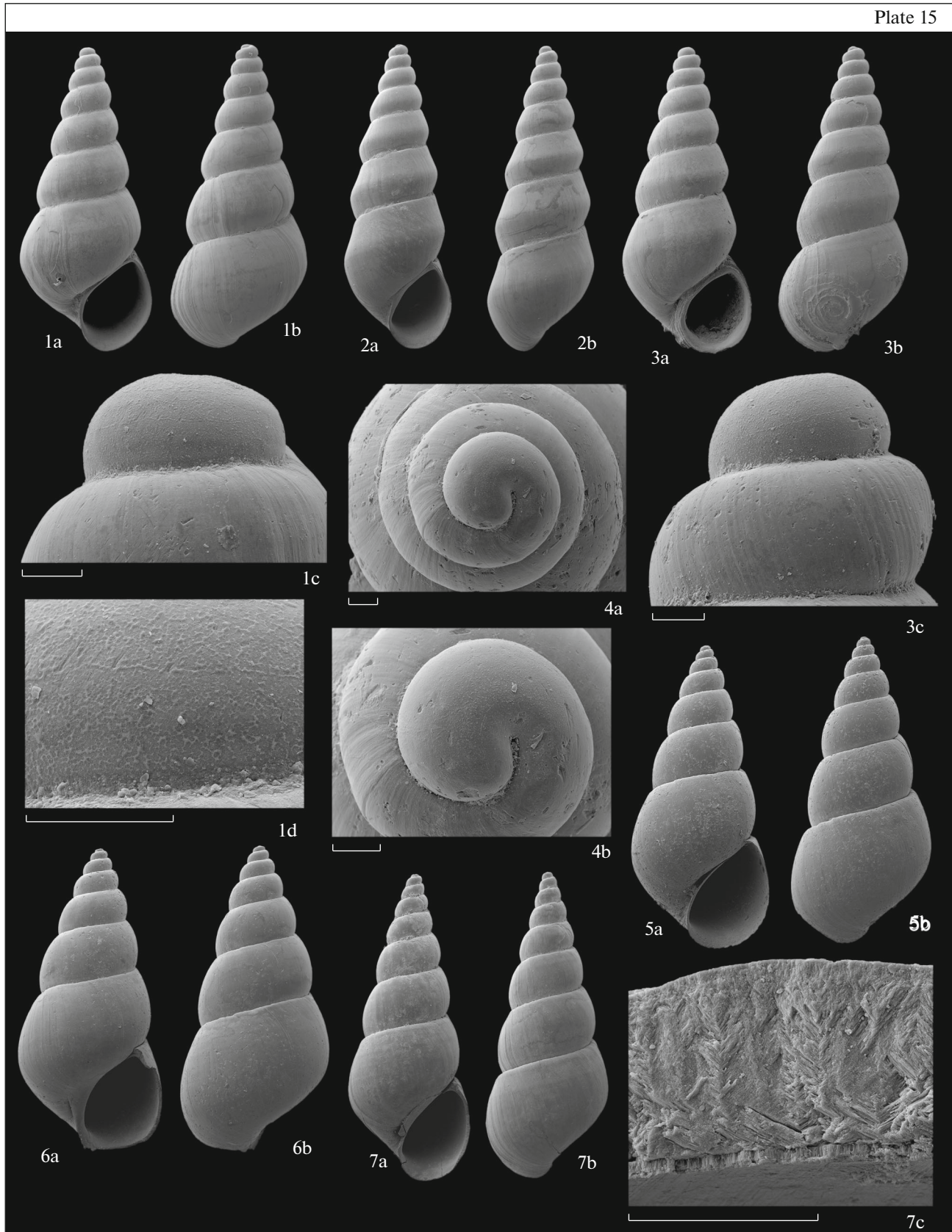
Plate 16, figs. 10–13; Plate 17, figs. 1–9; Plate 18, figs. 1–7

Etymology. From the Latin *caecus* (obscure).

Holotype. PIN PAH, no. 5621/38; Middle Sarmatian, beds with *Cryptomactra pesanseris*; Republic of Adygea, Maikop District, Kurdzhips River, Outcrop 1A₀. Figured: Pl. 17, fig. 1.

Description. Small, low-spined, paucispiral shells with a slit-like umbilicus, of 4.5–5 whorls, 2.3–3 mm high. The protoconch is about 1.3 whorls, with variable sculpture. The ornament consists of usually densely spaced microscopic pustules, often arranged in spiral rows. The pustules are less often arranged without visible order. The sculpture in some shells may consist predominantly of spiral rows of horizontal or oblique dashes, or the dashes alternate with spiral rows of pustules. The protoconch boundary is quite distinct, expressed in a sharp change in sculpture. The whorls of the teleoconch are convex, rounded, separated by a deep suture. The sculpture on the teleoconch may be

⁷ This material is not considered in the article. Firstly, it cannot be attributed to the *Cryptomactra* fauna, and secondly, the shells can be studied only in sections due to their fragility.



absent, usually represented by frequently arranged spiral elements of various shapes: from threads to barely visible striae, which equally cover the whorl side and base. The whorl side roundly passes into a convex base. The growth lines are slightly sigmoidal. The aperture is rounded, with thin lips, rounded below, rounded or rounded-angular above. The whorls of the teleoconch are convex, rounded, separated by a deep suture. The sculpture on the teleoconch may be absent, usually represented by often arranged spiral elements of various shapes: from ribs to barely visible striae, which equally cover the side and base. The whorl side roundly passes into a convex base. Growth lines are slightly sigmoidal. The aperture is round, with thin lips, round anteriorly, rounded or rounded-angular posteriorly.

The shell wall consists of three layers: outer and inner prismatic and middle cross-lamellar layers. The thickness of the outer and inner layers varies greatly, probably as the shell grows. Therefore, the outer and inner prismatic beds can reach a third of the shell thickness or become thinner, and the middle layer can form from a third to almost the entire thickness of the shell wall.

Variability. Variability is shown in collections from samples 19A and BS3. Both samples come from levels before and after maximum polymorphism within the species, which is typical for samples from Beds 9–11, but, nevertheless, demonstrate high variability in many parameters: shell slenderness, profile and growth rate of whorls; the presence or absence of the teleoconch sculpture, its appearance; variability of protoconch sculpture and shell wall structure. Particularly strong variability is observed in sample 19A from a single population (Pl. 16, figs. 10–13; Pl. 17, figs. 1–5). There are specimens only in it with a rather prominent sculpture of the teleoconch, represented by threads (Pl. 16, fig. 10; pl. 17, fig. 5) and the slenderest shells consisting of slowly growing and strongly convex whorls (Pl. 17, fig. 4), while the unsculpted shells are in the minority. The diversity of morphology is higher than in sample BS3. Shells are larger on the average in the BS3, their shape is more consistent, and the sculpture is reduced to more or less clearly expressed striae. Shells with spiral striations remain the predominant type. The ratio between shells with visible sculpture and outwardly smooth whorls in the sample BS3 is 3 : 1 (electron microscope surveys showed that shells with

very fine striated sculpture were also included in the “smooth” ones). Sample 19A shows a clear predominance of ornamented shells.

Sample 19A shows the polymorphism of *E. caeca* at the beginning of a strong increase in variability before the division of the species into several independent forms. Sample BS13 is the stabilization of the morphology of *E. caeca* after separation of its daughter species. Sculpture has further reduction up the section, which it leads to the next stage of morphogenesis in this lineage, identified as the species *E. minuta*.

Comparison. *E. caeca* differs usually from *E. minuta* in the distinct sculpture and great diversity in shape of shell and whorls, and protoconch sculpture, uncharacteristic of *E. minuta*. It is distinguished from *E. enikalensis* by smaller and more low-spined shells, a wider slit-like umbilicus, rounded late whorls and presence of sculpture. It differs from *E. striata* in the smaller and wider umbilicated shells with rounded whorls.

Occurrence. Uppermost Lower Sarmatian–Middle Sarmatian, lower part of the beds with *Cryptomacra pesansensis* of Ciscaucasia.

Material. Belaya River: sample BS3 (1502 specimens); Kurdzhips River: Outcrop 1A₀, sample 19A (838 specimens).

Edrozeba minuta Guzhov, sp. nov.

Plate 18, fig. 8; Plate 19, fig. 1–5; Plate 20, fig. 1, 2

Pseudoamnicola cyclostomoides: Lukeneder et al., 2011, text-fig. 4Q.

? *Hydrobia nympha*: Steklov, 1955, pl. 6, figs. 25, 26.

Etymology. From the Latin *minutus* (small).

Holotype. PIN, no. 5621/55; Middle Sarmatian, beds with *Cryptomacra pesansensis*; Republic of Adygea, Maikop District, Kurdzhips River, Outcrop 1C₂; figured in Pl. 19, fig. 5.

Description. Small, low-spined, shells with a few whorls, with a more or less wide slit-like umbilicus, of 3.7–4.5 whorls, 1.7–2.7 mm high. The protoconch has about 1.3 whorls, densely covered with microsculpture. It begins with chaotically and strongly sinuous cords, between which several rows of pustules soon appear, while the cords begin to lose integrity. The protoconch towards the end is densely covered with spiral rows of pustules, between which empty bands remain instead of disappearing cords. The demarcation with the teleoconch is rather sharp, by

← Explanation of Plate 15

Scale bar 100 μm. The dimensions of other shells are given in explanation.

Figs. 1–4. *Hydrobia neofrauenfeldi* sp. nov., Belaya River, Bed 39, sample BS2, lower part of the beds with *C. pesansensis*: (1) specimen PIN, no. 5621/20, height 5.9 mm: (1a) apertural view, (1b) abapertural view, (1c) apex, (1d) sculpture on protoconch; (2) specimen PIN, no. 5621/21, height 6.7 mm: (2a) apertural view, (2b) abapertural view; (3) holotype PIN, no. 5621/22, height 5.8 mm: (3a) apertural view, (3b) abapertural view, (3c) apex; (4) specimen PIN, no. 5621/23: (4a) apical view, (4b) protoconch, apical view.

Figs. 5–7. *Turricaspiya pseudocaspiya* (Sinzow, 1912), Kurdzhips River: (5) specimen PIN, no. 5621/25, height 6.8 mm, Outcrop 1C₁, middle part of the beds with *C. pesansensis*: (5a) apertural view, (5b) abapertural view; (6) specimen PIN, no. 5621/26, height 5.8 mm, the same locality: (6a) apertural view, (6b) abapertural view; (7) specimen PIN, no. 5621/27, height 8.5 mm, Outcrop 1C₃, upper part of the beds with *C. pesansensis*: (7a) apertural view, (7b) abapertural view, (7c) shell wall structure, outer lip.

the disappearance of microsculpture. The whorls are convex, rounded, separated by a rather deep suture, without sculpture. The whorl side roundly passes into a convex base. The growth lines are slightly sigmoid. The aperture is rounded, with thin lips, rounded anteriorly, rounded or rounded-angular posteriorly.

Variability. There are no more than five meters of section between samples BS3 with late *E. caeca* and BS2 with *E. minuta*, however, already the sample BS2 is represented only by unsculpted shells, i.e., the loss of sculpture occurred quickly. It seems logical to separate *E. minuta* based on the clear predominance of unsculpted shells in the sample at such gradual transition.

Early *E. minuta* are shown in the example of a sample from the landslide block of outcrop 1A₁, as they are better preserved. They fully reflect the morphology of *E. minuta* from the section near the village of Grozniy on the Belaya River and from the interval of outcrops 1A₂–1B₃ on the Kurdzhips River. There is only a slight decrease in height and an average decrease in the slenderness of the shells from the Kurdzhips River. The sample from Outcrop 1C₂ is characterized by even smaller and, on average, slightly wider shells than the stratigraphically lower material.

Comparison. A comparison with *E. caeca* is given in the description of the latter, and also see the paragraph on *E. minuta* variability above. It differs from *E. enikalensis* in smaller and more low-spined, narrow umbilicated shell with rounded whorls; from *E. striata*—in smaller and more low-spined shell with wider umbilicus, and smooth rounded whorls.

Occurrence. Lower part of the Middle Sarmatian, lower part of the beds with *Cryptomacra pesanseris*.

Material. Belaya River: samples BS2 (152 specimens), BS1 (118 specimens), 11A (179 specimens), assemblages 1 (1 specimen) and 2 (2 specimens); Kurdzhips River: outcrops 1A₁, sample 10A (287 specimens), 1A₂ (5 specimens), 1B₁ (1 specimen), 1C₁ (22 specimens), 1C₂, sample BS4 (167 specimens).

Edrozeba enikalensis (Kolesnikov, 1934)

Plate 20, figs. 3–8; Plate 21, figs. 1–7, Plate 22, fig. 1

Hydrobia enikalensis: Kolesnikov, 1934, p. 216, text-fig. 21, pl. 27, figs. 22–26; Volkova, 1955, p. 26, pl. 13, fig. 15; Volkova, 1974, p. 86, pl. 20, fig. 15; Ali-Zade, 1974, p. 108, pl. 35, figs. 6, 7.

Hydrobia stagnalis andrussowi: Özsayar, 1977, p. 56, pl. 7, fig. 8.

? *Hydrobia elongata*: Steklov, 1955, pl. 6, figs. 29, 30.

Lectotype. TsNIGR Museum, no. 285/11126, designated here: Middle Sarmatian, beds with *Cryptomacra pesanseris*; Crimea, Kerch Peninsula, coast near the Yeni-Kale lighthouse on Cape Fonar'; figured in Kolesnikov, 1934, pl. 27, fig. 22; here Pl. 20, fig. 3.

Description. Small low-spined shells, anophalous or with a narrow slit-like umbilicus, consisting of five–six whorls, 3.5–4.5 mm high. The protoconch is 1.3 whorls long, its surface is at first uneven with scattered numerous microscopic pustules, then the surface flattens out and bears numerous chaotic rows of densely arranged pustules. The transition to the teleoconch is expressed in the disappearance of pustules and the appearance of growth lines. The whorls of the teleoconch are rounded and convex, separated by a rather deep suture. The last one or two whorls may acquire an angular-rounded shape. The sculpture is absent. The growth lines on the whorl side are weakly sigmoidal, forming a shallow opisthocyrt curve at the top of the whorl. The aperture is rounded, with thin lips, angularly rounded posteriorly and rounded anteriorly.

The shell wall consists of thick cross-lamellar ostracum and thin prismatic myostracum.

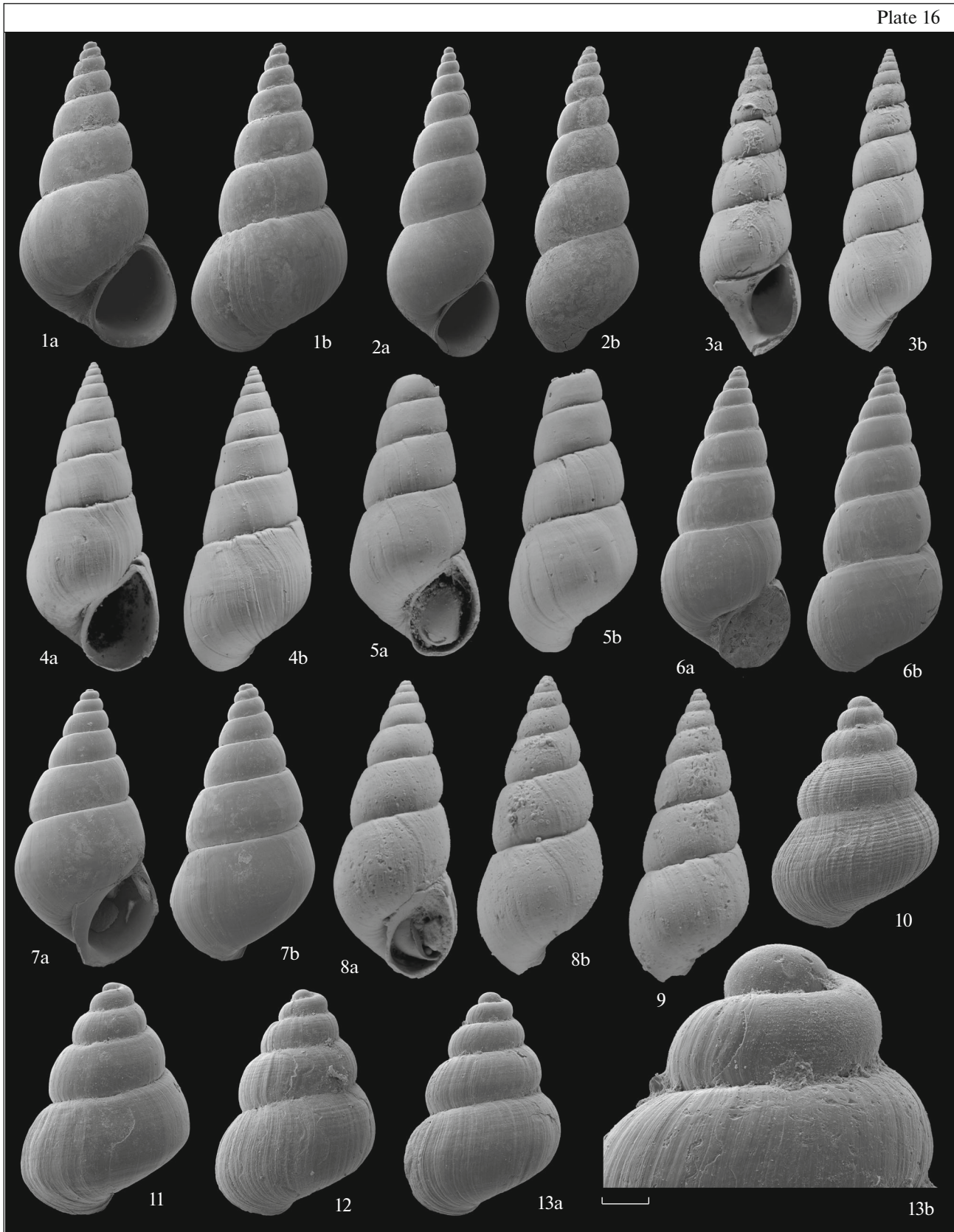
Variability. Two morphotypes of *E. enikalensis* were found on the Belaya River and in Outcrop 1A₁ on the Kurdzhips River, differing in slenderness, length and height of the shells. Slenderer, longer and taller shells are encountered in samples BS1, BS2, BS3 and 11A and the corresponding numbered assemblages. Adult shells in the lowest sample BS3 have six, rarely from 5.7 whorls, with height of 3.7–4.15 mm. Shells are only with rounded whorls, with a small admixture of more low-spined specimens (Pl. 20, fig. 8, Pl. 21, fig. 2). The appearance of the shells in sample BS2 is the

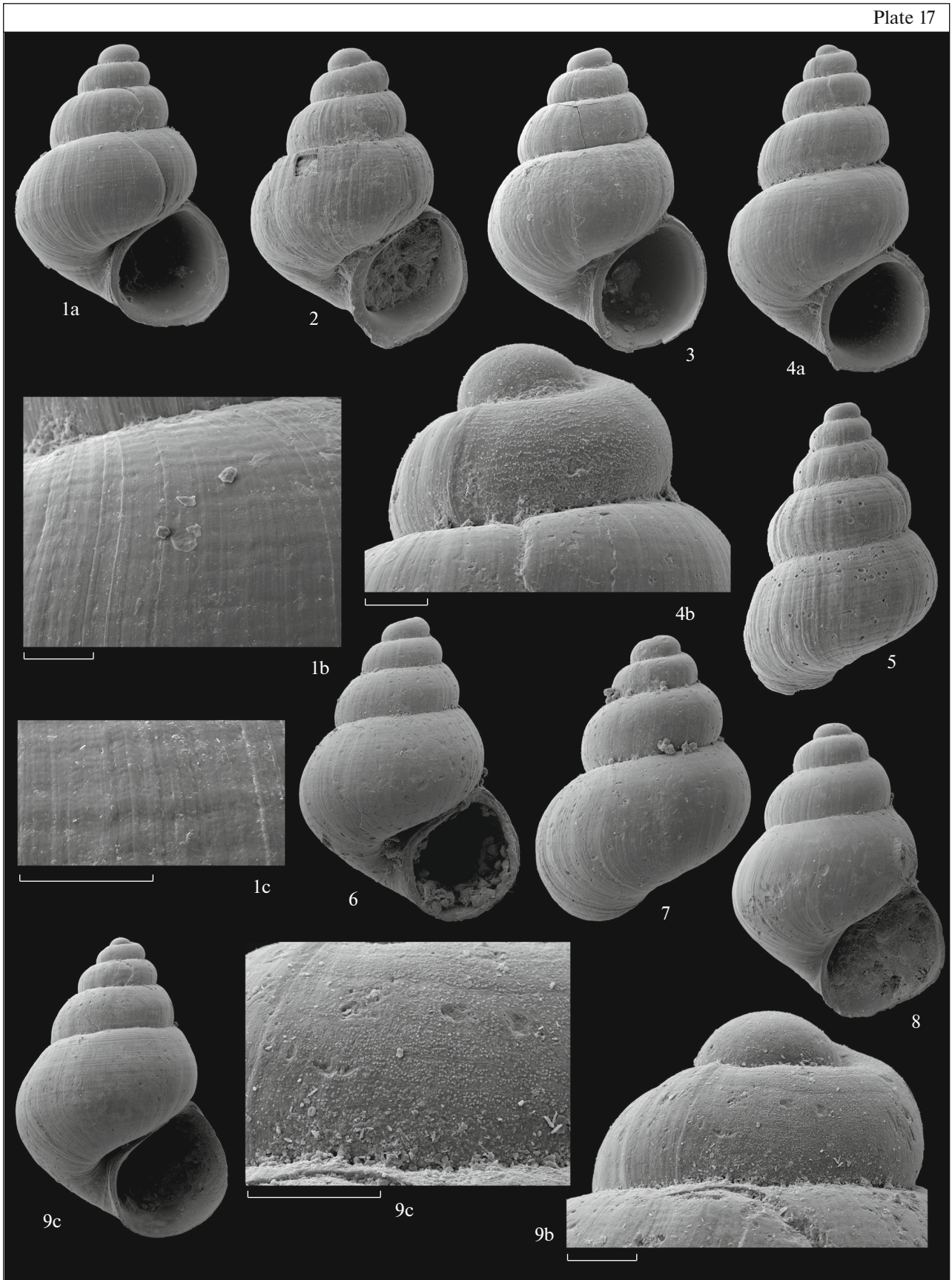
Explanation of Plate 16

Scale bar 100 μm. The dimensions of other shells are given in explanation.

Figs. 1–9. *Turricaspia pseudocaspia* (Sinzow, 1912): (1) specimen PIN, no. 5621/28, height 7.7 mm, Kurdzhips River, Outcrop 1C₃, upper part of beds with *C. pesanseris*: (1a) apertural view, (1b) abapertural view; (2) specimen PIN, no. 5621/29, height 10.1 mm, Kurdzhips River, Outcrop 1D₁, upper part of beds with *C. pesanseris*: (2a) apertural view; (2b) abapertural view; (3) paralectotype TsNIGR Museum, no. 95/11326, height 15.4 mm, Stavropol Krai, Izobil'nyi District, a well in the village of Tishchenskoe, Middle Sarmatian: (3a) apertural view, (3b) abapertural view; (4) paralectotype TsNIGR Museum, no. 98/11326, height 14 mm, the same locality: (4a) apertural view, (4b) abapertural view; (5) lectotype TsNIGR Museum, no. 290/11126, height 11.7 mm, the same locality: (5a) apertural view, (5b) abapertural view; (6) specimen PIN, no. 5621/30, height 7.7 mm, Stavropol Krai, Krasnogvardeiskoe District, borehole Is-k (Kavkazgeols'emka) at the village of Krasnogvardeiskoe, depth 422 m, lower part of the Middle Sarmatian: (6a) apertural view, (6b) abapertural view; (7) specimen PIN, no. 5621/31, height 4.7 mm, the same locality, depth 424 m: (7a) apertural view, (7b) abapertural view; (8) specimen PIN, no. 5621/32, height 10.3 mm, Krasnodar Krai, Krymsk District, Miroshnikova Shchel' Creek (near the village of Sauk-Dere), Outcrop SD-3, sample SD3, upper part of the Middle Sarmatian: (8a) apertural view, (8b) abapertural view; (9) specimen PIN, no. 5621/33, height 9.8 mm, the same locality.

Figs. 10–13. *Edrozeba caeca* sp. nov., Kurdzhips River, Outcrop 1A₀, sample 19A, Lower Sarmatian block in olistostrome. (10) specimen PIN, no. 5621/34, height 2.2 mm; (11) specimen PIN, no. 5621/35, height 1.9 mm; (12) specimen PIN, no. 5621/36, height 2 mm; (13) specimen PIN, no. 5621/37, height 2.1 mm: (13a) shell, (13b) protoconch.





same, adult shells varies in the length from 5.3 to 6 whorls and in the height from 3.8 to 4 mm. The first shells appear here with a rounded-angular profile on the last whorl. The portion of shells with an angular-rounded profile in later whorls becomes significant in samples BS1 and 11A. The length of the shells is from 5.4 to 6 whorls, the height is from 3.6 to 4 mm (one specimen has a height of 4.5 mm at a length of 6.2 whorls). Low-spined, angular shells most closely resemble those of *E. angulata* (Pl. 22, fig. 1). The shells are on average slightly more low-spined in sample 10A (Outcrop 1A₁). They have a shorter and lower shell (height 3.4–3.6, rarely up to 3.9 mm, length 4.8–5.4 whorls). Angularity is the same, occurring only on the last whorl. Single shells were found higher in the section (outcrops 1A₂–1C₁), they are slender as in the Belaya River section, usually without pronounced angularity.

Comparison. *E. enikalensis* differs from *E. caeca* and *E. minuta* in the larger, slender and usually long shells with a vestigial umbilicus, the appearance of angularity on later whorls. It also differs from *E. caeca* in the absence of sculpture. It differs from *E. striata* in slenderer smooth shells, whorls without angularity or with its different expression. Differs from *E. angulata* in the rounded or slightly angular (late) whorls, usually slenderer shells.

Remarks. The type material of the species mostly corresponds in morphology to the shells collected from Members 39–41 of section on the Belaya River.

The species occurs in the interval of outcrops 1A₂–1C₁ together with the mass *E. angulata*, from which it differs in slender shells without sharp angularity. It can be assumed that *E. enikalensis* split into two morphogroups, from which the group with lower-spined and angular shells gave rise to *E. angulata*, while the second group continued to coexist for some time until it was displaced by representatives of the first group. It is probable that, the species coexisted in the same territory after separation, but the areas of their populations did not intersect. It is supported by the study results of sample BS6 from the nodule horizon of Outcrop 1B₂. The sample contained 174 specimens of *E. angulata* and none of *E. enikalensis*.

Low-spined and weakly angular forms of *E. enikalensis* appear in the upper samples from the Belaya River section, low-spined shells with different development of angularity predominate in sample 10A.

E. angulata has already been encountered stratigraphically higher, beginning from Outcrop 1A₂. The actual process of dividing *E. enikalensis* into two species has not been documented, apparently, because of the stratigraphic hiatus is between sections on the Belaya and Kurdzhips rivers and, because the rate of the division process was high.

Occurrence. Middle Sarmatian of Crimea and Ciscaucasia, Transcaucasia (Azerbaijan) and Turkey (Sinop).

Material. Belaya River: samples BS3 (659 specimens), BS2 (47 specimens), BS1 (36 specimens), 11A (26 specimens), assemblages 4 (18 specimens), 3 (59 specimens), 2 (12 specimens) and 1 (67 specimens); Kurdzhips River: outcrops 1A₀ (1 specimen), 1A₁ (9 specimens), sample 10A (97 specimens), 1B₁ (6 specimens), 1B₃ (1 specimen), 1C₁ (1 specimen).

Edrozeba angulata Guzhov, sp. nov.

Plate 22, fig. 2–9; Plate 23, fig. 1

Hydrobia enikalensis: Steklov, 1955, pl. 6, fig. 31.

Pseudoamnicola producta unicarinata: Ali-Zade, 1974, p. 110, pl. 37, fig. 1–4.

Pseudoamnicola sp.: Lukeneder et al., 2011, figs. 4R, 4S.

Etymology. From the Latin *angulatus* (angular).

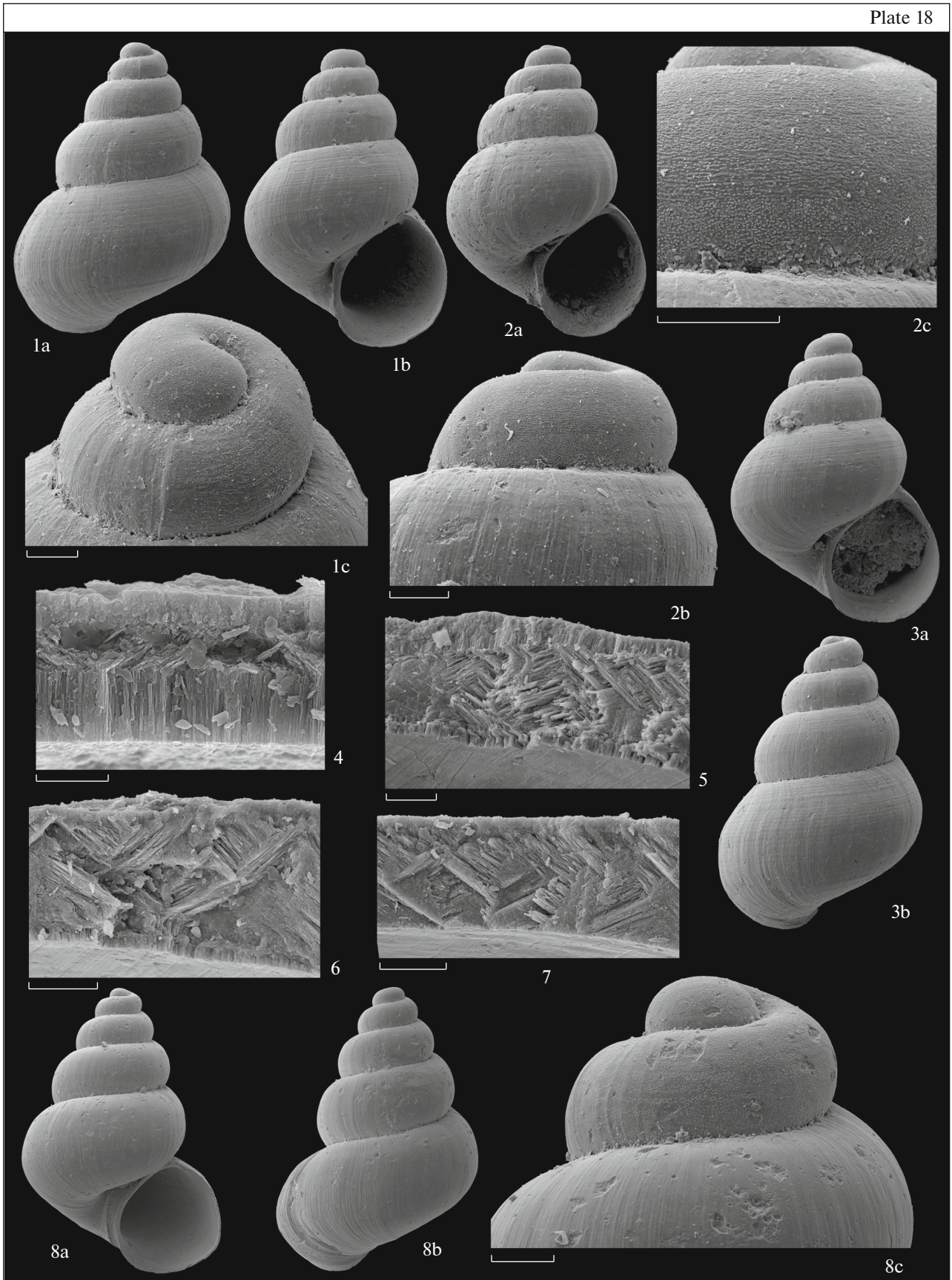
Holotype. PIN, no. 5621/72: Middle Sarmatian, beds with *Cryptomactra pesanseris*; Republic of Adygea, Maikop District, Kurdzhips River, Outcrop 1C₂; figured in Pl. 22, fig. 5.

Description. Small shells are anomphalous or with a narrow slit-like umbilicus, consist of 5–6 whorls, 3.5–5 mm high. The protoconch is 1.3 whorls long, its surface is initially uneven with numerous microscopic pustules scattered over it. Further, the surface is leveled, and the sculpture is replaced by very densely spaced and often stuck together pustules, arranged in spiral rows. The demarcation with the teleoconch passes through the disappearance of pustules. The first one or two whorls of the teleoconch are rounded-convex or flattened, then a rounded-angular bend develops, located on the whorl side somewhat below its middle, and the whorls become keeled. The bend often takes the form of a rounded keel. The whorl side above the bend is straight. It may become slightly concave on the last whorl in shells with a well-developed keel. The whorl side below the bend forms a single slightly convex sur-

Explanation of Plate 17

Scale bar 100 μm. The dimensions of other shells are given in explanation.

Figs. 1–9. *Edrozeba caeca* sp. nov.: (1–5) Kurdzhips River, Outcrop 1A₀, sample 19A, Lower Sarmatian block in olistostrome; (6–9) Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesanseris*. (1) holotype PIN, no. 5621/38, height 2.1 mm: (1a) shell, (1b) sculpture, (1c) character of microstriation; (2) specimen PIN, no. 5621/39, height 2 mm; (3) specimen PIN, no. 5621/40, height 2.1 mm; (4) specimen PIN, no. 5621/41, height 2.7 mm: (4a) shell, (4b) protoconch; (5) specimen PIN, no. 5621/42, height 2.3 mm; (6) specimen PIN, no. 5621/43, height 2.5 mm; (7) specimen PIN, no. 5621/44, height 2.25 mm; (8) specimen PIN, no. 5621/45, height 2.4 mm; (9) specimen PIN, no. 5621/46, height 2.8 mm: (9a) shell, (9b) protoconch, (9c) sculpture of protoconch.



face with the base. There is no sculpture, except for the occasional thin spiral striation. The growth lines are slightly sigmoidal, with an opisthocyrtoid bend at the top of the whorl. The aperture is rounded, rounded anteriorly and rounded-angular posteriorly. The lips are thin.

Variability. Outcrop 1C₁ is dominated by shells of 5–5.5 whorls at a height of 3.5–3.8 mm. The bend does not protrude as much and does not move upward on the last whorl, as it does with shells from sample BS4 (Outcrop 1C₂). The latter is dominated by shells with a strongly pronounced bend, 3.9–4.2 mm high with 5.4–5.8 whorls. Samples from outcrops 1A₂–1B₃ are dominated by shells with early non-keeled convex whorls of the teleoconch and then by a strong development of the carinate bend. The shells from sample BS4 are distinguished by the appearance of shells with less convex early whorls of the teleoconch. The bend becomes blunted further up the section, the shell becomes less keeled, and the whorls on the whorl become more flattened. Shells with fine spiral striations were found in the sample from Outcrop 1C₇ (collections of 2018). Numerous *E. angulata* with a smoothed keel and flat whorls on the spire, because the whorl side above the inflection remains flat, occurs in the upper part of the Middle Sarmatian (outcrop 1G₄, collections of 2018–2019). The gradual transformation of the species makes it possible to distinguish between its early and late representatives according to the features of their external appearance.

Comparison. This species differs from *E. caeca* and *E. minuta* in a larger, strong, almost anomphalous shell with keeled whorls. It differs from *E. enikalensis* in a strong and usually more low-spined shell with keeled whorls; from *E. striata*—in the absence of spiral sculpture, usually slenderer shells, by the character of the angularity of whorls.

Remarks. The collections showed that after the emergence of *E. angulata*, it became widespread in deposits of the upper part of the Middle Sarmatian. The species becomes one of the most widespread in Ciscaucasia among hydrobiids in deposits of different lithologies. It is found in large numbers in the Krymsk District, where the species is present in all samples taken from sandy and carbonate rocks overlying the clayey-aleuritic facies of the beds with *C. pesansensis*.

Occurrence. Middle Sarmatian of Ciscaucasia and Azerbaijan, including beds with *C. pesansensis*, except for their lower part.

Material. Kurdzhips River: outcrops 1A₂ (22 specimens), 1B₁ (4 specimens), 1B₂ (59 specimens), 1B₃ (4 specimens), 1B₅ (2 specimens), 1C₁ (62 specimens), 1C₂ (10 specimens), sample BS4 (101 specimens), 1C₅ (5 specimens), 1C₇ (21 specimens), 1D₁ (4 specimens), 1D₂ (1 specimen), 1D₃ (2 specimens).

Edrozeba striata Guzhov, sp. nov.

Plate 23, figs. 2–6; Plate 24, fig. 1

? *Ammicola cyclostomoides*: Steklov, 1955, p. 138, pl. 6, fig. 27, 28.

Etymology. From the Latin *striatus* (striated).

Holotype. PIN, no. 5621/79: Middle Sarmatian, beds with *Cryptomactra pesansensis*; Republic of Adygea, Maikop District, Outcrop 1A₁ on the Kurdzhips River, within the limits of the village of Sadovyi; figured in Pl. 23, fig. 3.

Description. The shells are small, with a narrow slit-like umbilicus, more developed in more low-spined specimens. The shells have about 5.5 whorls and 3.5–3.9 mm high. The teleoconch whorls have a rounded wide bend located below the middle of the whorl side of the whorl, rarely without a bend to the end of the shell. The whorls are convex and rounded in this case, with a maximum width below the middle of the whorl side. The suture is usually quite deep. Spiral sculpture consists of very frequent and relatively fine striae. The growth lines are slightly sigmoidal, with a slight opisthocyrt bend at the top of the whorl. The aperture is rounded, with thin lips. It is rounded anteriorly and rounded-angular posteriorly.

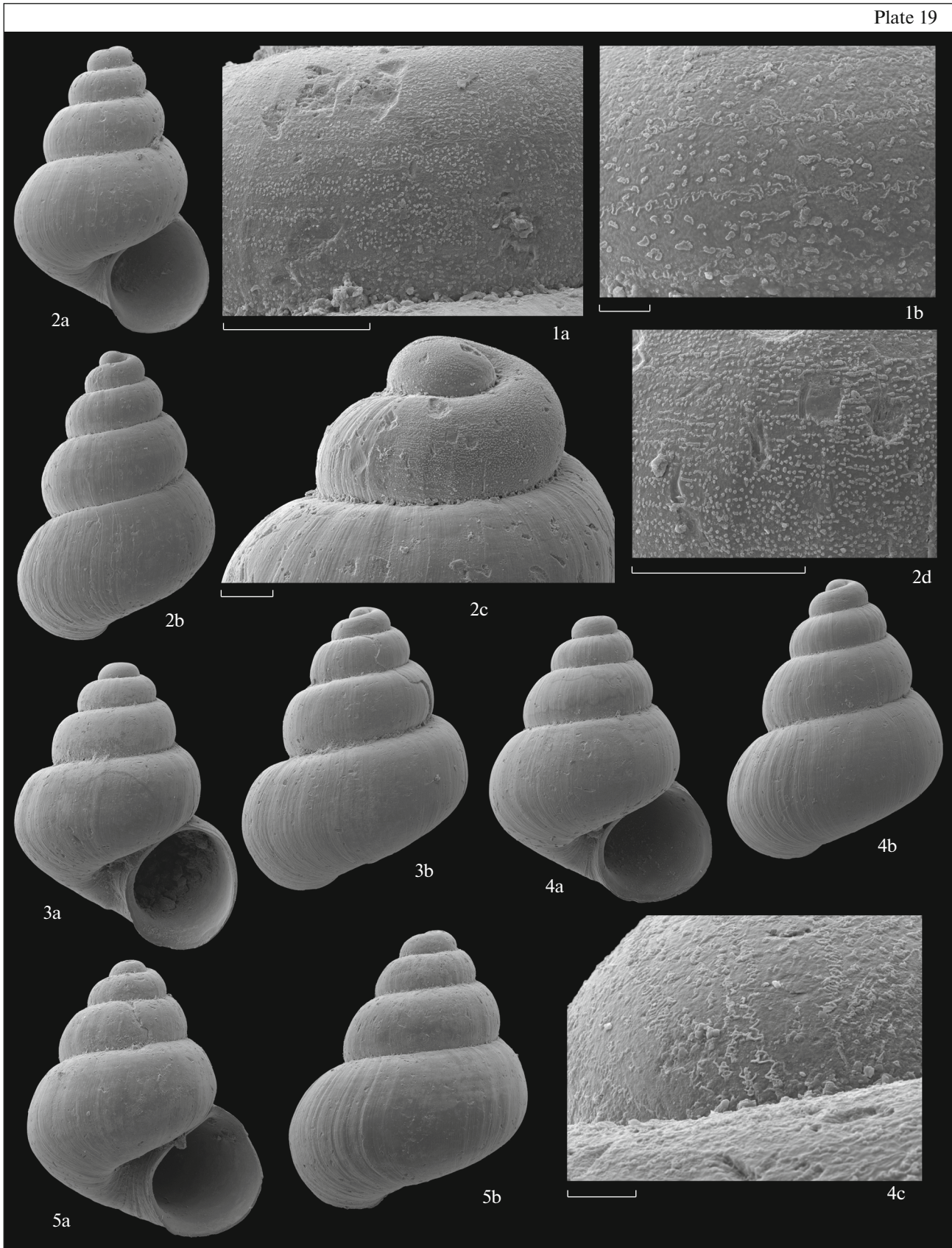
Variability. Sample 10A (Outcrop 1A₁) is clearly dominated by shells with a well-defined rounded bend. The shells are rather low-spined with a small portion of slenderer ones. Spiral sculpture is always present, although its prominence is difficult to determine, since shells are translucent. The shells are 3.5–3.7 mm high, rarely up to 3.9 mm, with a length of 5.3–5.5 whorls. Sample BS2 is dominated by low-spined shells with a rounded bend, all ones with well-defined spiral sculpture. Shells are up to 3.3–3.5 mm high with a length of 5.4 whorls (with five whorls at about 3 mm high). Shells vary significantly in a number of features in sample 11A. Rather low-spined shells

Explanation of Plate 18

Scale bar (1c, 2b, 2c, 8c) 100, (5–7) 20, (4) 10 μm. The dimensions of other shells are given in explanation.

Figs. 1–7. *Edrozeba caeca* sp. nov.: (1–3) Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesansensis*; (4–7) Kurdzhips River, Outcrop 1A₀, sample 19A, Lower Sarmatian block in olistostrome, shell wall in the posterior part of the outer lip; (1) specimen PIN, no. 5621/47, height 2.4 mm: (1a) abapertural view, (1b) apertural view, (1c) protoconch; (2) specimen PIN, no. 5621/48, height 2.5 mm: (2a) shell, (2b) protoconch, (2c) sculpture on protoconch; (3) specimen PIN, no. 5621/49, height 2.05 mm: (3a) apertural view, (3b) abapertural view; (4) specimen PIN, no. 5621/40; (5) specimen PIN, no. 5621/50; (6) specimen PIN, no. 5621/41; (7) specimen PIN, no. 5621/39.

Fig. 8. *Edrozeba minuta* sp. nov., Kurdzhips River, Outcrop 1A₁, sample 10A, olistostrome, block with Middle Sarmatian fauna, beds with *C. pesansensis*; specimen PIN, no. 5621/51, height 2.5 mm: (8a) apertural view, (8b) abapertural view, (8c) protoconch.



predominate. The bend on whorls is usually rounded, quite a few shells are with convex whorls without signs of angularity. Spiral sculpture is developed in the vast majority, more or less varying in expression. However, there are rare specimens, both with a slight angularity and without it, but without sculpture. Such shells become difficult to distinguish from *E. enikalensis*. Shells are 3.5–3.7 (rarely up to 3.9) mm high, with length of 5.4–5.6 whorls. Approximately the same situation is observed in the sample BS1. There are no unornamented shells here, but a portion of shells with very fine sculpture is noticeable. Such sculpture weaken up to hardly distinguishable striae. More than 200 shells have been collected from Bed 41 of the Belaya River section and only two of them lack sculpture. There are no such specimens in stratigraphically higher collections from the Kurdzhips River. The sample from Outcrop 1D₁ fits into the main spectrum of shell variability collected below the *Pseudocaspia* Member.

