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Middle Permian Rostroconchs of the Kazanian Stage of the East European Platform

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Abstract—Kazanian Rostroconchia of the East European Platform are represented by only two species: *Oxyprora tschernyschewi* (Licharew, 1931) and *Anetshella golowkinskyi* (Netchaev, 1884). The shell morphology in the families Bransoniidae and Anetshellidae, and related terminology, are discussed. It was demonstrated that the genus *Oxyprora* Hoare, Mapes et Yancey, 2002 should be included in the family Bransoniidae. The species composition of this genus is discussed.

Keywords: Permian, Kazanian Stage, Roadian Stage, Rostroconchia, *Anetshella*, *Oxyprora*, morphology, systematic paleontology

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INTRODUCTION

A total of nine species of conocardioid rostroconchs were described from the Permian of Russia (Frederiks, 1915; Licharew, 1931, 1939; Tchernyshev, 1939; Zavodowsky, 1960, 1970; Muromtseva and Gus'kov, 1984), including *Arceodomus* sp. from the low hills (shikhans) of Bashkortostan (Pojeta and Runnegar, 1976). Most of descriptions were made from single, fragmentary specimens, some of them represented by molds.

Conocardioid rostroconchs were not known from the Kazanian Stage of the Volga–Ural region until now. A deliberate search for them was conducted after the description (Mazaev, 2012) of unusual rostroconchs of *Anetshella golowkinskyi* (Netchaev, 1894). High levels of polymorphism and endemism in molluskan communities of the Volga-Ural Anteclise indirectly suggested that, in the same sites in which *Anetshella* were collected, some ancestral forms might also be found, possibly some Bransoniidae (Mazaev, 2012).

During fieldwork carried out in 2012–2013 on a section of the Lower Kazanian Substage on the Sok River and on the sections of the Upper Kazanian Substage on the right bank of the Volga River (near the village of Krasnovidovo) and in the interfluve of the Vyatka and Nemda rivers, a total of 32 conocardioid rostroconchs were found in the Chimbulat quarry (Kirov Region).

All of the rostroconchs found belong to the same species, which was described by Licharew (1931) as *Conocardium tschernyschewi* based on material collected from the Permian sediments of the northern wing of the Moscow Syneclise and South Timan. The good condition of the material used in this study allowed the morphological description of this species to be updated. Following a new combination of some features, the species should be included in the genus *Oxyprora* Hoare, Mapes et Yancey, 2002.

Simultaneously with the new records of *Oxyprora*, additional specimens of *Anetshella golowkinskyi* were collected. Some morphological features, as well as the geographical and stratigraphic distribution of this species are clarified in this paper.

The following abbreviations were used in this study: (MSU) Lomonosov Moscow State University; (KGM) Stuckenberg Kazan Geological Museum; (CRGM) Chernyshev Central Research Geological Museum, (PIN) Borissiak Paleontological Institute, Russian Academy of Sciences.

MATERIAL

Licharew (1931) described two specimens of *O. tschernyschewi* (Licharew, 1931) housed in CRGM, coll. no. 2933. Material collected by F.N. Chernyshev in the upper reaches of the Vychegda River at the village of Pomozdino (Fig. 1) is represented by a cast from an imprint (Licharew, 1931, pl. 1, fig. 14a, specimen no. 9) and by an internal mold (Licharew, 1931, pl. 1, figs. 19a, 19b, 19c, 19d, specimen no. 10). Later Chernyshev (1939) repeated some illustrations of the latter specimen and accompanied them with a description. This specimen was chosen as the lectotype of *Conocardium tschernyschewi*.

On the Vaga River (village of Porog) (Fig. 1) Licharew also found a specimen of *Anetshella golowkinskyi* (CRGM, coll. no. 8185, specimen no. 15), and following the descriptions of Netschajew (1894) he identified it, although with a question mark, as belonging to the genus *Lepetopsis* (Licharew, 1939). This record expands the known geographic distribution of the species described in my previous paper (Mazaev, 2012). All listed specimens were collected from the Kazanian deposits, although their more exact stratigraphic position is not known.

The specimens of *O. tschernyschewi* described here were collected at two localities (no. 4919/19 and no. 4919/25) belonging to the same reef buildup exposed in the Chimbulat quarry (Kirov Region) (Fig. 1). This formation certainly corresponds to those exposed in the Kremeshki quarry (Fig. 1). An extended lens in which the Roadian ammonoid assemblage had been collected from the Kremeshki quarry (Leonova et al., 2005) corresponds to the top of this buildup. From a preliminary analysis of gastropod assemblages we conclude that the stratigraphic position of these reef buildups corresponds to the lower part of Upper Kazanian Substage.