Comparison. This species differs from *E. angulata* in having sculpture, more low-spined shells, and a weakly pronounced rounded bend. It differs from *E. enikalensis* in more low-spined shells, spiral sculpture, and a different character of angularity. It differs from *E. caeca* in larger, narrow-umbilicated, strong shells, often with the development of a slightly pronounced rounded bend at the base of the whorl side; it differs from *E. minuta*, also by the presence of sculpture.

Occurrence. Middle Sarmatian, beds with *C. pesansensis*, Ciscaucasia.

Material. Belaya River: samples BS2 (47 specimens), BS1 (53 specimens), 11A (103 specimens), assemblages 3 (15 specimens), 2 (10 specimens), 1 (65 specimens); Kurdzhips River: outcrops 1A₁ (13 specimens), sample 10A (207 specimens), 1B₁ (4 specimens), 1B₂ (17 specimens), 1D₁ (1 specimen).

Genus *Pomatiasia* Guzhov, gen. nov.

Etymology. To indicate the similarity of the shells to those of the terrestrial genus *Pomatias*. Feminine.

Type species. *Pomatiasia cyclostomoides* (Sinzow, 1880).

Description. Shells are from low-spined to naticoid, from anomphalous to widely phaneroomphalous. The protoconch is about whorl, weakly ornamented. The whorls are convex, delineated by a deep

suture, and covered with spiral sculpture. The growth lines are directly prosocline or orthocline. The aperture is rounded, angularly rounded posteriorly, rounded anteriorly, with thin lips.

Composition. Type species.

Comparison. It differs from other hydrobiids in a specific *Pomatias*-shaped or naticoid umbilicated shell covered with spiral sculpture.

Occurrence. Lower Sarmatian of Romania and Ciscaucasia, Middle Sarmatian of Moldova, in Ciscaucasia in beds with *Cryptomactra pesansensis*.

Pomatiasia cyclostomoides (Sinzow, 1880)

Plate 24, figs. 2–8; Plate 25, figs. 1–7

Amnicola cyclostomoides: Sinzow, 1880, p. 13, pl. 8, figs. 50–52; Kolesnikov, 1934, p. 218, pl. 27, figs. 41–43.

Valvata (Cincinna) carasiensis: Jekelius, 1944, p. 55, pl. 7, figs. 16–19.

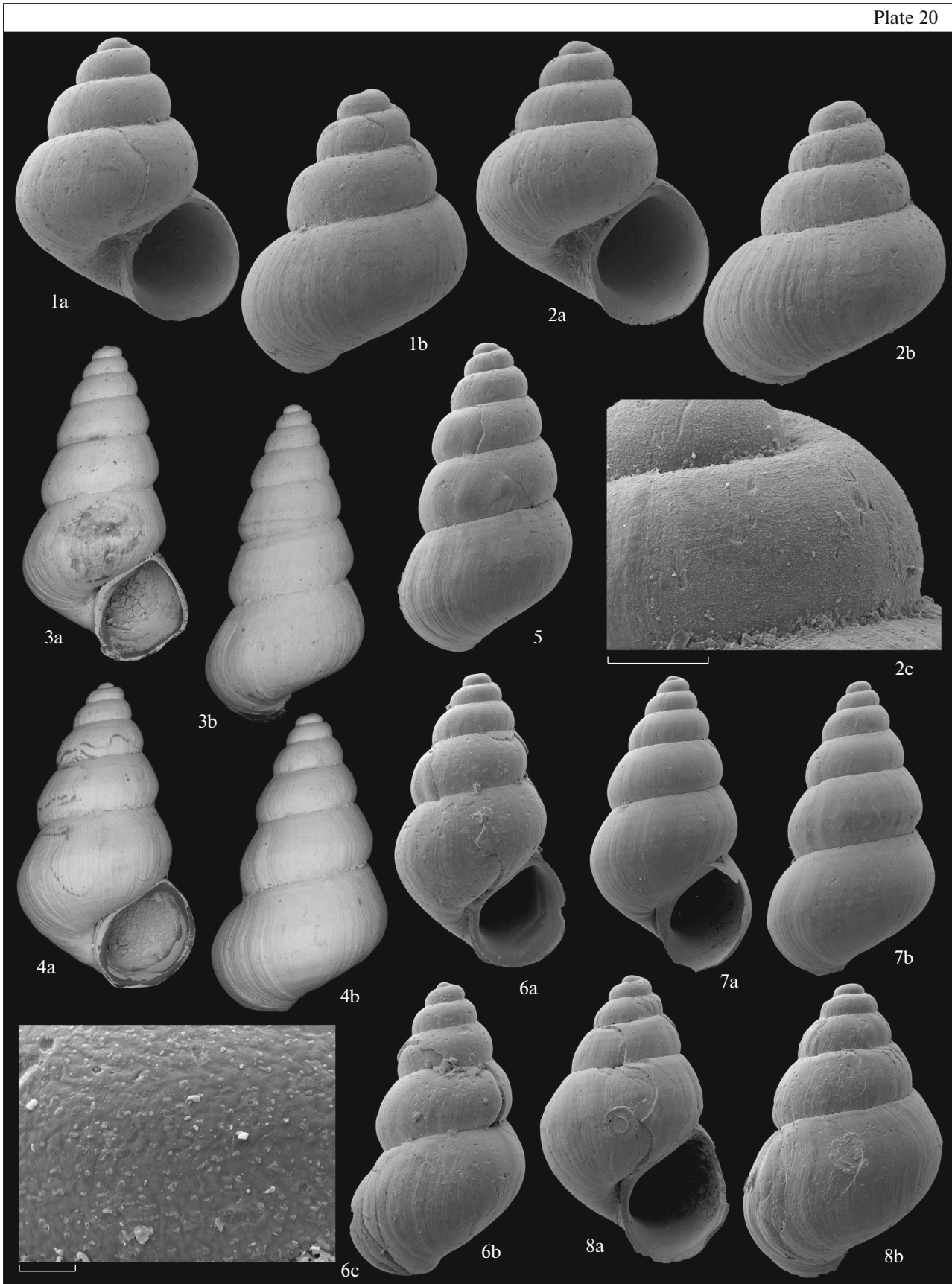
Lectotype designated herein; TsNIGR Museum, no. 292/11126: Middle Sarmatian; Moldova, Chişinău. Since the shell comes from the collection of I.F. Sinzow, it can be considered as one of the syntypes and be chosen as a lectotype; figured by Kolesnikov, 1934, pl. 27, fig. 41; here: Pl. 24, fig. 2.

Description. The shells are with a few whorls, from 3.5–4.5 whorls, up to 2–3.2 mm high. The protoconch has 1.3 whorls and microsculpture of a specific appearance (Pl. 25, fig. 1b). Indistinct broad band-like textures are also visible on protoconchs. The shells vary greatly in appearance, and in accordance with the geometry of the shell, several features conjugately change. They can be divided into two morphological groups: *Pomatias*-like and naticoid shells. *Pomatias*-like shells are low-spined, with a slit-like umbilicus, rarely umbilicated, composed of convex whorls, covered with variable dense spiral sculpture on the teleoconch. It varies from fewer broad band-like ribs to more numerous and narrower threads and/or striae. The whorls are rounded, convex, separated by a deep suture. The whorl side roundly passes into a convex base, which rounded at the transition to the umbilical wall. Anomphalous shells are the ultimate morph in the direction of high spire, they are distinguished by the widest and coarsest sculpture. The naticoid shells are moderately to widely umbilicated, formed by more embracing whorls, which makes them low-spined, and in extreme cases the diameter of the shell may be equal

Explanation of Plate 19

Scale bar 100 µm, except for (1b, 4c) 20 µm. The dimensions of other shells are given in explanation.

Figs. 1–5. *Edrozeba minuta* sp. nov.: (1–4) Kurdzhips River, Outcrop 1A₁, sample 10A, from olistostrome, block with Middle Sarmatian fauna, beds with *C. pesansensis*; (5) Outcrop 1C₂, sample BS4, upper part of beds with *C. pesansensis*. (1) specimen PIN, no. 5621/51: (1a) sculpture close to end of protoconch, (1b) sculpture near the beginning of protoconch; (2) specimen PIN, no. 5621/52, height 2.2 mm: (2a) apertural view, (2b) abapertural view, (2c) protoconch, (2d) sculpture close to the end of protoconch; (3) specimen PIN, no. 5621/53, height 2.1 mm: (3a) apertural view, (3b) abapertural view; (4) specimen PIN, no. 5621/54, height 2 mm: (4a) apertural view, (4b) abapertural view, (4c) sculpture on protoconch nucleus; (5) holotype PIN, no. 5621/55, height 1.85 mm: (5a) apertural view, (5b) abapertural view.



to the height of the shell. Spiral sculpture also varies, like that of *Pomatias*-like shells, but it is thinner and less prominent on average. Sculpture often seems represented by thin grooves dividing the surface of the shell into narrow strips due to the strong flattening of sculpture. The convex whorl side smoothly passes into the convex base. The latter forms a distinct rounded keel at the transition to the umbilical wall. The degree of development of the keel increases with an decrease of spire height of the naticoid coiling of the shell. The keel is not observed in *Pomatias*-like shells. The umbilical wall is unornamented in all morphs, and the sculpture on the base is weaker than on the whorl side or disappears. Between the described types of shells there are transitional variants with median values of features. The growth lines are slightly straight prosocline. The aperture is rounded, with thin lips, angularly rounded posteriorly, rounded anteriorly, in naticoid shells often with an angular reflection associated with the umbilical keel.

The shell wall consists of a thick cross-lamellar ostracum and a very thin prismatic myostracum.

V a r i a b i l i t y. We can see how the morphological norm and the gradient of variability vary in different samples due to numerous specimens. The height of the shell is not indicative when comparing samples with different norms in shell geometry, because the shape of the shell varies greatly within a species. Thus, the more high-spined *Pomatias*-like shells are always taller than the more low-spined naticoid shells. Therefore, measurements are given for different morphs, whenever possible. Sample 19A (Outcrop 1A₀), presented by more or less slender *Pomatias*-shaped shells, with a slit-like umbilicus, and without naticoid morphs. The shells are 2.35–3 mm high and consist of 4–4.3 whorls. The morphology is quite stable in general, with variation of the slenderness of the shell and the shape of the spiral sculpture. Sample BS3 is mainly represented by less slender *Pomatias*-like shells with a significant admixture of not very low-spined naticoid and intermediate shells. *Pomatias*-like shells have 4.2–4.4 whorls at a height of 2.7–3 mm, intermediate morphs have 4–4.2 whorls and a height of 2.4–2.6 mm, naticoid morphs have 3.5 whorls and a height of 2–2.2 mm. Sample BS2 is dominated by intermediate and *Pomatias*-like shells with a smaller number of

naticoid shells. *Pomatias*-like shells have 4.1–4.4 whorls and a height of 2.65–2.85 mm, transitional shells have 3.7–4.2 whorls and a height of 2.1–2.4 mm, and naticoid shells have 3.6–4.2 whorls and a height of 2.05–2.15 mm. Sample 11A is dominated by naticoid morphs with rarer transitional and rare *Pomatias*-like shells. Transitional and naticoid shells are almost the same size and length: 2.5–3 mm with a length of 4–4.5 whorls; *Pomatias*-like shell has 4.5 whorls and 3.15 mm high.

The shells are located in the plates in the direction from the most high-spined *Pomatias*-like to low-naticoid ones. Collections in 2018 showed that *Pomatias*-like shells are found in the Lower Sarmatian, following the example of sample 19A. Naticoid shells begin to play a significant role in beds with *C. pseudotellina*, often becoming predominant in samples from beds with *C. pesansensis*.

R e m a r k s. Difference between the size of *P. cyclostomoides* from *Cryptomactra* Beds and the type material is significant. The largest shells from the Belaya River reach 3 mm in height, while the lectotype is 3.8 mm in height. This is probably due to the difference in habitats. The type material comes from shallow-water detrital limestones.

Shells identified by Ali-Zade (1974, pl. 36, figs. 3–5) as *Amnicola cyclostomoides*, in my opinion, do not belong either to the indicated species or to the genus *Pomatiasia*.

O c c u r r e n c e. As for the genus.

M a t e r i a l. Belaya River: samples BS3 (731 specimens), BS2 (317 specimens), BS1 (140 specimens), 11A (132 specimens), assemblages 4 (3 specimens), 3 (5 specimens) and 1 (6 specimens); Kurdzhips River: outcrops 1A₀ (3 specimens), sample 19A (332 specimens), 1A₁, sample 10A (154 specimens), 1A₂ (1 specimen), 1B₁ (1 specimen), 1B₂ (3 specimens), 1B₃ (1 specimen), 1C₁ (29 specimens), 1C₂, sample BS4 (38 specimens), 1D₁ (1 specimen).

Family Nassariidae Iredale, 1916

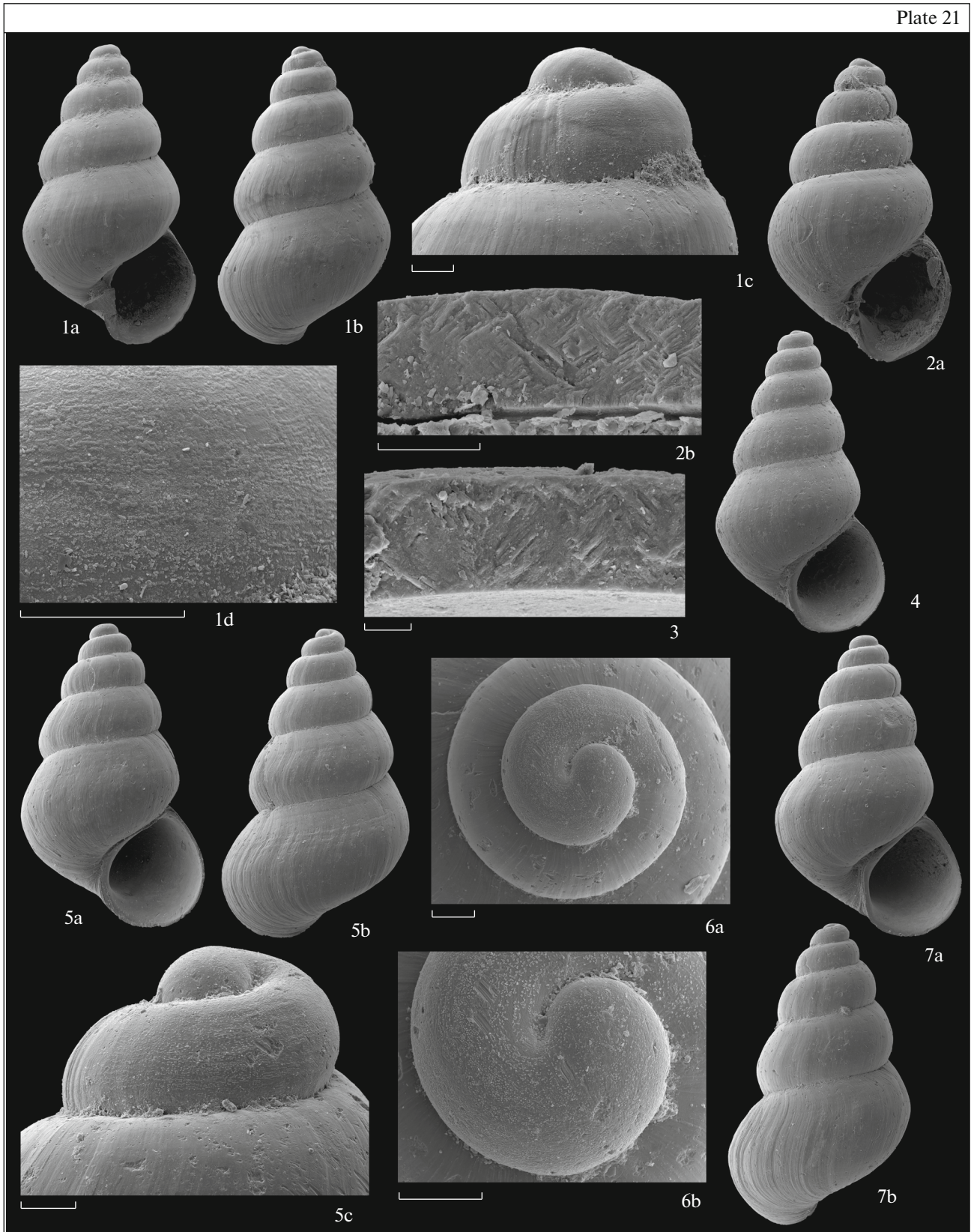
Sarmatian nassariids were originally described as part of the genera *Nassa* or *Buccinum*. They became separated initially in the publications of V.P. Kole-

Explanation of Plate 20

Scale bar (2c) 100, (6c) 20 μm. The dimensions of other shells are given in explanation.

Figs. 1–2. *Edrozeba minuta* sp. nov., Kurdzhips River, Outcrop 1C₂, sample BS4, upper part of beds with *C. pesansensis*. (1) specimen PIN, no. 5621/56, height 1.9 mm: (1a) apertural view, (1b) abapertural view; (2) specimen PIN, no. 5621/57, height 1.8 mm: (2a) apertural view, (2b) abapertural view, (2c) sculpture of protoconch.

Figs. 3–8. *Edrozeba enikalensis* (Kolesnikov, 1934). (3–4) Crimea, Kerch Peninsula, shore at the Yeni-Kale lighthouse on Cape Fonar', Middle Sarmatian, beds with *C. pesansensis*; (5–8) Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesansensis*. (3) Lectotype TsNIGR Museum, no. 285/11126, height 4.75 mm: (3a) apertural view, (3b) abapertural view; (4) paralectotype TsNIGR Museum, no. 286/11126, height 4.5 mm (figured in Kolesnikov, 1934, pl. 27, fig. 23): (4a) apertural view, (4b) abapertural view; (5) specimen PIN, no. 5621/58, height 3.4 mm; (6) specimen PIN, no. 5621/59, height 3.45 mm: (6a) apertural view, (6b) abapertural view, (6c) microsculpture of the first half of the protoconch; (7) specimen PIN, no. 5621/60, height 4 mm, deviant specimen: (7a) apertural view, (7b) abapertural view; (8) specimen PIN, no. 5621/61, height 3.1 mm: (8a) apertural view, (8b) abapertural view.



snikov, when he recognized the genus *Akburunella* in 1934 (then still part of the family Buccinidae) with the type species *Nassa akburunensis* Andrussow, 1902. He did not focus on the morphological features that distinguish the genus from other Sarmatian species assigned to *Buccinum*. He indicated in addition to a brief morphological description that *Akburunella* species are confined to the deeper Sarmatian facies, and we see from the description of their distribution that it is *Cryptomactra* Beds. He emphasized the morphological feature of *Akburunella* in 1939: the absence of a subsutural row of nodes (it was formulated as a smooth suture of whorls in 1934). Other Sarmatian nassariids were placed by him in the new genus *Duplicata* without a diagnosis and indication of the type species, which was first done by Korobkov (1955), and the name *Duplicata* was made available in that publication. *Buccinum duplicatum* Sowerby, 1831 was designated as the type species. Kolesnikov subdivided initially the Sarmatian *Buccinum* into seven groups (1934: denoted by Roman numerals), and in *Duplicata* he recognized (1939) in *Duplicatula* five sections with type species and brief diagnoses (except for the *Duplicata* section): *Duplicatula* (type species *Buccinum duplicatum-verneuili* Sinzow, 1875), *Corbiana* (*Buccinum corbianum* Orbigny, 1844), *Dissita* (*Buccinum dissitum* Eichwald, 1830) and *Omnivaga* (*Buccinum omnivagum* Kolesnikov, 1932). Papp (1939, 1954, 1974) assigned nassariids from the Lower Sarmatian of the Vienna Basin to the genus *Dorsanum* Gray, 1847. The division of Sarmatian nassariids into two genera *Dorsanum* and *Akburunella* is fixed after his papers. There is any mention of the Kolesnikov's 1939 system neither in the paper of Papp (Papp, 1954), nor in subsequent authors (Boda, 1959; Spajić, 1966; Švagrovský, 1971, etc.). It can be assumed that they did not know about it. The genus *Dorsanum* was adopted by Soviet specialists (Ali-Zade, 1974; Zelinskaya et al., 1968: *Akburunella* is synonymized with *Dorsanum*). At the same time, Roshka (1961) in a separate article discussed different points of view on the taxonomy of Sarmatian nassariids. Muskhelishvili (1967) proposed to classify Sarmatian nassariids into a separate subfamily Duplicatinae within the family Nassidae, within the genera *Duplicata* and *Akburunella*. However, she did not formulate how Duplicatinae differs from other subfamilies, limiting herself to comparison with fossil representatives

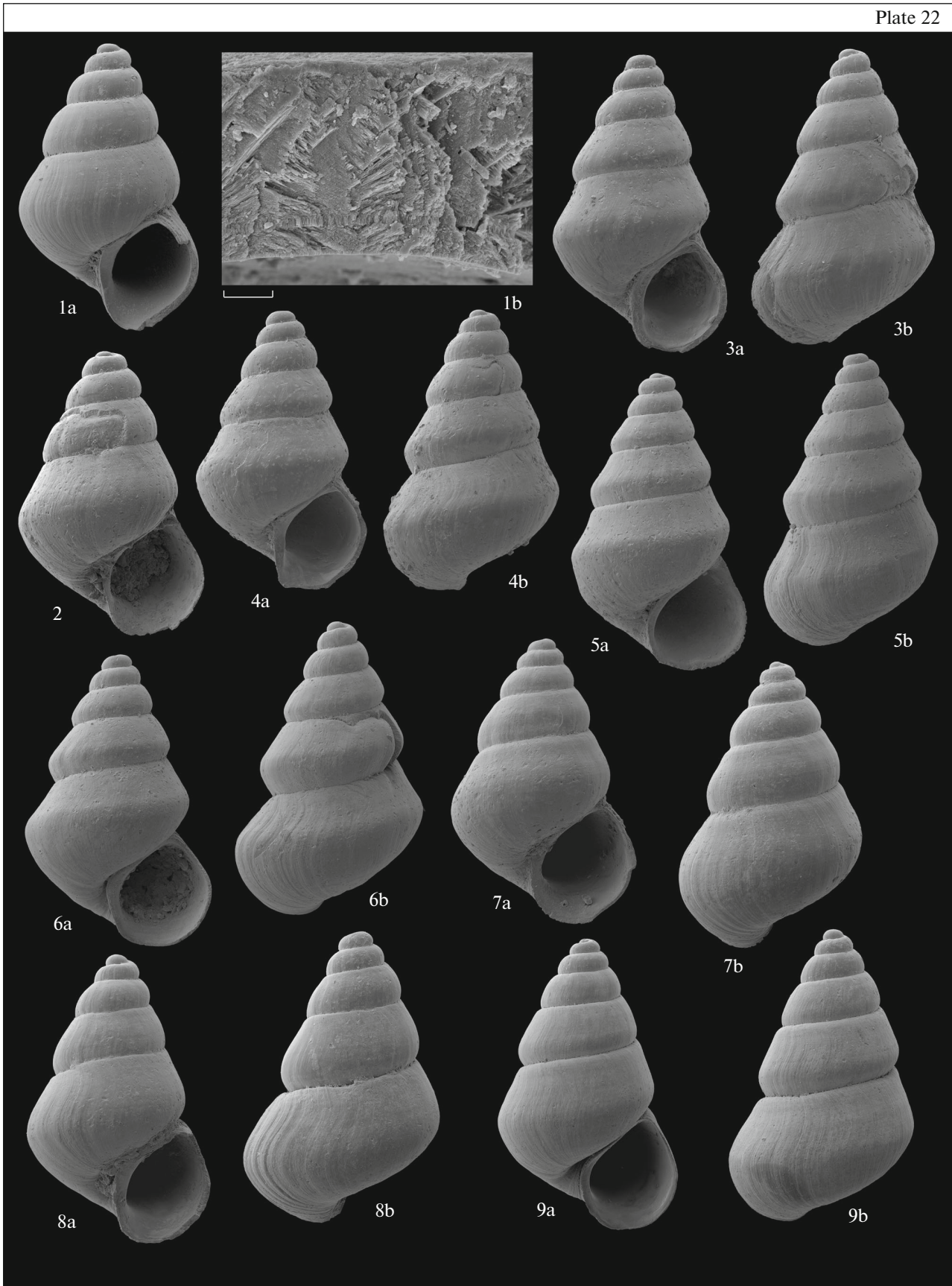
of the genus *Dorsanum* outside the Sarmatian basin. A somewhat different system was proposed by Kojumdgieva (1969a): she united all Sarmatian nassariids, except for the genus *Akburunella*, as the subgenus *Duplicata* of the genus *Dorsanum*. Bulgarian authors (Andréeva-Ouchéva, 1952, Kojumdgieva, 1969a) somewhat blurred the taxonomic boundaries of the genus *Akburunella* in their studies. Some of the material from the finer-grained deposits of Bulgaria has been erroneously assigned to the *Akburunella* species in the sense of Kolesnikov (it is discussed in the descriptive part, in the remarks to *A. akburunensis*).

Later, species that were not originally included in the genus and unknown in *Cryptomactra* facies began to be assigned to *Akburunella*. Harzhauser and Kowalke (2004) proposed to include in it the following species: *Buccinum fraudulentum* Kolesnikov, 1932, *B. jacquemarti* Orbigny, 1844, *B. kolesnikovii* Simionescu et Barbu, 1940, *B. moldavicum* Simionescu et Barbu, 1940, *B. renovatum* Kolesnikov, 1932, *B. verneuili* Orbigny, 1844, and *B. triformis* Kolesnikov, 1932. Other Sarmatian nassariids in the same article are assigned to the genus *Duplicata*. Species from the Neogene of the Central Paratethys, previously assigned to *Dorsanum*, are redefined as *Duplicata* or *Cylenina*. This decision is based on differences in the nature of sculpture and a different character of the protoconch in modern *Dorsanum* species. *Duplicata* and *Akburunella* are considered in the subfamily Dorsaninae. Later, an article (Lozouet and Galindo, 2015) was published, in which the taxonomy of the Miocene Nassariidae is discussed, including species from the Paratethys. In particular, *Duplicatula* Kolesnikov, 1939 is correctly established as a valid name instead of *Duplicata*, which becomes valid from 1955. The first section of Kolesnikov, established in accordance with the ICZN code, was chosen as a valid name. Lozouet and Galindo see no difference between *Dorsanum* and *Duplicatula*, as they include the Neogene species like *Duplicatula* from the Atlantic Neogene and modern *Dorsanum* in the same genus. Moreover, the question of the discrepancy between the Neogene species and modern *Dorsanum* is not even raised, as if this view does not exist. Kravchenko (2011) assigned Sarmatian nassariids to the genus *Dorsanum*, which includes several subgenera: *Akburunella*, *Duplicata*, *Omnivaga*, *Orbignella*, *Sarmatodorsanum*, and *Spinsum*, but the system has not been validated in publications and the

← Explanation of Plate 21

Scale bar 100 µm, except for (2b) 50, (3) 20 µm. The dimensions of other shells are given in explanation.

Figs. 1–7. *Edrozeba enikalensis* (Kolesnikov, 1934). (1–3) Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesansensis*; (2) Belaya River, Bed 41, sample 11A, lower part of the beds with *C. pesansensis*; (5–7) Kurdzhips River, Outcrop 1A₁, sample 10A, from olistostrome, block with Middle Sarmatian fauna, beds with *C. pesansensis*. (1) specimen PIN, no. 5621/62, height 3.7 mm: (1a) apertural view, (1b) abapertural view, (1c) protoconch, (1d) sculpture close to the end of the protoconch; (2) specimen PIN, no. 5621/63, height 3.2 mm, deviant specimen: (2a) apertural view, (2b) shell wall at the posterior part of the outer lip; (3) specimen PIN, no. 5621/60, shell wall in the same area; (4) specimen PIN, no. 5621/64, height 4 mm; (5) specimen PIN, no. 5621/65, height 3.5 mm: (5a) apertural view, (5b) abapertural view, (5c) protoconch; (6) specimen PIN, no. 5621/66: apical view of the protoconch; (7) specimen PIN, no. 5621/67, height 3.5 mm: (7a) apertural view, (7b) abapertural view.



criteria for distinguishing subgenera are unknown. She also assigned “non-canonical” species to *Akburunella*: *Buccinum kishinevense* Kolesnikov, 1932, *B. seminudum* Kolesnikov, 1932, *B. triformis*, and *B. verneuillii*. The remaining species proposed by Harzhauser and Kowalke for *Akburunella* are distributed among other subgenera. Evidently, there are certain problems within the Sarmatian Dorsaninae with understanding the composition of *Akburunella*, since the morphological criteria included in its diagnosis do not allow it to be clearly separated from *Duplicatula*. For clarity, I discuss below the concrete examples how the two main criteria for identifying *Akburunella* in sense of Kolesnikov: ecological (confinement to *Cryptomactra* facies), and morphological (the absence of a subsutural row of nodes or a subsutural spiral ridge). I also reviewed in addition to my own collections the type material of all the species included by Kolesnikov in *Akburunella* and *Buccinum/Duplicata*, as well as other originals by Kolesnikov for the papers of 1932 and 1934, and the type material of *Akburunella* for the species of Andrussov and Kudriavtzev.

Morphological criterion. Sculptured species of *Akburunella* are characterized by a fairly wide weakly sculptured zone, which makes up a significant part of the whorl side and is located between the suture and the upper primary rib. The upper ends of the collabral ridges can be observed only on it, and, less often, single secondary spiral ribs or threads, which are very rarely located above its middle, and if and appear there, then they are very weakly developed. However, a similar character of the upper part of the whorl is observed in several species outside *Akburunella*: these are the above-mentioned species *jacquemarti*, *kolesnikovii*, *verneuillii*, as well as *Buccinum ignobile* Kolesnikov, 1932, *B. triformis* Kolesnikov, 1932 with all varieties of Kolesnikov. Other species, both with and without isolation of the upper part of the whorl, have any spiral sculpture elements adjoining to the suture: (a) a more or less prominent and often tubercular ridge (*B. dissitum*, *B. duplicatum*, *B. opinabile* Kolesnikov, 1932, etc.); (b) a row of more or less large nodes (*B. pseudogracile* Kolesnikov, 1932, *B. duplicatum*, *B. verneuillii*, etc.), sometimes poorly developed

(*B. gricevense* Kolesnikov, 1932, *B. subspinosum* Sinzow, 1892); (c) spiral rib or thread (*B. renovatum*). Finally, there are species with a strongly reduced sculpture or without it (*B. impexum* Kolesnikov, 1932, *B. seminudum*, *B. repuerasco* Kolesnikov, 1932). Thus, there are not only species, which are common with *Akburunella* in its main morphological features, but it is possible to relatively build transitions from *Akburunella* species to the species with a different structure of the subsutural area.

Ecological criterion. All *Akburunella* species according to Kolesnikov are restricted to the *Cryptomactra* Beds. Only *A. akburunensis* was indicated for the Lower Sarmatian of Ciscaucasia in a separate line, but we do not find any confirmation of this in the paleogeographic part (Kolesnikov, 1934). There is no reference to the Lower Sarmatian in an earlier paper (Kolesnikov, 1932). Only the chapter on the Kerch Peninsula has a description according to which the lower part of *Cryptomactra* Beds with an assemblage of several species of *Akburunella* is assigned to the Lower Sarmatian (1934, p. 440). At the same time, the *Cryptomactra* Beds of Ciscaucasia are everywhere limited by the Middle Sarmatian. It can only be stated that at that time the Lower–Middle Sarmatian boundary on the Kerch Peninsula was drawn in the upper part of the *Cryptomactra* Beds (Arkhangelsky et al., 1930). Kolesnikov adhered to the same point of view until the end of his life (Kolesnikov, 1932, p. 126; 1934; 1949, p. 25).

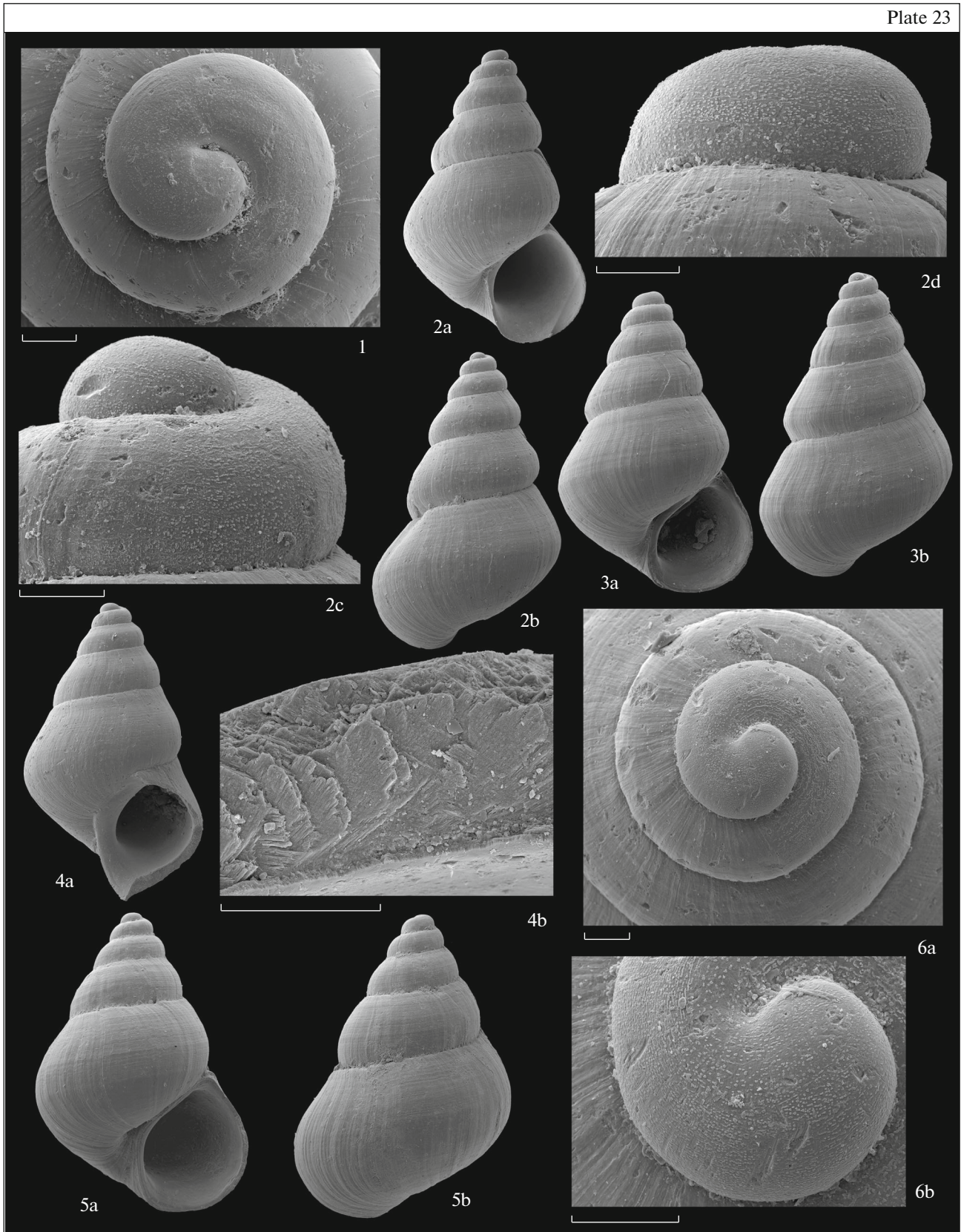
My observations in Adygean sections show that *A. akburunensis* appears above the beginning of the *Cryptomactra* beds. Collections in the Lower–Middle Sarmatian boundary beds demonstrate that the genus *Akburunella* appeared earlier, probably in the first half of the Lower Sarmatian, since by the beginning of *Cryptomactra* Beds its species composition is already quite diverse. *Akburunella* continues to occur throughout the upper part of the Lower Sarmatian interval. Specimens of *Duplicatula* were also collected in clay facies below the *Cryptomactra* Beds. They are represented by a morphogroup with a subsutural ridge in the section on the Belaya River, and have the minimal species diversity. *Duplicatula* does not occur at the same levels as *Akburunella* with rare exceptions. The

Explanation of Plate 22

Scale bar 200 μ m. The dimensions of other shells are given in explanation.

Fig. 1. *Edrozeba enikalensis* (Kolesnikov, 1934), specimen PIN, no. 5621/68, height 3.4 mm, Belaya River, Bed 41, sample 11A, Middle Sarmatian, lower part of the beds with *C. pesansensis*: (1a) apertural view, (1b) structure of the shell wall in the middle part of the outer lip.

Figs. 2–9. *Edrozeba angulata* sp. nov. (2) specimen PIN, no. 5621/69, height 3.4 mm, Kurdzhips River, Outcrop 1C₁, middle part of the beds with *C. pesansensis*; (3) specimen PIN, no. 5621/70, height 3.7 mm, the same locality: (3a) apertural view, (3b) abapertural view; (4) specimen PIN, no. 5621/71, height 3.45 mm, the same locality: (4a) apertural view, (4b) abapertural view; (5) holotype PIN, no. 5621/72, height 4.1 mm, Kurdzhips River, Outcrop 1C₂, sample BS4, middle part of the beds with *C. pesansensis*: (5a) apertural view, (5b) abapertural view; (6) specimen PIN, no. 5621/73, height 3.8 mm, the same locality: (6a) apertural view, (6b) abapertural view; (7) specimen PIN, no. 5621/74, height 3.4 mm, Kurdzhips River, Outcrop 1C₇, upper part of the beds with *C. pesansensis*: (7a) apertural view, (7b) abapertural view; (8) specimen PIN, no. 5621/75, height 3.4 mm, the same locality: (8a) apertural view, (8b) abapertural view; (9) specimen PIN, no. 5621/76, height 4 mm, Kurdzhips River, Outcrop 1G₄, upper part of the beds with *A. naviculata*: (9a) apertural view, (9b) abapertural view.



role of *Duplicatula* is very small when they found together. *Akbrunella* are found up the section throughout the entire clayey-aleuritic and sandy-aleuritic series including the strata above the latest finds of *Cryptomactra*. They form a mixed assemblage with “typical Middle Sarmatian fauna” in the upper part of the Middle Sarmatian interval. The latter is stated mainly due characteristic bivalve mollusks, whereas gastropods are mostly represented by forms whose ancestors are confined to the *Cryptomactra* Beds, or by eurybiont forms, which are also common in *Cryptomactra* Beds. *Duplicatula* and *Gibbula*, which are characteristic of the typical Middle Sarmatian fauna, were found in a subordinate amount. Two sections of the argillaceous Sarmatian were visited in the Krymsk District in 2019. The middle Sarmatian in the ravine near the village of Akkermanka consists of a clays, on which limestones with numerous *Duplicatula* lie. Sandy clays below them contain only *Akbrunella*. At the same time, neither me, nor previous authors (Prokopov, 1914) found *Cryptomactra* in the clays. A similar situation is on Sauk-Dere Creek, where a series of sandstones and calcarenites, in which only *Duplicatula* are occasionally found, overlies a thick clayey series. The upper part of the latter contains abundant typical Middle Sarmatian bivalves, while *C. pesanseris* occurs at some levels. At the same time, the assemblage consists of numerous *Akbrunella* (mainly *A. enikalensis*), *Gibbula urupensis* and *T. pseudocaspia*. That is, assemblage has a gastropod composition that is similar to the upper part of the *Cryptomactra* Beds on the Belaya River.

Thus, the ecological criterion still looks more consistent, although *Akbrunella* are found beyond the *Cryptomactra* Beds, remaining within the same facies. It is noteworthy that the findings of *Akbrunella* (in the original definition) are not recorded outside Ciscaucasia and the eastern part of the Crimea. The only reliable finds are illustrated by Ali-Zade (1974) is also from the northeastern part of Azerbaijan, where *Akbrunella* is probably confined to clay interbeds as an admixture to a typical Middle Sarmatian fauna. One gets the impression about *Akbrunella* as an element of fauna with a limited distribution area within the basin, connected to the area with *Cryptomactra* facies.

As far as morphological criteria are concerned, the detailed collections of the fauna in the sections of Ady-

gea showed that the formation of the Sarmatian biota proceeded at different rates. Thus, the Early and Middle Sarmatian boundary is marked by an episode of explosive morphogenesis, which is replaced later by an already slower evolution with morphogenetic leaps in some lineages. The speed and depth of morphological transformations are so great during episodes of explosive diversification that it is necessary to select material very finely in order to bring the constantly changing morphotypes together and not make mistakes in comparing them. At the same time, several derived taxa often arise from one initial form, in which the content of morphological changes may differ fundamentally. And it is not unique when the child form of one lineage converges with the ancestral form of some other lineage. These constant multidirectional transformations are superimposed by rare reversions in morphogenesis, which complicates revealing the phylogenetic relationships between Sarmatian species. Therefore, in my opinion, there is no point in correcting the composition of *Akbrunella* and *Duplicatula*, as it will be more meaningful after careful and properly organized collection of material allowing recognition of all the transformations of their morphotypes.

Only Kolesnikov (1932, 1949) wrote briefly on the origin of *Akbrunella*. He acknowledged that the scheme he proposed was very approximate and provisional. He proposed to consider the species *A. akbrunensis* ancestral for all *Akbrunella* species, was suggested that it evolved from the “Konkian” species *D. neutra* (Kolesnikov, 1932) (synonyms *Buccinum neutra* var. *pergrave* Kolesnikov, 1932, *B. praeakbrunense* Kolesnikov, 1932). Only one place is indicated in the literature from which this species is known. This is now a quarry south of the village of Sunzhenskaya, previously known as the location near the vilage of Popov (now the village of Privol’nyi), Chekist (now Sunzhenskaya on the same place), on Mount Dubrovaya. Most of the authors (Liverovskaya, 1935; Zhizhchenko, 1940; *Stratigrafiya...*, 1986; Zhgenti, 1991, etc.) dated the section of the quarry as Konkian. Its fauna is significantly different from other known Konkian localities, so that the deposits in the Nevinka River basin were recognized based on the assemblage of mollusks in the Dubroviaya Beds (Zhgenti, 1991).

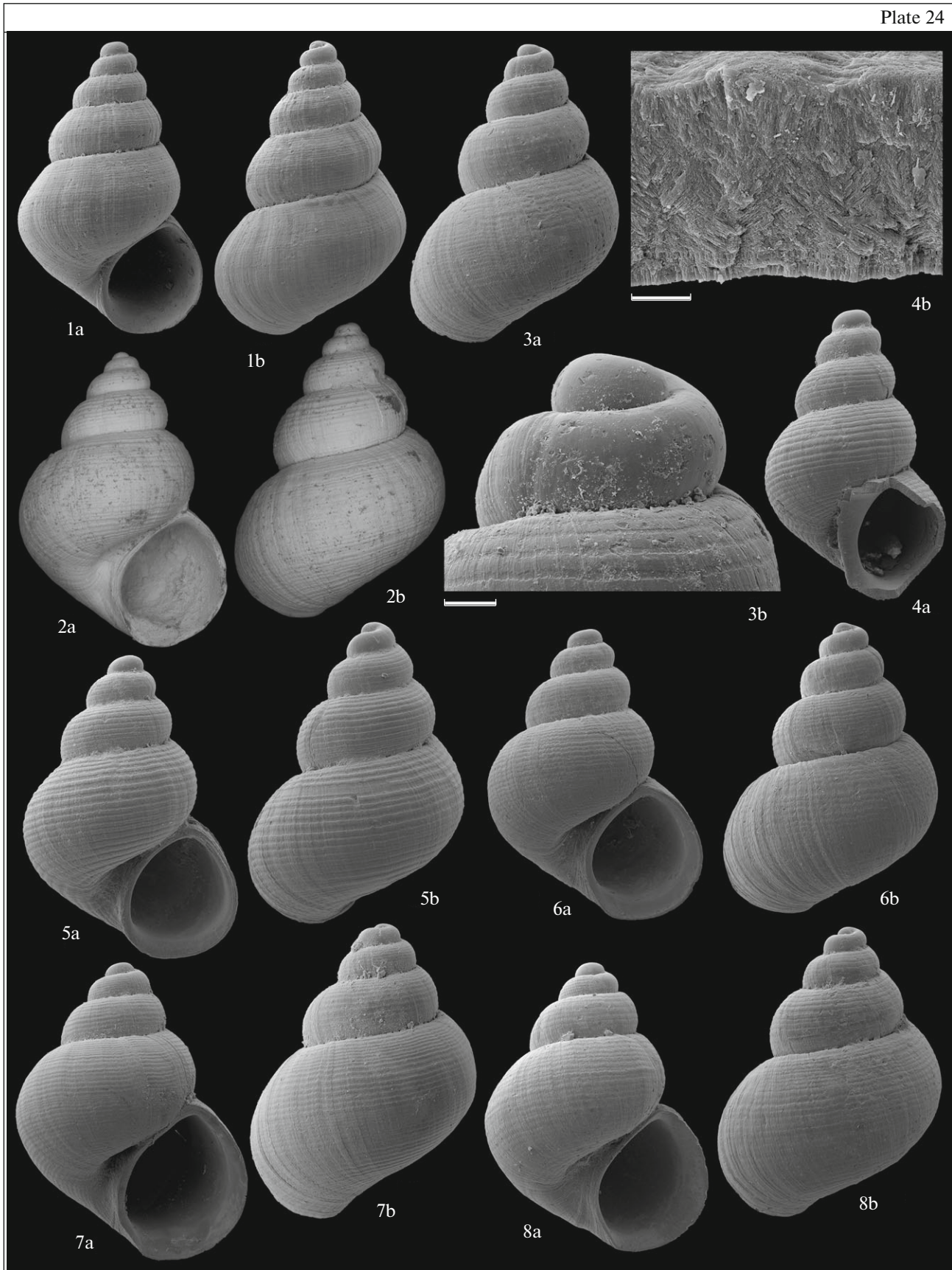
Paramonova (1994) had a different opinion, in that she attributed part of the series exposed in the quarry

Explanation of Plate 23

Scale bar 100 μ m. The dimensions of other shells are given in explanation.

Fig. 1. *Edrozeba angulata* sp. nov., specimen PIN, no. 5621/77, Kurdzhips River, Outcrop 1B₂, middle part of the beds with *C. pesanseris*, initial whorls in apical view.

Figs. 2–6. *Edrozeba striata* sp. nov.: (2–4, 6) Kurdzhips River, Outcrop 1A₁, sample 10A, from olistostrome, block with Middle Sarmatian fauna, beds with *C. pesanseris*; (5) Belaya River, Bed 41, sample 11A, lower part of the beds with *C. pesanseris*. (2) specimen PIN, no. 5621/78, height 3.7 mm: (2a) apertural view, (2b) abapertural view, (2c) protoconch, (2d) microsculpture in the middle part of the protoconch; (3) holotype PIN, no. 5621/79, height 3.45 mm: (3a) apertural view, (3b) abapertural view; (4) specimen PIN, no. 5621/80, height 3.5 mm: (4a) shell, (4b) structure of the shell wall in the middle part of the outer lip; (5) specimen PIN, no. 5621/81, height 3.4 mm: (5a) apertural view, (5b) abapertural view; (6) specimen PIN, no. 5621/82: (6a) apical view of protoconch, (6b) sculpture of the initial part of the protoconch.



Explanation of Plate 24

Scale bar (3b) 100, (4b) 20 μm . The dimensions of other shells are given in explanation.

Fig. 1. *Edrozeba striata* sp. nov., specimen PIN, no. 5621/83, height 3.25 mm, Bed 41, sample 11A, lower part of the beds with *C. pesansensis*: (1a) apertural view, (1b) abapertural view.

Figs. 2–8. *Pomatiasia cyclostomoides* (Sinzow, 1880): (2) lectotype TsNIGR Museum, no. 292/11126, height 3.8 mm, Chişinău, Middle Sarmatian: (2a) apertural view, (2b) abapertural view; (3) specimen PIN, no. 5621/84, height 2.75 mm, Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesansensis*: (3a) abapertural view, (3b) protoconch; (4) specimen PIN, no. 5621/85, height 2.45 mm, Belaya River, Bed 41, sample 11A, lower part of the beds with *C. pesansensis*: (4a) apertural view, (4b) shell wall at the posterior part of the outer lip; (5) specimen PIN, no. 5621/86, height 2.4 mm, Kurdzhips River, Outcrop 1A₀, sample 19A, Lower Sarmatian block from olistostrome: (5a) apertural view, (5b) abapertural view; (6) specimen PIN, no. 5621/87, height 2.6 mm, Kurdzhips River, Outcrop 1A₁, sample 10A, from olistostrome, block with Middle Sarmatian fauna, beds with *C. pesansensis*: (6a) apertural view, (6b) abapertural view; (7) specimen PIN, no. 5621/88, height 2.55 mm, Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesansensis*: (7a) apertural view, (7b) abapertural view; (8) specimen PIN, no. 5621/89, height 3 mm, Kurdzhips River, Outcrop 1A₁, sample 10A, from olistostrome, block with Middle Sarmatian fauna, beds with *C. pesansensis*: (8a) apertural view, (8b) abapertural view.

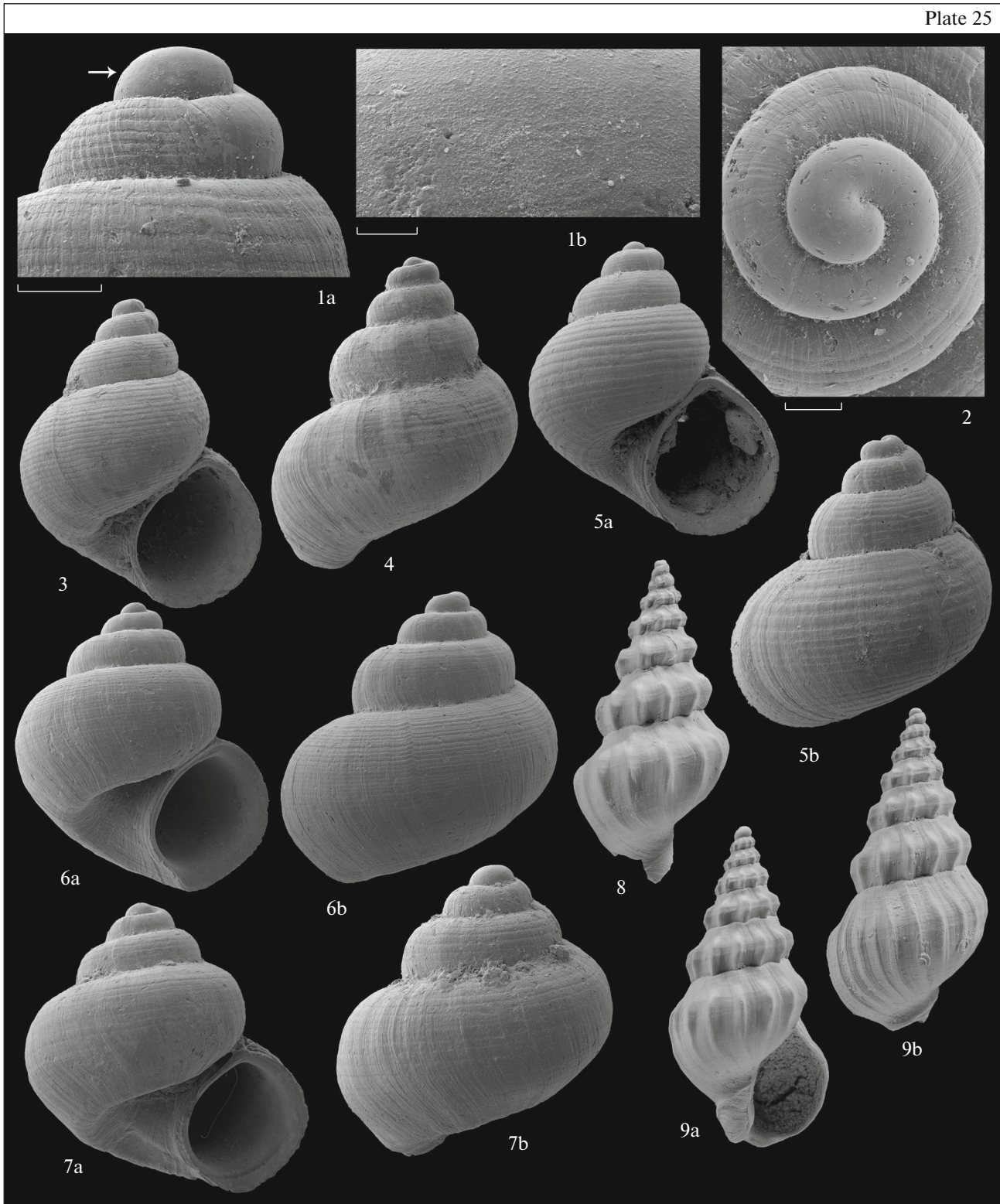
to the Lower Sarmatian Kuzhora Beds based on the bivalve assemblage.⁸ Our team has been collecting material for three years, including sampling, the analysis of which suggests that the gastropod assemblage in the upper part of the section is mixed: it consists of the Konkian fauna of different ages, redeposited in the Early Sarmatian, to which Early Sarmatian forms are added. The latter include *D. neutra*. Most its shells are confined to a solid slab capping the Kuzhora Beds section. The second most important proportion of shells comes from coquina lenses slightly below the slab, of the same age. Most of the shells of the *Gibbula* species characteristic of the Dubrovian Konkian are also confined to the coquinae, although they are also found below, in the Konkian (according to Paramonova) part of the section. It is obvious that the species *D. neutra* appeared as early as the Konkian time according to data from other localities. It is known from the undoubted Konkian in Transcaucasia and Transcaspia (Iljina, 1993).

A sample was taken in the middle part of the Lower Sarmatian section of the Aul'chik Gully from the *Ervilia* coquina, containing *Ervilia trigonula* Sokolov (abundant), *Obsoletiformes ruthenica* (Hilber) (frequent), *O. volhynica* (Grischkevitch), *Plicatiformes pseudoplicata* (Friedberg), *Maetra* cf. *eichwaldi* Laskarev, *Mytilaster volhynicus* (Eichwald), *Donax* sp., *Venerupis* sp., rare redeposited *Varicorbula gibba* (Olivi) (S.V. Popov's identification), in which an assemblage of redeposited Konkian gastropods (99% of shells) similar to the Dubrovaya Beds assemblage was found. A few shells, which can be interpreted as Lower Sarmatian by the state of their preservation are also present. *D. neutra* and *Gibbula*, typical of the

Dubrovaya section, are among them. N.S. Volkova illustrated a specimen of *D. neutra* found in the Lower Sarmatian of Stavropol (as *Buccinum duplicatum*: Volkova, 1955, pl. 14, fig. 10; 1974, pl. 17, fig. 10). The origin of *A. akburunensis* from *D. neutra* seems reasonable, since the oldest form in the *akburunensis* lineage, collected in the Lower Sarmatian of the Aulchik Gully, has the greatest similarity with it. However, the reduction of the diversity of *Akburunella*, which existed at the beginning of the Middle Sarmatian, to one common species still looks very doubtful, except that in the Early Sarmatian there was another episode of explosive morphogenesis, similar to that found at the Early–Middle Sarmatian boundary.

In addition to *D. neutra*, finds of typical *Duplicatula* are known in the Konkian with a developed row of nodes near the suture, with a spiral furrow running below. A representative of the genus is described from the Konkian of Novocherkassk as *Buccinum janitor* Kolesnikov var. *sokolovi* (Kolesnikov, 1932). The age of that specimen is not in doubt, since the fauna from this locality is well preserved, excluding the possibility of redeposition in the Sarmatian (Bogatchew, 1905). Probably the same species was listed by Bogatchew (1903) as *Buccinum nodosocostatum* Hilber. Similar juvenile *Duplicatula* were found in the Konkian of the Belaya River basin (Chumnaya Gully, author's data). This *Duplicatula* is too different from the known Lower Sarmatian *Akburunella* to be regarded as an ancestor. It is more likely that the Sarmatian *Duplicatula* found on the Belaya below the beds with *Cryptomaetra pesansensis* originated from that species. When describing the collabral sculpture of *Akburunella*, it became necessary to introduce additional terminology to reflect smaller changes in the morphology of the collabral ridges. The ridges are divided into ordinary, pointed and lamellar. Pointed ridges have a clearly visible (with a small increase) line of growth arrest is visible along their top. Such ridges are characterized by a narrower and sharper upper part of the transverse profile. They are found in several species of *Akburunella*, especially characteristic of the gerontic stage. Lamellar ridges have the side in front of the growth arrest line clearly protrudes in the form of a lirated edge above the part of the ridge following the line of the growth arrest.

⁸ An unpublished detailed description of the section in the quarry was found in Paramonova's manuscripts, in which the lower part of the exposed rocks was attributed to the Konkian, and the upper part was assigned to the Lower Sarmatian Kuzhora and Zbruch Beds. Our material comes from a part assigned to the Kuzhora Beds, judging by the description of the section. Noteworthy, there is still no detailed bed-by-bed faunal characterization of the section due to lithological uniformity (sandy series with interbeds and lenses of coquina, lenses and concretions of sandstone), rapid change in bedding along strike, and usually poor exposure. Exact matching of independent descriptions is also excluded.



Such ridges are found in *A. laminaris*, late *A. akburunensis*, and occur at the gerontic stage in other species. The uneven secretion of the shell was also present in the forms with ordinary ridges, but this did not lead to

visually well-defined features. Ordinary ridges are wider in transverse profile, with a rounded top. Sometimes, sharpness or lirae is clearly visible only at high magnifications, for example, in *A. akburunensis* from

Explanation of Plate 25

Scale bar (2) 500, (1a) 200, (2b) 20 μm . The dimensions of other shells are given in explanation.

Figs. 1–7. *Pomattasia cyclostomoides* (Sinzow, 1880): (1) specimen PIN, no. 5621/89, Kurdzhips River, Outcrop 1A₁, sample 10A, from olistostrome, block with Middle Sarmatian fauna, beds with *C. pesansensis*: (1a) protoconch, (1b) protoconch surface (see arrow in 1a); (2) specimen PIN, no. 5621/90, Belaya River, Bed 41, sample 11A, lower part of the beds with *C. pesansensis*: apical view of protoconch; (3) specimen PIN, no. 5621/91, height 3.05 mm, Kurdzhips River, Outcrop 1A₀, sample 19A, Lower Sarmatian block in olistostrome; (4) specimen PIN, no. 5621/92, height 2.85 mm, Kurdzhips River, Outcrop 1A₁, sample 10A, from olistostrome, block with Middle Sarmatian fauna, beds with *C. pesansensis*; (5) specimen PIN, no. 5621/93, height 2.4 mm, Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesansensis*: (5a) apertural view, (5b) abapertural view; (6) specimen PIN, no. 5621/94, height 2.05 mm, Kurdzhips River, Outcrop 1A₁, sample 10A, from olistostrome, block with Middle Sarmatian fauna, beds with *C. pesansensis*: (6a) apertural view, (6b) abapertural view; (7) specimen PIN, no. 5621/95, height 2.2 mm, Belaya River, Bed 41, sample 11A, lower part of the beds with *C. pesansensis*: (7a) apertural view, (7b) abapertural view.

Figs. 8–9. *Akburunella akburunensis* (Andrussow, 1902), Belaya River, assemblage 1, lower part of the beds with *C. pesansensis*. (8) specimen PIN, no. 5621/96, height 19 mm; (9) specimen PIN, no. 5621/97, height 19.3 mm: (9a) apertural view, (9b) abapertural view.

Outcrop 1A₁ (Pl. 27, fig. 3), although ridges are not perceived as such at low magnifications. Ridges are considered to be ordinary in descriptions, by default, unless the presence of sharpness or lamellarity is specifically mentioned.

Subfamily Dorsaninae Cossmann, 1901

Genus *Akburunella* Kolesnikov, 1934*Akburunella akburunensis* (Andrussow, 1902)

Plate 25, figs. 8–9; Plate 26, figs. 1–12; Plate 27, figs. 1–6

Nassa akburunensis: Andrussow, 1902, p. 494, pl. 9, figs. 24, 25; Gatuev, 1913, figs. 21, 22.

Buccinum curtum: Kudriavtzev, 1928, p. 17, pl. 2, fig. 14.

Buccinum akburunensis: Kudriavtzev, 1928, pl. 2, fig. 19.

Buccinum akburunense: Kolesnikov, 1932, p. 114, pl. 5, figs. 1–5; Davidaschvili, 1932, p. 65, pl. 10, figs. 16, 17; Zhizhchenko, 1934, p. 72, pl. 9, figs. 11, 13, 14.

Buccinum akburunensis var. *acutum*: Kudriavtzev, 1928, pl. 2, figs. 24, 25.

Buccinum akburunense var. *acutum*: Kolesnikov, 1932, p. 114, pl. 5, figs. 1–5.

Buccinum akburunense var. *sequax*: Kolesnikov, 1932, p. 116, pl. 5, figs. 14–21.

Akburunella akburunensis: Kolesnikov, 1934, p. 273, pl. 32, figs. 1–3; Volkova, 1955, p. 27, pl. 12, figs. 17, 18; Volkova, 1974, p. 96, pl. 19, figs. 17, 18; Lukeneder et al., 2011, fig. 4U; Harzhauser and Kowalke, 2004, p. 38, pl. 5, fig. 18, pl. 7, figs. 14, 15.

Akburunella akburunensis var. *sequax*: Kolesnikov, 1932, p. 275, pl. 32, figs. 7–9; Volkova, 1974, p. 97, pl. 20, fig. 16.

Dorsanum (Akburunella) akburunensis: Wenz, 1943, p. 1505, text-fig. 4211; Korobkov, 1955, pl. 93, fig. 22; *Osnovy*, 1960, pl. 24, figs. 4, 5.

Buccinum (Akburunella) akburunensis var. *sequax*: Korobkov, 1955, pl. 93, fig. 25.

Dorsanum akburunensis: Zelinskaya et al., 1968, p. 197, pl. 46, fig. 29.

Lectotype. TsNIGR Museum, no. 15/11284: Middle Sarmatian, beds with *Cryptomactra pesansensis*; Crimea, Kerch Peninsula, coast near Yeni-Kale lighthouse on Cape Fonar'. Designated by Kojumdgieva (1969a, p. 88), figured by Andrussow, 1902, pl. 9, fig. 25.

Description. High-spined anomphalous shell, consisting of 1.3 protoconch whorls and six (rarely up to 6.5) teleoconch whorls, up to 20 mm high and up to 9.5 mm wide. The protoconch is high-spined, covered

with fine microsculpture, demarcated from the teleoconch by a change in sculpture. The microsculpture is poorly visible, consisting of very densely spaced very thin striae, which initially have a wavy character and uneven height, which is why it is broken into bands with sinuous edges on the surface of the nucleus. The teleoconch consists of convex, usually angular or keeled whorls on the spire, the last whorl may become rounded. The suture is quite deep and even. The sculpture is represented by narrow high ridges, among which ordinary ridges predominate in early representatives. Later representatives has pointed ridges on the last whorl, and the latest ones have all ridges becoming pointed or lamellar. Two, rarely three or, as a rare aberration, four primary spiral ribs run across the ridges. Usually, the ribs are well developed on the earlier whorls, decreasing to some extent as the shell grows. The lower (third primary) rib can pass at the level of the suture, then the whorl side is two-ribbed, or above it, with three-ribbed whorl side as a result. A weaker secondary rib is sometimes present above the upper primary rib. The upper primary rib disappears later than the others. Nodes are present at the places where the ribs intersect with the ridges, while the ribs are well defined. The elevations of the ridges remain only at the level of the upper primary rib when the ribs are absent. Sometimes elevations are sharp, giving the shell a keeled appearance. The maximum width of the whorls is at the level of these elevations. The ridges quickly smooth to the top of whorl, not reaching the suture. Their length varies downward from the whorl side from absence at the base to complete intersection of the base in a weakened form. The direction of the ridges is almost orthocone. The penultimate whorl has 11–13, rarely up to 15 ridges. The columella has a well-developed fasciolar ridge. The aperture is elongated-oval, with thin lips, angular posteriorly, with wide and short semi-open canal anteriorly.

Variability. An example of variability is given from the largest sample from assemblage 1. Collections from other intervals are given comparatively to assemblage 1.

Spiral sculpture. The shells with two primary ribs, in which the third primary rib is obscured below the

suture, sharply predominate. There are quite a few shells in which it is located above the suture. Also, shells are three-ribbed, in which a secondary rib appears early above the upper primary rib. Usually, its appearance also leads to blurring the angularity formed by the profile of the ridges at the level of the upper primary rib. Occasionally, there are shells with four primary ribs, including when they are all above the suture. The additional rib is located below the second primary rib. The reduction of sculpture is also varied in rate and degree of prominence; rare aberrations are also found here. For example, a shell with two initially visible primary ribs, with the lower rib disappearing early, has been found. Or a shell with a slight weakening of the ribs as it grows.

Collabral sculpture. The ridges are always well defined, ordinary. Pointed ridges usually appear at the gerontic stage, but sometimes sharpness develops earlier, up to two whorls from the end of the shell. The elevation of the ridges at the level of the upper rib varies greatly, which is reflected in the prominence of the angularity of the whorls. The length of the ridges down the whorl also varies, as reflected in the description.

The gerontic stage takes from half to a quarter of a whorl and is expressed in the increase, thinning and lowering of the ridges, the appearance of sharpness (if it was not there before), the disappearance of the rudiments of spiral sculpture and elevations on the ridges. Moreover, the longer the stage, the better the progress of these changes is usually expressed. However, some specimens have an anomalous character: the stage takes up to a whorl and is expressed in the reduction of the entire sculpture, the greater, the longer the stage. A rounded whorl remains at the maximum, covered with coarse growth lines. The first type of gerontic changes—Pl. 25, fig. 9b, Pl. 26, fig. 7; the second one—Pl. 26, fig. 4.

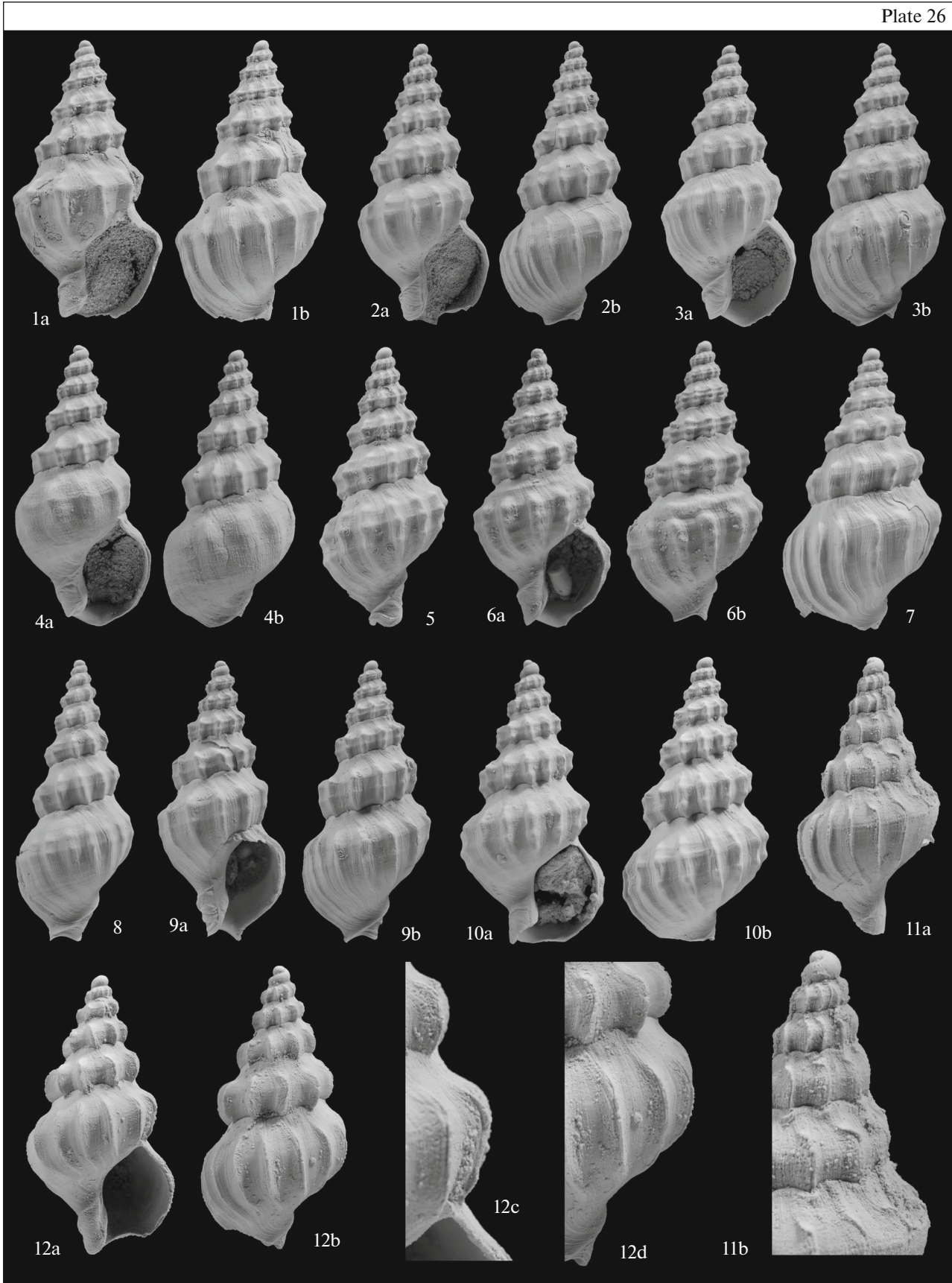
The height of adult shells is usually 18–20 mm with a diameter of 8–9.5 mm and 6 whorls of the teleoconch, but aberrant shells are found, for example, of five whorls and with 14.5 mm in height. The slenderness of shells varies slightly, usually the index (height/diameter) is 2.2, in rare especially low-spined aberrant forms it can drop to 1.75.

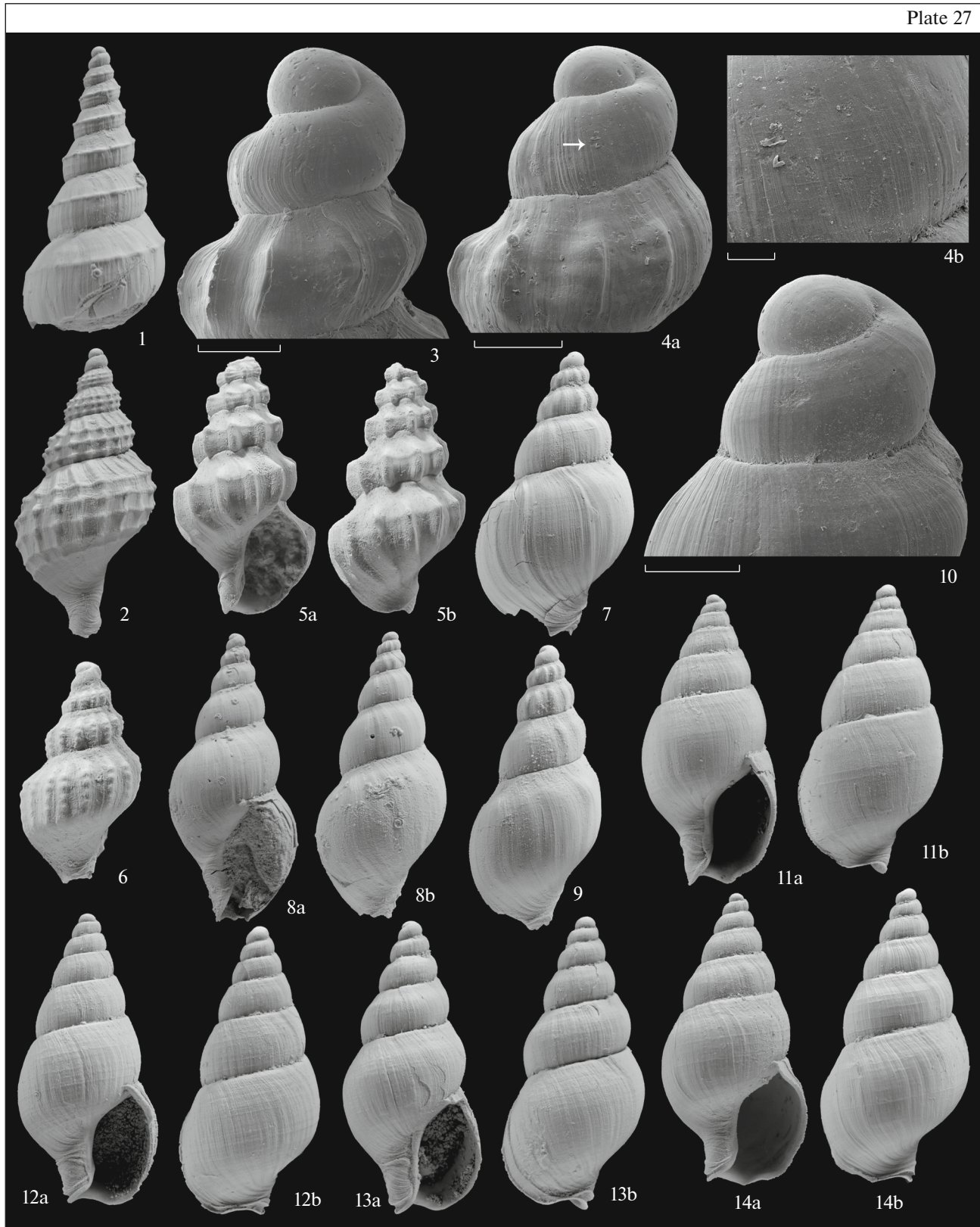
A similar set of morphs is observed in assemblages 2 and 3. An increase in variability is observed in assemblage 4 (a selection mainly from Bed 34) due to the growth of the role of deviant forms. A noticeable number of shells have reduced ridges combined with a low-spined shape and a rather pronounced spiral sculpture. The sample from the olistostrome block in Outcrop 1A₁, shows disappearance of morphs with well-defined spiral sculpture, while shells with high ridges and early reduction of spiral sculpture predominate. There were no shells, in which the pointed ridges occur beyond the gerontic stage. The latter is very short (usually no more than a quarter of a whorl) and is weakly expressed in a slight increase in the frequency of the ridges and prominence of their sharpness. The material from outcrops 1A₂–1B₃ shows that there are quite a few forms with a weakened reduction of spiral sculpture. This is especially characteristic of Outcrop 1B₂ (Pl. 26, fig. 10). The gerontic stage is poorly developed, similar to the sample from Outcrop 1A₁. Shells from 1C₁ show weakened rib reduction. They have more developed lirae at the end of the shell in comparing to samples from outcrops of groups 1A and 1B.

Only a few complete adult specimens are collected in the section above, so it is difficult to judge the change in morphology in later whorls. Shells from outcrops 1C₃ and 1C₅ have well-developed sculpture on the first three or four whorls of the teleoconch, similar to those as in shells collected below. Only Outcrop 1C₇ gave the first find of specimen with a pointed ridges on early teleoconch whorls. Outcrop 1D₁ contains only shells with pointed ridges throughout the entire teleoconch. Change in ridges associates with a strong reduction of the spiral sculpture (the same in the specimen from 1C₇). These changes are more pronounced in shells from 1D₃ outcrops: spiral sculpture disappears, and ridges become lamellar in some shells. The changes also lead to rounding of the whorls, as the ridges lose their elevation at the level of the upper primary rib (Pl. 26, figs. 11–12). This morphotype differs so much from the morphology of the earlier *A. akburunensis* that it may represent a separate taxon, although I refrain now for such decision due to the paucity of material.

Explanation of Plate 26

Figs. 1–12. *Akburunella akburunensis* (Andrussow, 1902): (1) specimen PIN, no. 5621/98, height 15.7 mm, Belaya River, assemblage 1, lower part of the beds with *C. pesansensis*: (1a) apertural view, (1b) abapertural view; (2) specimen PIN, no. 5621/99, height 19.3 mm, the same locality: (2a) apertural view, (2b) abapertural view; (3) specimen PIN, no. 5621/100, height 17.3 mm, the same locality: (3a) apertural view, (3b) abapertural view; (4) specimen PIN, no. 5621/101, height 16.5 mm, the same locality: (4a) apertural view, (4b) abapertural view; (5) specimen PIN, no. 5621/102, height 15.2 mm, the same locality; (6) specimen PIN, no. 5621/103, height 16.7 mm, Belaya River, assemblage 2, lower part of the beds with *C. pesansensis*: (6a) apertural view, (6b) abapertural view; (7) specimen PIN, no. 5621/104, height 16.2 mm, Kurdzhips River, Outcrop 1A₁, sample 10A, from olistostrome, block with Middle Sarmatian fauna, beds with *C. pesansensis*: (8) specimen PIN, no. 5621/105, height 18 mm, the same locality; (9) specimen PIN, no. 5621/106, height 18.3 mm, Kurdzhips River, section of the river with outcrops 1A₂–1B₃, middle part of the beds with *C. pesansensis*: (9a) apertural view, (9b) abapertural view; (10) specimen PIN, no. 5621/107, height 16 mm, Kurdzhips River, Outcrop 1B₂, middle part of the Beds with *C. pesansensis*: (10a) apertural view, (10b) abapertural view; (11) specimen PIN, no. 5621/108, height 12.5 mm, Kurdzhips River, Outcrop 1D₃, beds with *A. naviculata*: (11a) shell, (11b) lamellar auricles on ridges; (12) specimen PIN, no. 5621/109, height 14.5 mm, the same locality: (12a) apertural view, (12b) abapertural view; (12c–12d) ridge morphology—broken lirae protrusions are visible in front of the growth arrest line.





Explanation of Plate 27

Scale bar 500 μm , except for (4b) 100 μm . The dimensions of other shells are given in explanation.

Figs. 1–6. *Akburunella akburunensis* (Andrussow, 1902): (1) specimen PIN, no. 5621/110, height 14 mm, Belaya River, Bed 34, lower part of the beds with *C. pesansensis*: strongly deviating form with reduction of almost all sculpture; (2) specimen PIN, no. 5621/117, height 16.5 mm, Kurdzhips River, outcrops 1A₂–1B₃, middle part of the beds with *C. pesansensis*: strongly deviating form with well-developed tubercles with reduction of the rest of the sculpture; (3) specimen PIN, no. 5621/111, Kurdzhips River, Outcrop 1A₁, sample 10A, from olistostrome, block with Middle Sarmatian fauna, beds with *C. pesansensis*: protoconch and the beginning of the teleoconch, sharpness and even lamellarity of the ridges are visible already at the beginning of the teleoconch; (4) specimen PIN, no. 5621/112, Belaya River, sample BS3, lower part of the beds with *C. pesansensis*: (4a) general view of the protoconch and beginning of the teleoconch, (4b) poorly visible finest spiral microstriation on protoconch (arrow in 4a); (5) specimen TsNIGR Museum, no. 11/5248 (holotype *Buccinum akburunensis* var. *acutum*: Kudriavtzev, 1928, pl. 2, fig. 25), height 14.2 mm, vicinity of Stavropol, beds with *C. pesansensis*: (5a) apertural view, (5b) abapertural view; (6) specimen TsNIGR Museum, no. 6/5248 (holotype⁹ of *Buccinum curtum*: Kudriavtzev, 1928, pl. 2, fig. 14), height 9.6 mm, vicinity of Stavropol, beds with *C. pesansensis*.

Figs. 7–10. *Akburunella nefanda archaica* subsp. nov.: (7) specimen PIN, no. 5621/115, height 12.2 mm, Kurdzhips River, section of the river with outcrops 1A₂–1B₃, middle part of the beds with *C. pesansensis*: deviant specimen; (8) holotype PIN, no. 5621/113, height 17.7 mm, Belaya River, Bed 34, lower part of the beds with *C. pesansensis*: (8a) apertural view, (8b) abapertural view; (9) specimen PIN, no. 5621/114, height 11.3 mm, Belaya River, assemblage 3, lower part of the beds with *C. pesansensis*; (10) specimen PIN, no. 5621/116, Belaya River, sample BS3, lower part of the beds with *C. pesansensis*: protoconch and beginning of teleoconch.

Figs. 11–14. *Akburunella leiococoncha* (Andrussow, 1902): (11) specimen PIN, no. 5621/118, height 11.9 mm, Belaya River, Bed 34, lower part of the beds with *C. pesansensis*: (11a) apertural view, (11b) abapertural view; (12) specimen PIN, no. 5621/119, height 11.5 mm, the same locality: (12a) apertural view, (12b) abapertural view; (13) specimen PIN, no. 5621/120, height 11.2 mm, the same locality: (13a) apertural view, (13b) abapertural view; (14) specimen PIN, no. 5621/121, height 11.5 mm, Belaya River, assemblage 3, lower part of the beds with *C. pesansensis*: (14a) apertural view, (14b) abapertural view.

The *acuta* (Kudriavtzev, 1928) and *sequax* (Kolesnikov, 1932, 1934) were included in the species earlier. Both are considered here as deviant morphs within the species *akburunensis*. The *acuta* variety is characterized by abnormally high and thick ridges (Pl. 27, fig. 5¹⁰) with a reduction in spiral sculpture, while the variety *sequax* included morphs with different types of strong sculpture reduction (Pl. 27, fig. 1 shows an example of an even stronger deviation). Such specimens occasionally occur in samples of the species at different stratigraphic levels. The variety *enikalense*, proposed by Kolesnikov (1932, 1934) within *akburunensis* is not considered intraspecific and it is described below as a separate species. *Buccinum curtum* represents rare, strongly deviant specimens of *A. akburunensis* with numerous spiral tuberculate ribs of the same prominence (Pl. 27, fig. 6).

Comparison. *A. akburunensis* differs from other described species in its large, high-spined shell with well-developed prominent collabral sculpture and usually much finer spiral sculpture.

Remarks. Morphologically *Duplicatula kolesnikovi* (Simionescu et Barbu, 1940) and *D. verneuili* (Orbigny, 1844) are the closest to *A. akburunensis* in morphology, but they were not found in *Cryptomactra* facies and known only from shallow-water carbonate facies with an assemblage of the so-called typical Middle Sarmatian fauna. *D. kolesnikovi* has two rather widely spaced primary spiral ribs and weakly developed ridges on the whorl side, which form well-devel-

oped nodes when crossed. Sometimes, a secondary rib is formed immediately above the upper primary rib, also with nodes. The height of the nodes contrasts with the background of the otherwise low sculpture. *A. akburunensis* is distinguished by the prevalence of collabral sculpture, which is high and sharp, regardless of where it intersects with spiral elements. The nodes, if any, are not more prominent than the rest of the sculpture. *D. verneuili*¹¹, like *A. akburunensis*, has large (for the genus) slender shell with a predominance of collabral sculpture. However, *A. akburunensis* is well distinguished by its spiral sculpture: even morphs with its well-developed sculpture differ from *D. verneuili* in the absence of ribs at the base and their smaller number on the whorl side. Also *A. akburunensis* has sharper and usually higher collabral sculpture. *A. akburunensis*, *D. kolesnikovi*, and *D. verneuili* are examples of convergence in different lineages.

There are records of *A. akburunensis* in publications on the biota of the western part of the Sarmatian Basin. Shells assigned to this species were first illustrated by Andréeva-Ouchéva (1952, pl. 12, fig. 6) from the Sarmatian of Bulgaria. Despite the poor printing, it is clear that the illustrated specimen is not related to the indicated species, but rather belongs to the genus *Duplicatula*. There is also incorrect identification of other species characteristic of the *Cryptomactra* Beds: *A. multicosata* (Kudriavtzev, 1928) (ibid., pl. 12, fig. 7) and *A. scalaris* (Andrussow, 1902) (ibid., pl. 12, figs. 8, 9). The shells definitely do not belong to the indicated species, but are probably species resembling such as *Duplicatula kolesnikovi*, *D. verneuili*, or *D. jacquemartii* (Orbigny, 1844). The situation is similar to that with

⁹ Kudriavtzev designated the holotype in the inventory of the collection.

¹⁰ Specimen no. 11/5248 was marked in the inventory of the Kudriavtzev's collection as holotype, although his paper no has designation of the types. The type, figured in his Pl. 2, fig. 24, was not deposited originally by N.A. Kudriavtzev in the collection.

¹¹ The type material of *D. verneuili* is available in site <https://science.mnhn.fr> (specimen MNHN.F.R54691).

shells figured by E. Kojumdgieva as *Dorsanum* (*Akburunella*) *akburunense akburunense* and *D. (A.) akburunense stavropolense* (1969a, pl. 37, figs. 14–16 and 17, 18, respectively). It is difficult for me to assign them to other species, as it is necessary to have a good understanding of the composition and variability of *Duplicatula* species from that part of the basin (fig. 18 is definitely *Duplicatula kolesnikovi*). Finally, Kravchenko (2011, figure in text-fig. 2) made an attempt to identify some representatives from the group of *D. verneuili* as *A. akburunensis*. The indication of *A. akburunensis* from the Middle Sarmatian of Azerbaijan (Ali-Zade, 1974, p. 267, pl. 45, fig. 8) cannot be considered justified either, since the illustrated specimen does not belong to the indicated species. It is close to morphs of *A. akburunensis* with anomalously well-developed spiral sculpture but differs from them in the presence of ribs (and well-defined) at the base of the shell.

D. (A.) akburunensis described from the Sarmatian of Turkey (Özsayar, 1977, p. 63, pl. 10, fig. 9), is probably a young shell of *D. duplicatum verneuili* (Sinzow, 1875). The assignment of the location (Pazar, il Rize) to only the Lower Sarmatian is doubtful.

Occurrence. Middle Sarmatian, beds with *Cryptomactra pesanseris* of the Crimea and Ciscaucasia.

Material. Belaya River: samples BS3 (22 specimens), BS2 (7 specimens), BS1 (5 specimens), assemblages 5 (1 specimens), 4 (90 specimens), 3 (60 specimens), 2 (85 specimens), 1 (361 specimens); Kurdzhips River: outcrops 1A₀ (1 specimen), 1A₁ (125 specimens), 1A₂ (14 specimens), 1A₂–1B₃ (37 specimens), 1B₁ (17 specimens), 1B₂ (58 specimens), 1B₃ (38 specimens), 1B₅ (6 specimens), 1C₁ (10 specimens), 1C₃ (4 specimens), 1C₅ (4 specimens), 1C₇ (2 specimens), 1D₁ (14 specimens), 1D₃ (10 specimens).

Akburunella nefanda (Kolesnikov, 1932)

Buccinum nefandum: Kolesnikov, 1932, p. 117, pl. 5, figs. 22–26.

Akburunella nefanda: Kolesnikov, 1934, p. 276, pl. 32, figs. 10–13.

Lectotype herein designated. TsNIGR Museum, no. 10/11125: Middle Sarmatian, beds with *Cryptomactra pesanseris*; Stavropol Krai, Armavir District, village of Ubezhsenskaya, figured by Kolesnikov, 1932, pl. 5, figs. 22, 23; 1934, pl. 32, fig. 13.