As a result of fieldwork in 2012–2013, the collection of rostroconchs (PIN, no. 4919) expanded significantly, and included new specimens of *Anetshella golowkinskyi*. Some of them were the first specimens collected from the stratotype area at the Sok river (Fig. 1) (locality no. 4919/20, village of Kamyshla, outcrop at the Fire Station; bed of yellow bioclastic limestone with numerous bryozoan imprints, crinoid columnals, brachiopod and molluskan shells; Upper Kamyshla Beds, Lower Kazanian Substage). Other specimens of *Anetshella* were collected in the Chimbulat quarry (localities no. 4919/25 and no. 4919/26) and in the Kremeshki quarry (locality 4919/6).

The material described in this paper is housed in the Borissiak Paleontological Institute (PIN), Russian Academy of Sciences, coll. 4919.

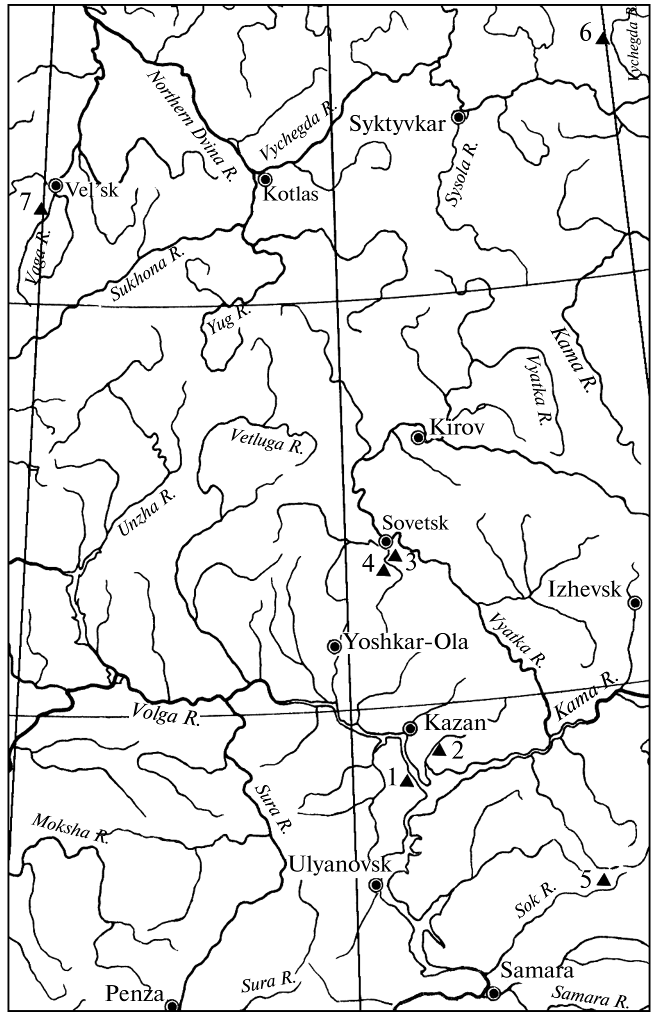


Fig. 1. Rostroconch localities in sediments of the Kazanian Stage on the East European platform: (1) group of localities Krasnovidovo, Upper Kazanian Substage; (2) Bima quarry, Upper Kazanian Substage; (3) Kremeshki quarry, Upper Kazanian Substage; (4) Chimbulat quarry, Upper Kazanian Substage; (5) Kamyshla, Lower Kazanian Substage; (6) Pomozdino, Kazanian Stage; (7) outcrops at the Vaga River, Kazanian Stage.

PRESERVATION AND PROCESSING OF MATERIALS

In only three of the specimens of *O. tschernyschewi* was the shell entirely leached away, allowing relatively good latex casts showing the sculpture of outer surface to be obtained. In other specimens the inner layer of the shell was entirely dissolved, but the outer layer had re-crystallized and was inseparable from the matrix, hiding the structure of the sculpture on the outer surface. Possibly the outer layer includes also both middle and inner layers as defined by Rogalla et al. (2003). Calcite that substituted the outer layer is semi-transparent, radial elements of sculpture are usually white, comarginal elements are hardly visible even on moistened specimens (Figs. $2a^4$, $2b^1$). Latex casts obtained from these specimens show a shell surface with eroded outer layer (Figs. $2a^1$, $2a^2$, $2b^2$, $2b^3$). Such shells (without the outer layer) were used to describe many species of conocardioid rostroconchs including the type species of the genus *Oxyprora* as shown by Hoare et al. (2002). Therefore, depending on the type of preservation of studied specimens, it is possible to see on latex casts either the surface of the inner shell layer as in shells with an eroded outer layer (Figs. $2a^1$, $2a^2$, $2b^2$, $2b^3$), or the surface of the outer layer, i.e., the shell ornamentation, as it is usually understood (Pl. 3, figs. 1a–1j, 2a–2h; Pl. 4, figs. 1h–1j).