Description. High-spined anomphalous shell, consisting of 1.3 protoconch whorls and up to seven teleoconch whorls, up to 22 mm high. The protoconch is high-spined, covered with fine microsculpture, separated from the teleoconch either indistinctly or by the appearance of ridges and the disappearance of microsculpture. Microsculpture consists of very dense and very thin striae, which have a wavy character and unequal height at the beginning of the protoconch, due to which the surface of the nucleus is broken into bands with sinuous edges. The teleoconch consists of convex rounded whorls separated by a straight and rather deep suture. The sculpture is represented by almost orthocone ridges, which either disappear with

the growth of the shell or remain until the end of the shell. Weakly pronounced fine spiral striation is common on the surface of whorls. The last whorl is high, rounded, and smooth. The growth lines on the whorl side are almost orthocone, deviating slightly forward at the upper suture. The columella has a well-developed fasciolar ridge. The aperture is oval elongated, with thin lips, angular posteriorly, with wide and short semi-open canal anteriorly.

Composition. Subspecies *A. nefanda archaica* and *A. nefanda nefanda*.

Comparison. This species differs from *A. leioconcha* in the development of ridges and larger sizes. It also differs from later *A. leioconcha* in slenderer shell, rounded convex whorls separated by a deeper suture, and the absence of a subsutural shoulder.

Remarks. Kolesnikov casually mentioned the presence of keel on the ornamented whorls, but this is not observed in the type material. Some species of *Duplicatula* with strongly reduced sculpture are convergently similar to *A. nefanda*. *A. nefanda* differs from “*D. substriatum* (Sinzow, 1875)” in the presence of collabral sculpture, the absence of rudimentary spiral ribs and a normally slenderer shell. It differs from *D. impexum* (Kolesnikov, 1932) in the slenderness of shells and a different pattern of sculpture. *D. impexum* has rudiments of sculpture on early whorls, which are represented by either spiral or collabral elements and residually shouldered whorls.

Occurrence. Middle Sarmatian, beds with *Cryptomactra pesanseris* of Ciscaucasia.

Akburunella nefanda archaica subsp. nov.

Plate 27, figs. 7–10

Holotype. PIN, no. 5621/113: Middle Sarmatian, lower part of the beds with *Cryptomactra pesanseris*; Republic of Adygea, Maikop District, outcrop on the Belaya River near the upper vicinity of the village of Groznyi, Bed 34; figured in Pl. 27, fig. 8.

Description. Enough high-spined anomphalous shell, consisting of 1.3 protoconch whorls and six (rarely up to 6.5) teleoconch whorls, up to 20 mm high and up to 9.5 mm wide. The protoconch is high-spined, covered with fine microsculpture, separated from the teleoconch either indistinctly or by the appearance of ridges and the disappearance of microsculpture. Microsculpture of the protoconch is as in the species. The teleoconch consists of convex rounded whorls separated by a straight and rather deep suture. The sculpture is represented by fuzzy, almost orthocone ridges, which disappear by the third or fifth whorl, before which they gradually weaken. The longer the stage with ridges, the more clearly, they are developed at its beginning. A weakly pronounced fine spiral striation is common on the surface of whorls. The last whorl is high, rounded and smooth. A gerontic stage may be at shell end, manifested in the appearance of growth interruption lines and even the appear-

ance of narrow and low ridges associated with them. The growth lines on the whorl side are almost orthocline, deviating slightly forward at the upper suture. The columella has a well-developed fasciolar ridge. The aperture is oval elongated, with thin lips, angular posteriorly, with a wide and short semi-open canal anteriorly.

Variability. The subspecies is known mainly in fragments of the juvenile stage, usually presented by the first two or three whorls of the teleoconch, due to the great fragility of shells. It is not possible to accurately estimate the length of the sculpted stage (until the ridges completely disappear), as well as the shape of the last two whorls in many shells. But some trends are visible. The largest and stratigraphically lowest sample comes from Bed 34. The stage with ridges is short, occupies 1.5–2.5 whorls, and the ridges are weakly expressed, sometimes poorly visible. One specimen has extended late whorls. Similar extent and appearance of the stage with ridges is in assemblage 3. The broadening of later whorls is not noted. There are two specimens from assemblage 1: one has with three early whorls, all of which are ridged, the other is represented by the last one and a half smooth whorls. The situation is slightly different in outcrops of group 1B. They contain shells, in which ridges can be visible from 2.5 to 4 whorls. All shells from the uppermost outcrops 1B₂ and 1B₃ in the section have at least three whorls with ridges, but the last whorl, apparently, is always smooth (preserved in one specimen).

The slenderness of shells with unswollen late whorls varies within 2.1–2.3, although wider aberrations are found (Pl. 27, fig. 7; slenderness 1.8).

Comparison. This subspecies differs from *A. nefanda nefanda* in the early disappearance of the collabral sculpture, which is absent on the late whorls.

Remarks. An unsculpted *Akburunella* species is collected in Beds 9–13, which is considered to be ancestral to *A. nefanda*. It is distinguished by the absence of sculpture and usually two swollen last whorls of the teleoconch, due to their accelerated growth in diameter compared to the previous ones. Uniform growth of whorls becomes the norm in *A. nefanda archaica* (see holotype), but sometimes there are individuals with similarly swollen whorls.

Occurrence. Middle Sarmatian, lower part of beds with *Cryptomacra pesanseris* Ciscaucasia.

Material. Belaya River: sample BS3 (7 specimens), assemblages 4 (Bed 34, 15 specimens), 3 (11 specimens), 1 (2 specimens); Kurdzhips River: outcrops 1A₁ (1 specimen), 1A₂–1B₃ (1 specimen), 1B₁ (1 specimen), 1B₂ (5 specimens), 1B₃ (1 specimen).

Akburunella leiococha (Uspenskaja, 1927)

Plate 27, figs. 11–14; Plate 28, figs. 1–6

Buccinum (Nassa) leiococha: Uspenskaya, 1927, p. 639, pl. 24, figs. 19–22.

Buccinum substriatulum: Kudriavtzev, 1928, p. 15, pl. 2, figs. 28–30.

Buccinum leiococha: Davidaschvili, 1932, p. 62, pl. 10, figs. 7, 12–14; Kolesnikov, 1932, p. 124, pl. 5, figs. 45–48.

Akburunella leiococha: Kolesnikov, 1934, p. 282, pl. 32, figs. 43–45; Volkova, 1955, p. 28, pl. 13, figs. 5, 6; Volkova, 1974, p. 97, pl. 20, figs. 5, 6; Harzhauser and Kowalke, 2004, p. 41, pl. 7, fig. 6.

Dorsanum (Akburunella) leiococha: Korobkov, 1955, pl. 93, fig. 27.

Dorsanum leiococha: Zelinskaya et al., 1968, p. 202, pl. 47, figs. 15, 16.

Lectotype designated herein; TsNIGR Museum, no. 61/1815; Middle Sarmatian, Beds with *Cryptomacra pesanseris*; Krasnodar Krai, Kuban River near town of Armavir; figured by Uspenskaya, 1927, pl. 34, fig. 19, 20; here: Pl. 28, fig. 6.

Description. Small low-spined anomphalous shell, consisting of 1.3 protoconch whorls and 4.3–5 teleoconch whorls, up to 12 mm high, up to 6.5 mm wide. The protoconch is high-spined, covered with fine microsculpture. It consists of very dense and very fine striae, which at the beginning of the protoconch have a wavy character and unequal height, due to which the surface of the nucleus covers by bands with sinuous edges. The boundary between the protoconch and the teleoconch is unclear, defined by the appearance of growth lines, or occasionally marked by a line of growth interruption. The teleoconch consists of convex whorls separated by a shallow even suture and covered with numerous spiral striae and more or less coarse growth lines. The whorls approach adapically the suture straight or round off to form a very narrow ramp. The whorl side in the lower half is almost vertical, above the whorls gradually narrow. The last whorl is rounded, with a maximum width in the middle, and may have a slightly concave profile in the upper part. Growth lines are slightly prosocline or prosocline-opisthocyrt. The columella sometimes has a low fasciolar ridge. The aperture is oval-elongated, with thin lips, angular posteriorly, with a wide and short semi-open canal anteriorly.

Variability. The variability is associated in assemblages 1 (199 specimens) and 2 (55 specimens) with a greater or less pronounced ramp, the presence or absence of a concavity of the adapical part of the last whorl, in the slenderness of the shell. More low-spined morphs with a slenderness of 1.75–1.8, which rarely increases to 2, sharply predominate among the shells. The proportion of slenderer shells increases (the slenderness is up to 2.07) in assemblage 3 (48 specimens). The ramp is usually reduced, and the whorls of the spire are often more convex. Assemblages 4 and 5 (328 specimens) have many slenderer shells with more convex whorls than in assemblage 1, with a reduced ramp and no adapical concavity on the last whorl. Exceptions are very few. The slenderness varies from 1.85 to 2. A different morphological trend is observed in the stratigraphically highest collection from Outcrop 1B₁: almost all shells are without a ramp, but the slenderness is the same, as in the shells from assemblages 1 and 2. Aberrant low-spined forms with a slenderness up to 1.6 are found only occasionally.

A growth arrest is frequently observed in adult shells just before the terminal aperture, with a blade-like and low-rising edge of the penultimate aperture.

Comparison. This species differs from *A. nefanda* (Kolesnikov, 1932) in more low-spined and smaller shells with less convex whorls and the absence of collabral sculpture. It differs from other *Akburunella* species it differs in the small low-spined unornamented shells.

Remarks. It differs from the convergently similar *Duplicatula impexum* in the slenderer smooth shells without rudiments of sculpture. Late *A. leioconcha* also differ from it in the flattened whorls.

Previous publications have raised a discussion about the synonymy of *A. leioconcha* and *Buccinum substriatum* Sinzow, 1875 (Uspenskaya, 1927; Kudriavtzev, 1928; Kolesnikov, 1932, 1934). N.Yu. Uspenskaya did not consider the species to be synonymous and pointed to the flattened whorls, lower-spined shells, the presence of a ramp (sic. “rim at the suture”), a shallow suture and coarser growth lines as differences between *A. leioconcha* and *B. substriatum*. V.P. Kolesnikov was of the same opinion, pointing out differences in the fasciolarity, but there is no redescription of Sinzow’s species in his papers. N.A. Kudriavtzev did not consider the differences essential for the conservation of the two species, pointing out that *A. leioconcha* differs in a thinner shell and the absence of spiral ribs, as presented in picture of *B. substriatum*. In the same place, he referred to Sinzow’s diagnosis, which indicates the optional presence of ribs. The author was able to examine Sinzow’s specimen (Sinzow, 1875, pl. 4, fig. 12; figured here: Pl. 28, fig. 7) and compare it with the shells of *A. leioconcha*. Sinzow’s specimen is housed under no. 46/11135 (TsNIGR Museum, Saint Petersburg) and comes from a quarry near the Orhei road in Chişinău. Probably, he meant the quarry on the Byk River in the village of Ryshkanovka. Now it is the Rîşcani District, and the position of the Orhei road corresponds to Petru Rareş street and Orhei highway.

Firstly, *B. substriatum* Sinzow is a junior homonym of *B. substriatum* Orbigny, 1850, so *A. leioconcha*

is retained as a priority name in any case. Secondly, I fully agree with the differences between *A. leioconcha* and “*B. substriatum*” indicated by Uspenskaya, with one “but”: she had at her disposal later specimens of *A. leioconcha*, similar in morphology to our shells from assemblages 1 and 2 from the Belaya River. However, the differences from earlier representatives (that is, from assemblages 4 and 5) become less obvious. The following difference can be indicated between them: “*B. substriatum*” has more convex whorls with a rudiment of spiral sculpture visible on Sinzow’s material on all whorls. The question arises whether “*B. substriatum*” to be an even more ancient form of *A. leioconcha*, standing closer to the original ornamented ancestor? Then “*B. substriatum*” must originate from the Lower Sarmatian, so the first undoubted *A. leioconcha* comes from the very base of the Middle Sarmatian (Belaya River). Sinzow’s specimen was collected from Middle Sarmatian limestones. “*B. substriatum*” illustrated by Uspenskaya (1927, pl. 34, fig. 23; housed in the TsNIGR Museum, no. 68/1815), comes from the middle Sarmatian of the village of Volkovo, and has the same state of preservation as the shells of *A. leioconcha* in Uspenskaya’s collection. It differs from the syntype in that the rudiments of spiral sculpture are more pronounced but can also be traced from the early whorls of the teleoconch. More than a thousand shells of *A. leioconcha* have been collected in the lower parts of the Middle Sarmatian of Adygea, but none of them has a rudiment of sculpture similar to *B. striatum*. The spiral sculpture, presented in *A. leioconcha*, has a different character: these are frequent striae of different thickness, whose order varies from shell to shell. The assumption that “*B. substriatum*” is an aberrant form with a rudiment of densley spaced sculpture is also doubtful since *A. leioconcha* is unknown both from the Sarmatian of Chişinău and the entire western part of the Sarmatian Basin. Hence, a shell like “*B. substriatum*” most likely descended from an ornamented ancestor through the loss of sculpture in parallel with *A. leioconcha*. However, it cannot be ruled out that the *sub-*

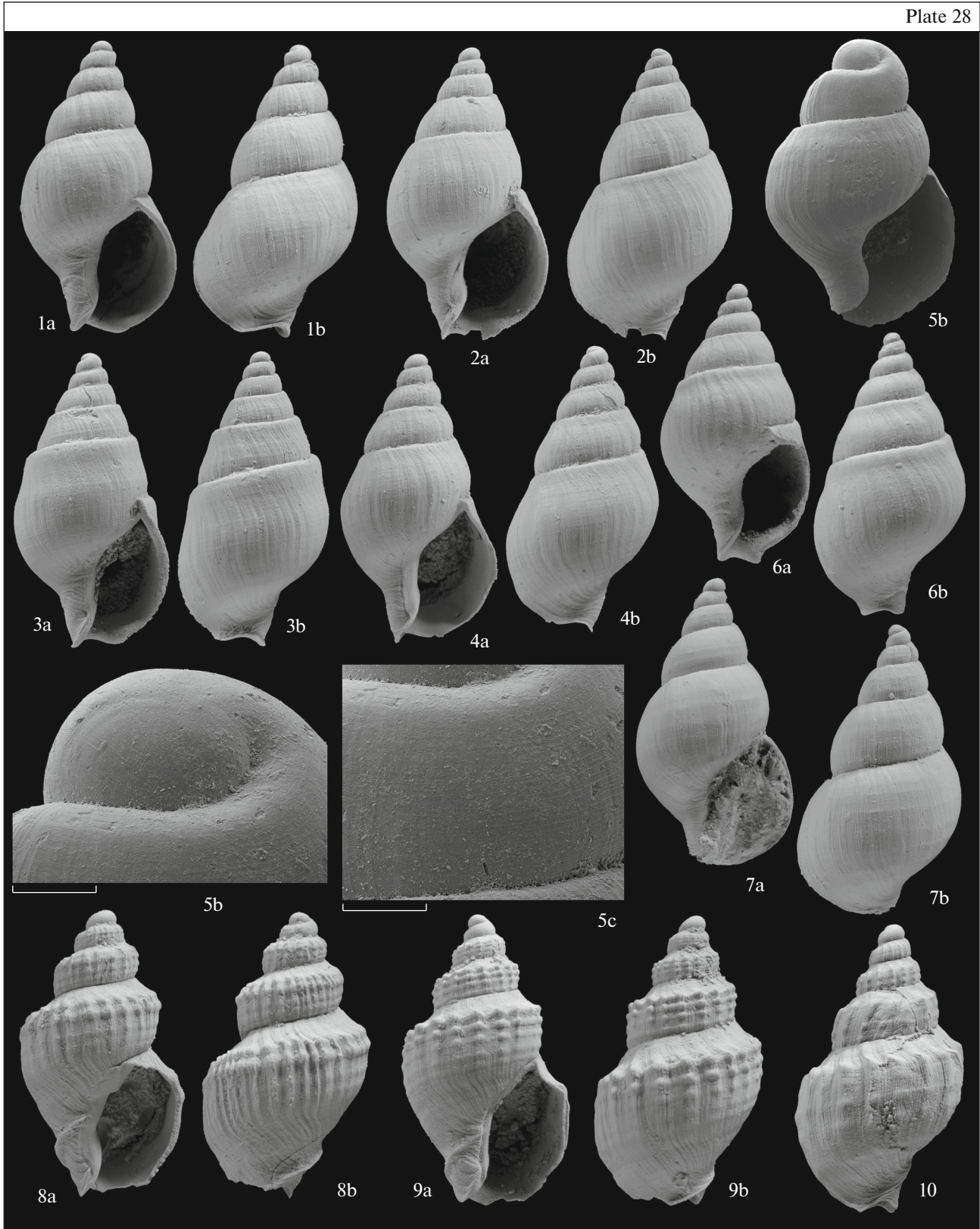
Explanation of Plate 28

Scale bar 200 µm. The dimensions of other shells are given in explanation.

Figs. 1–6. *Akburunella leioconcha* (Andrussow, 1902): (1) specimen PIN, no. 5621/122, height 9.5 mm, Belaya River, assemblage 3, lower part of the beds with *C. pesansensis*: (1a) apertural view, (1b) abapertural view; (2) specimen PIN, no. 5621/123, height 9.7 mm, Belaya River, assemblage 1, lower part of the beds with *C. pesansensis*: (2a) apertural view, (2b) abapertural view; (3) specimen PIN, no. 5621/124, height 11.5 mm, the same locality: (3a) apertural view, (3b) abapertural view; (4) specimen PIN, no. 5621/125, height 10.8 mm, Kurdzhips River, Outcrop 1B₁, middle part of the beds with *C. pesansensis*: (4a) apertural view, (4b) abapertural view; (5) specimen PIN, no. 5621/126, height 2.8 mm, the same locality: (5a) protoconch and beginning of teleoconch, (5b) microsculpture on the nucleus (5c) microstriation before the end of the protoconch; (6) lectotype TsNIGR Museum, no. 61/1815, height 11.8 mm, vicinity of Armavir, Middle Sarmatian: (6a) apertural view, (6b) abapertural view.

Fig. 7. “*Buccinum substriatum* Sinzow, 1875”, specimen TsNIGR Museum, no. 46/11135 (type from Sinzow, 1875, pl. 4, fig. 12), height 12.9 mm, Moldova, Chişinău, quarries near the Orhei road, Middle Sarmatian: (7a) apertural view, (7b) abapertural view.

Figs. 8–10. *Akburunella carabinica* (Kudriavtzev, 1928): (8) specimen PIN, no. 5621/127, height 9.7 mm, Belaya River, Bed 34, lower part of the beds with *C. pesansensis*: (8a) apertural view, (8b) abapertural view; (9) specimen PIN, no. 5621/128, height 10.4 mm, the same locality: (9a) apertural view, (9b) abapertural view; (10) specimen PIN, no. 5621/129, height 11.3 mm, Belaya River, assemblage 3, lower part of the beds with *C. pesansensis*, deviant specimen with reduced sculpture.



striatulum-like findings in *Cryptomactra* Beds may be an extremely rare aberration of *A. leiococoncha*.

Occurrence. Lower¹² (?) and Middle Sarmatian, beds with *Cryptomactra pesanseris* of the Crimea and Ciscaucasia.

Material. Belaya River: assemblages 5 (8 specimens), 4 (320 specimens), 3 (81 specimens), 2 (55 specimens) and 1 (199 specimens), samples BS3 (43 specimens) and BS2 (2 specimens); Kurdzhips River: outcrops 1A₀ (2 specimens), 1A₁ (11 specimens), 1B₁ (28 specimens).

***Akburunella carabinica* (Kudriavtzev, 1928)**

Plate 28, figs. 8–10; Plate 29, figs. 1–6

Buccinum carabinicum: Kudriavtzev, 1928, p. 19, pl. 2, figs. 20–23; Kolesnikov, 1932, p. 121, pl. 5, figs. 49–52.

Akburunella carabinica: Kolesnikov, 1934, p. 279, pl. 32, figs. 31–33.

Dorsanum carabinicum: Zelinskaya et al., 1968, p. 198, pl. 46, figs. 33, 34.

Holotype. TsNIGR Museum, no. 8/5248; Middle Sarmatian, beds with *Cryptomactra pesanseris*; Stavropol Krai, in the vicinity of the city of Stavropol. Kudriavtzev is designated as holotype in the inventory of the collection; the specimen is not mentioned in this status in his paper; figured by Kudriavtzev, 1928, pl. 2, fig. 20; here: Pl. 29, fig. 5.

Description. Small low-spined anomphalous shell, consisting of 1.3 protoconch whorls and four teleoconch whorls, up to 11.5 mm high and up to 7.5 mm wide. The protoconch is separated from the teleoconch by a change in sculpture. The teleoconch consists of convex gradate, adapically angular whorls, covered with ridges and spiral sculpture. Narrow inclined ramp is at the top of the whorls. It is straight or concave in profile, covered with more or less strongly smoothed ridges. It is bordered below by a tuberculate arising rib, which makes the ramp looking concave in profile. The vertical part of the whorl side, covered with ridges and from three to five spiral ribs, follows below. Spiral ribs become progressively less pronounced in a downward direction. They form weakly expressed small nodes or thickenings when crossing with ridges. The whorl side smoothly passes into a high convex base, in the upper part of which up to three strongly smoothed edges can be. The ridges are also end here, gradually smoothing out. The ridges are almost orthocline to weakly opisthocyrt. Pointed ridges are often present on the last whorl, and sometimes they have a rudimentary lamellarity. Their number varies from 14 to 19 at the last whorl (before the gerontic stage). The aperture is oval elongated, with thin lips, angular posteriorly, with a short and wide semi-closed canal anteriorly. The columella has a well-developed fasciolar ridge. The gerontic stage corresponds to the last third or quarter of a whorl. It is

expressed in the presence of wrinkles due to numerous lines of growth arrest, which usually leads to the loss of ridges. Ridges become more densely spaced, when they do not disappear.

Variability. Assemblage 1 (53 specimens) is represented by shells with 3–5 primary ribs on the whorl side, of which the upper one, rarely the second one from the top, is the highest, the following ones are progressively less pronounced. Another rib may appear from under the suture as the shell grows, which is normal for shells with 4 to 5 ribs. Base has up to three strongly smoothed edges or without them. The latter is typical for shells with a large number of ribs on the whorl side. A rather narrow ramp is at the top of the whorl. It is often concave in shells with more frequent ribs. Therefore, the whorls are gradate, and the shell has an appearance similar to *Cancellaria*. The distribution according to the number of ribs on the first whorl of the teleoconch is as follow: 55% shells with three, 37% with four and 8% with five ribs. The last two whorls have pointed ridges, which also predominate earlier. The degree of manifestation of sharpness varies greatly: it is more often pronounced in shells with a large number of ribs, up to the appearance of lamellarity (on the last whorl in one shell with five ribs). Sharpness are poorly developed only on the last whorl in rare shells.

The second largest sample comes from assemblage 4 (35 specimens), all shells collected in Bed 34. There are a number of differences from shells from assemblage 1: the shell has only three or four ribs on the whorl side, they are approximately equal. The ribs, except for one or two upper ones, are often strongly smoothed, so there is usually no sculpture on the base. The ridges of almost all shells have a slightly pronounced sharpness, which usually increases only at the gerontic stage. There are no lamellarity. The ridges are on average less pronounced than in Assemblage 1. The ramp at the top of the whorl is slightly sloping, slightly concave and sometimes straight. There are shells with archaic sculpture in the sample, bringing them closer to the ancestral form (Pl. 28, fig. 8). Usual morphology for assemblage in Pl. 28, fig. 9. Shells of assemblage 3 (including sample BS2) are very close to ones of assemblage 1 in terms of sculpture, although the appearance and arrangement of spiral elements is more variable. The shells with three and four ribs are approximately equal in number. The sharpness of the ridges is more often developed and more pronounced than in assemblage 4. It is characteristic of all shells.

Material from higher stratigraphic levels than assemblage 1 is represented by single shells, which does not allow recognition of trends in the morphogenesis of *A. carabinica*. They correspond to most shells of assemblage 1 in terms of sculpture.

Kolesnikov's figured specimens are closest in morphology to the shell shown in Pl. 29, fig. 2.

Comparison. It differs from *A. spinosa* in the development of ribs and ridges, with the latter pre-

¹²In 2018, very similar shells were found in the middle part of Member 7, which is of Lower Sarmatian age.

dominating in the relief. Tubercles do not develop, while they are well developed in *A. spinosa* together with reduction of ribs and ridges. The species differs from *A. bosporana* in the prevalence of ridges over spiral ribs, often more weakly expressed and closely spaced located ribs on the whorl side below the ramp, and poor development of ribs at the base. It also differs from late *A. bosporana* in the gradate whorls.

Occurrence. Middle Sarmatian, beds with *Cryptomactra pesanseris* of Ciscaucasia.

Material. Belaya River: Beds 34 (31 specimens) and 41 (5 specimens), assemblages 4 (4 specimens), 3 (21 specimens), 2 (5 specimens) and 1 (53 specimens), samples BS3 (5 specimens), BS2 (2 specimens) and BS1 (4 specimens); Kurdzhips River: outcrops 1A₁ (3 specimens), 1B₁ (6 specimens).

Akburunella bosporana (Andrusov, 1902)

Plate 29, fig. 7

Nassa bosporana: Andrussov, 1902, p. 490, pl. 9, fig. 23.

Buccinum bosporanum: Kudriavtzev, 1928, pl. 2, fig. 15; Davidaschvili, 1932, p. 69, pl. 10, fig. 15; Kolesnikov, 1932, p. 118, pl. 5, figs. 12, 13.

Buccinum praedo: Kolesnikov, 1932, p. 122, pl. 5, figs. 53–55.

Akburunella bosporana: Kolesnikov, 1934, p. 277, pl. 32, figs. 16, 17; Volkova, 1955, p. 27, pl. 13, figs. 1, 2; Volkova, 1974, p. 96, pl. 20, figs. 1, 2.

Akburunella inflata: Kolesnikov, 1934, p. 280, pl. 32, figs. 34–36.

Dorsanum (Akburunella) bosporanum: Korobkov, 1955, pl. 93, fig. 23.

Dorsanum bosporanum: Zelinskaya et al., 1968, p. 198, pl. 46, fig. 32.

? *Buccinum duplicatum-verneuili* var. *inflata*: Sinzow, 1912, pl. 13, fig. 106.

? *Akburunella akburunensis*: Lukeneder et al., 2011, fig. 4V.

Lectotype designated herein. TsNIGR Museum, no. 11/11284; Middle Sarmatian, beds with *Cryptomactra pesanseris*; Crimea, Kerch Peninsula, Mount Akhtiar south of Lake Tobechik; figured in Andrussov, 1902, pl. 9, fig. 23.

Description. Small, low-spined, anomphalous shell, consisting of 1.3 whorl protoconch and 4–4.5 whorl teleoconch, up to 12 mm high, up to 7 mm wide. The boundary between protoconch and teleoconch is marked by a change in sculpture. The teleoconch consists of convex whorls rapidly growing in diameter, covered with reticulate sculpture. A more or less inclined ramp can be isolated at the top of the whorl side. The whorl overlap decreases slightly as the shell grows. Ribs and ridges are about the same height, but since the ribs have a clear outline, they prevail in the relief. There are two primary ribs on the whorl side, to which an intercalating rib is usually added approximately in the middle of the ramp. Thin and frequent ridges follow across the ribs, forming small nodes when crossing the ribs. The ridges are prosocline at the ramp, becoming orthocline below it. There are 14–18 ridges on the whorl preceding the gerontic stage. The whorl side smoothly passes into a high convex base, covered at the top with the ends of the ridges

and four ribs, the upper of which runs at the level of the suture and sometimes rises above it on spire. The ribs on the whorl side and base are almost equal and spaced at approximately the same distance. The aperture is oval elongated, with thin lips, angular posteriorly, with a wide and short semi-open canal anteriorly. The columella has a well-developed fasciolar ridge. The gerontic stage corresponds to the last third of a whorl. It is expressed in the development of wrinkling due to numerous lines of growth arrest, which usually leads to the loss of ridges. Ridges become more frequent, when they not disappear.

Variability. It is expressed in the absence or appearance of a secondary rib in the middle of the ramp. The shell from assemblage 1 has the strongly inclined ramp, slightly contrasting with the part of the whorl surface located below. This specimen is closest in appearance to the lectotype of the species. The earlier forms from assemblages 4 and 5 have wider, shorter shells and with a clearly separated ramp, making them more similar to the putative ancestral form with even smaller shells and a well-defined ramp. The ridges vary somewhat in prominence from forms with more pronounced ridges to forms with more prominent ribs.

Comparison. The species distinguishes from *A. carabinica* by the prevalence of ribs over ridges, widely spaced and often better developed ribs, especially on the base. It also differs from Late *A. bosporana* also differs from *A. carabinica* in a poorly separated ramp and, therefore, non-gradate whorls. It differs from *A. spinosa* in the well-defined thin ridges and ribs, small nodes; from *A. stavropolensis* (Kudriavtzev, 1928)—in the fine sculpture, prevalence of ribs over ridges, number and character of ribs. *A. stavropolensis* has big ridges, strongly prevailing over two spiral ribs, which disappear on the last whorl.

Remarks. *A. bosporana* remains the least studied species, selected by N.I. Andrussov. Kolesnikov (1932) pointed out that he had only two specimens of this species, including Andrussov's original specimen, at the time of the description of Sarmatian nasariids. This is also confirmed by the fact that subsequent researchers refigured the shell from Andrussov's paper. However, in my opinion, most of the shells of *bosporana* were first attributed by Kolesnikov to a separate species *Buccinum praedo* Kolesnikov, 1932, which was then included in the synonymy of the species *Akburunella inflata* (Sinzow, 1912). The types of *B. praedo* are housed in the TsNIGR Museum under the numbers 117/11125 and 118/11125. Both shells are reported from the *Cryptomactra* Beds near the farm of Kozlov (now village of Kozlov in the Izobil'nyi District of the Stavropol Krai) and represent a variant of *bosporana* with a sharp prevalence of ribs over ridges. Such degree of dominance of ribs over ridges is not observed among our shells. The inclusion of *praedo* in the synonymy of *inflata* is also considered incorrect. The original description of *Buccinum duplicatum verneuili* var. *inflata* Sinzow, 1912 was accompa-

nied by illustrations of two shells: from the village of Mărcăuți (Moldova) and from the well of the village of Tishchensky (Stavropol Region). The remarks suggest the first specimen should be considered the main one, while the specimen from Tishchenskoe (housed in the TsNIGR Museum, collection 11326), with which Kolesnikov synonymized *praedo*, is a young shell, according to I.F. Sinzow, and therefore cannot be chosen as a basic specimen, i.e., it cannot be designated the lectotype of *inflata*. The adult shell belongs to *Duplicatula*, while the specimen from Tishchenskoe belongs to *Akburunella*. Both originals of the variety *inflata* are not conspecific to *praedo* in my opinion. Can the Tishchensky specimen of *inflata* belong to the species *bosphorana*? The shell, judging by the list of fauna given by Sinzow, comes from the part of Sarmatian overlaying *Cryptomacra* Beds, which is analogous to beds with *Atamarcia naviculata* on the Belaya River. This is evidenced by the very large *Turricaspia pseudocaspia* described from Tishchenskoe, which were found in the upper part of beds with *A. naviculata* on the Kurdzhips River, downstream the bridge in the village of Krasnooktyabr'skii. Thus, Sinzow's shell was located stratigraphically higher than the known Kolesnikov's *praedo* and *bosphorana* s.s., demonstrating a great similarity with the latter. It cannot be ruled out that it may be a later representative of the lineage of *A. spinosa*. As for the synonymization of *praedo* with *bosphorana*, there are only minimal differences between them in the details of sculpture. *A. bosphorana* differs from early *A. enikalensis* in the weakly pronounced sculpture without high nodes and a more low-spined shell. Late *enikalensis* converge with *bosphorana* only in the Sarmatian above *Cryptomacra* Beds.

A. bosphorana occasionally occurs only in the lower part of *Cryptomacra* beds in the section on the Belaya River, and this species is not yet found at their base. Another form is found in Beds 8–13, which is assumed to be the predecessor of *A. bosphorana*. It has not been previously described.

Occurrence. Middle Sarmatian, beds with *Cryptomacra pesansensis* of Crimea and Ciscaucasia.

Material. Belaya River: assemblages 5 (4 specimens), 4 (4 specimens) and 1 (1 specimen).

Akburunella spinosa Guzhov, sp. nov.

Plate 29, figs. 8–10

Etymology. From The Latin *spinus* (spinous).

Holotype. PIN, no. 5621/135; Middle Sarmatian, beds with *Cryptomacra pesansensis*; Republic of Adygea, Maikop District, Belaya River, outcrop near the upper outskirts of the village of Grozny, Bed 34; figured in Pl. 29, fig. 8.

Description. Enough high-spined anomphalous shell, consisting of 1.3 protoconch whorls and five teleoconch whorls, up to 17–18 mm high, up to 10 mm wide. The protoconch is high-spined, covered with fine microsculpture, separated from the teleoconch by a change of sculpture. Microsculpture consists of very dense and very thin striae, which have a wavy character and unequal height at the beginning of the protoconch, due to which the surface of the nucleus is divided into bands with sinuous edges. The teleoconch consists of gradate whorls, with a well-delimited more or less inclined ramp at the top. The ramp is straight, without spiral sculpture. The sculpture consists of weakly pronounced ridges and ribs, at the intersection of which rather large nodes are developed. The ribs and ridges are more pronounced on early whorls than on later ones. There are two or three ribs on the whorl side, depending on whether the third rib appears above the suture or not. It often rises above the suture as the shell grows. The ridges on the whorl side are orthocone or slightly opisthocline. Last whorl has 18–20 nodes in a row. The whorl side smoothly passes into a high convex unsculpted base, in the upper part of which a rudimentary fourth rib is sometimes visible. The growth lines on the ramp are prosocone, becoming orthocone or weakly opisthocline below on the whorl side. The aperture is elongated oval, with thin

Explanation of Plate 29

Scale bar 100 μ m, except for (10a) 500 μ m. The dimensions of other shells are given in explanation.

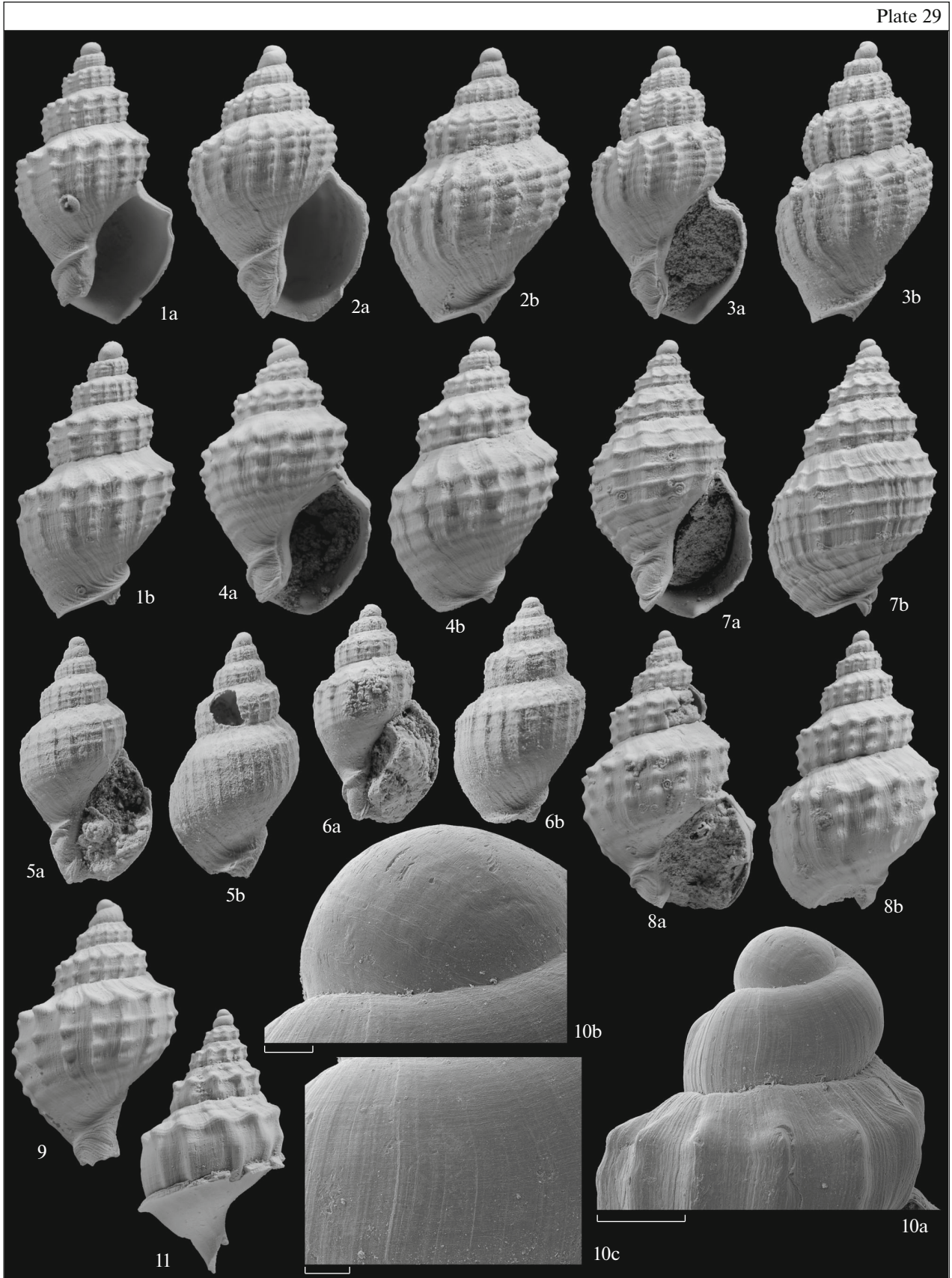
Figs. 1–6. *Akburunella carabinica* (Kudriavtzev, 1928): (1) specimen PIN, no. 5621/130, height 11.4 mm, Belaya River, assemblage 1, lower part of the beds with *C. pesansensis*: (1a) apertural view, (1b) abapertural view; (2) specimen PIN, no. 5621/131, height 9.3 mm, the same locality: (2a) apertural view, (2b) abapertural view; (3) specimen PIN, no. 5621/132, height 11.4 mm, the same locality: (3a) apertural view, (3b) abapertural view; (4) specimen PIN, no. 5621/133, height 9.8 mm, the same locality: (4a) apertural view, (4b) abapertural view; (5) holotype TsNIGR Museum, no. 8/5248, height 11.5 mm, vicinity of Stavropol, beds with *C. pesansensis*: (5a) apertural view, (5b) abapertural view; (6) paratype TsNIGR Museum, no. 9/5248 (specimen from Kudriavtzev, 1928, pl. 2, fig. 21), height 9.6 mm, the same locality: (6a) apertural view, (6b) abapertural view.

Fig. 7. *Akburunella bosphorana* (Andrussow, 1902), specimen PIN, no. 5621/134, height 12 mm, Belaya River, assemblage 1, lower part of the beds with *C. pesansensis*: (7a) apertural view, (7b) abapertural view.

Figs. 8–10. *Akburunella spinosa* sp. nov.: (8) holotype PIN, no. 5621/135, height 14.3 mm, Belaya River, Bed 34, lower part of the beds with *C. pesansensis*: (8a) apertural view, (8b) abapertural view; (9) specimen PIN, no. 5621/136, height 9.6 mm, Kurdzhips River, Outcrop 1A₁, from olistostrome, block with Middle Sarmatian fauna, beds with *C. pesansensis*; (9) specimen PIN, no. 5621/137, Belaya River, sample BS3, lower part of the beds with *C. pesansensis*: (10a) protoconch and beginning of teleoconch, (10b) microsculpture on the nucleus, (10c) microsculpture before the end of the protoconch.

Fig. 11. *Akburunella* aff. *stavropolensis* (Kudriavtzev, 1928), specimen PIN, no. 5621/138, height 13.7 mm, Kurdzhips River, outcrops 1A₂–1B₃, middle part of the beds with *C. pesansensis*.

Plate 29



lips, angular posteriorly, and with a short and wide semi-closed canal anteriorly. The columella has a well-developed fasciolar ridge. The gerontic stage covers the last third of whorl. It is expressed in the development of wrinkling due to numerous lines of growth interruption, often accompanied by reduced sculpture.

Variability. Ridges and ribs in shells from assemblages 3 and 4 are less developed than in the later representatives from the outcrops on the Kurdzhips River. In addition, ridges and ribs may be poorly developed from the beginning of the teleoconch in early representatives, or ridges are better expressed at first, later they are strongly smoothed out. The prominence of sculpture remains almost unchanged in shells from the Kurdzhips. The slenderness of shells varies significantly in the samples. The lower samples are dominated by slender shells, while the higher ones have more low-spired shells.

Comparison. This species is distinguished from *A. carabinica* by well-developed nodes prevailing over other sculpture, widely and evenly spaced ribs, and less pronounced ridges. It differs from *A. bosporana* in the weakly expressed ridges and ribs against the background of large nodes, and also differs from late *bosporana* in gradate whorls. It differs from early *A. enikalensis* in the poorly developed ridges and ribs, and differs from late *enikalensis* in poorly developed ribs, better pronounced ridges and in the shape of the nodes, which are shorter, high and spiny, in contrast to the nodes of late *enikalensis*, which are strongly elongated along the ribs and smoothly elevated.

Occurrence. Middle Sarmatian, lower and middle part of beds with *Cryptomactra pesanseris* of Ciscaucasia.

Material. Belaya River: assemblages 4 (12 specimens), 3 (2 specimens) and 1 (2 juvenile specimens), sample BS3 (8 juvenile specimens); Kurdzhips River: Outcrop 1A₁ (6 specimens).

Akburunella aff. *stavropolensis* (Kudriavtzev, 1928)

Plate 29, fig. 11

Description. Enough high-spired anomphalous shell consists of 1.3 protoconch whorls and several teleoconch whorls, probably up to 16–17 mm high. The teleoconch consists of gradate whorls with two primary spiral ribs, which well developed initially. Later, they begin to smooth out, while the lower rib disappears earlier. A row of nodes remains, when the upper rib is reduced. An inclined ramp is formed above the upper rib, sometimes it bears with one secondary rib. Ridges run across ribs. They vary greatly in thickness and height: there are the shells with taller and thicker ordinary ridges (Pl. 29, fig. 11) or the shells with narrow, low and pointed ridges. The ridges run from suture to suture, 12–15 on the last preserved whorl. Ridges also disappear during ontogeny in one specimen. The ridges and growth lines are prosocline on the ramp and almost orthocline below it.

Comparison. This form is represented by single shells with a broken last whorl, which differ significantly from other *Akburunella* species. They are close to the phylogenetic line of *bosporana* in the slenderness and shouldering of the shell, differing from all species in sculpture of two ribs, which are lost as the shell grows. *A. stavropolensis* (Kudriavtzev, 1928) has a similar ontogeny (holotype is shown in Pl. 30, fig. 1). However, there are differences: it has two well developed ribs until the last whorl, where they quickly disappear. The ridges are prominent, they are pointed on the spire, becoming lamellar on the last whorl, when ribs disappear. The ridges are less tall and usually narrow in *A. aff. stavropolensis*. The specimen, illustrated in Pl. 29, fig. 11, differs from the other two specimens in heavy ridges and a upper primary rib, which keeps relief long time. Variability of *A. stavropolensis* remains unknown, because the species is known from a single specimen. Specimens, illustrated by Kolesnikov (1932, 1934) as *Buccinum stavropolense* or *Akburunella stavropolensis*, are not considered by the author as representing these species, but they partly were assigned here to *A. laminaris*.

Occurrence. Middle Sarmatian, middle part of beds with *Cryptomactra pesanseris* Ciscaucasia.

Material. Kurdzhips River: outcrops 1A₂–1B₃ (1 specimen), 1B₃ (1 specimen), 1C₁ (1 specimen).

Akburunella enikalensis (Kolesnikov, 1932)

Plate 30, figs. 2–7

Buccinum akburunense var. *enikalense*: Kolesnikov, 1932, p. 115, pl. 5, figs. 6–9.

Buccinum egorlykense: Kolesnikov, 1932, p. 117, pl. 5, figs. 10, 11.

Akburunella akburunensis var. *enikalensis*: Kolesnikov, 1934, p. 274, pl. 32, figs. 4, 5.

Akburunella egorlykensis: Kolesnikov, 1934, p. 276, pl. 32, figs. 14, 15.

Dorsanum akburunensis enikalensis: Zelinskaya et al., 1968, p. 198, pl. 46, fig. 30.

Dorsanum egorlykensis: Zelinskaya et al., 1968, p. 201, pl. 47, fig. 4.

Lectotype. Designated herein. TsNIGR Museum, no. 96/11125; Middle Sarmatian; Stavropol Krai, Izobil'nyi District, village of Kozlov; figured by Kolesnikov, 1932, pl. 5, figs. 8, 9.

Description. Low-spired anomphalous shell, consisting of 1.3 whorl protoconch and 4–4.5 whorl teleoconch, up to 18 mm high and up to 9.5 mm wide. The protoconch is high-spired, clearly separated from the teleoconch by the appearance of sculpture. The teleoconch consists of convex whorls separated by a rather deep sinuous suture. The maximum width of the whorls is in the middle of the whorl side. The sculpture consists of ridges, which vary from almost reduced to fairly well-defined, but low. They can be traced on the last whorl from the suture to the upper part of the base, having an opisthocyrt direction. The ribs are clearly defined, protruding due to the nodes elongated along them. Two or three primary ribs are

visible on the spire. A wide zone without ribs separates at the top of the whorl. Zone may be covered by more or less pronounced secondary rib or thread, which can appear at different levels. The whorl side smoothly passes into a high convex base, on which one or two ribs are developed. Growth lines on the whorl side are opisthocyrt, bent back ward at the base. The columella has a well-developed fasciolar ridge. The aperture is elongated oval, with thin lips, angular posteriorly, with a wide and short semi-open canal anteriorly. The gerontic stage is not expressed.

Variability. The number of spiral ribs on the whorl side in late *enikalensis* from Outcrop 1G₄ can vary from two to three due to the location of the third primary rib above the suture or due to the appearing of a secondary rib or thread above the upper primary rib. The third primary rib may be visible from the very beginning of the teleoconch or appear due to the decrease in whorl embrace with the growth of the shell. Secondary rib and visible third primary rib were not observed together on found shells. The ridges are usually well-defined, but look noticeably less prominent than the ribs, although there are rare shells in which the ridges can be almost equivalent to ribs in strength or when they are almost invisible. The illustration in Pl. 30, fig. 7 shows the shell, in which the ratio of the prominence of the ribs and ridges corresponds to the prevailing norm, while fig. 6 shows an example of shells with the highest ridges, and fig. 5 shows a shell with hypertrophied ribs. The ancient *enikalensis* have strictly two primary ribs on the whorl side, and the third primary rib runs at the level of the suture and is not visible on the spire. The ridges in *enikalensis* from outcrops of group 1D are, on average, better developed than in *enikalensis* from 1G₄, but they are not also so high as ribs (pl. 30, figs. 3, 4). Only *enikalensis* from 1C₂ has the ridges and ribs are equal in height, but the latter visually prevail due to their sharp outlines (Pl. 30, fig. 2). The nodes in late *enikalensis* are strongly elongated along the rib, forming an elongated semicircular elevation. Earlier *enikalensis* have on average shorter and more elevated nodes, due to which they can acquire a highly rounded or angularly rounded longitudinal profile.

Comparison. Differences are given in the descriptions of other species.

Remarks. Kolesnikov described two forms, which to a varying degree, correspond to *enikalensis* in the interpretation presented above. *Buccinum akburunense* var. *enikalense* is represented in the collections of the TsNIGR Museum by two specimens, of which 96/11125 was chosen as the lectotype, as the most similar to the material at our disposal. It corresponds to a morph with more pronounced ridges found among late *enikalensis* from the Kurdzhips River (Pl. 30, fig. 6). Specimen 95/11125 (Kolesnikov, 1932, pl. 5, figs. 6, 7) is more reminiscent of *enikalensis* from out-

crops 1C–1D, differing in lower spiral sculpture from the specimen from Outcrop 1C₂. The type of *Buccinum egorlykense* (104/11125: Kolesnikov, 1932, pl. 5, figs. 10, 11) is possibly a deviant form of late *enikalensis*, from which it differs in four primary ribs on the whorl side.

Occurrence. Middle Sarmatian, except the lower part of the beds with *C. pesanseris*, Crimea and Ciscaucasia.

Material. Kurdzhips River: outcrops 1C₂ (2 specimens), 1C₇ (1 specimen), 1D₁ (4 specimens), 1D₃ (10 specimens), 1G₂ (3 specimens), 1G₄ (167 specimens).

Akburunella laminaris Guzhov, sp. nov.

Plate 30, figs. 8–12, Plate 31, figs. 1–2

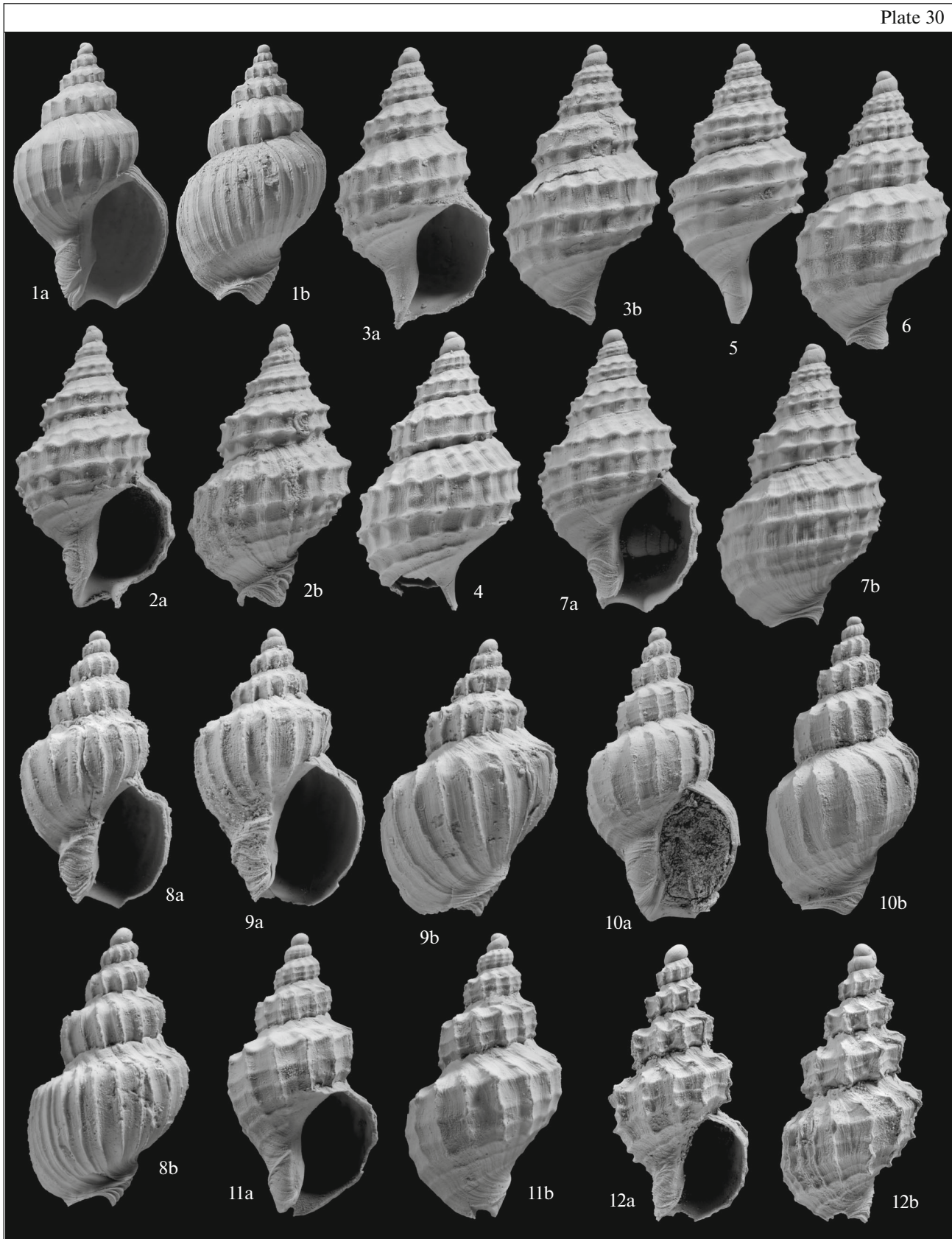
Buccinum stavropolense: Kolesnikov, 1932, pl. 5, figs. 33, 34.

Akburunella stavropolensis: Kolesnikov, 1934, pl. 32, fig. 27.

Etymology. From the Latin *laminaris* (lamellar).

Holotype. PIN, no. 5621/147; Middle Sarmatian, beds with *Cryptomactra pesanseris*; Republic of Adygea, Maikop District, Belaya River, outcrop near the upper vicinity of the village of Groznyi, Bed 34; figured in pl. 30, fig. 10.

Description. Enough high-spired anomphalous shell, consisting of one protoconch whorl and 4–4.5 teleoconch whorls, with adult shells of 12–16 mm high and up to 6–9 mm wide, respectively. The protoconch is high-spired, distinctly separated from the teleoconch by the appearance of sculpture. The teleoconch consists of convex whorls separated by a rather deep sinuous suture. Maximum width of whorls at the top of the whorl side, at the level of the maximum elevation of the ridges. The sculpture consists of narrow and sharp lamellar ridges, to which spiral ribs can be added. The ridges rise to their maximum in the upper part of the whorl side, at the level of the upper primary rib in spirally ornamented forms. The ridges are orthocline or weakly prosocline, do not continue to the base or flatten quickly at its top. The ribs vary from well-defined to completely reduced, even on the first whorl of the teleoconch. More often, at least a rudimentary sculpture is preserved, which is usually better seen at the beginning of the teleoconch. The ridges have elevations in the form of lamellar spines at the intersections with well-defined ribs. Whorl side has three primary ribs, of which the lower one runs close to the suture. The upper third of the whorl side is occupied by somewhat inclined and concave area, on which one secondary thread can develop. The whorl side roundly passes into a conically convex base. Three more or less pronounced ribs can be seen on the base. Growth lines on the whorl side are almost orthocline, deviating forward on the ramp. The columella possesses a well-developed fasciolar ridge. The aperture is slightly oval elongated, with thin lips, angular posteriorly, with a wide and short semi-open canal anteriorly. The geron-



Explanation of Plate 30

Fig. 1. *Akburunella stavropolensis* (Kudriavtzev, 1928), holotype¹³ TsNIGR Museum, no. 7/5248 (specimen from Kudriavtzev, 1928, pl. 2, fig. 16, 17), height 18 mm, vicinity of Stavropol, beds with *C. pesansensis*: (1a) apertural view, (1b) abapertural view.

Figs. 2–7. *Akburunella enikalensis* (Kolesnikov, 1932): (2) specimen PIN, no. 5621/139, height 16.6 mm, Kurdzhips River, Outcrop 1C₂, upper part of beds with *C. pesansensis*: (2a) apertural view, (2b) abapertural view; (3) specimen PIN, no. 5621/140, height 14.6 mm, Kurdzhips River, Outcrop 1D₃, upper part of the beds with *C. pesansensis*: (3a) apertural view, (3b) abapertural view; (4) specimen PIN, no. 5621/141, height 13 mm, Kurdzhips River, Outcrop 1D₁, upper part of the beds with *C. pesansensis*; (5) specimen PIN, no. 5621/142, height 15.8 mm, Kurdzhips River, Outcrop 1G₄, upper part of beds with *A. naviculata*; (6) specimen PIN, no. 5621/143, height 13 mm, the same locality; (7) specimen PIN, no. 5621/144, height 12.9 mm, the same locality: (7a) apertural view, (7b) abapertural view.

Figs. 8–12. *Akburunella laminaris* sp. nov.: (8) specimen PIN, no. 5621/145 (m. early *laminaris*), height 10 mm, Belaya River, Beds 8–11 (in talus), lowest Middle Sarmatian: (8a) apertural view, (8b) abapertural view; (9) specimen PIN, no. 5621/146 (m. early *laminaris*), height 11 mm, Belaya River, Bed 13, sample BS9, lower part of the beds with *C. pesansensis*: (9a) apertural view, (9b) abapertural view; (10) holotype PIN, no. 5621/147 (m. late *laminaris*), height 16.2 mm, Belaya River, Bed 34, lower part of the beds with *C. pesansensis*: (10a) apertural view, (10b) abapertural view; (11) specimen PIN, no. 5621/148 (m. *muricata*), height 12.8 mm, Aul Gully, lower part of the beds with *C. pesansensis*: (11a) apertural view, (11b) abapertural view; (12) specimen PIN, no. 5621/149 (m. *muricata*), height 11.4 mm, Belaya River, assemblage 3, lower part of the beds with *C. pesansensis*: (12a) apertural view, (12b) abapertural view.

tic stage is not always expressed, it can take 0.25–0.5 whorl from the end of the shell and be expressed in the increase in the frequency of the ridges and the intensification of their lamellarity.

Variability. Three morphological groups can be distinguished within the species: morphs *muricata*, early *laminaris* and late *laminaris*. The morph *muricata* is found throughout the entire stratigraphic interval of the species. It is characterized by the slender shells with a well-defined spiral sculpture and a visually less distinctly separated ramp (Pl. 30, fig. 12; Pl. 31, fig. 1). The ridges are more or less spiny, depending on the degree of development of the ribs. It is usually smaller than late *laminaris*. Early *laminaris* are found only in Beds 9–13. They have a moderately low-spired to the most low-spired, most sharply gradate shell, usually with a complete reduction in spiral sculpture, with a well separated and slightly sloping concave ramp (Pl. 30, figs. 8, 9). Late *laminaris* are found higher in the section, they are, characterized by a strong reduction of spiral sculpture, the largest size and medium slenderness of the shell. The ramp is slightly isolated, not concave. The holotype of the species belongs to this morph. There are shells intermediate between morphs.

Comparison. *A. laminaris* differs from other species in strictly lamellar ridges.

Occurrence. Middle Sarmatian, lower part of the beds with *Cryptomactra pesansensis* Ciscaucasia.

Material. Aul Gully (4 specimens); Belaya River: Beds 8–11 (2 specimens), 26–28 (1 specimen), 34 (2 specimens), sample BS9 (20 specimens), BS8 (2 specimens), BS3 (1 specimen), assemblages 6 (5 specimens), 5 (2 specimens), 3 (1 specimen); Kurdzhips River: outcrops 1A₂ (1 specimen), 1B₁ (1 specimen).

¹³Kudriavtzev designated the holotype in the inventory of the collection.

Akburunella caucasica (Kudriavtzev, 1928)

Plate 31, figs. 3–12; Plate 32, fig. 1

Nassa scalaris: Andrussow, 1902, p. 492, pl. 9, figs. 26, 27 (non *Nassa scalaris* Borson, 1825, non *Nassa scalaris* A. Adams, 1852).

Buccinum scalaris: Kudriavtzev, 1928, pl. 2, figs. 1–5.

Buccinum scalaris var. *causicum*: Kudriavtzev, 1928, p. 16, pl. 2, figs. 6, 7.

Buccinum scalare: Davidaschvili, 1932, p. 66, pl. 10, fig. 18; Kolesnikov, 1932, p. 123, pl. 5, figs. 56–59.

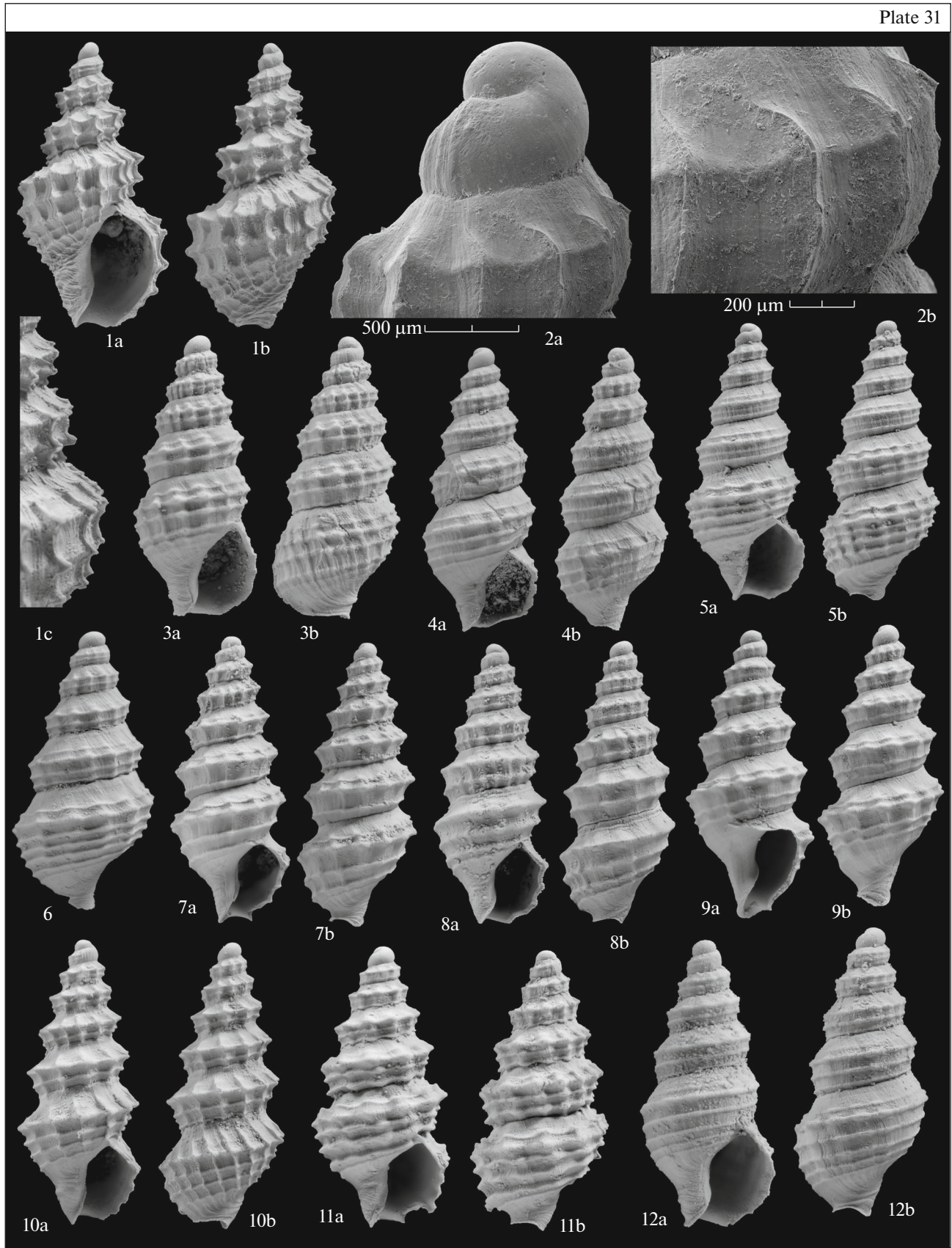
Akburunella scalaris: Kolesnikov, 1934, p. 281, pl. 32, figs. 37–39; Volkova, 1955, p. 27, pl. 13, figs. 3, 4; Volkova, 1974, p. 97, pl. 20, figs. 3, 4; Ali-Zade, 1974, p. 120, pl. 45, figs. 4–6; Harzhauser and Kowalke, 2004, p. 40, pl. 7, fig. 5.

Dorsanum scalaris: Zelinskaya et al., 1968, p. 204, pl. 47, fig. 31.

Akburunella caucasica: Harzhauser and Cernohorsky, 2011, p. 33.

Type series is lost. Collection for the N.A. Kudriavtzev's paper is housed in the TsNIGR Museum under no. 5248, however, syntypes were absent initially.

Description. Small high-spired anomphalous shell, consisting of 1.3 whorl protoconch and six whorls teleoconch, up to 11 mm high and up to 4.5 mm wide. The protoconch is separated from the teleoconch only by a change in sculpture. Microsculpture on the protoconch of very dense and very thin striae, which at the beginning of the protoconch have a wavy character and uneven height. The teleoconch consists of convex and keeled whorls covered with spiral ribs and collabral ridges. There is usually a gradual decrease in whorl overlap degree during the two or three last whorls. There are two primary ribs on the whorl side. The upper rib is topped with a keel, the lower rib is located close to the suture or slightly above it. They shift upwards as the whorl overlap increases, and the third primary rib appears from below the suture on the last whorl. The keel is located above the middle of the whorl side. There is often a thin secondary rib above the keel, which usually is close to it. Less commonly, a thin thread develops at the very top of the whorl, and sometimes there is an secondary rib between the first and second or second and third primary ribs. The ridges are prosocline, poorly devel-



oped, form tubercles on the ribs, which usually elongated along the ribs. The largest tubercles are on the keel. The ridges on the last whorl are 12–15, rarely up to 18. The ridges are not higher than the ribs, differ from them in the indistinct outlines. The whorl side roundly passes into a conically convex base. There are one or two ribs at the top of the base. Growth lines are prosocline. The columella sometimes has a low fasciolar ridge. The aperture is elongated oval, with thin lips, angular posteriorly, and with a wide and short semi-open canal anteriorly. Often from the last half-whorl to a quarter of a whorl is occupied by the gerontic stage, which characterizes in large increasing of density of ridges, with their reduction up to coarse growth lines.

Variability. Harzhauser and Cernohorsky (2011) discovered that *Nassa scalaris* Andrussov, 1902 is a junior homonym and proposed as a valid species name a variety recognized by Kudriavtzev—*Buccinum scalaris* var. *caucasicum*. Judging by the description, Kudriavtzev classified the shell with a large number of secondary ribs as a variety: on the whorl side, in addition to the primary ribs, there are secondary ribs above the keel and between the first and second primary ribs. He also pointed out the low keel and high collabral sculpture compared to “typical” *scalaris*. Very poor photographs do not allow evaluation of other morphological features of Kudriavtzev’s shells. The type material of *N. scalaris* is housed in the TsNIGR Museum in the collection no. 11284, which contains the original specimen no. 13/11284 (height 10.4 mm) (see Andrussov, 1902, pl. 9, fig. 27). Second specimen no. 12/11284 is indicated as an original specimen figured in Andrussov’s pl. 9, fig. 26, but does not match the illustration. Both specimens figured by Andrussov belong to shells with a minimal set of spiral elements: only primary ribs are developed on the whorl side, of which the lower one becomes visible due to a decrease of whorl embrace towards the end of the shell. At the same time, the specimen in fig. 26 has the usual frequency of collabral sculpture, while specimen in fig. 27 has

anomalously sparse sculpture, that it becomes clear, basing on the available material from the Belaya River.

Below I consider how fundamental are the differences in sculpture between *caucasicum* and *scalaris* using the sample from assemblage 1 (99 specimens) as an example. Designations: thread at the top of whorl—c, secondary ribs—sr, primary ribs (from upper to lower)—P1...P3.

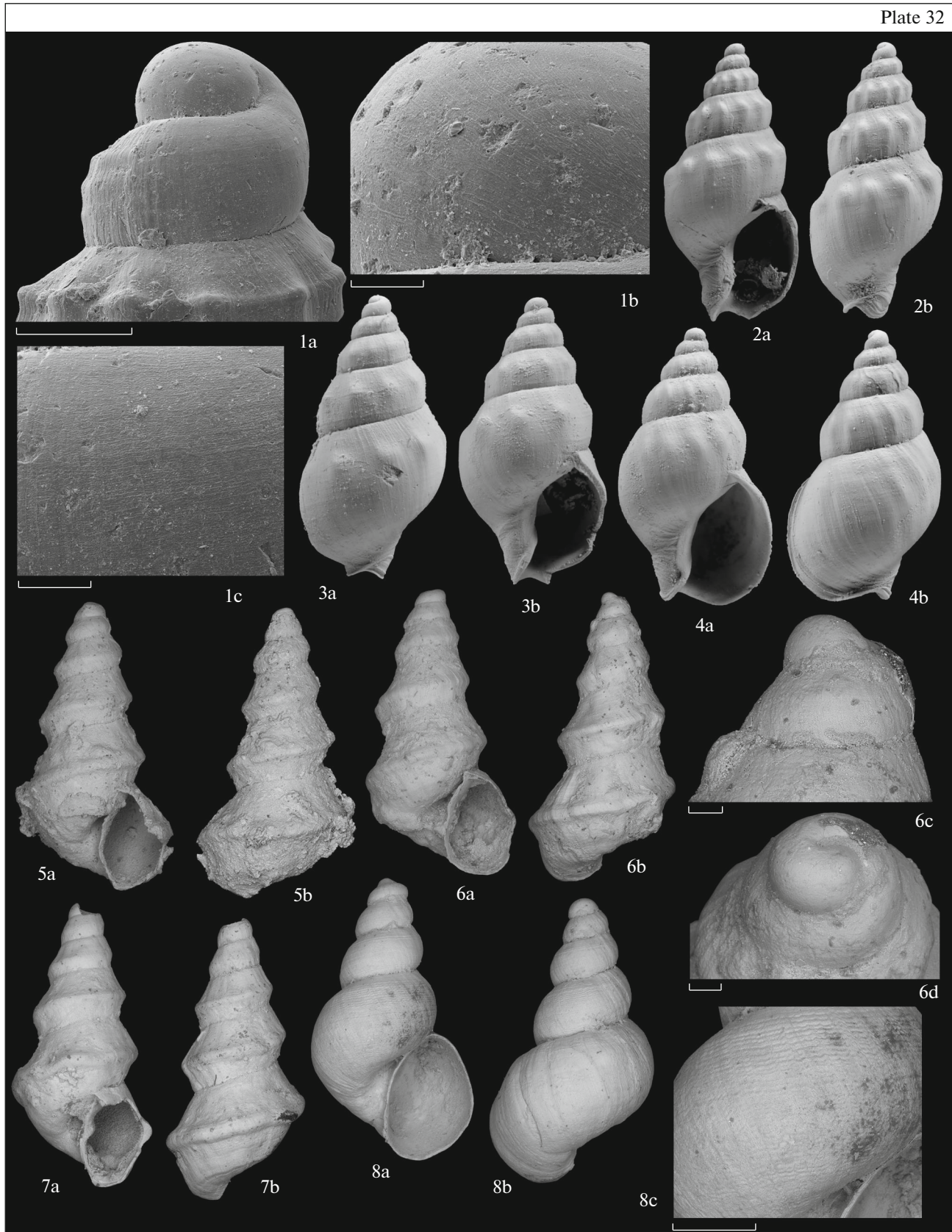
Approximately 40% of shells have a secondary rib above the keel in addition to two primary ribs on the whorl side, and two ribs are on the base. The rest of the shells are divided into many variations. The second most important part are the shells with subsutural thread and with absence of an secondary rib above the keel. There are some specimens with a thread and an secondary rib together. The secondary rib adjoins usually to P1 (which forms a keel), but less often it is located far from the rib, sometimes in the middle between suture and P1. The secondary rib above P1 usually appears on the second or third whorl, but may appear much later, up to the last whorl. The subsutural thread or stria may appear quite early, but more often appear on the last two whorls. Almost all shells have a straight surface above the keel, but occasionally it can be concave. There are also individual shells that develop a secondary rib between P1 and P2 or between P2 and P3. The location of P2 on early whorls is usually close to the suture, although in some shells it is initially obscured beneath the suture, or located above it, occasionally close to the middle of the whorl side. P2 rises relatively high above the suture with decreasing of whorl overlap, and P3 and a secondary rib (if it presents) between P2 and P3 can come out from beneath the suture. The degree of the whorl overlap change varies greatly, very rarely the whorl overlap does not change with growth. The relief and height of the sculpture also varies. The sculpture formula P1P2P3sr or P1P2P3 is typical for shells with high and sharp spiral sculpture. The ridges can be well or poorly expressed. In the latter case, the nodes are also poorly developed, and the shell becomes externally close to

Explanation of Plate 31

Scale bar (1a) 500, (1b) 100 μ m. The dimensions of other shells are given in explanation.

Figs. 1–2. *Akburunella laminaris* sp. nov.: (1) specimen PIN, no. 5621/150 (m. *muricata*), height 11.4 mm, Aul Gully, lower part of the Middle Sarmatian: (1a) apertural view, (1b) abapertural view, (1c) lamellar ledge at the top of the ridges; (2) specimen PIN, no. 5621/151, Bed 13, sample BS9, lower part of the beds with *C. pesansensis*: (1) protoconch and beginning of teleoconch, (1b) ridges with a broken lamellar top.

Figs. 3–12. *Akburunella caucasica* (Kudriavtzev, 1928): (3) specimen PIN, no. 5621/152, height 8.9 mm, Belaya River, Bed 34, lower part of the beds with *C. pesansensis*: (3a) apertural view, (3b) abapertural view; (4) specimen PIN, no. 5621/153, height 8.8 mm, the same locality: (4a) apertural view, (4b) abapertural view; (5) specimen PIN, no. 5621/154, height 11 mm, Belaya River, assemblage 3, lower part of the beds with *C. pesansensis*: (5a) apertural view, (5b) abapertural view; (6) specimen PIN, no. 5621/155, height 7.9 mm, Belaya River, Bed 34, lower part of the beds with *C. pesansensis*; (7) specimen PIN, no. 5621/156, height 11 mm, Belaya River, assemblage 1, lower part of the beds with *C. pesansensis*: (7a) apertural view, (7b) abapertural view; (8) specimen PIN, no. 5621/157, height 10.3 mm, the same locality: (8a) apertural view, (8b) abapertural view; (9) specimen PIN, no. 5621/158, height 9.2 mm, Belaya River, assemblage 2, lower part of the beds with *C. pesansensis*: (9a) apertural view, (9b) abapertural view; (10) specimen PIN, no. 5621/159, height 9.8 mm, Kurdzhips River, Outcrop 1B₂, middle part of the beds with *C. pesansensis*: (10a) apertural view, (10b) abapertural view; (11) specimen PIN, no. 5621/160, height 9.5 mm, Belaya River, assemblage 1, lower part of the beds with *C. pesansensis* (strongly deviant specimen): (11a) apertural view, (11b) abapertural view; (12) specimen PIN, no. 5621/161, height 8.5 mm, Kurdzhips River, Outcrop 1B₁, middle part of the beds with *C. pesansensis* (strongly deviant specimen): (12a) apertural view, (12b) abapertural view.



A. tscharnozskii (Kudriavtzev, 1928), which has a high and sharp spiral sculpture with complete reduction of the ridges and nodes. In general, the relief of spiral and collabral sculpture can vary greatly, and independently of each other, creating various combinations. The keel is greatly reduced together with the reduction of spiral sculpture, and the ribs become thinner.

Shells with the following sculpture formulas occur in assemblage 1: *P1P2P3, *P1P2P3sr, *cP1P2P3sr, srP1P2P3, srP1P2P3sr, csrP1P2P3sr, **P1P2srP3sr, **srP1P2srP3sr, cP1srP2P3. *—morphs corresponding to *scalaris* of Andrussow, **—variety *caucasicum* of Kudriavtzev. It can be seen even from a small sample that *scalaris* and *caucasicum* are variations of a rather variable species.

Similar variability was found in assemblage 2 (6 specimens) and sample BS2 (5 specimens). The formula csrP1srP2P3sr (2 specimens) was encountered, and more shells are with an secondary rib between P2 and P3, which may be a random factor, given the small size of these collections. Assemblage 3 (61 specimen) and BS3 (11 specimen) have most of the shells with secondary rib between P2 and P3. Usually, P2 is initially located highly above the suture, and in many shells P1 and P2 are very close to each other and are located near the middle of the whorl side. Shells from assemblage 4 do not contradict the morphological norm of assemblage 3. A weakening of the relief of sculpture is characteristic. The role of morphs with formulas srP1P2srP3sr and srP1P2P3sr is gradually increasing in assemblages 3 and 4.

The highest position is occupied by shells collected from outcrops of group 1B. There are several shells with sculpture of the formula srP1P2P3 from Outcrop 1B₃. Shells from Outcrop 1B₁ have the formulas ccsrP1P2P3, srP1P2P3 and P1P2P3 with a tendency to reduce sculpture over P1. The most representative sample from the horizon with nodules in Outcrop 1B₂ (46 specimens). The shells are characterized by consistently sharp and high sculpture with formulas P1P2P3 (33% of shells), cP1P2P3 (1 specimen), srP1P2P3. Thus, a significant role is played by shell with complete reduction of secondary ribs, including the most stably developed secondary rib above P1 in

earlier *A. caucasica*. The forms with the reduction of this secondary rib predominate among the shells with the formula srP1P2P3. The particularly abrupt and sharp keel is characteristic for shells with reduction or absence of that rib because the height and close position of the secondary rib to P1 was significantly affect the profile of the keel.

Forms with a strong reduction of sculpture predominate among the rare strongly deviant specimens, which is an atavism of the ancestor morphology, since, according to the materials of 2018, *caucasica* comes from a poorly ornamented form, and the earliest *caucasica* from Beds 8–13 have a less developed sculpture.

Shells from assemblages 3 and 4, showed in the Plate 31, correspond to *caucasica* in the understanding of Kudriavtzev (Pl. 31, figs. 3–6), which above are gradually replaced by shells corresponding to *scalaris* in the understanding of Andrussow (Pl. 31, figs. 7–10). The bottom row in photographic plate 31 is represented by anomalous specimens: with sharp ridges (Pl. 31, fig. 10), hypertrophy of spiral sculpture (Pl. 31, fig. 11) and reduction of collabral sculpture (Pl. 31, fig. 12), making the latter similar to *A. tscharnozskii* (Kudriavtzev, 1928).

Comparison. It differs from the most similar *A. tscharnozskii* in the development of collabral sculpture and tuberculous spiral ribs. It differs from other species in a small turricate shell with a well-developed reticulate nodular sculpture and carinate whorls.

Occurrence. Middle Sarmatian, beds with *Cryptomacra pesanseri* of Crimea and Ciscaucasia; Middle Sarmatian of Azerbaijan.

Material. Belaya River: assemblages 4 (28 specimens), 3 (61 specimen), 2 (65 specimens) and 1 (99 specimens), samples BS3 (11 specimen) and BS2 (5 specimens); Kurdzhips River: outcrops 1A₀ (2 specimens), 1A₁ (43 specimens), 1A₂ (7 specimens), 1A₂–1B₃ (14 specimens), 1B₁ (19 specimens), 1B₂ (46 specimens), 1B₃ (4 specimens), 1C₁ (1 specimen).

Akburunella sinuosa Guzhov, sp. nov.

Plate 32, figs. 2–4

Ety m o l o g y. From the Latin *sinuosus* (plicated).

← Explanation of Plate 32

Scale bars (1a, 8c) 500, (1b, 1c, 6c, 6d) 100 μm. The dimensions of other shells are given in explanation.

Fig. 1. *Akburunella caucasica* (Kudriavtzev, 1928), specimen PIN, no. 5621/162, Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesanseri*: (1a) protoconch and beginning of teleoconch, (1b) microsculpture on the nucleus, (1c) microsculpture near the end of the protoconch.

Figs. 2–4. *Akburunella sinuosa* sp. nov., Belaya River, assemblage 5, lower part of the beds with *C. pesanseri*: (2) holotype PIN, no. 5621/163, height 11 mm: (2a) apertural view, (2b) abapertural view; (3) specimen PIN, no. 5621/164, height 9.8 mm: (3a) apertural view, (3b) abapertural view; (4) specimen PIN, no. 5621/165, height 9 mm: (4a) apertural view, (4b) abapertural view.

Figs. 5–7. *Odostomia besfsarabica* (Sinzow, 1877), Chişinău, Middle Sarmatian: (5) lectotype TsNIGR Museum, no. 336/11126, height 4 mm: (5a) apertural view, (5b) abapertural view; (6) paralectotype TsNIGR Museum, no. 337/11126, height 3.8 mm: (6a) apertural view, (6b) abapertural view, (6c) and (6d) protoconch; (7) paralectotype TsNIGR Museum, no. 338/11126, height 3.9 mm: (7a) apertural view, (7b) abapertural view.

Fig. 8. *Odostomia enikalensis* (Kolesnikov, 1934), Kerch, Yeni-Kale lighthouse, Middle Sarmatian: (5) lectotype TsNIGR Museum, no. 331/11126, height 3.9 mm: (8a) apertural view, (8b) abapertural view, (8c) sculpture on teleoconch.

H o l o t y p e. PIN, no. 5621/163; Middle Sarmatian, beds with *Cryptomactra pesansensis*; Republic of Adygea, Maikop District, Belaya River, outcrop near the upper vicinity of the village of Grozny, assemblage 5; figured in Pl. 32, fig. 2.

D e s c r i p t i o n. Small and enough low-spined anomphalous shell, consisting of 1.2 whorl protoconch and 4–4.5 whorls teleoconch, up to 11 mm high, up to 5.5 mm wide. The boundary between protoconch and teleoconch is indistinct and can be drawn by the appearance of growth lines. The teleoconch consists of convex whorls separated by an even and rather deep suture. The sculpture is represented by more or less pronounced short ridges restricted by the whorl side and spiral striae. The maximum width of the whorls is in the middle of the whorl side, or slightly higher, at the level of the greatest height of the ridges. Ridges are almost lost over the entire shell or disappear on the last whorl in some shells. Other shells have one (upper) or two rudimentary primary ribs are observed on the whorl side, in addition to well-defined ridges. The upper rib runs at the level of the maximum height of the ridges. A narrow rounded ramp may be at the top of the whorl. The whorl side roundly passes into a smooth base. Growth lines are weakly prosocline. The columella sometimes has a low, usually dichotomous, fasciolar ridge. The aperture is elongated oval, with thin lips, angular posteriorly, with a wide and short semi-open canal anteriorly.

V a r i a b i l i t y. The most pronounced ridges cross the entire whorl side, but often the ridges are reduced to elongated rounded nodes gradually smoothing downward and abruptly breaking off above.

C o m p a r i s o n. It differs from other species in small low-spined shells with sculpture of poorly developed ridges.

O c c u r r e n c e. Middle Sarmatian, lower part of the beds with *Cryptomactra pesansensis*; Ciscaucasia.

M a t e r i a l. Belaya River: assemblages 5 (18 specimens) and 2 (1 specimen), Beds 32 (3 specimens) and 34 (1 specimen).

Family Pyramidellidae Gray, 1840

Probably, the Middle Sarmatian pyramidalids were first described by Hoernes (1874) as *Melania fuchsii* Hoernes (discussed below) from the Middle Sarmatian of Chişinău (Moldova). Later Sinzow (1877) described a new species *Odostomia (Odontostoma) bessarabica* from the same place. These were enough high-spined shells with carinate whorls and with a fold on columella.

Kolesnikov (1934) redescribed the species and additionally indicated its heterostrophy. He figured two shells, which show no many diagnostic features due to poor print quality. Below a redescription is the species based on a re-examination of the types from Kolesnikov's publication. Since they come from

Sinzow's collection, they can be considered as the type series of the species.

Kolesnikov (1934) also described two more species of Middle Sarmatian pyramidellids, also assigned to the genus *Odostomia*: *O. fuchsii* (R. Hoernes, 1874) from the Middle Sarmatian of Chişinău (collection of I.F. Sinzow) and *O. enikalensis* Kolesnikov, 1934 from the Middle Sarmatian of the Kerch Peninsula (Crimea, collection of N.I. Andrussow). Hoernes illustrated as enough high-spined shell with smooth convex whorls as *Melania fuchsii*, without indications of heterostrophy or columellar fold. Kolesnikov attributed to this species the slenderer shells, with a heterostrophic protoconch and on a teleoconch with sculpture of spiral striae on a teleoconch (Pl. 33, fig. 3). On the one hand, Kolesnikov's interpretation looks unconvincing, on the other hand, the diversity of Sarmatian gastropods is not so great that there are some options for a different interpretation of the Hoernes' species, especially if his drawing is quite close to Kolesnikov's shells despite being sketchy. However, it is desirable to re-examine the type material of *M. fuchsii* in order to remove the contradictions between the Hoernes' diagnosis and Kolesnikov's interpretation. Redescription of *O. enikalensis* and "*O. fuchsii*", based on Kolesnikov's specimens, is done below. *O. moldavica* Simionescu et Barbu, 1944 from the middle Sarmatian of Chişinău is the last described species. It is known by a single, low-spined shell consisting of rapidly growing glumate whorls. The authors indicate the presence of a columellar fold, and although they did not indicate heterostrophy when describing pyramidellid, the photograph shows the similarity with a heterostrophic protoconch (Simionescu and Barbu, 1940, pl. 2, figs. 43–44).

I describe two new species of pyramidellid from beds with *Cryptomactra pesansensis* of the Belaya River basin: *O. caucasica* and *Brachystomia succineiformis*. *O. caucasica* differs from *O. enikalensis* in the weak development of spiral sculpture and angular whorls, while *B. succineiformis* is characterized by a very short thin-walled shell of rapidly growing whorls.

Data on Lower Sarmatian pyramidalids are limited to the publications of Jekelius (1944) and Švagrovský (1971). Jekelius showed one form called *O. bessarabica*, which differs from the type material of this species: whorls usually have a well-defined angularity, but there is no keel as such. Most likely, the Jekelius' material belongs to the same lineage as *O. bessarabica* but represents its ancestral form. Švagrovský described three species from the Sarmatian of Czechoslovakia: *O. fuchsii* and *O. perrara* Boettger, 1902 from the Lower and lowest Middle Sarmatian, and *O. dispar* Boettger, 1907 from the Lower Sarmatian. All species have low-spined shells with smooth, convex or flattened whorl sides on whorls, with a well-developed columellar fold. It is not clear how his *O. fuchsii* and *O. dispar* differ, since they have a similar appearance and size, and the author does not give a comparison. It is suspected that the columellar fold of *O. dispar*, left

over from the subsequent chipped whorl, was mistaken for a spiral rib on the base that it is emphasized in the description and discussion (see Švagrovský, 1971, pl. 64, fig. 6). *O. perrara* is distinguished by its small size and is either a highly variable species or a mixture of different species, judging from the photographs. On the whole, the Lower Sarmatian pyramidalids are characterized by a more familiar appearance for Odostomini than the Middle Sarmatian species.

Sarmatian pyramidelids remain a poorly studied group, since they occur sporadically and played a very minor role in benthic communities. The presence of Odostomini in Sarmatian deposits is not surprising, as members of this tribe show one of the highest tolerances to changes in salinity in the basin. Quaternary Odostomini were found (Iljina, 1966) in the Karangatian (*Auristomia* Monterosato, 1884, *Brachystomia* Monterosato, 1884), Dzhemetinian (*Auristomia*, *Brachystomia*, *Odostomia*) and Kalamitian (*Brachystomia*) deposits. They are found throughout the water area in the today Black Sea, including the somewhat desalinated northwestern part (Iljina, 1966; *Opredelitel'*, 1972). However, they are absent in the benthos of the Sea of Azov, where pyramidelids are represented only by Chrysallidini (Anistratenko et al., 2011). Odostomini is also widely represented in the Early Chokrakian Basin (Zhizhchenko, 1936; Iljina, 1993; author's collections), which was Miocene analogue of the Black Sea. Their role among pyramidelids, especially in *Auristomia* (Guzhov, 2017), even increases in the slightly freshened part of the sea, located on the territory of the modern Stavropol Upland (Ciscaucasia). The pyramidelids came to the Sarmatian Sea from the preceding Badenian Basin in the west and/or Konkian Basin in the east. They were diverse and numerous in both basins, although the Konkian pyramidelids remain almost unknown: finds of *Brachystomia*, *Parthenina*, and *Turbonilla* are described (Livrovskaya, 1935; Zhgenti, 1991; Iljina, 1993). I discovered the genus *Eulimella* and several species of the genus *Odostomia* in Veselyakna Beds of Konkian, near the town of Tul'skii. The spiral sculpture, keels and angularity of the whorls characteristic of the Sarmatian pyramidalids are not known from the normal marine *Odostomia*, and they are probably an example of specific morphological morphogenesis in an isolated poor fauna. Thus, numerous examples of the appearance of carinate shells in various taxonomic groups are known for gastropods. For example, this is known for some Sarmatian trochids (discussed or described above *Gibbula urupensis* (Uspenskaja, 1927), *G. papilla* (Eichwald, 1851) and *Kolesnikovella blainvillei* (Orbigny, 1844)), Pannonian melanopsids (Jekelius, 1944) and viviparids (Lubenescu and Zazu-leac, 1985), viviparids and ampullarids from the Pliocene lakes of the Albertine Graben (Van Damme and Pickford, 1995, 1999) and others.

The spiral sculpture of the non-carinate Sarmatian *Odostomia* makes them similar to the species of the genus *Ondina* Folin, 1870. However, *Ondina* does not

show sufficient euryhaline, therefore it is not found in the Black Sea and in the mesohaline basins of the Eastern Paratethys. But some of the Early Chokrakian *Odostomia* are characterized by the appearance of a spiral striation, which makes them similar to *Ondina*. The development of spiral sculpture like the appearance of keels, in groups, for which this is uncharacteristic, is one of the dominant morphological transformations during divergence within isolated and initially poor faunas. Therefore, it is quite expected to see them in Sarmatian *Odostomia*.

Genus *Odostomia* J. Fleming, 1813

Odostomia bessarabica (Sinzow, 1877)

Plate 32, figs. 5–7

Odostomia (*Odontostomia*) *bessarabica*: Sinzow, 1877, p. 20, pl. 7, figs. 36–39.

Odostomia bessarabica: Kolesnikov, 1934, p. 235, pl. 27, figs. 44–47, text-fig. 29; Simionescu and Barbu, 1940, p. 65, pl. 6, figs. 76, 77; Özsayar, 1977, p. 66, pl. 12, fig. 2.

? *Odostomia bessarabica*: Jekelius, 1944, p. 85, pl. 23, figs. 1–5.

Lectotype. TsNIGR Museum, no. 336/11126; Middle Sarmatian; Moldova, Chişinău; figured in Kolesnikov, 1934, pl. 27, figs. 44, 45; here: Pl. 32, fig. 5.

Description. Minute, enough high-spired, narrowly umbilicated, paucispiral shell, consisting of 5–5.5 whorls, up to 4 mm high, up to 2.1 mm wide. The protoconch is about one whorl long, intermediate between medioaxial and coaxial.¹⁴ The teleoconch consists of four carinate whorls separated by a rather deep suture. The keel is obtuse, located slightly below the middle of the whorl side. A fine spiral striation is visible on the whorl side of specimen 337/11126. The whorl side smoothly passes into a low convex base. Whorls with an elevated cross-section, the aperture is oval, angular posteriorly and rounded anteriorly. The columellar fold appears in the middle of the columella somewhat behind the apertural margin.

Dimensions. Lectotype (height 4 mm, width 2 mm), paralectotypes 337/11126 (height 3.8 mm, width 2 mm) and 338/11126 (height 3.9 mm, width 1.9 mm).

Comparison. This species is distinguished by carinate whorls from other Sarmatian pyramidelids.

Occurrence. Lower Sarmatian (?) of Turkey, Middle Sarmatian of Moldova.

Material. Type series (specimens come from I.F. Sinzow's collection): lectotype and two paralectotypes 337/11126 (Kolesnikov, 1934, pl. 27, fig. 46) and 338/11126 (Kolesnikov, 1934, pl. 27, fig. 47); type locality.

Odostomia enikalensis Kolesnikov, 1934

Plate 32, fig. 8; Plate 33, fig. 1–2

Odostomia enikalensis: Kolesnikov, 1934, p. 234, pl. 27, figs. 48–51, text-fig. 27.

¹⁴Terminology after Schröder (1995).

Lectotype. TsNIGR Museum, no. 331/11126; Middle Sarmatian; Crimea, Kerch Peninsula, Cape Fonar', at Yeni-Kale lighthouse; figured in Kolesnikov, 1934, pl. 27, fig. 48, 49; here: Pl. 32, fig. 8; Pl. 33, fig. 1.

Description. Minute, enough high-spined, narrowly umbilic; icated shell, consisting of five whorls, 4 mm high, up to 2.2 mm wide. The protoconch is medioaxial, about a whorl long. The teleoconch consists of four convex whorls separated by a deep suture. The whorls are oval in cross-section, covered with frequent spiral threads and striae. The whorl side smoothly passes into a low convex base. The aperture is oval, rounded posteriorly and anteriorly. The columellar fold is low, runs in the middle of the columella, and appears slightly behind the apertural margin.

Dimensions. Lectotype (height 3.9 mm, width 2.2), paralectotype 332/11126 (height 3.9 mm, width 2.2 mm).

Comparison. It differs from *O. fuchsii* in the less slender shells, lower whorls, deeper suture and broader umbilicus; from *O. caucasica*—in the prominent spiral sculpture, and non-angular, evenly convex whorls.

Occurrence. Middle Sarmatian of the Crimea.

Material. Type series (specimens come from the collection of N.I. Andrussov): lectotype and two paralectotypes 332/11126 (Kolesnikov, 1934, pl. 27, fig. 50) and 333/11126 (Kolesnikov, 1934, pl. 27, figs. 52, 51); type locality.

***Odostomia fuchsii* R. Hoernes, 1874**

Plate 33, fig. 3

Melania fuchsii: Hoernes, 1874, p. 38, pl. 2, fig. 11.

Odostomia fuchsii: Kolesnikov, 1934, p. 235, pl. 27, figs. 52–54, text-fig. 28; Simionescu and Barbu, 1940, p. 66, pl. 6, figs. 73–75; Zelinskaya et al., 1968, pl. 33, figs. 12, 13.

Description. Minute, high-spined, narrowly umbilicated or anomphalous shell, consisting of 6 whorls, 5 mm high, up to 2.3 mm wide. The protoconch is medioaxial, about a whorl long. The teleoconch consists of five convex whorls separated by a rather deep suture. The whorls are convex, with a maximum width about the middle of the height of the whorl side. They have an elevated oval cross-section, covered with frequent spiral threads and striae. The whorl side smoothly passes into a high convex base. The aperture is elongated oval, rounded in front anteriorly, rounded-angular posteriorly. The columellar fold is low, runs in the middle of the columella, and appears slightly behind the apertural margin.

Dimensions. 334/11126 (height 4.8 mm, width 2.25 mm).

Comparison given when describing other species.

Occurrence. Middle Sarmatian of Moldova.

Material. Originals from Kolesnikov's paper (specimens come from the collection of I.F. Sinzow):

specimens 334/11126 (Kolesnikov, 1934, pl. 27, figs. 52, 53) and 335/11126 (Kolesnikov, 1934, pl. 27, fig. 54); Middle Sarmatian, Chişinău.

***Odostomia caucasica* Guzhov, sp. nov.**

Plate 33, figs. 4–5

Etymology. After the region of occurrence.

Holotype. PIN, no. 5621/166; Middle Sarmatian, beds with *Cryptomacra pesanseris*; Republic of Adygea, Maikop District, Belaya River, outcrop near the upper vicinity of the village of Groznyi, Bed 4; figured in Pl. 33, fig. 4.

Description. Minute, enough high-spined, paucispiral and narrowly umbilicated shell, consisting of 5–5.5 whorls long, up to 5.2 mm high. The protoconch is medioaxial, smooth, one whorl long. The teleoconch consists of 4–4.5 convex, rounded-angular, rarely rounded, whorls, separated by a rather deep suture. The whorls are highly oval in cross section, tapering adapically. The sculpture is usually represented by thin and poorly defined spiral striae. The whorl side is flattened or convex, with an angularity slightly below the middle of its height. The whorl side roundly passes into a convex base. The height of the last whorl is 60–65% of the height of the shell. Growth lines are weakly prosocline. The aperture is drop-like, tapering adapically, with thin lips, rounded anteriorly and rounded-angular posteriorly. The columellar fold passes in the middle of the columella, appears a little behind the apertural margin, and varies greatly: from well-defined to absent.

Dimensions. Holotype (height 5.1 mm, width 2.4 mm), paratype no. 5621/167 (height 4.4 mm, width 2.5 mm).

Comparison. This species differs from other species of Sarmatian *Odostomia* in the poor development of sculpture and the usually angular outline of the whorls.

Remarks. Plate 33, fig. 5 shows a deviant specimen, while the remaining shells correspond to the holotype in shell parameters.

Occurrence. Middle Sarmatian, beds with *Cryptomacra pesanseris* of Ciscaucasia.

Material. Belaya River: sample BS3 (10 specimens), assemblages 3 (3 specimens) and 4 (1 specimen).

Genus *Brachystomia* Monterosato, 1884

***Brachystomia succineiformis* Guzhov, sp. nov.**

Plate 33, fig. 6

Etymology. For similarity to the shells of the genus *Succinea* Draparnaud.

Holotype. PIN, no. 5621/168; Middle Sarmatian, beds with *Cryptomacra pesanseris*; Republic of Adygea, Maikop District, Belaya River, outcrop near the upper vicinity of the village of Groznyi, Bed 4.

Description. Minute, oval, anomphalous and thin-walled shells, consisting of three whorls, up to 2.5 mm high. The protoconch is from one whorl, medioaxial. The teleoconch consists of two rapidly growing convex whorls separated by a rather deep suture. The last whorl is 80–85% of the shell height. There is either no sculpture, or the finest spiral striation appears. The whorl side is convex, roundly passes into a high convex base. The whorls are highly oval in cross section, somewhat tapering apically. Growth lines are prosocline. The aperture is highly oval, with thin lips, rounded anteriorly. A narrow columellar fold runs in the middle of the columella, appears slightly behind the apertural margin.

Dimensions. Holotype (height 2.4 mm, width 1.5 mm).

Comparison. It differs from other species of *Brachystomia* in its very short shell of rapidly growing, highly oval whorls.

Occurrence. Middle Sarmatian, beds with *Cryptomactra pesanseris* of Ciscaucasia.

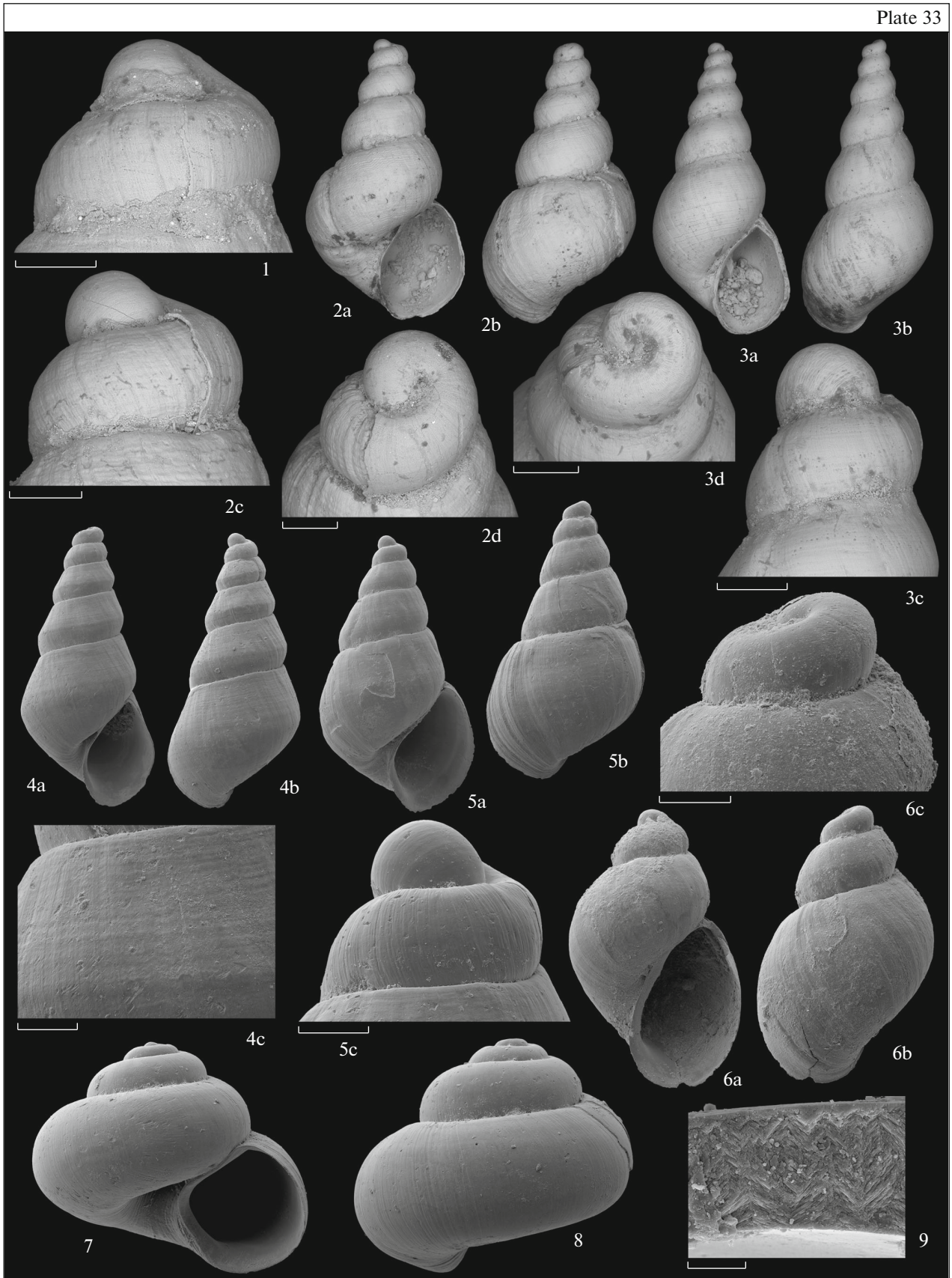
Material. Belaya River: samples BS3 (2 specimens), BS2 (1 specimen), BS1 (1 specimen).

Family Cornirostridae Ponder, 1990

The family was first established for the Sarmatian by Bandel (2010), with three genera: *Cornirostra* with the species *C. moesiensis* (Jekelius, 1944), *Sarmatorostr* Bandel, 2010 with the species *S. anistratenkorum* Bandel, 2010 and *Spiricornirostra* Bandel, 2010 with *S. pantikapaionensis* Bandel, 2010. *Sarmatorostr* was established to recognize its high-spined shell, and *Spiricornirostra* was established based on the spiral ribbing of the non-teleoconch. The last two genera have a short and smooth protoconch separated from the teleoconch by a well-defined line of growth interruption. The shells assigned to *C. moesiensis* from the type locality (Romania, Soceni) also have such a protoconch, while shells from the vicinity of the village of Yurkino (Crimea) have protoconch and teleoconch, which are not separated. The shells from both localities are the same as in the rest features. The photographs of *moesiensis* in Bandel's paper are made in such way that it is impossible to understand the character of the whorl cross section, which is also not indicated in the text. Jekelius (1944) pointed to a dorso-ventrally elevated aperture, which is clearly visible in his photographs (ibid., pl. 7, figs. 11–14; holotype, fig. 12). It remains unclear what exactly the type material of Jekelius is, since it is clear from Bandel's paper that he did not see the type specimens of the species. The same applies to two other specimens which Jekelius identified as *Valvata simplex* Fuchs, 1870 and *V. minima* Fuchs, 1877. Bandel presumably synonymizes the first form with *moesiensis* and mentions the second in an unclear status when describing *V. naticina* Menke, 1845. The question remains of their relationship with Bandel's unsculptured species of

moesiensis and *anistratenkorum*. It should be noted curiosities with reference to the Crimean material of *C. moesiensis* sensu Bandel. The material undoubtedly comes from Sarmatian deposits, since there is no Badenian, or any other interval with normal marine sediments in the Miocene sections of the Kerch Peninsula. The material comes from the eastern margin of Bulganak Bay and from Cape Gazan, east of the village of Yurkino.

Recognition of a separate genus *Sarmatorostr* based on the shell shape seems unconvincing, which is demonstrated by the collections from the Sarmatian of Adygea. A high spire is only one of the morphological states of *S. anistratenkorum* with variable shell geometry. Two trends can be identified in this range of variability: evolutionary and ecological. Gradual change from lower-spined shells to more high-spined ones is visible in evolution. Thus, only low-spined shells are found in the Lower Sarmatian (many in the collections of 2018), which do not differ in geometry from the known modern *Cornirostra* (Pl. 35, figs. 2–4). The spire becomes higher at the Lower–Middle Sarmatian boundary, which tendency continues throughout the lower part of the beds with *C. pesanseris*. The ecological aspect is expressed in the greater variability of the species in more high-energy water environments. Thus, the largest dispersal of values in spire height, including the presence of the most high-spined shells, was obtained from sample BS3, taken from the sandy interbed with nodules in Bed 34 (extreme forms: Pl. 33, fig. 7 and Pl. 34, fig. 6). There, some shells are slenderer than the specimens illustrated by Bandel, while on the other side there are the shells with a spire lower than that in one his paratype (see Bandel, 2010, pl. 2, fig. 20). Shells in samples collected up the section, from clays or silts outside the nodule horizons (with evenly distributed fauna in the bed), are on average more low-spined, the slenderest of which (Pl. 34, figs. 2, 3) occupy an intermediate position between the holotype and the aforementioned paratype of the species. For this reason, we consider the basis for recognizing the genus *Sarmatorostr* to be untenable and assign *anistratenkorum* to the genus *Cornirostra*. The species *anistratenkorum* is divided into two subspecies according to the evolutionary trend: *anistratenkorum* s.s. and *anistratenkorum umbilicaris*. The lower-spined Lower Sarmatian shells were united in *umbilicaris*, in which the umbilicus expands as the spiral become lower. *C. anistratenkorum umbilicaris* is externally closest to *V. simplex* and *V. minima* sensu Jekelius, 1944. While *V. simplex* is distinguished by an almost planispiral shell, then *V. minima* probably (no lateral view) has the same geometry as *umbilicaris*. Therefore, it cannot be ruled out that Jekelius described representatives of the same morphogenetic lineage only from a lower interval, where the shell spire is even lower. It is necessary to re-examine their type material to test the hypothesis.



Cornirostridae was considered an exclusively marine family prior to Bandel's paper. Recent *Cornirostra* are known from the Pacific Ocean and the Caribbean Sea and are represented by three species. In general, less than two dozen species are known in Cornirostridae, which is explained both by their small size (i.e., difficult to collect) and, probably, by their insignificant role in communities. Bandel's paper showed that Cornirostridae are not only able to tolerate a significant decrease in salinity: its estimates are not higher than 15‰ for the central part of the Sarmatian Sea in the Lower and Middle Sarmatian (Zhizhchenko, 1958; Kojumdgieva, 1969b; Iljina et al., 1976), but also have a sufficient diversity. Moreover, Cornirostridae were shown to be progressive eurybiotes according to Merklin (1966), which resulted in their divergence and a greater role in the Sarmatian communities. The latter is confirmed by samples from Lower Sarmatian and lower part of Middle Sarmatian of Adygea, where *C. anistratenkorum* is one of the most abundant species (Text-figs. 28–30).

Genus *Cornirostra* Ponder, 1990

Cornirostra anistratenkorum (Bandel, 2010)

H o l o t y p e. Geologisch-Paläontologisches Institut and Museum, Universität Hamburg, no. 4703, Middle Sarmatian; Crimea, Kerch Peninsula, Cape Khroni; figured in Bandel, 2010, pl. 2, fig. 19.

D e s c r i p t i o n. Low-spined, narrow umbilicated shell consists of 3.5–5 smooth round whorls, 1.5 to 2.2 mm high. The protoconch is about a whorl long, smooth, distinctly separated from the teleoconch by a line of growth interruption, with a slight extension at the end. The whorls are separated by a deep suture, closely adjacent to each other. Growth lines are almost orthocone. The aperture is round, with thin lips.

Shell wall of two layers: a thick cross-lamellar ostracum and a very thin prismatic myostracum

C o m p o s i t i o n. *C. anistratenkorum anistratenkorum* (Bandel, 2010), *C. anistratenkorum umbilicaris* subsp. nov.

C o m p a r i s o n. It differs from *C. moesiensis* in a larger shell of round whorls, while in *C. moesiensis* the whorls have a cross section elongated in height.

R e m a r k s. The specimen chosen by K. Bandel as the holotype is atypically high-spined, judging from the material collected by the present author. Only in sample BS3 is there a small number of similar specimens (Pl. 34, fig. 5).

O c c u r r e n c e. As for the genus.

Cornirostra anistratenkorum anistratenkorum (Bandel, 2010)

Plate 33, figs. 7–9; Plate 34, figs. 1–8; Plate 35, fig. 1

Sarmatorostris anistratenkorum: Bandel, 1990, p. 97, pl. 2, figs. 19–24 (*anistratenkoi*—typographic error).

D e s c r i p t i o n. Low-spined, narrow umbilicated shells consist of 4–5 smooth round whorls, up to 2.2 mm high. The protoconch is about a whorl long, smooth, distinctly separated from the teleoconch by a line of growth interruption, with a slight extension at the end. The whorls are separated by a deep suture, closely adjacent to each other. As a result, their palatal wall envelops the base of the whorl, greatly thinning and sometimes almost disappearing. Growth lines are almost orthocone. The aperture is round, with thin lips.

V a r i a b i l i t y. The variability is expressed in a considerable difference in the slenderness of the shell. Slender shells grow slower in diameter and have a narrower umbilicus. The height of adult shells varies from 1.9 to 2.2 mm, and the diameter varies from 1.9 to 2.4 mm. The shell height to diameter ratio varies from 0.86 to 1.1.

C o m p a r i s o n. It differs from *C. anistratenkorum umbilicaris* in the higher spire and narrower umbilicus.

O c c u r r e n c e. Middle Sarmatian of the Crimea; beds with *Cryptomactra pesansensis* of Ciscaucasia.

M a t e r i a l. Belaya River: samples BS3 (613 specimens), BS2 (69 specimens), BS1 (202 specimens), 11A (96 specimens), assemblage 1 (8 specimens); Kurdzhips River: outcrops 1A₁, sample 10A (308 specimens), 1A₂ (1 specimen), 1B₃ (2 specimens), 1C₁ (8 specimens), 1C₂ (2 specimens) and sample BS4 (87 specimens), 1C₇ (1 specimen).

Explanation of Plate 33

Scale bar 200 μm, except for (9) 20 μm. The dimensions of other shells are given in explanation.

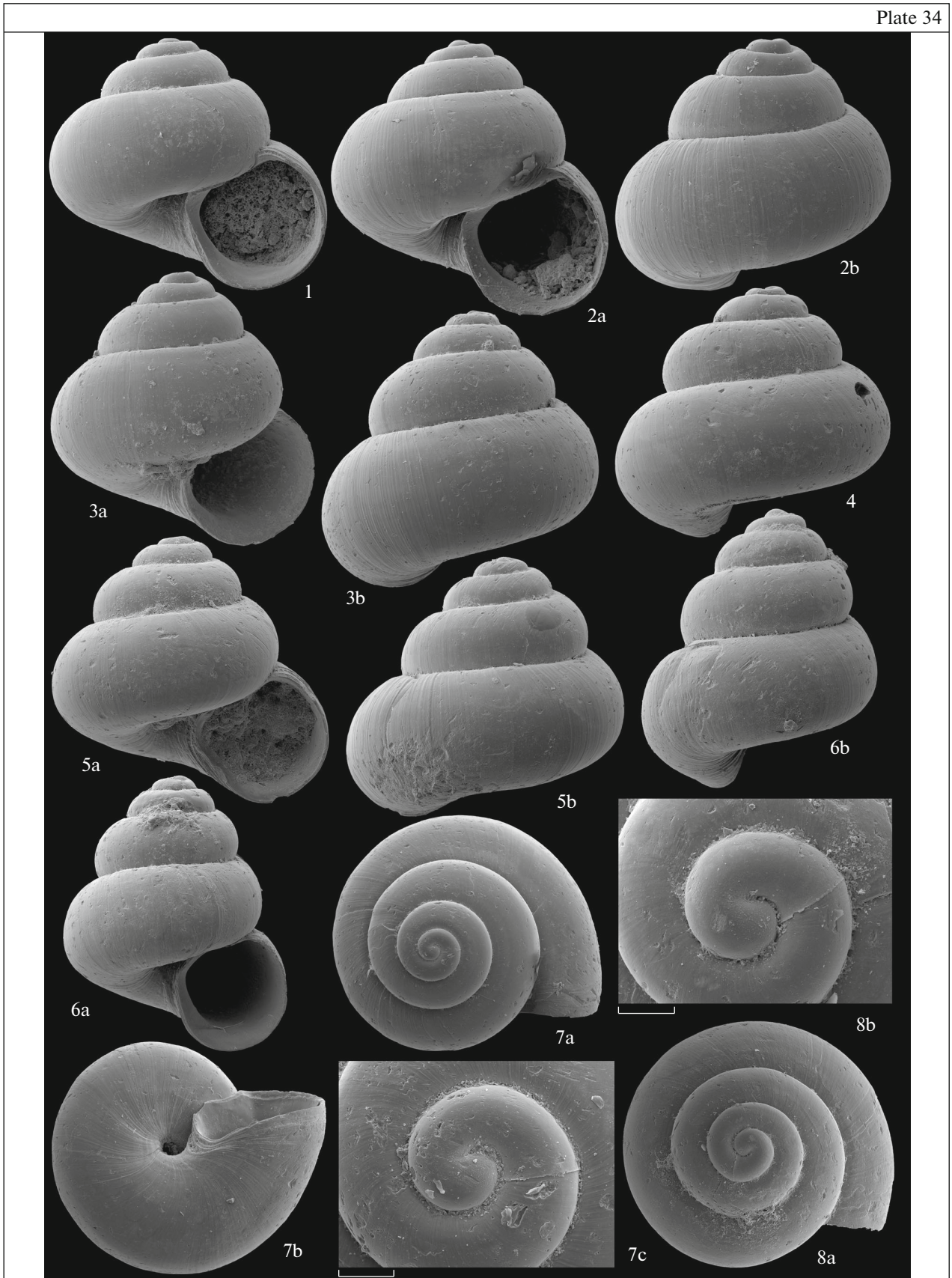
Figs. 1–2. *Odostomia enikalensis* (Kolesnikov, 1934), Kerch, Yeni-Kale lighthouse, Middle Sarmatian: (1) lectotype TsNIGR Museum, no. 331/11126, protoconch; (2) paralectotype TsNIGR Museum, no. 332/11126, height 3.9 mm: (2a) apertural view, (2b) abapertural view, (2c) and (2d) protoconch.

Fig. 3. *Odostomia fuchsii* (R. Hoernes, 1874), specimen TsNIGR Museum, no. 334/11126, height 4.8 mm, Chișinău, Middle Sarmatian: (3a) apertural view, (3b) abapertural view, (3c) and (3d) protoconch.

Figs. 4–5. *Odostomia caucasica* sp. nov., Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesansensis*: (4) holotype PIN, no. 5621/166, height 5.1 mm: (4a) apertural view, (4b) abapertural view (4c) character of sculpture on teleoconch; (5) specimen PIN, no. 5621/167, height 4.5 mm: (5a) apertural view, (5b) abapertural view, (5c) protoconch.

Fig. 6. *Brachystomia succineiformis* sp. nov., holotype PIN, no. 5621/168, height 2.4 mm Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesansensis*: (6a) apertural view, (6b) abapertural view, (6c) protoconch.

Figs. 7–9. *Cornirostra anistratenkorum anistratenkorum* (Bandel, 2010): (7) specimen PIN, no. 5621/169, height 1.75 mm, Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesansensis*; (8) specimen PIN, no. 5621/170, height 1.75 mm, the same locality; (9) specimen PIN, no. 5621/171, Outcrop 1A₁, sample 10A, olistostrome, block with Middle Sarmatian fauna, beds with *C. pesansensis*: shell wall at the posterior part of the outer lip.



Explanation of Plate 34

Scale bar 100 μm . The dimensions of other shells are given in explanation.

Figs. 1–8. *Cornirostra anistratenkorum anistratenkorum* (Bandel, 2010): (1) Belaya River, Bed 41, sample 11A, lower part of the beds with *C. pesanseris*; (2, 3, 7) Outcrop 1A₁, sample 10A, olistostrome, block with Middle Sarmatian fauna, beds with *C. pesanseris*; (4–6, 8) Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesanseris*. (1) specimen PIN, no. 5621/172, height 2.15 mm; (2) specimen PIN, no. 5621/173, height 1.75 mm: (2a) apertural view, (2b) abapertural view; (3) specimen PIN, no. 5621/174, height 2.15 mm: (3a) apertural view, (3b) abapertural view; (4) specimen PIN, no. 5621/175, height 1.85 mm; (5) specimen PIN, no. 5621/176, height 1.9 mm: (5a) apertural view, (5b) abapertural view; (6) specimen PIN, no. 5621/177, height 2.25 mm: (6a) apertural view, (6b) abapertural view; (7) specimen PIN, no. 5621/178, diameter 2.25 mm: (7a) apical view, (7b) abapical view, (7c) protoconch; (8) specimen PIN, no. 5621/179, diameter 1.4 mm: (8a) apical view, (8b) protoconch.

Cornirostra anistratenkorum umbilicaris Guzhov, subsp. nov.

Plate 35, figs. 2–4

Etymology. From the Latin *umbilicaris* (umbilical).

Holotype. PIN, no. 5621/182; uppermost Lower Sarmatian; Republic of Adygea, Maikop District, Kurdzhips River, near the upper vicinity of the village of Sadovyi, Outcrop 1A₀; figured in Pl. 35, fig. 3.

Description. Low-spined, narrow umbilicated shell consists of 3.5–3.8 smooth rounded whorls, up to 1.6 mm high and up to 2 mm in diameter (height to diameter ratio 0.75–0.8). The protoconch is about whorl long, smooth, distinctly separated from the teleoconch by a line of growth interruption, with a slight extension at the end. The whorls are separated by a deep suture, closely adjacent to each other. The palatal wall of the whorl adjoins the previous whorl, as in *C. anistratenkorum* s.s. Growth lines are straight and weakly prosocline in direction. The aperture is round, with thin lips.

Comparison. From *C. anistratenkorum anistratenkorum* it differs in the lower spire and wider umbilicus.

Occurrence. Upper most Lower Sarmatian of Ciscaucasia.

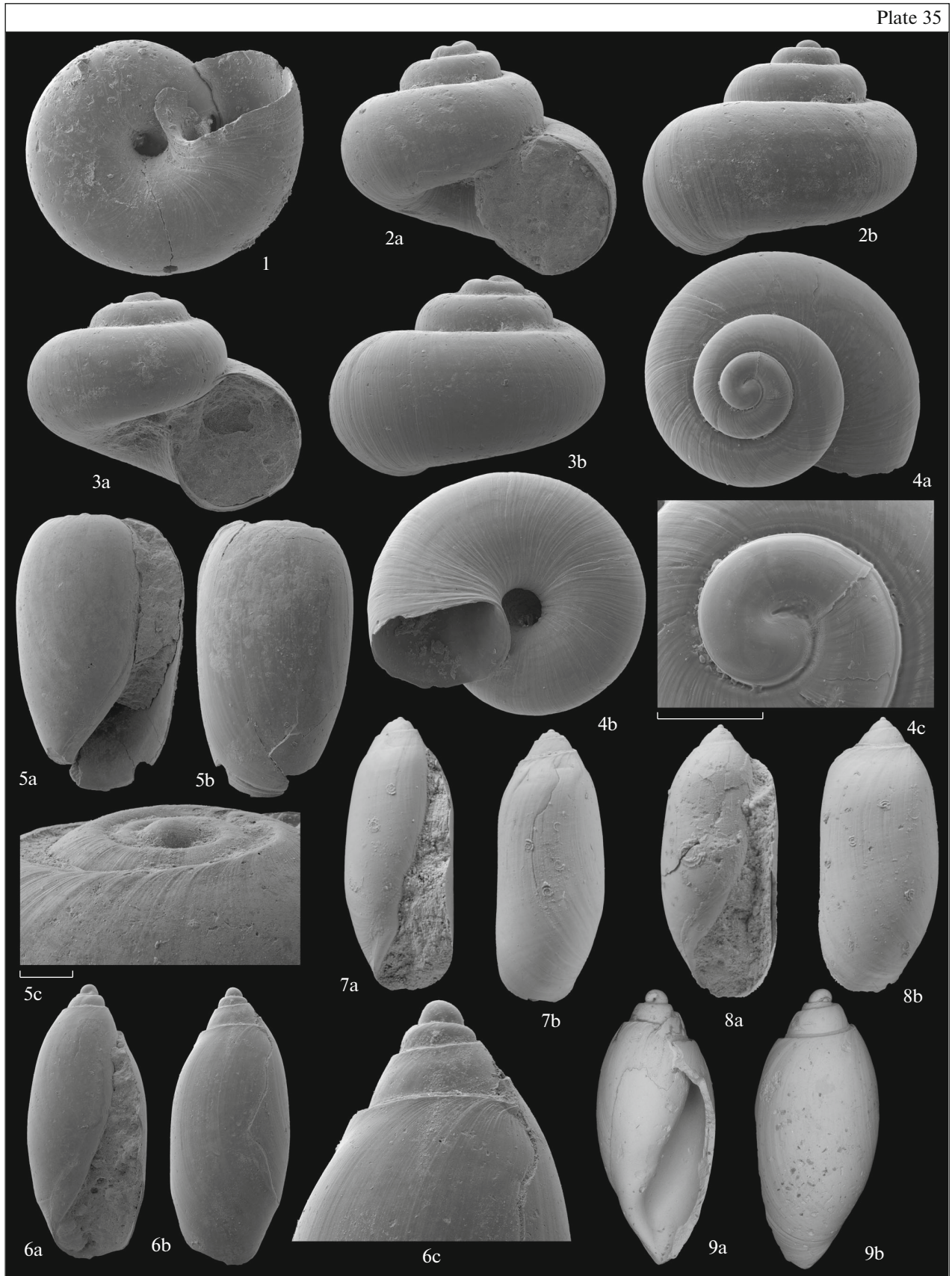
Material. Kurdzhips River: Outcrop 1A₀, sample 19A (74 specimens).

Superfamily Bulloidea Gray, 1827

The families Tornatinidae and Retusidae in Sarmatian have much in common in the strategy of morphological transformations, which is why they are associated with the same taxonomic problems. Both families are represented by single genera: *Acteocina* and *Retusa*. Their distribution across sections of Adygea is very uneven. *Retusa* plays a large role in the Lower Sarmatian, being one of the dominant taxa. *Acteocina* appears from the top of Member 7. Both genera remain numerous or not rare in the interval up to Bed 34 (with the exception of the “barren” interval of Beds 14–24), but they occur higher up as single specimens. They are not known from the *Pseudocaspia* Member, both genera reappear only in outcrops of group 1G.

Retusa is represented in the Lower Sarmatian of Adygea by the only species that initially (sample AU1) has a very consistent morphology: moderately elongated¹⁵ (for the genus) shell, with flat or weakly convex outline, with rounded, but sharp shoulder at the top of the whorl, with a weakly concave apex and weak growth lines. V.P. Kolesnikov attributed similar shells to the species *Bulla pupa* Eichwald, 1851 (Kolesnikov, 1934, pl. 33, figs. 25–27). Our form also corresponds to the only one syntype of *B. pupa* found in Eichwald’s collection (Pl. 36, fig. 9). Similar shells from the Neogene deposits of the Paratethys is now attributed to *R. truncatula* (Bruguière, 1792) (Berger, 1953; Papp, 1954; Švagrovský, 1971; Iljina, 1993). The basic morphotype of recent *R. truncatula* is a moderately elongated shell with a straight or slightly concave profile, a concave apex and growth lines enhanced to frequent and thin folds that start above the shoulder and descend down the whorl. However, there is also a certain variability associated with variation in the elongation of the shell, the coarseness of the growth lines and even the appearance of spiral striations. The similar morphology of *R. truncatula* is described and illustrated by Berger (1953) for the normally marine basins of the Central Paratethys. It is absent in the Middle and Upper Miocene of the Eastern Paratethys. The Tarkhanian contains moderately elongated shells with a straight or slightly concave profile. The surface of the shells is relatively rough depending on the coarseness of the growth lines, no wrinkling is observed. The coarseness of the growth lines decreases in the Lower Chokrakian, and the profile becomes straight or slightly convex. However, similar morphs are also found in the Central Paratethys and the Miocene Mediterranean (Berger, 1953; Landau et al., 2013). Peyrot (1933) recognized such shells as *Tornatina (Retusa) truncatuloides* Peyrot, 1933. It is also expected that the shift in the morphological norm in the Eastern Paratethys may be associated with a different geochemistry of the basin. A similar phenomenon was revealed by the author for the genus *Caecum*: an early Chokrakian unsculpted form described by Iljina (1993) as *C. banoni* Benoist, 1874, it evolved from the commonly concentrically sculptured morph of the same species. This transition can be traced in samples

¹⁵This refers to the shell height and diameter ratio.



← Explanation of Plate 35

Scale bar 200 µm. The dimensions of other shells are given in explanation.

Fig. 1. *Cornirostra anistratenkorum anistratenkorum* (Bandel, 2010), specimen PIN, no. 5621/180, diameter 1.9 mm, Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesanseris*.

Figs. 2–4. *Cornirostra anistratenkorum umbilicaris* subsp. nov., Kurdzhips River, Outcrop 1A₀, sample 19A, olistostrome, Lower Sarmatian block; (2) specimen PIN, no. 5621/181, height 1.7 mm: (2a) apertural view, (2b) abapertural view; (3) holotype PIN, no. 5621/182, height 1.6 mm: (3a) apertural view, (3b) abapertural view; (4) specimen PIN, no. 5621/183, diameter 1.65 mm: (4a) apical view, (4b) abapical view, (4c) protoconch.

Figs. 5–9. *Acteocina lajonkaireana* (Basterot, 1825): (5) specimen PIN, no. 5621/184 (morph *obtusa*), height 4.6 mm, Kurdzhips River, Outcrop 1A₀, sample 19A, olistostrome, Lower Sarmatian block: (5a) apertural view, (5b) abapertural view, (5c) apical part of shell; (6) specimen PIN, no. 5621/185 (morph *volhynica*), height 5.1 mm, Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesanseris*: (6a) apertural view, (6b) abapertural view, (6c) apical part shell; (7) specimen PIN, no. 5621/186 (morph *okenii*), height 11 mm, Belaya River, Bed 34, lower part of the beds with *C. pesanseris*: (7a) apertural view, (7b) abapertural view; (8) specimen PIN, no. 5621/187 (morph *okenii*), height 12.3 mm, Belaya River, assemblage 3, lower part of the beds with *C. pesanseris*: (8a) apertural view, (8b) abapertural view; (9) specimen PM SPbGU, no. 3/528a (syntype of *Alicula volhynica* Eichwald, 1830), height 3.2 mm, Ukraine, Ternopil Region, Zbarazh District, village of Zalistsi, Sarmatian: (9a) apertural view, (9b) abapertural view.

from the middle and upper Tarkhanian. However, the loss of rugosity does not occur in shells attributed to *R. truncatula* from Quaternary deposits and from the modern Black Sea (Milachewitch, 1916; Iljina, 1966; *Opredelitel'*, 1972). On the other hand, the East Paratethyan shells differ in the shape of the shell to a greater extent than the original Miocene species *R. truncatula*, which overcame the salinity barrier of the Eastern Paratethys.

There are large samples of *R. truncatula* in the interval of Beds 7–13, which show an increase in intraspecific polymorphism. The highest polymorphism was found in the sample BS9. Three morphological groups can be recognized here (Fig. 21). The first one (morphogroup *pupa*) is described above and is the most numerous (Figs. 21e–21g). The second group (morphogroup *elongata*) is the smallest, distinguished by a shell elongated in height, a more rounded bend at the top of the whorls, often a narrowed apical end of the shell, and a last whorl, which sometimes completely adapically obscures the previous whorls (Figs. 21a–21d). The third group (morphogroup *gerassimovi*) differs from the group *pupa* in having a sharp shoulder at the top of the whorls, increased growth lines to form wrinkles, and with a flat to concave whorl profile, especially near the adapical shoulder (Figs. 21h–21j). There is also a difference in shell size, which decreases according to the scheme: *elongata* → *pupa* → *gerassimovi* (also see below). The transition between *elongata* and *pupa* is smooth, whereas it is sharper between *pupa* and *gerassimovi*. The latter morph corresponds to the appearance of the species described by Kolesnikov as *Bulla gerassimovi* Kolesnikov, 1934. Specimens of *elongata* are not observed up the section, while specimens of *gerassimovi* are always present in the samples. It is quite possible that later *gerassimovi* evolved into a separate species, but this is not obvious in the beds with *Cryptomacra pseudotellina* and lower part of beds with *Cryptomacra pesanseris*, and the samples in the higher part of the Sarmatian on the Belaya River become insufficient to state its discreteness.

Retusa finds are scarce above Beds 14–24—most of the material comes from Bed 34, where the genus is represented by two morphogroups: *pupa* and *gerassimovi* in equal proportions. Notable is the appearance of specimens with a slightly protruding spire in *gerassimovi* in sample BS2 and in *pupa* from Outcrop 1C₁ (Pl. 37, fig. 4) is notable. Similar *pupa* are closest in appearance to Konkian specimen *R. melitopolitana* (N. Sokolov, 1899) (Text-fig. 22). N.A. Sokolov (1899) pointed out that *R. melitopolitana* also occurs in the Lower Sarmatian. Kolesnikov also attributed to this species part of the Lower and Middle Sarmatian material, including shells, transitional between *elongata* and *pupa* (Kolesnikov, 1934: pl. 33, figs. 21–24). According to our collections, it appears that the Sarmatian “*melitopolitana*” are only convergently similar to the Konkian, being a result of the morphogenesis of *R. truncatula* at the beginning of the Middle Sarmatian.

The genus *Acteocina* in Member 7 is represented by a variable species, which we define as *A. lajonkaireana* (Basterot), in which polymorphism and isolation of several morphological groups gradually increase. There is a few material from Member 8, but the species is already quite clearly divide into groups beginning the upper part of Member 9. They reach the greatest isolation at the level of sample BS9 (Bed 13), where they can no longer be lined up in one series of variability and two separate groups are distinguished. The first group includes the shells closest to *A. lajonkaireana*. In total, they are characterized by more fragile subcylindrical shells. They have a very low, slightly gradate spire, a groove with a mantle band, and a slow downward tapering of the shell (Text-fig. 23b–23d). Here I will refer to them as the morph *okenii*, since shells of this appearance were described as *Alicula okenii* Eichwald, 1830. Kolesnikov (1934) identified similar shells as *Bulla okeni*. The type material of *A. okenii* (Pl. 36, fig. 1) does not differ in appearance from *A. lajonkaireana*, which indicates its synonymy. The main difference between the Sarmatian *A. lajonkaireana* is the large size of adult shells (see below). Morph *okenii* is mixed in the sample BS9 with a small number

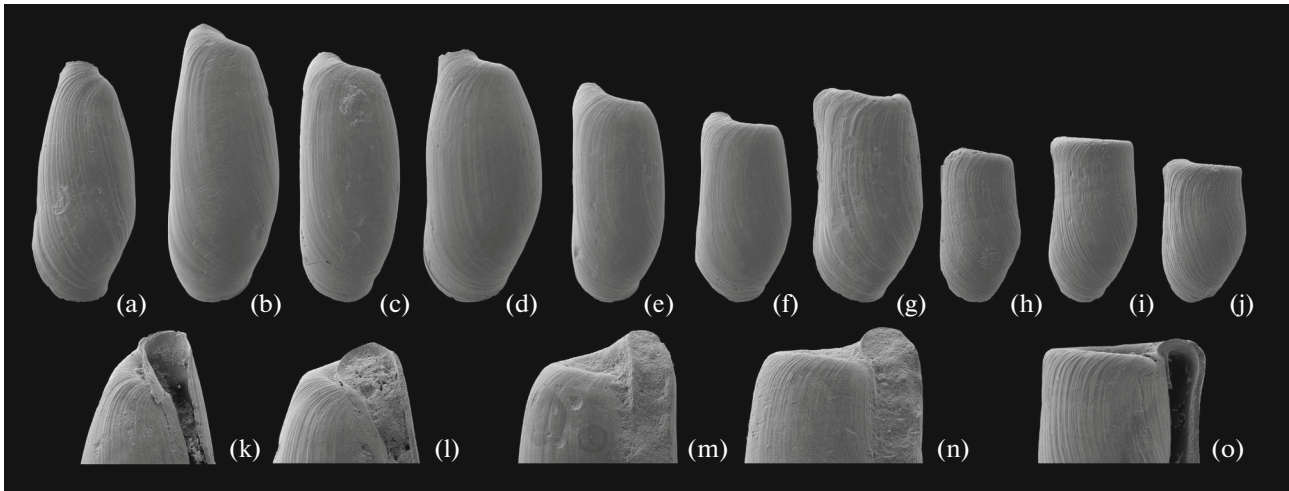


Fig. 21. Variability of *Retusa truncatula* in sample BS9: (a–d, k, i) morphogroup *elongata* (e–g, m, n) morphogroup *pupa* (h–j, o) morphogroup *gerassimovi*. Specimens: (a, k) specimen PIN, no. 5621/203, height 3.2 mm; (b, l) specimen PIN, no. 5621/204, height 3.7 mm; (c) specimen PIN, no. 5621/205, height 3.3 mm; (d) specimen PIN, no. 5621/206, height 3.35 mm; (e, m) specimen PIN, no. 5621/207, height 2.9 mm; (f, n) specimen PIN, no. 5621/208, height 2.5 mm; (g) specimen PIN, no. 5621/209, height 2.8 mm; (h) specimen PIN, no. 5621/210, height 2.05 mm; (i, o) specimen PIN, no. 5621/211, height 2.2 mm; (j) specimen PIN, no. 5621/212, height 1.9 mm. All specimens at the same scale.

of shells with a flat or even concave apex, with a mantle band (Fig. 23a). Described analogues of this morph have not been found (hereinafter referred to as the morph *obtusa*). There are transitions within the group.



Fig. 22. Previously unfigured syntype of *Cylichnina melitopolitana* N. Sokolov, 1899, Ukraine, Zaporizhzhia Region, Zaporizhzhia District, right bank of the Konka River, near the village of Yul'ivka, Konkian, Veselyanska Beds. Specimen TsNIGR Museum, no. 499/302, height 7 mm. Scale bar 500 μ m.

The second group of shells is more polymorphic (Figs. 23e–23h), within which no boundaries can be drawn. The history of the morphogenesis of this group in the interval below sample BS9 shows that the main trend is moving towards the rise of the spire. The shell becomes slenderer in this case. All shells of the second group in sample BS9 have a gradate spire, with an apical ramp without a mantle band. Brownish pigmentation is often observed along the inner edge of the ramp. Shells with the highest spire (Fig. 23h) are similar to the species described by Kolesnikov as *Bulla intacta* Kolesnikov, 1934, while morphs with lower spire (Figs. 23e–23g) are more similar to *B. pseudourupensis* Kolesnikov, 1934. Therefore, the group can be conditionally divided into two corresponding morphs: *typica* with appearance corresponding to Kolesnikov's *B. pseudourupensis*, and *turris*, corresponding to his *B. intacta*. If *typica* usually has a more pronounced whorl tapering downwards, then *turris* more often has a whorl shape closer to a cylindrical one. The sample also contains a few shell morphs of *turris* with rapidly tapering whorls, which makes them particularly similar to the species described by Kolesnikov as *Bulla monstrosa* Sinzow, 1875. It may have originated from similar specimens of *turris*. Due to the division of *Acteocina* from Beds 9–13 into two discrete morphological groups, the related morphs are considered here as two separate species: *okenii* and *obtusa* morphs as *A. lajonkaireana*, and *typica* and *turris* as *A. pseudourupensis*.

The large sample of *Acteocina* comes only from Bed 34 in the section above the barren interval of Beds 14–24. Here, the size differentiation between the larger *A. lajonkaireana* and the smaller *A. pseudourupensis* is already clearly visible. New morphotypes also

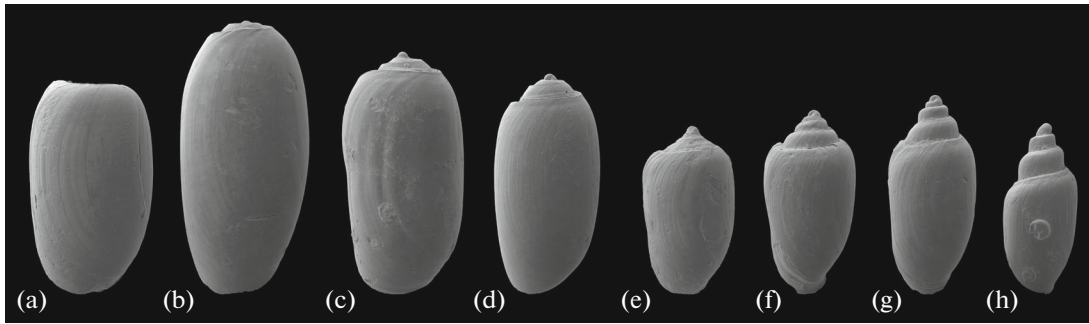


Fig. 23. Variability of *Acteocina lajonkaireana* and *Acteocina pseudourupensis* in sample BS9: (a–d) *A. lajonkaireana* morphs: (a) *obtusa* and (b–d) *okenii*; (e–h) morphs of *A. pseudourupensis*: (e–g) *typica* and (h) *turris*. Morph *obtusa* of *A. lajonkaireana* is represented by very rare specimens in the sample; most high-spined *okenii*, as in (21d), are few; predominate shells are shown in (21b–21c). Shells of *Acteocina pseudourupensis* shells shown in (21e) are the least common, while those shown in (21f–21g) are dominant. Shells of the morph *obtusa* are less common than the latter, but their proportion is still significant: (a) specimen PIN, no. 5621/213, height 4.2 mm; (b) specimen PIN, no. 5621/214, height 5.4 mm; (c) specimen PIN, no. 5621/215, height 4.75 mm; (d) specimen PIN, no. 5621/216, height 4.35 mm; (e) specimen PIN, no. 5621/217, height 3.25 mm; (f) specimen PIN, no. 5621/218, height 3.6 mm; (g) specimen PIN, no. 5621/219, height 4 mm; (h) specimen PIN, no. 5621/220, height 3.35 mm. All specimens are in the same scale.

appear. These are slenderer shells in *A. lajonkaireana* (Pl. 35, fig. 6). The species *Alicula volhynica* Eichwald, 1830 is closer to them, but the found syntypes are not so gracile (Pl. 35, fig. 9). The shell of *A. pseudourupensis* no longer narrows down so much, which is why the morphs are more consistent with Kolesnikov's diagnosis of the species. A shortened form with cylindrical whorls and a low, strongly gradate spire also appears (Pl. 36, fig. 8)—hereinafter the morph *dolium*. Single *Acteocina* shells, collected higher to section, up to the *Pseudocaspia* Member, are not extending beyond the described morphs. The genus again reappears only in outcrop 1G₄, where it is represented by the forms described by Kolesnikov as *Bulla sinzovi* Kolesnikov, 1934, *B. intacta*, *B. okeni*, and *B. pseudourupensis*. That is, these are mostly the same forms that I also recorded at the base of the beds with *C. pesanseris*.

I would like to touch upon the problem of the origin of the Sarmatian Bulloidea with raised spires at the end of the morphological review. We must return for this to the genus *Retusa*. I have pointed out the appearance in *Cryptomactra* Beds of *Retusa* with a protruding spire. A few *Retusa*, collected above the *Cryptomactra* beds, in outcrop 1G₄, correspond to the appearance of *Retusa usturtensis* (Eichwald, 1851)¹⁶ in the interpretation of Kolesnikov (1934). There are also numerous *Retusa* from the Miroshnikov Shchel Creek (Krasnodar Krai, Krymsk District), which are consistent in appearance with the shells from the Belaya River. *Retusa* from creek are also collected above the *Cryptomactra* facies, from an overburden of calcarenites and sandstones of the upper Middle Sarmatian. Almost all samples are represented by shells with protruding spire, and in some shells the spire is higher than in *Acteocina* of the morph *intacta*. *Retusa* with a flat apex is represented by a few specimens (corresponding to

R. enikalensis (Kolesnikov, 1934)). The variety of other morphs is great and noticeably exceeds what is reflected in the literature. Found shells correspond in

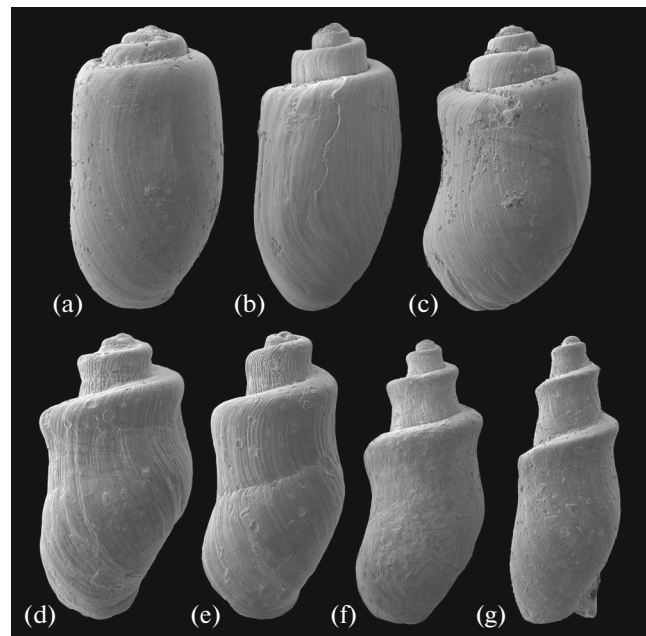


Fig. 24. Variability of *Retusa* with spire from calcarenites of the upper part of the Middle Sarmatian (Krasnodar Krai, Krymsk District, village of Sauk-Dere, Miroshnikova Shchel' Creek). Shell in (21a) may derived of the morphogroup *pupa*, whereas shells (21d–21g) are similar to those of morphogroup *gerassimovi*; other shells could have equally evolve from either morphogroup: (a) specimen PIN, no. 5621/221, height 4.15 mm; (b) specimen PIN, no. 5621/222, height 5.4 mm; (c) specimen PIN, no. 5621/223, height 5.1 mm; (d) specimen PIN, no. 5621/224, height 5.2 mm; (e) specimen PIN, no. 5621/225, height 4.1 mm; (f) specimen PIN, no. 5621/226, height 3 mm; (g) specimen PIN, no. 5621/227, height 3.2 mm.

¹⁶The type material of the species was lost.



Fig. 25. Giant shell of *R. truncatula* of 15 mm high (specimen PIN, no. 5621/228). Ukraine, Mykolaiv Region, Voznesens'k District, in the vicinity of Voznesens'k, Middle Sarmatian.

morphology to *Retusa usturtensis* according to Kolesnikov (1934) and Simionescu and Barbu (1940), *B. plicatilis* according to Simionescu and Barbu (1940), as in *Retusa plicatilis* (Sinzow, 1877) (Sinzow, 1877; Kolesnikov, 1934), but without the concavity of the whorls and coarse growth lines. There are also high-spined shells with strongly concave whorls (Text-fig. 24). Moreover, there is impression that this is an extremely polymorphic species, into which there are intermediate forms in the samples between most of the indicated types. According to the literature, wide distribution in basin is revealed only for the form *usturtensis* in Kolesnikov's interpretation. It is reported from the western and central parts of the Middle Sarmatian Sea, while *R. plicatilis* is known only from Sinzow's collections from the Middle Sarmatian of Chişinău and it is probably a rather rare form (*B. plicatilis* in Simionescu and Barbu, 1940 is *R. usturtensis*). The material from Miroshnikova Shchel' is dominated by morphs unknown from the Sarmatian, which are probably mostly the result of the morphogenesis of the morphogroup/species *gerassimovi*, limited in distribution by *Cryptomactra* facies.

The maximum elevation of the spire in *Acteocina* leads to the appearance of shells, described as *A. intacta*, which are widespread in the western and central parts of the Middle Sarmatian Sea. The protrusion of the spire in *Retusa* and *Acteocina* is one example of parallelism in morphogenesis of Sarmatian gastropods. A similar trend in trochids led to the formation of the genera *Sinzowia* and *Kishinewia*. This

trend began and ended earlier in *Acteocina* than in *Retusa*, leading to *intacta*-like shells as early as the beginning of the Middle Sarmatian. The trend started a little later for *Retusa*, but continued throughout the Middle Sarmatian, resulting in a much higher elevation of the spire. It should also be noted that the morphological basis of the genera was different, since initially *A. lajonkaireana* has a weakly protruding spire, while *R. truncatula* has it sunk into the apex.

Another interesting aspect is the sizes of the Sarmatian Bulloidea. They are distinguished by their large size, and this applies to both genera. Modern species of *Retusa* of the World Ocean have sizes of adult shells mainly in the range of 3–5 mm, whereas *Acteocina* has 5–12 mm, but usually no more than 9–10 mm. Modern *R. truncatula* reaches 5 mm in height, while *A. lajonkaireana* in the Miocene of France reaches 4 mm (Peyrot, 1933). Early Chokrakian *A. lajonkaireana* reached 3.5–4 mm; *R. truncatula*—up to 2.5 mm. Tarkhanian specimens are few in number, represented by fragile shells, difficult to extract without destroying the outer whorls. However, they were repeatedly observed by the author in the bed, on average, the shell is somewhat smaller than the Lower Chokrakian ones. There are no data on the size of Konkian shells of these species. According to Berger (1953), the Badenian *R. truncatula* was up to 3.5–4 mm, while the Lower Sarmatian subspecies *sarmatica* and *pappi* identified by him were up to 2.5 mm. Berger paid attention to the change of *A. lajonkaireana* in the Badenian–Sarmatian interval. He drew up a visual diagram (ibidem: p. 108), which shows how the maximum size of the species changes: if the Badenian shells were 3.5–4 mm in height, then the lower Sarmatian ones reach 12 mm (subspecies *A. lajonkaireana maxima* Berger, 1953). Jekelius (1944) gave similar figures for the Lower Sarmatian species. Defined by him species reach a height: *Bulla lajonkaireana* up to 12 mm, *Bulla convoluta* Brocchi, 1814 (=mixture of shells *Acteocina* and *Retusa*) up to 3 mm, *Bulla truncatula* up to 2.5 mm. Kolesnikov (1934) gives the largest dimensions for his *Bulla okeni*—up to 14 mm, indicating that the shell reaches such dimensions in the Middle Sarmatian. Its other species of *Acteocina* (like *B. inflexa*, *B. urupensis*, *B. usturtensis*, *B. sinzovi*, *B. intacta*) are up to 7–10 mm in size. The sizes of *Retusa* species are on average lower, although a large dispersal of numbers remains. Shells identified by Kolesnikov reach a height: *Bulla gerassimovi* of 9 mm, *B. melitopolitana*—7 mm, *B. pupa* and *B. plicatilis*—4.5 mm, *B. enikalensis*—3 mm. However, there is a significantly larger *Retusa*, with a shell up to 15 mm (Fig. 25). Thus, there are two features: great variability in the size of adult shells and anomalously large sizes of Sarmatian representatives in both genera. The Sarmatian *Acteocina* only occasionally exceed the size of the shells of large modern species, but a threefold increase occurs compared to the original Badenian *A. lajonkaireana*. A similar picture in the lineage of the Badenian–Sarmatian *Retusa* is with increasing in five times that, making the Sar-

matian species the largest in the history of the genus. This gigantism is a parallelism to a similar phenomenon in large hydrobiids.

However, the gigantism of Bulloidea differs from that of hydrobiids, as collections in the Sarmatian of Adygea show. If the increase of *Hydrobia/Turricaspia* in the size of adult shells was the same for all shells of the species at each stage of morphogenesis, then here we encounter a wide dispersal in the size of terminal shells. *R. truncatula* from the lowest sample AU1 (Lower Sarmatian, Aul'chik Gully) has height of shells up to 3–3.5 mm. Variability in shell height increases further up in the section, as polymorphism grows. The morphogroup *pupa* in sample BS9 has a height of up to 3.2 mm, the morphogroup *gerassimovi* up to 2.2, occasionally up to 2.8 mm, and the morphogroup *elongata* has the highest shell of 3.4–3.8 mm. Shells of morph *elongata* reach 4–5 mm high in the sample BS13. These are the limit sizes for samples, or the sizes in the sample are smaller. However, at the same time, shells of *Retusa* of the morphogroup *pupa* up to 9 mm are known from assemblage 6. A similar situation is apparent for *Acteocina*. Height of adult shells is 4.5–5 mm in sample BS14, larger shells in sample BS11 are up to 6 mm high and more (broken off). Height reaches to 3.5–4 mm (morphogroup *intacta*) and 4.5–6 mm (morphogroup *okenii*) in sample BS9. At the same time, single larger specimens are known: with 8 mm high (morph *okenii*) from assemblage 6, the largest shells in assemblage 3 and 4 are 12.5 and 11 mm in height, respectively, also of the morph *okenii*. It is noteworthy that all the largest shells above Assemblage 5 belong to this morphotype. While differences in size between morphogroups can be interpreted, the status of rare hypertrophied shells remains unclear. Is there any other biological basis behind this gigantism?

A few words about supraspecific taxa proposed to clarify the taxonomy of the Sarmatian Bulloidea. Korobkov (1955) introduced two new subgenera for the Sarmatian opisthobranchian mollusks: *Cylichna (Sarmatocylichna)* with the type species *Bullina usturtensis* Eichwald, 1851 and *Acteocina (Sarmatina)* with the type species *Bulla intacta* Kolesnikov, 1934. I consider their recognition unnecessary. The situation is more complicated with the genus *Alicula* Eichwald, 1830. It was proposed in the narrative text with a brief diagnosis and comparison, without specifying the type or typical species (Eichwald, 1830, p. 214). It included (without indicating synonymy) in the order of mention in the text: *A. okenii* Eichwald, 1830, *A. lichtensteinii* Eichwald, 1830, and *A. volhynica* Eichwald, 1830. According to ICZN recommendation 69A9, the type species is considered here to be the first cited species by the original author, which is *A. okenii*. It is now generally regarded as a subspecies of *Acteocina lajonkaireana* (Basterot, 1825). *A. volhynica* is usually considered synonymous with *A. lajonkaireana* or its subspecies *okenii*. *A. lichtensteinii* was not mentioned in the literature for a long time after Eichwald, but in

our opinion, this form arises from the divergence of *A. lajonkaireana* in Sarmatian. It appears that *Alicula* Eichwald, 1830, being a valid and available name, is a senior synonym of *Acteocina* Gray, 1847. However, I am not aware of any publications¹⁷ where the name *Alicula* was used, including publications by Eichwald, who later assigned the corresponding species to the genus *Bullina* (Eichwald, 1851, 1853). At the same time, the name *Acteocina* was and is actively used as a taxonomic unit, the number of such works is in the hundreds. Therefore, according to ICZN Article 23.9.2, it is proposed to consider *Alicula* Eichwald, 1830 as a *nomen oblitum* and give priority to the junior synonym *Acteocina* Gray, 1847 as a *nomen protectum*.

The species descriptions below are compiled according to the material that comes from the published interval. The discussed material from the lower part of the section was not taken into account in the diagnosis. Synonyms given for Sarmatian interval only. Here it is necessary to note some details. The Lower Sarmatian forms corresponding to the species *A. lajonkaireana* and *A. pseudourupensis* (as a morph *typica*) in the current interpretation are considered as components of the species *A. lajonkaireana*, since according to our materials their separation has not yet occurred. The Middle Sarmatian forms, more characteristic of the morph *typica*, are indicated under question in the synonymy of *A. pseudourupensis*, since neither the photographs nor the text can establish the nature of the ramp (whether the mantle band is developed). Such images in most cases are omitted in synonymy. The type material of *A. intacta* Kolesnikov, 1934 may come from a higher interval of the Middle Sarmatian, where the form could already be separated from *A. pseudourupensis*, which makes its inclusion in the synonymy conditional. The synonymy of *R. truncatula* does not include the *R. truncatula sarmatica* Berger, 1953 (Berger, 1953, p. 91, pl. 16, fig. 20; Papp, 1954: p. 59, pl. 10 fig. 2) with shortened shells and a form described as *Bulla convoluta* (Simionescu and Barbu, 1940, p. 128, pl. 6, figs. 50, 51; Jekelius, 1944, pl. 26, figs. 8–10), with convex whorls and a flat apex. Both morphotypes not is found in the samples of *R. truncatula* from Adygea. But it is clear that there is a transition to a more elongated form, according to the series of *R. truncatula sarmatica* shells illustrated by J. Švagrovský (1971, p. 417, pl. 72, figs. 10–13). *A. eichwaldi* (Kolesnikov, 1934) (Kolesnikov, 1934, p. 291, pl. 33, figs. 16–19), also reported from the *Cryptomactra* Beds, is very similar in shell appearance to the morph *typica*, but differs in the presence of a selenizone, according to Kolesnikov's description, a feature that is always absent in the examined

¹⁷Cossmann (1895, p. 100) used *Alicula* Eichwald, 1830 with the type species *Bulla cylindrica* Helbling, 1779 (non Gmelin), thereby synonymizing it with *Alicula* Ehrenberg, 1831. This interpretation of *Alicula* Eichwald, 1830 is incorrect and cannot be used.

A. pseudourupensis. The species *A. sinzovi* (Kolesnikov, 1934) (*ibid.*, p. 290, text-fig. 38, pl. 33, fig. 20) is not included in the synonymy of *A. lajonkaireana*, since a similar form was found in Outcrop 1G₄. There it clearly differs from the accompanying *A. lajonkaireana* in its thin-walled shell and flat apex. *R. enikalensis* (Kolesnikov, 1934) was encountered by me only above the *Cryptomactra* Beds (Krymsk District) and the shell shape repeats *R. truncatula sarmatica*.

Family Tornatinidae P. Fischer, 1883

Genus *Acteocina* Gray, 1847

Acteocina lajonkaireana (Basterot, 1825)

Plate 35, figs. 5–9; Plate 36, fig. 1

- Alicula okenii*: Eichwald, 1830, p. 214.
Alicula volhynica: Eichwald, 1830, p. 214.
Bullina okeni: Eichwald, 1851, p. 146, pl. 11, fig. 17; 1853, p. 307, pl. 11, fig. 17.
Bullina volhynica: Eichwald, 1851, p. 146, pl. 11, fig. 18; 1853, p. 308, pl. 11, fig. 18.
Bullina lajonkaireana: Eichwald, 1851, p. 147; 1853, p. 309.
Bulla lajonkaireana: Hörnes, 1856, p. 624, pl. 50, fig. 9; Simionescu, 1902, p. 28, pl. 12, fig. 15; Laskarev, 1903, p. 103, pl. 5, figs. 34, 35; Kolesnikov, 1934, p. 285, text-fig. 33, pl. 33, figs. 1–4; Simionescu and Barbu, 1940, p. 126, pl. 6, figs. 54–56, ? figs. 52, 53; Jekelius, 1944, p. 90, pl. 26, fig. 1–7; Tudor, 1955, p. 105, pl. 8, fig. 69.
Bulla (Cyllichna) lajonkaireana: Laskarev, 1903, p. 103, pl. 5, figs. 34, 35.
Tornatina okeni: Friedberg, 1928, p. 540, pl. 35, fig. 12.
Tornatina okeni var. *buhlovensis*: Friedberg, 1928, p. 540, pl. 35, figs. 13, 14.
Tornatina lajonkaireana var. *volhynica*: Friedberg, 1928, p. 543, pl. 35, fig. 17.
Tornatina lajonkaireana: Friedberg, 1928, p. 542, pl. 35, fig. 16; Böhm, 1934, pl. 2, fig. 16; Krach, 1952, p. 9, pl. 1, figs. 17–20.
Bulla reseniensis: Kolesnikov, 1934, p. 286, pl. 33, figs. 5–7.
Bulla okeni: Kolesnikov, 1934, p. 288, pl. 33, figs. 8–10; Moiescu, 1955, p. 216, pl. 20, figs. 14, 15.
Bulla inflexa: Kolesnikov, 1934, p. 289, text-fig. 36, pl. 33, figs. 11–13.
Bulla urupensis: Kolesnikov, 1934, p. 290, text-fig. 37, pl. 33, figs. 14, 15.
Tornatina lajonkaireana var. cf. *buhlovensis*: Böhm, 1934, pl. 2, fig. 17.
Tornatina okeni: Krach, 1952, pl. 1, figs. 21, 23.
Tornatina cf. *inflexa*: Krach, 1952, p. 10, pl. 1, figs. 26, 27.
Tornatina urupensis?: Krach, 1952, p. 11, pl. 1, figs. 24, 25.
Acteocina lajonkaireana lajonkaireana: Berger, 1953, p. 104, pl. 17, figs. 54–61; Papp, 1954, p. 59, pl. 10, figs. 4–7; Boda, 1959, pp. 628, 725, pl. 32, figs. 6, 7, 13–18; Koyumdzhieva, 1969a, p. 117, pl. 39, figs. 9–11, 14, 15; Švagrovský, 1971, p. 406, pl. 71, figs. 1–6; Nicorici, 1971, p. 231, pl. 7, figs. 19–22; Papp, 1974, p. 354, pl. 11, figs. 3–7; Özsayar, 1977, p. 68, pl. 12, figs. 7, 8; Filipescu et al., 1999, pl. 3, fig. 21; Ionesi et al., 2005, pl. 3, fig. 13, pl. 17, fig. 21; Ionesi, 2006, p. 203, pl. 6, fig. 10.
Acteocina lajonkaireana okeni: Berger, 1953, p. 105, pl. 17, fig. 62, pl. 20, fig. 96; Papp, 1954, p. 61, pl. 10, fig. 8; Boda, 1959, p. 629, 725, pl. 32, fig. 8, 9; Švagrovský, 1971, p. 412, pl. 71, fig. 13–15; Ionesi and Țăbără, 2004, pl. 4, figs. 11, 12; Ionesi et al., 2005, pl. 3, fig. 14, pl. 17, fig. 22; Ionesi, 2006, p. 204, pl. 6, fig. 11.
Acteocina lajonkaireana ventricosa: Berger, 1953, p. 105, pl. 20, figs. 97, 98; Papp, 1954, p. 60, pl. 10, fig. 9; Papp, 1974, p. 355, pl. 11, fig. 8.

Acteocina lajonkaireana maxima: Berger, 1953, p. 106, pl. 20, figs. 99, 100; Papp, 1954, p. 60, pl. 10, fig. 11; Spajić, 1966, pl. 4, fig. 13; Papp, 1974, p. 355, pl. 11, figs. 10, 11.

Acteocina lajonkaireana sinzovi: Berger, 1953, p. 106, pl. 20, fig. 101; Papp, 1954, p. 60, pl. 10, fig. 10; Boda, 1959, pp. 629, 726, pl. 32, fig. 10–12; Papp, 1974, p. 355, pl. 11, fig. 9.

Acteocina lajonkaireana sinzovi: Švagrovský, 1971, p. 410, pl. 71, figs. 7–12; Ionesi B. and Ionesi V., 1972, pl. 4, fig. 3–5; Ionesi et al., 2005, pl. 3, fig. 15, pl. 17, fig. 23; Ionesi, 2006, p. 204, pl. 6, fig. 12.

Acteocina (Acteocina) lajonkaireana: Korobkov, 1955, text-fig. 185.

Acteocina lajonkaireana: Švagrovský, 1959, pl. 12, fig. 8; *Osnovy*, 1960, text-fig. 700; Švagrovský, 1964, pl. 21, fig. 6; Spajić, 1966, pl. 1, fig. 5; Zelinskaya et al., 1968, p. 237, pl. 53, figs. 14, 15; Ionesi B. and Ionesi V., 1972, pl. 3, figs. 37–40, pl. 4, figs. 1, 2; Fordinál and Zlinská, 1994, pl. 12, fig. 9; Zlinská and Fordinál, 1995, pl. 25, fig. 4; Harzhauser and Kowalke, 2002, pl. 13, figs. 18, 19; Lukeneder et al., 2011, fig. 4; Tamaş et al., 2013, p. 78, fig. 4h; Mikuž and Križnar, 2015, p. 222, pl. 1, figs. 1–5.

Acteocina okeni: Zelinskaya et al., 1968, p. 238, pl. 53, figs. 19, 20.

Acteocina reseniensis: Zelinskaya et al., 1968, p. 238, pl. 53, figs. 21, 22.

Acteocina (Acteocina) lajonkaireana lajonkaireana: Rado, 1971, pl. 5, fig. 127.

? *Tornatella minuta*: Baily, 1858, p. 147, pl. 10, fig. 7.

? *Tornatella inflexa*: Baily, 1858, p. 147, pl. 10, fig. 8.

Description. Minute, paucispiral anomphalous shells, having up to four teleoconch whorls and up to 12.5 mm high. The elongation of the shell is about 1.9–2.1, rarely up to 2.3. The protoconch is transaxial, about a whorl long, densely covered with microsculpture of transverse ridges and pits. The demarcation with the teleoconch is clear and even, with a line of growth interruption. Teleoconch whorls from flattened to slightly convex. The subsequent whorl almost completely overlaps the previous whorls. The maximum width of the shell is usually at the top of the whorl. The whorls tend to taper downwards slowly, with a rounding at the base. The apex is flat to with low spire, having a straight or slightly gradate profile. The whorl are rounded off apically to form a narrow ramp. It is grooved with a mantle band, rarely a selenizone develops with a delay. Growth lines are bent sharply backward at the outer edge of the ramp, below which they have a prosocyrct direction. They make an opisthocyrct loop on mantle band. The aperture has thin outer and inner lips. The inner lip often has a brownish pigmentation, reflected on the whorl surface as a more or less wide band. The outer lip has a prosocyrct shape. The aperture is narrow, strongly dorsoventrally elongated, wider anteriorly, with a rounded anterior margin. Posterior joint of the lips is acute-angled, usually with a relatively deep notch directed backwards, often with the formation of a mantle slit.

Variability. Brief characteristics of morphs:

Obtusa. Elongated oval shell with slightly concave to flat apex. Whorls from flattened to convex, with a maximum width at the top. Ramp with a mantle band along its inner margin, the outer part of the ramp is even or convex. The downward taper of the whorls varies. An example of the morph in Pl. 35, fig. 5 (the

appearance of a mantle band from the middle of the teleoconch is visible).

Okenii. Elongated oval, subcylindrical shell with low spire, with a straight or slightly gradate profile. The whorls are flattened, with maximum width at the top, slightly tapering downwards. There is a mantle band located on the ramp in a groove (Pl. 35, figs. 7, 8).

Volhynica. Fusiform shell with maximum elongation (up to 2.3), with a low non-gradate spire. Whorls uniformly convex, with a maximum width closer to the middle. Ramp in the form of a groove with a mantle band in it (Pl. 35, fig. 6).

Comparison. The species differs from *A. pseudourupensis* in more brittle shells with a lower spire, development of a mantle band, and with an angular posterior notch in aperture.

Occurrence. Lower and Middle Sarmatian; throughout the sea basin.

Material. Belaya River: Bed 34 (8 specimen—*okenii*, *volhynica*) sample BS3 (8 specimens—*okenii*, *volhynica*), assemblages 3 (3—*okenii*) and 4 (1 specimen—*okenii*); Kurdzhips River: outcrops 1A₀, sample 19A (4 specimens—*obtusa*), 1B₁ (1 specimen—*okenii*), 1B₂ (2 specimens—*okenii*).

Acteocina pseudourupensis (Kolesnikov, 1934)

Plate 36, figs. 2–8

Bulla pseudourupensis: Kolesnikov, 1934, p. 296, text-fig. 42, pl. 33, figs. 46, 47.

Tornatina intacta: Krach, 1952, p. 11, pl. 1, figs. 1–3.

Cylichna pseudourupensis: Zelinskaya et al., 1968, p. 236, pl. 53, fig. 5.

Acteocina lajonkaireana: Ali-Zade, 1974, p. 121, pl. 45, figs. 9–11.

? *Bulla intacta*: Kolesnikov, 1934, p. 298, text-fig. 35, pl. 33, figs. 34, 35.

? *Bulla lajonkaireana*: Simionescu and Barbu, 1940, pl. 6, figs. 40, 41.

? *Bulla okeni*: Simionescu and Barbu, 1940, pl. 6, fig. 57.

? *Bulla inflexa*: Volkova, 1955, pl. 10, figs. 10, 11.

? *Acteocina (Sarmatina) intacta*: Korobkov, 1955, text-fig. 186.

? *Acteocina inflexa*: Volkova, 1974, pl. 24, figs. 10, 11; *Osnovy*, 1960, pl. 27, fig. 19.

Description. Minute oval and elongated oval paucispiral anomphalous shells, having up to four teleoconch whorls and up to 6 mm high. Shell elongation is from 1.8 to 2, usually about 2. The protoconch is transaxial, about whorl long, densely covered with microsculpture of transverse ridges and pits. The demarcation with the teleoconch is clear and even, with a line marking growth arrest. The teleoconch whorls are usually flattened and slowly tapering downwards, rarely slightly convex and more rapidly tapering downwards. Subsequent whorls are very strongly embrace the previous ones. The maximum width of the shell is at the top of whorl, rarely a little lower. The apex is with a low spire, more or less gradate in outline. The whorls round off at the top to form a narrow subhorizontal ramp. The ramp is slightly convex to flat, without mantle band, often with dark coloration. The

growth lines are prosocyrty below the ramp, relatively strongly deviate backwards on it. The aperture with thin outer and inner lips. The inner lip often has a brownish pigmentation, reflected on whorl surface as a more or less wide band. The outer lip has a prosocyrty shape. The aperture is narrow, strongly dorsoventrally elongated, wider anteriorly, with a rounded posterior margin. The joint of the lips is acute-angled posteriorly, without a notch directed backward.

Variability. Brief characteristics of morphs:

Turris. Elongated oval shell with the highest gradate spire. Elongation is 2–2.2. Maximum whorl width is at the top (Pl. 36, figs. 6, 7).

Typica. Elongated oval shell with a low triangular slightly gradate spire. Elongation is 2–2.3. Whorls from flattened to convex, with a maximum width at the top or slightly below (Pl. 36, figs. 2–5).

Dolium. Oval shell with low gradate spire. Elongation is 1.8–2. The whorls are flattened, with a maximum width at the top (Pl. 35, fig. 7).

Occurrence. Middle Sarmatian of Western Ukraine, Ciscaucasia, Azerbaijan, ? Moldova.

Material. Belaya River: Bed 34 (11 specimens—*typica*, *turris*) samples BS3 (46 specimens—all morphs), BS2 (6 specimens—*typica*, *dolium*), BS1 (1 specimen—*typica*), 11A (1 specimen—*typica*), assemblages 3 (2 specimens—*typica*) and 5 (1 specimen—*typica*); Kurdzhips River: Outcrop 1B₃ (1 specimen—*typica*).

Family Retusidae Thiele, 1925

Genus *Retusa* T. Brown, 1827

Retusa truncatula (Bruguière, 1792)

Plate 36, figs. 9–10; Plate 37, figs. 1–8

Bulla pupa: Eichwald, 1851, p. 145, pl. 11, fig. 16; Eichwald, 1853, p. 306, pl. 11, fig. 16; Kolesnikov, 1934, p. 293, text-fig. 40, pl. 33, figs. 25–27; Krach, 1952, p. 12, pl. 2, figs. 11–14; Volkova, 1955, p. 28, pl. 13, fig. 9.

Bulla lajonkaireana: Toula, 1892, pl. 6, fig. 13.

Bulla (Cylichna) truncata: Laskarev, 1903, p. 104, pl. 5, fig. 33.

Tornatina truncatula: Friedberg, 1928, p. 544, pl. 36, figs. 1, 2.

Bulla melitopolitana: Kolesnikov, 1934, p. 292, text-fig. 39, pl. 33, figs. 21–24; Krach, 1952, p. 13, pl. 2, figs. 10, 29.

Bulla gerassimovi: Kolesnikov, 1934, p. 294, text-fig. 41, pl. 33, figs. 28–30.

Bulla truncatula: Simionescu and Barbu, 1940, p. 129, pl. 6, figs. 44, 45; Jekelius, 1944, p. 90, pl. 26, figs. 13–16.

Bulla convoluta: Jekelius, 1944, pl. 26, figs. 11, 12.

Retusa (Retusa) truncatula pappi: Berger, 1953, p. 91, pl. 16, fig. 19; Papp, 1954, p. 58, pl. 10, fig. 1; Papp, 1974, p. 357, pl. 11, fig. 1.

Retusa (Retusa) truncatula sarmatica: Berger, 1953, pl. 16, fig. 21; Papp, 1954, p. 59, pl. 10, fig. 3.

Retusa truncatula: Boda, 1959, pp. 628, 725, pl. 32, fig. 5; Zelinskaya et al., 1968, p. 234, pl. 52, figs. 23, 24; Ionesi B. and Ionesi V., 1972, pl. 4, figs. 6–10; Lukeneder et al., 2011, fig. 4X; Tămaş et al., 2013, p. 78, fig. 4h.

Cylichna enikalensis: Zelinskaya et al., 1968, p. 235, pl. 53, figs. 1, 2; Ali-Zade, 1974, p. 122, pl. 45, fig. 15; Özsayar, 1977, p. 69, pl. 12, fig. 11.

Explanation of Plate 36

Scale bar 200 μm , except for (1c) 500 μm . The dimensions of other shells are given in explanation.

Fig. 1. *Acteocina lajonkaireana* (Basterot, 1825), specimen PM SPbGU, no. 3/524b (syntype of *Alicula okenii* Eichwald, 1830), height 4.1 mm, Sarmatian¹⁸: (1a) apertural view, (1b) abapertural view, (1c) apical part of shell.

Figs. 2–8. *Acteocina pseudourupensis* (Kolesnikov, 1934): (2) Belaya River, Bed 41, sample 11A, lower part of the beds with *C. pesansensis*; (3–4, 6–8) Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesansensis*; (5) Kurdzhips River, Outcrop 1B₂, middle part of the beds with *C. pesansensis*. (2) specimen PIN, no. 5621/188 (morph *pseudourupensis*), height 4.25 mm: (2a) apertural view, (2b) apical part of shell; (3) specimen PIN, no. 5621/189 (morph *pseudourupensis*), height 6.2 mm: (3a) apertural view, (3b) abapertural view, (3c) apical part of shell; (4) specimen PIN, no. 5621/190 (morph *pseudourupensis*), height 3.6 mm; (5) specimen PIN, no. 5621/191 (morph *pseudourupensis*), height 4.8 mm: (5a) apertural view, (5b) abapertural view, (5c) apical part of shell; (6) specimen PIN, no. 5621/192 (morph *intacta*), height 3.5 mm: (6a) apertural view, (6b) abapertural view; (7) specimen PIN, no. 5621/193 (morph *intacta*), height 4 mm: (7a) apertural view, (7b) abapertural view, (7c) apical part of shell; (8) specimen PIN, no. 5621/194 (morph *dolium*), height 3 mm: (8a) apertural view, (8b) abapertural view, (8c) apical part of shell.

Figs. 9–10. *Retusa truncatula* (Bruguière, 1792): (9) specimen PM SPbGU, no. 3/521 (syntype of *Bulla pupa* Eichwald, 1851), height 2.75 mm, Kazakhstan, Ustyurt Plateau, Middle Sarmatian: (9a) apertural view, (9b) abapertural view, (9c) apical view; (10) specimen PIN, no. 5621/195 (morph *usturtensis*), height 4.15 mm, Belaya River, assemblage 3, lower part of the beds with *C. pesansensis*: (10a) apertural view, (10b) abapertural view.

Cylichna melitopolitana: Zelinskaya et al., 1968, p. 236, pl. 53, figs. 3, 4; Özsayar, 1977, p. 69, pl. 12, fig. 12; Ionesi et al., 2005, pl. 3, fig. 17.

Cylichna pupa: Zelinskaya et al., 1968, p. 236, pl. 53, figs. 6, 7; Volkova, 1974, p. 100, pl. 20, fig. 9.

Cylichna (Cylichna) melitopolitana: Korobkov, 1955, text-fig. 180; Koyumdzhieva, 1969a, p. 119, pl. 40, figs. 3–7.

Retusa truncatula truncatula: Iliescu et al., 1968, p. 153, pl. 39, fig. 5; Švagrovský, 1971, p. 414, pl. 72, figs. 1–6.

Retusa truncatula pappi: Švagrovský, 1959, pl. 12, fig. 7; Švagrovský, 1964, pl. 21, fig. 5; Švagrovský, 1971, p. 419, pl. 72, figs. 7–9; Ionesi et al., 2005, pl. 3, fig. 16.

Retusa truncatula sarmatisa: Özsayar, 1977, p. 69, pl. 12, fig. 13.

Description. Small subcylindrical paucispiral anomphalous shells are from 2.5 to 7.5 mm high. The maximum width of the shell is in the lower half, while higher it to some extent narrows. Shell elongation ratio varies from 1.8 to 2.1, but usually 2. The protoconch is transaxial and short, mostly hidden by subsequent teleoconch whorls. Its microsculpture consists of chaotically located ridges, elongated transversely to the whorl, and large rounded pores. The teleoconch composed of flat or slightly concave whorls, completely enclosing preceding whorls. The apex is usually slightly concave or flat, sometimes with a slightly projected gradate spire. A narrow horizontal ramp is developed at the top of the whorl, below it passes into the vertical side of the whorls through a relatively sharp rounded bend. The shoulder may appear as a spiral rim on shells with a concave whorls profile. There are only growth lines on the surface of the whorls: they are opisthocyrt on the ramp and become prosocyrt below the shoulder. They vary greatly in coarseness: from mild to intensified to the state of narrow folds. The aperture is strongly elongated in height, flask-shaped, with thin lips, rounded and wide anteriorly and narrow and long posteriorly, with a rounded adapical joint of the lips. The upper part of the aperture may more or

less strongly rise above the preceding whorl. It usually forms adapically a rounded structure, which is wider than the aperture below, when such rise is high.

Variability. The species can be divided into two main morphogroups in the studied interval: *pupa* (Pl. 36, fig. 10; Pl. 37, figs. 2–4) and *gerassimovi* (Pl. 37, figs. 5–8). *Gerassimovi* is less variable group, characterized by shells usually 2.5–3 mm high, rarely to 4 mm (Outcrop 1B₂), usually with a concave profile of the whorls, the sharpest shoulder and coarse growth lines unlike the pupa. *Pupa* is more polymorphic in composition. The common features for its representatives are flat whorls, a less sharp rounded bend, weakly expressed growth lines, and the absence of a separate rounded posterior part of the aperture. At the same time, the character of the narrowing of the shell towards the apex varies significantly in *pupa*. The adapical part of the shells of both morphogroups varies from concave to having a rudimentary spire. In addition, there are shells that combine features of both morphogroups.

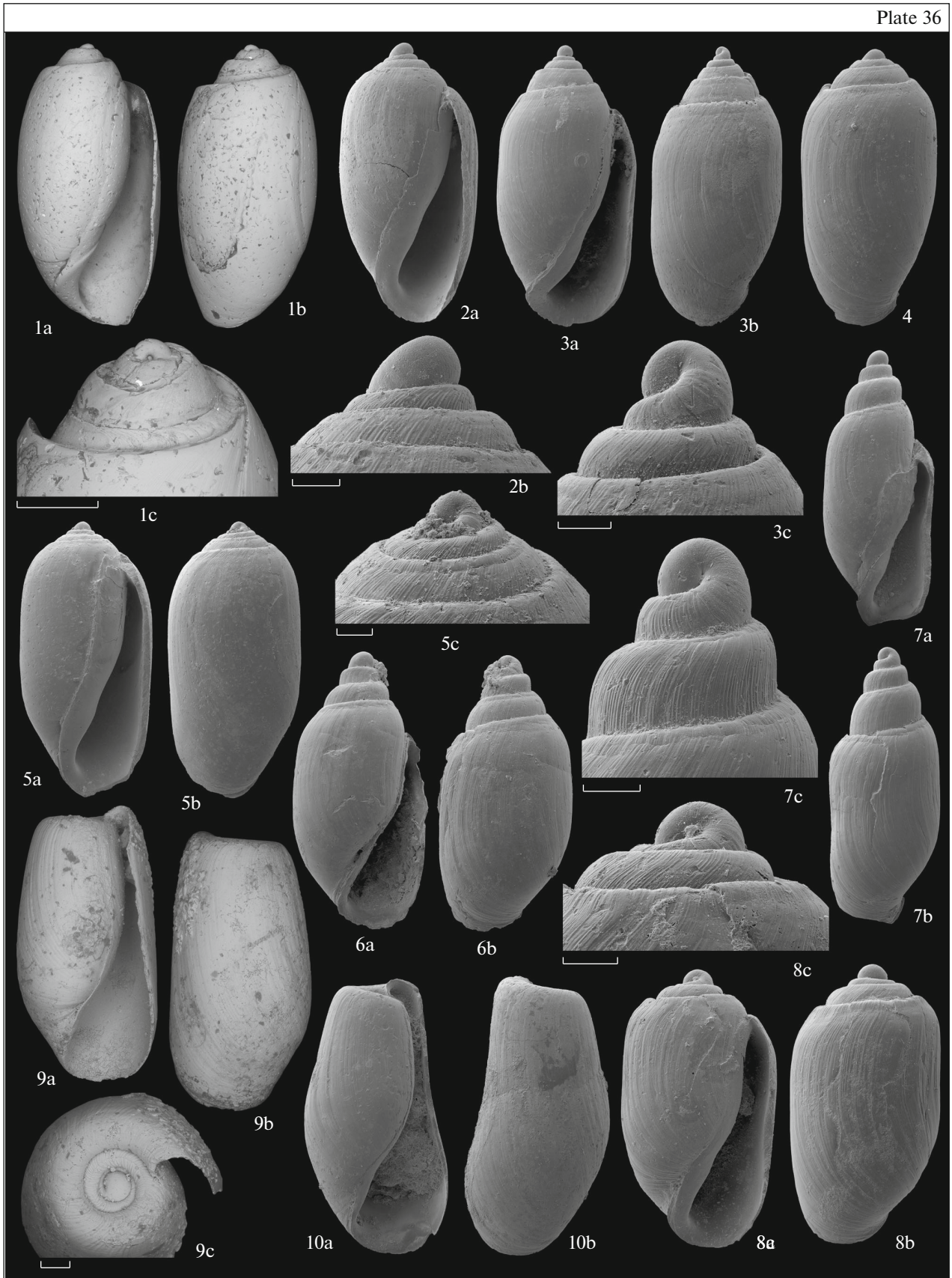
Occurrence. Lower and Middle Sarmatian; throughout the marine basin.

Material. Belaya River: samples BS3 (31 *gerassimovi* + 24 *pupa*), BS2 (6 *gerassimovi* + 4 *pupa*), BS1 (3 *gerassimovi* + 1 *pupa*), 11A (1 *gerassimovi* + 2 *pupa*), assemblages 4 (1 *gerassimovi* + 5 *pupa*) and 3 (1 *pupa*); Kurdzhips River: outcrops 1A₀, sample 19A (17 *gerassimovi*), 1A₁, sample 10A (1 *gerassimovi*), 1B₂ (1 *gerassimovi*), 1C₁ (5 *pupa*).

GASTROPODS: MORPHOGENESIS AND COMMUNITIES

This chapter is divided into two parts: in the first, the nature of morphological transformations in various supposed phylogenetic lineages of gastropods is outlined. Their description also takes into account preliminary data on the collections of 2018, which for the most part go beyond the stratigraphic framework of the material processed for the paper and significantly amend and clarify the phylogenetic relationships of gastropods in the studied stratigraphic inter-

¹⁸Two places are indicated on the label to the original: Chişinău (Moldova) and Kuncha (Ukraine, Khmelnytskyi Region, Teofipol' District). The middle Sarmatian is distributed in Chişinău, while Laskarev (1914, p. 210) indicated the Lower Sarmatian for the village of Kuncha.



val. For the latter, the nature of the morphological changes is discussed in more detail and also considered in the descriptions of taxa. The second part of the chapter presents statistics on samples processed from the *Cryptomacra* Beds.

*General Comments on Phylogeny
and Morphogenesis of Gastropods*

Family Trochidae. Two species are assigned to the genus *Gibbula* in the studied interval: *G. urupensis* (Uspenskaja) and *G. proluxa* (Volkova). *G. urupensis* is frequently found in the *Cryptomacra* Beds from Bed 26 on the Belaya River and occurs occasionally in *Pseudocaspia* Member to Outcrop 1E₃ on the Kurdzhips River. The species was not found below Bed 26. However, Beds 11–13 yielded a new trochid species with a shell of smooth rounded whorls and a strongly reduced ribbed stage. Seven percent of its shells have a rounded angularity or a rudimentary keel, which brings them closer to *G. urupensis*. The same species from Member 9 has no such specimens. Finally, unusual shells of *G. urupensis* were found in sample BS5, which by its hydrobiid assemblage correlates with the interval of Beds 14–24 on the Belaya River. They are distinguished by a reduced ribbed stage and a weakly developed keel or rounded angularity at a growth stage, at which the later *G. urupensis* has a well-shaped keel. Thus, the shell from BS5 appears to be an intermediate link between the smooth trochid from Beds 9–13 and true *G. urupensis*. At the same time, Member 4 contained two shells almost indistinguishable from *G. urupensis* with a longer ribbed stage. Thus, there is a form that may turn out to be a “heterochronous twin” of *G. urupensis*. A gradual shortening of the ribbed stage is observed in the interval of the main *G. urupensis* finds (above the level of Bed 33). It is noticeable only when comparing *urupensis* from the lower *Cryptomacra* Beds and from the upper part of the *Pseudocaspia* Member. *G. proluxa* is known only by single finds from upper interbeds with nodules on the Belaya River (assemblages 3 and 4). Its origin is still debatable, however, a potential predecessor was found in Member 8.

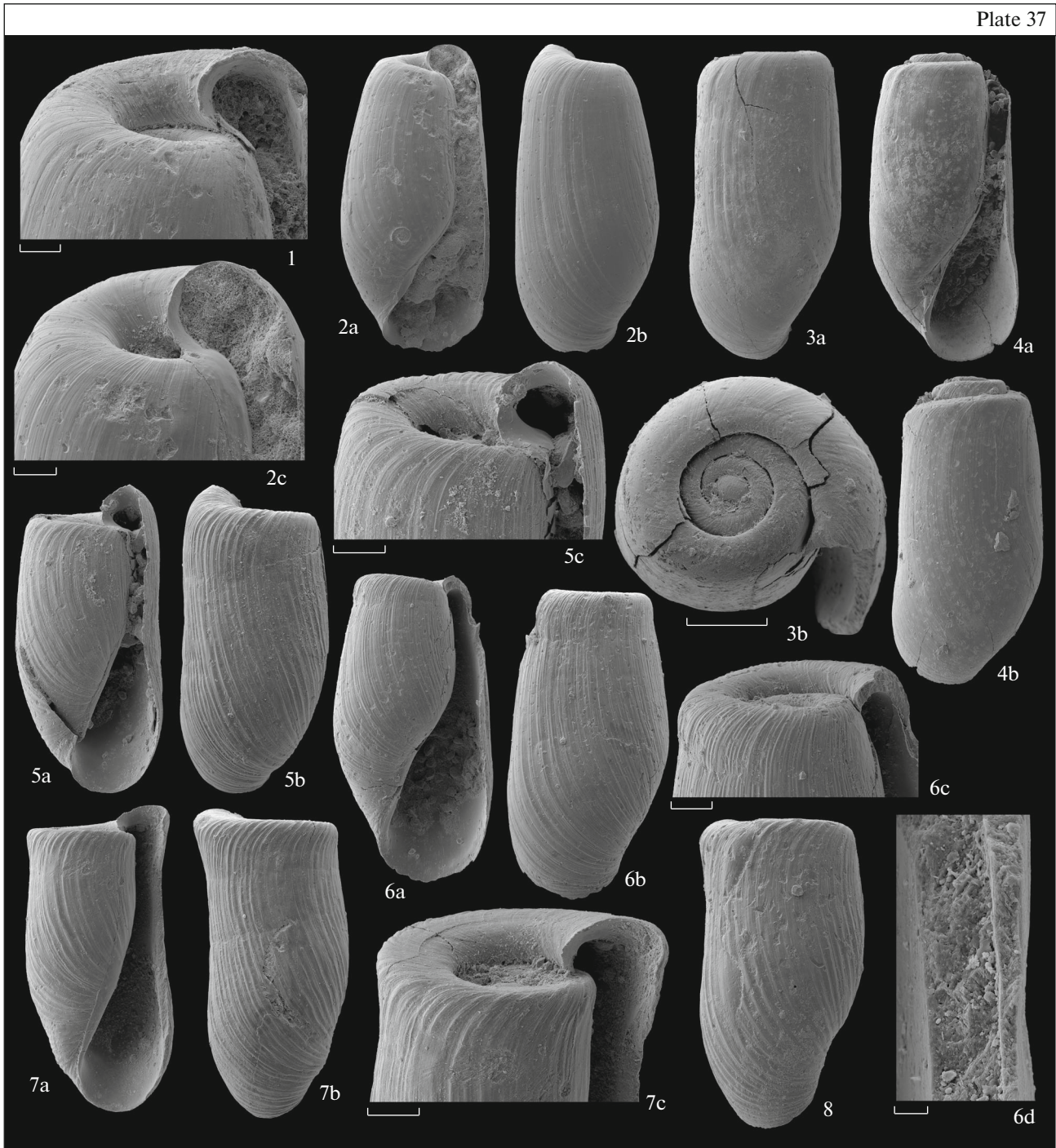
Kolesnikoviella minor appeared at the beginning of the Middle Sarmatian. Beds 9–13 yielded shells that vary greatly in the spire and sculpture. The variation lies in the degree of slenderness of the spire and the height of the spiral and collabral sculpture. The morph with the most elevated spire and the prominent sculpture is the starting point for the future species *minor*. Finds of *Kolesnikoviella* shells higher up in the section are sporadic and represented by very juvenile specimens, but it can be seen that there is an archaic ancestral variant with lower spire and well-developed but unsharp sculpture, juvenile shells, well-isolated from them, with higher spire, high and sharp sculpture, even blade-like keel (samples BS2 and BS3). Here it is already clearly visible that the morph *minor* is separated from the ancestral form and develops towards

increasing the prominence of sculpture. In 2018, numerous shells of late *minor* shells were collected from the upper part of the Middle Sarmatian, which is distinguished by an even higher keel, acquiring an undulating character, as in *K. blainvillei*. Probably, *blainvillei* developed in parallel from the same ancestral form, but under conditions of shallow water facies.

Family Hydrobiidae. Members of the family are the most significant in assemblages, they account for the largest number of specimens in samples. They are represented by several phylogenetic lineages (Fig. 26).

The earliest *Edrozeba* on the Belaya River are found in the middle part of Member 7. The roots of *Edrozeba* go back to the Early Sarmatian. Probably, *E. caeca* originated from *E. sarmatica* (Jekelius), found at a lower level in the Aul’chik Gully. The splitting of *Edrozeba* into four morphogroups began at the very base of the *Cryptomacra* Beds (Beds 9–13).

The first leads to the separation of *E. striata*, through some increase in size and the formation of a conical-triangular shell shape and the development of spiral sculpture. The second morphogroup leads to the isolation of *E. enikalensis* through the increase and elongation of the shell. This is also accompanied by a change in the microsculpture of the protoconch, while in *E. striata* it remains unchanged. The third morphogroup is a dead end, which occupies an intermediate position between *E. caeca* and the predecessor of *E. enikalensis*, characterized by wide, conical, smooth, short shells with rapidly growing whorls. This morphogroup is not observed above Bed 26. The original line of *Edrozeba* continues after the separation of the species. It is represented by a highly variable *E. caeca* at the very base of the *Cryptomacra* Beds, transforming higher into the morphologically more consistent, always smooth and, on average, more low-spined *E. minuta*. All spirally ribbed forms first disappear in the process of transition, they are no longer in sample BS2, then the reduction of polymorphism continues due to a decrease in variability in the shell length, coiling angle, whorl shape and growth rate of whorls. These changes continue throughout the section on the Belaya River above the member with nodule horizons, while samples on the Kurdzhips River are encountered with only little variability. *E. minuta* from Outcrop 1C₂ has a more low-spined and smaller shell. Separation of the lineages of *E. striata* and *E. enikalensis* from the species *E. caeca* occurs somewhere in the interval of Beds 14–24, since they are already discrete above. Above in section, lineages are characterized by *E. striata* and *E. enikalensis*, respectively, which are preceded by rapid morphological transformations. Subsequently, the species *E. angulata* separates from *E. enikalensis*. The transition is associated with the development of an angular bend on the whorl. *E. angulata* is traceable to the upper Middle Sarmatian, where the late *angulata* differs from that of the lower horizons by the flattening of the whorls above the bend due to subsequent reduction of the keel-like bend.



Explanation of Plate 37

Scale bar 200 μm , except (3b) 500 and (6d) 20 μm . The dimensions of other shells are given in explanation.

Figs. 1–8. *Retusa truncatula* (Bruguière, 1792): (1) Belaya River, assemblage 3, lower part of the beds with *C. pesansensis*; (2, 5–8) Belaya River, Bed 34, sample BS3, lower part of the beds with *C. pesansensis*; (3–4) Kurdzhips River, Outcrop 1C₁, middle part of the beds with *C. pesansensis*. (1) specimen PIN, no. 5621/195 (morph *pupa*), apical part of shell; (2) specimen PIN, no. 5621/196 (morph *pupa*), height 3.7 mm: (2a) apertural view, (2b) abapertural view, (2c) apical part of shell; (3) specimen PIN, no. 5621/197 (morph *pupa*), height 3.65 mm: (3a) abapertural view, (3b) top view; (4) specimen PIN, no. 5621/198 (morph *pupa*), height 3.65 mm: (4a) apertural view, (4b) abapertural view; (5) specimen PIN, no. 5621/199 (morph *gerassimovi*), height 2.3 mm: (5a) apertural view, (5b) abapertural view, (5c) apical part of shell; (6) specimen PIN, no. 5621/200 (morph *gerassimovi*), height 2.9 mm: (6a) apertural view, (6b) abapertural view, (6c) apical part of shell, (6d) structure of the shell wall in the adapical part of the outer lip (the whorl surface on the right side); (7) specimen PIN, no. 5621/201 (morph *gerassimovi*), height 2.4 mm: (7a) apertural view, (7b) abapertural view, (7c) apical part of shell; (8) specimen PIN, no. 5621/202 (morph *gerassimovi*), height 2.1 mm.

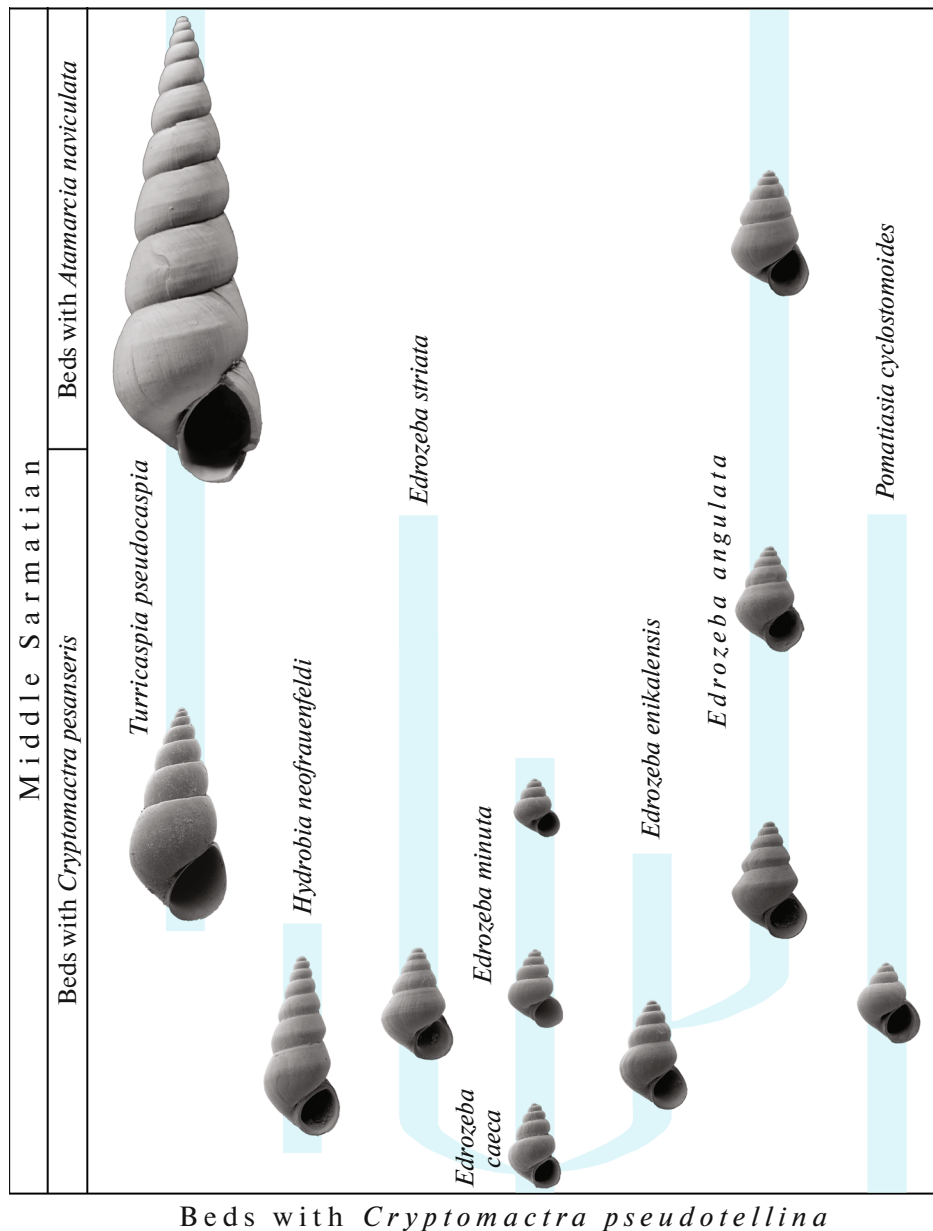


Fig. 26. Scheme of evolution and stratigraphic distribution of hydrobiids based on materials from the Belaya River basin. Different stages of morphogenesis are additionally illustrated within some species. All shells are drawn to the same scale.

The lineage of the genus *Pomatiasia* can be traced from the same stratigraphic level as the lineage of the genus *Edrozeba*. *Pomatiasia* is represented by a single variable species, *P. cyclostomoides*, the uppermost records of which come from Outcrop 1C₇. The earliest known *P. cyclostomoides* are shells described by Jekelius (1944) from the Lower Sarmatian of Romania under the name *Valvata carasiensis*. Its appearance is based on more high-spired and narrow umbilicated shells, which is also characteristic of the earliest *P. cyclostomoides* from the Belaya River. High-spired and narrow umbilicated shells with coarser sculpture clearly predominate in the samples, collected below the Beds with *Cryptomacra pseudotellina*, while the role of naticoid shells increases

above. Shells were found in the upper Middle Sarmatian, which can be considered as a new morphological stage in the development of the *P. cyclostomoides* lineage.

Separate lineages that do not show branching are the lineage of the genera *Hydrobia* and *Turricaspia*. According to the collection data of 2018, the *Hydrobia* lineage is traced from Member 9 in the section on the Belaya River to Outcrop 1B₂ and consists of two stages: it is a shortened and dwarf form in Beds 9–13, which begins to lengthen and increase towards the end of the indicated interval, changing in the stage of *H. neofrauenfeldi* somewhere before Bed 26. The lowest *H. pseudocaspia* was found in an interbed with nodules in Outcrop 1B₂, but

the first mass occurrence is in Outcrop 1B₃. This form has the greatest distribution in the entire *Pseudocaspia* Member and continues to dominate among gastropods in the upper Middle Sarmatian. There is a gradual enlargement of the shell throughout the interval, which in the upper Middle Sarmatian reaches a maximum value, which is similar to the size of shells in the type series of the species. Probably, this trend also took place in older deposits, as evidenced by even smaller shells of *T. pseudocaspia* from the Novoalekseevskaya Borehole (Stavropol Krai), which, based on the assemblage of other hydrobiids, can be dated to the interval between Beds 12 and 34 of section on the Belaya River. The material from the borehole also shows that the lineage *Hydrobia* and *Turricaspia* were already morphologically distinct.

Family Nassariidae. The most morphologically diverse group is the genus *Akburunella* (Fig. 27). The genus *Duplicatula* is found in the Lower and lower Middle Sarmatian (before the beginning of the beds with *Cryptomacra pesanseris*), so is not discussed here.

The *Akburunella akburunensis* lineage can be traced back to the early Sarmatian. The oldest find comes from the Lower Sarmatian with *Abra reflexa* and *Obsoletiforma lithopodolica* from the Aulchik Gully and is represented by an as yet undescribed species, which in turn gives the following undescribed species collected from the Beds 9–13 interval on the Belaya River. *A. akburunensis* evolved from the latter through the transformation of collabral sculpture (it becomes much rarer and coarser). *A. akburunensis* was found in Adygea in the range from assemblage 5 in an outcrop on the Belaya River to Outcrop 1D₃ on the Kurdzhips River. The species goes through three stages of morphological transformations in this interval. Initially, forms with a significant reduction in spiral sculpture predominate. Subsequently, the role of forms increases with the strengthening of ribs (the interval of outcrops of groups 1B and 1C), and a sharp transformation of morphology, beginning with Outcrop 1C₇, occurs with the loss of spiral sculpture and the transformation of ordinary ridges into pointed or lamellar ridges.

The *Akburunella nefanda* lineage is rooted below *Cryptomacra* Beds, probably having an ornamented ancestor. The true *A. nefanda* evolved from the ancestral form collected in Beds 9–13, which is probably only convergent in morphology with *A. leiocncha*. The ancestral form is also collected in the upper reaches of the Aul Gully, which finds may be dated as interval of *Cryptomacra* Beds from Member 8 to somewhat below Bed 26 of the Belaya River section, based on the assemblage of accompanying forms. The topmost find is a single shell from assemblage 5 (in the section description listed as *A. aff. nefanda*), while assemblage 4 already contains *A. nefanda archaica*. The subspecies differs from the ancestral form by the appearance of ridges at the beginning of the teleoconch, while the ancestral form has no sculpture, only occasionally rudiments of sculpture of the *A. akburunensis* type appear on the initial whorls of the teleo-

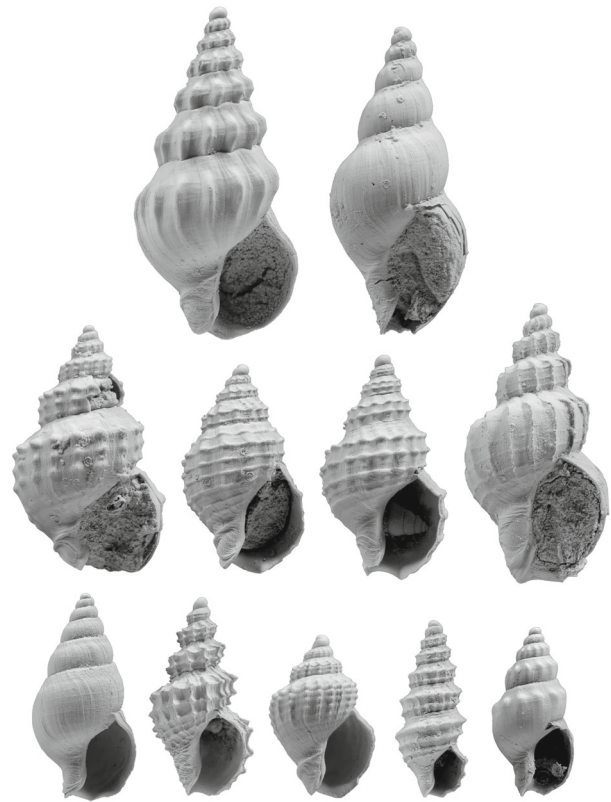


Fig. 27. Size classes and diversity of morphology of *Akburunella* from the *Cryptomacra* Beds of the Adyghean Sarmatian. Three size classes for the height of adult shells (from top to bottom): I class—up to 20 mm, II class—up to 16 mm, III class—up to 12 mm. Order of species by class (from left to right): top row—*A. akburunella*, *A. nefanda*; middle row—*A. spinosa*, *A. bosporana*, *A. enikalensis*, *A. laminaris* (m. *laminaris*); bottom row—*A. leiocncha*, *A. laminaris* (m. *muricata*), *A. carabunica*, *A. caucasuca*, *A. sinuosa*. **A. bosporana* was placed in class II according to Kolesnikov (1934). All shells are on the same scale.

conch. Also, the latter is characterized by a wider shell due to the rapidly growing late whorls in diameter, which becomes uncharacteristic in *nefanda archaica*. Further development of *A. nefanda* goes in the direction of increasing manifestation of collabral sculpture, which in later representatives (*A. nefanda nefanda*) from the upper part of *Cryptomacra* Beds reaches the last whorl, disappearing only at the gerontic stage.

The *Akburunella leiocncha* lineage is rooted in the Lower Sarmatian, the first single finds of which were made in Member 7, and it is massively represented in Member 9 and higher. *A. leiocncha* is poorly separated in Beds 9–13 from the ancestral form for *A. nefanda*, clearly differing only in size and shape whorls at adult shell. *A. leiocncha* and *A. nefanda* are already clearly distinguished in Bed 30. *A. leiocncha* is transformed above Bed 36: the shell becomes on average more low-spired, the whorls become more flattened, and a narrow ramp develops at the top of the whorls. Such specimens of *leiocncha* predominate from Bed 39 onward. The ramp is probably lost further

up. *A. leiiconcha* can be traced up to the *Pseudocaspia* Member.

Akburunella bosporana Group. It includes several species with similar morphology: *A. bosporana*, *A. spinosa*, *A. carabinica*, and *A. enikalensis*. *A. bosporana* and *A. carabinica*, in our opinion, descend from a single ancestor. Ancestral representatives of both species were found in Beds 9–13, differing from each other in the degree of development of sculpture, but otherwise very similar. The transition between the ancestral form from the base of *Cryptomactra* Beds and the true *A. bosporana* remains unclear due to the extreme rarity of the latter. *A. carabinica* comes from another ancestral form, through the development of sculpture and enlargement of the shell. *A. carabinica* is known from Bed 34, where specimens with archaic morphology are still admixed with it, and the species continues to occur in the interval up to Outcrop 1B₂. There is an increase in the number of spiral ribs below the ramp and the development of pointed ridges in the interval of Beds 34–39. *A. carabinica* is unknown in *Pseudocaspia* Member, but a new species *Akburunella* was found in the upper Middle Sarmatian, which can be considered a derivative of *carabinica*. It is distinguished by a partial reduction in sculpture and the disappearance the sharpness of ridges. The lineage of *A. spinosa* includes a rare species of the same name, the first representatives of which are known from Member 8. The origin of *A. enikalensis* is still unclear, but it may be descended from *A. bosporana* or *A. spinosa*. *A. enikalensis* is known in the *Cryptomactra* facies from single specimens in Outcrop 1C₂ and higher (but is first found in the sands of Outcrop 1B₃) and is most common in the upper Middle Sarmatian assemblages. Two morphogenetic stages are recognizable: an early stage with sharper sculpture, better defined ridges, shorter and taller tubercles, and a later stage characterized by well-developed but lower ribs, reduced ridges, lowering and lengthening of nodes along the ribs. The late stage can be traced from outcrops of group 1D and higher, while below, there was probably a rather rapid transition to the early stage, but the material is extremely scarce.

The first early representatives of the *A. caucasica* lineage were found in Member 8. They occur in the Member 9–Bed 13 interval together with a presumed ancestral species (new to science), which differs from the early *caucasica* with reduced sculpture in the form of a row of spines on the keel-like bend. *A. caucasica* undergoes several morphological transformations, which makes it possible to distinguish four successive morphological stages. The earliest *caucasica* from Beds 8–13 have somewhat smaller shells and weaker sculpture than the later form, collected above up to Beds 36. Above, there is a simplification and further strengthening of sculpture, which leads to the appearance of a morphotype with most widely spaced and sharp sculpture, distributed above Bed 36 to the *Pseudocaspia* Member, where the record of this lineage is interrupted. It is found again in the upper Mid-

dle Sarmatian, where a few found specimens have a morphology identical to that of specimens from Beds 30–36. Perhaps the last stage of morphogenesis is reversible. *A. sinuosa* are known from Member 9 and are possibly closely related to *A. caucasica*, descending from a common ancestral species.

The species *A. laminaris* differs from other *Akburunella* in shorter protoconch and lamellar collabral sculpture. It is known from rare finds from the beginning of the *Cryptomactra* Beds to the *Pseudocaspia* Member. The species is very polymorphic—it may turn out that active morphogenesis occurs in the specified interval with the separation on two species. The latter cannot be confirmed due to the paucity of material in the upper part of the distribution interval and due presence of the finds of transitional forms in its lower part.

Family Cornirostridae is represented by a single species, *Cornirostra anistratenkorum*. Here, only one trend can be identified that distinguishes the late *anistratenkorum* from the earliest representative of this taxon: the specimens from Member 8 and below are distinguished by a lower coiled and wider umbilicated shell than later representatives, as a result of which the earlier variant is recognized as the subspecies *C. anistratenkorum umbilicaris*. There is a change in the morphological norm towards more high-spined shells, named as *C. anistratenkorum* s.s., in Beds 9–13.

Family Retusidae. *Retusa* is originally represented by *R. truncatula* with consistent morphology (morphogroup *pupa*), collected in the Lower Sarmatian of Aul'chik Gully, in Beds 2–5 on the Belaya River. Morphological variability within the species increases in Member 7, which leads in the interval of Beds 9–13 to the formation of the morphogroups *elongata*, *pupa*, and *gerassimovi*. The role of *Retusa* in assemblages decreases sharply higher in the section, so that they are known from only a few shells for most of the interval up to the *Pseudocaspia* Member. The morphogroup *elongata* is no longer present there, but *pupa* and *gerassimovi* are represented almost equally. The first *pupa* and *gerassimovi* also appear with a slightly raised spire. Above, the genus is known from Outcrop 1G₄, where only *R. usturtensis* is represented.

Family Acteocinidae. *Acteocina* is known from Member 7, where it is already represented by the rather polymorphic species *A. lajonkaireana*, from which the species *A. pseudourupensis* separates above, in Beds 9–13. More high-spined shells appear, in turn, in *pseudourupensis*, which are combined into the morph *turris*. The role of *Acteocina* in the communities drops sharply higher up section, but the sample from Bed 34 shows that morphogenesis continues. The genus is known from rare finds above Bed 34 up to the *Pseudocaspia* Member. *Acteocina* appears again in outcrops 1G₂–1G₄, where it is represented by the same forms as in the lower part of the *Cryptomactra* Beds. Additionally there is a species identified as *A. sinzovi*, which evolved from *A. lajonkaireana*.

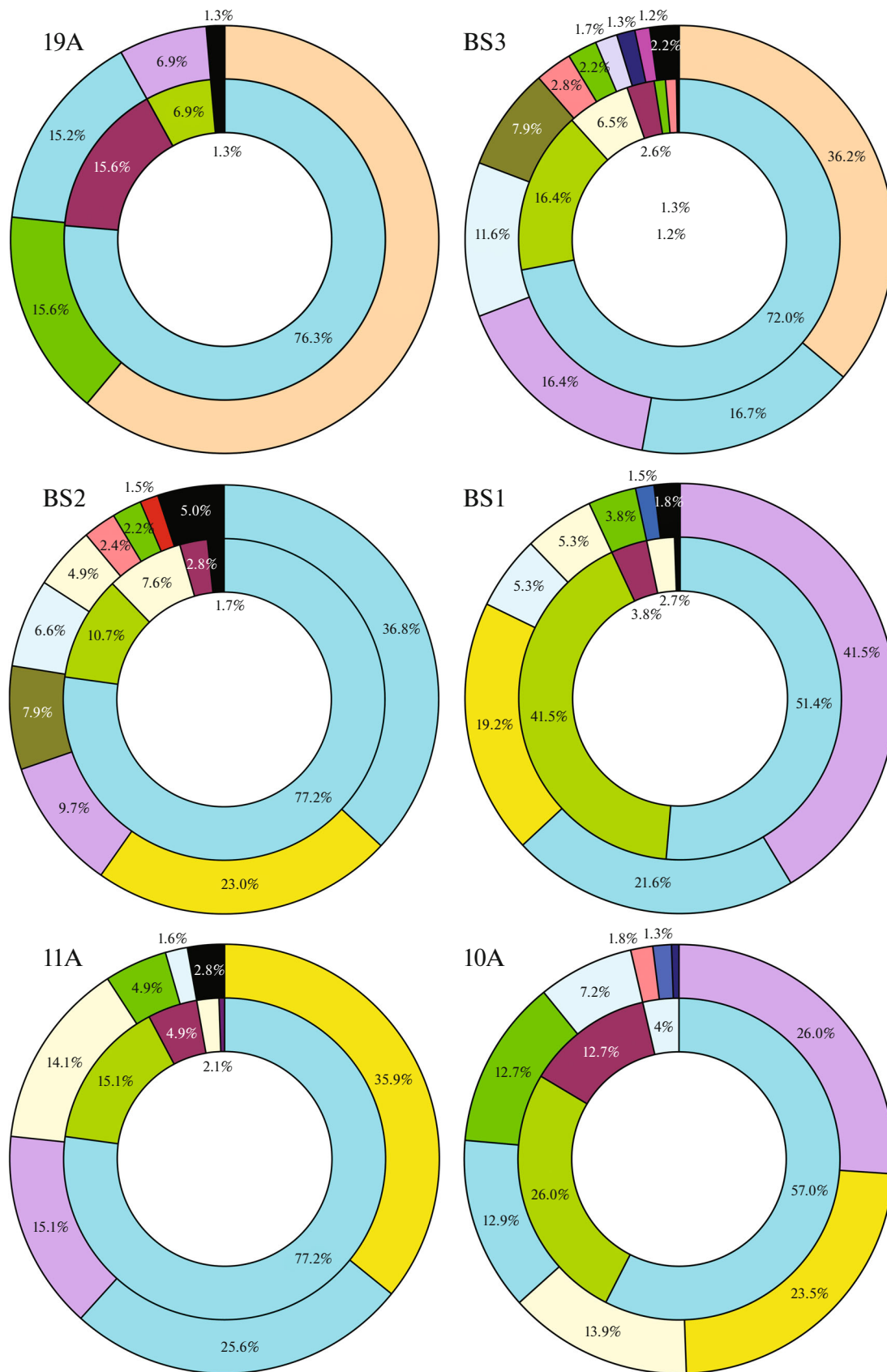


Fig. 28. Ring diagrams of the composition of gastropod communities. The outer ring shows the proportion of species, the inner ring shows the proportion of families in the communities taken from the samples (by the number of shells). Samples 19A (3660 specimens), BS3 (5700 specimens), BS2 (1140 specimens), BS1 (1120 specimens), 11A (760 specimens), 10A (1640 specimens).

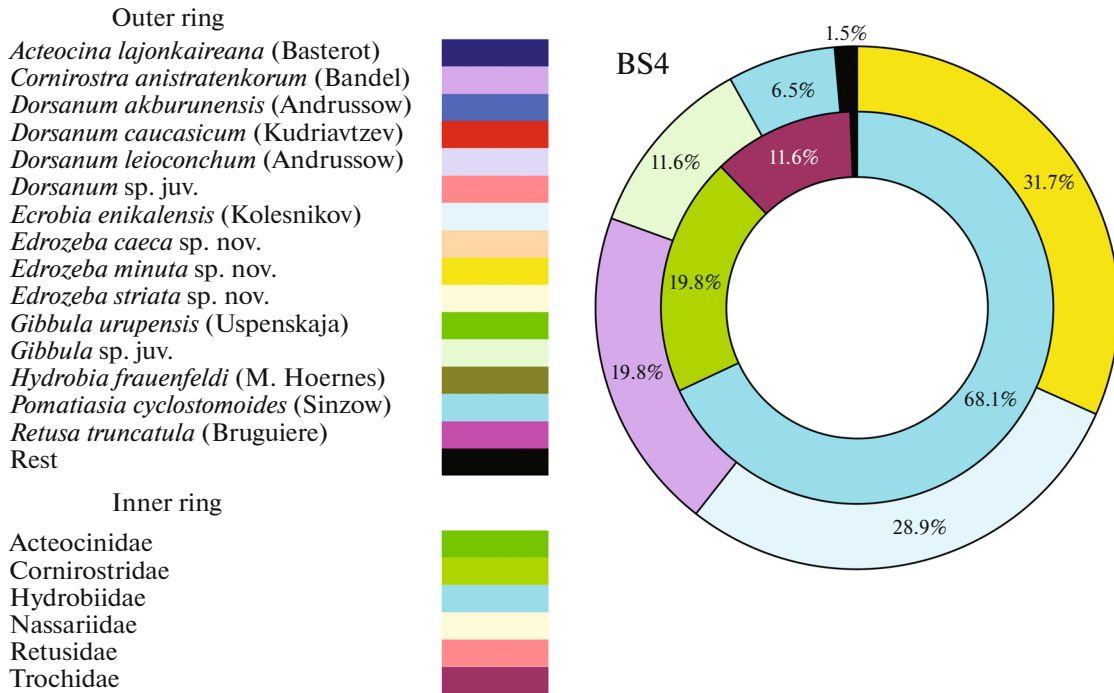


Fig. 29. Ring diagram of the composition of the gastropod community from sample BS4 (530 specimens). Symbols as in Fig. 28.

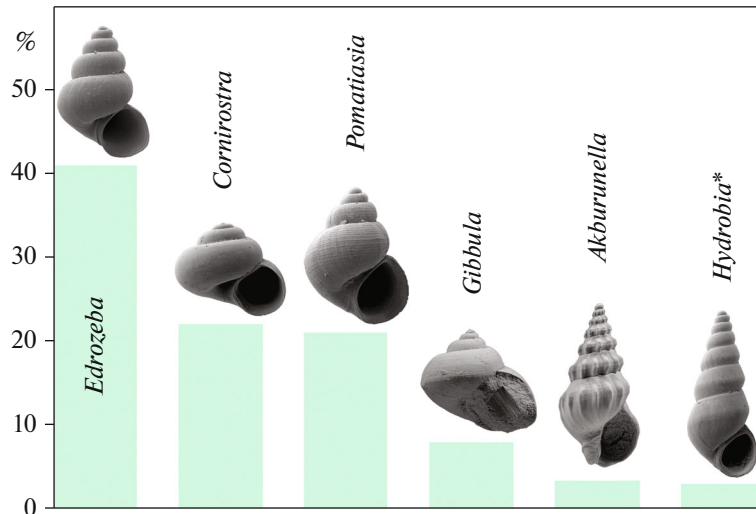


Fig. 30. The average role of genera in gastropod communities for the studied interval of the *Cryptomactra* Beds below the *Pseudocaspia* Member. **Hydrobia* is distributed only in the lower part of the interval, where its share is about 7%.

Structure of Gastropod Communities

The main material on small gastropods was obtained from seven samples (Figs. 28, 29) collected in the *Cryptomactra* Beds at different levels. Samples 19A and 10A come from blocks in the Kurdzhips River olistostrome, the rest are taken from undisturbed beds. At the same time, only sample BS4 originates from the lower part of the *Pseudocaspia* Member, since not any level was found above that is promising for a representative assemblage. Samples are divided into three groups based on localization in the rock. Sample 19A

comes from a tiny lens in clays, species samples from which can be considered population samples. Sample BS3 comes from the nodule horizon, where the fauna is highly concentrated and highly diverse. The remaining samples are taken from clays and aleurites, where the fauna is scattered over the bed, this is the reason for the smaller number of shells, which, nevertheless, remains indicative. The samples differ in specific diversity due to different localization: the largest in sample BS3, and the smallest one is in samples 19A and BS4. However, all samples have common features. The family Hydrobiidae makes up the statistical majority everywhere:

from 51 to 77% of the shells. A decrease in the proportion of hydrobiids is always accompanied by an increase in the abundance of Cornirostridae: from 11 to 41.5%. Trochidae also play an important role: from 3 to 15.6%. Nassariids make up the remainder of the assemblages and are usually represented by several species. The role of Pyramidellidae, Retusidae and Acteocinidae is usually negligible (Fig. 30). Sample 19A stands out between the other samples by the Lower Sarmatian age, basing on the composition of hydrobiids. They are represented in it *Edrozeba caeca* and high-spired *Pomatiasia cyclostomoides*. This is in good agreement with the collections of year 2018 from the Belaya River outcrop, where *Hydrobia* also disappears below the *Cryptomacra* Beds, and the splitting of *E. caeca* into several species has not yet taken place. The shells of Hydrobiidae in samples, collected below the *Pseudocaspia* Member, are approximately proportionally divided between *E. caeca*–*E. minuta* and *Pomatiasia*, with less numerous *E. striata* and *E. enikalensis/E.angulata*, often mixed with *Hydrobia*. The *pseudocaspia* Beds are characterized by the replacement of *H. neofrauenfeldi* by *Turricaspia pseudocaspia*, which visually becomes the most common species in the upper part of the Sarmatian section. While other gastropod species are still quite frequent in the lower part, depletion and dispersion of the fauna occurs above. Hydrobiids of outcrops 1C₇–1D₃, contain (in addition to *T. pseudocaspia*) only a few *Cornirostra* and *Pomatiasia* with more numerous *E. angulata* confined to individual horizons. Only *T. pseudocaspia* with rare *G. urupensis* are known in outcrops of group 1E. This distribution is consistent with field observations of *Cryptomacra* Beds at Sauk-Dere Creek (Krasnodar Krai, Krymsk District). The main diversity of small hydrobiids, the distribution of *H. neofrauenfeldi* and *Cornirostra* is also confined in creek to the lower part of the beds, while only *T. pseudocaspia*, *G. urupensis* and some *Akburunella* (*A. enikalensis* and some other species, which not found in Adygea) are found higher up. The reason for this depletion of the small biota is inexplicable and is an enigma of the *Cryptomacra* Beds.

CONFLICT OF INTEREST

The author declares that he has no conflicts of interest.

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