On specimens with leached outer layers, some parts of the shell were not entirely dissolved, and because of this, some parts of the internal molds around the ventral commissure and marginal areas of the anterior gape have no reticulate ornamentation. The actual shape of the carina is not seen on casts because on imprints (specimens nos. 4919/25-10, 4919/25-11, and 4919/25-137) the narrow carina cavity is filled by leftovers of the outer shell layer. Therefore on casts (Pl. 3, figs. 1d, 2c, 2f, 2h; Pl. 4, fig. 1j) there is a clearly

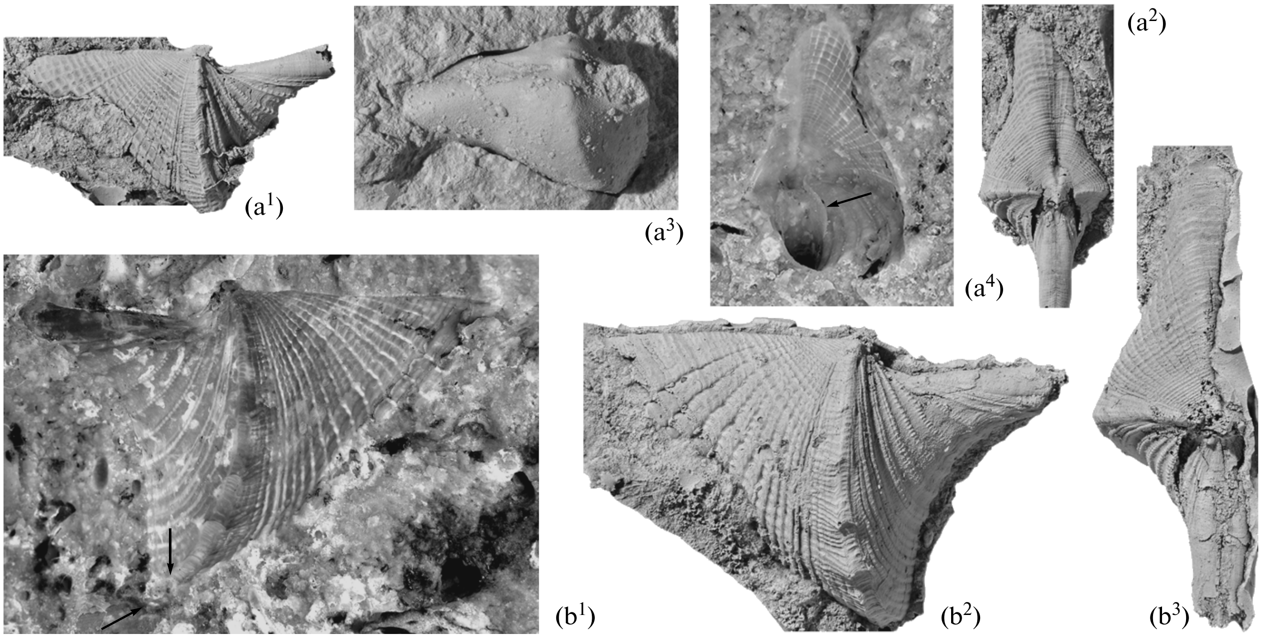


Fig. 2 *Oxyprora tschernyschewi* (Licharew, 1931), ×4. Kirov Region; Chimbulat quarry, locality no. 4919/25: (a) specimen no. 4919/25-14: (a^1, a^2) latex casts demonstrate the outer surface of the inner layer of the shell (shell with eroded outer layer), left view, upper view; (a^3) internal mold, internals cast of rostrum broken, top of dissoconch and central tubercle corresponding to position of the larval shell are clearly visible; (a^4) re-crystallized outer layer of the shell joined with matrix, on the inner surface the rostral clefts are seen as longitudinal folders (shown by arrow), calcite is partially white on radial and partially on comarginal elements of the sculpture; (b) specimen no. 4919/25-12: (b^1) re-crystallized outer layer of the left valve of dissoconch attached to the matrix, arrows show the massive carina, calcite on the radial elements of ornamentation is white; (b^2, b^3) latex casts demonstrate the outer surface of the inner layer of the shell (shell with eroded outer layer), differences in ornamentation on the different areas and segments of the shell are clearly visible; the type of sculpture does not correspond to the sculpture of the outer surface (see Pls. 3, 4).

expressed band with thin ribs that represents the morphology of the outer surface of the inner layer. The carina itself, as one might judge from the specimen no. 4919/25-12, was relatively massive, well defined, and separated from the rostral field by a wide shallow groove (Figs. $2b^1$, 4).

Specimens of *Anetshella golowkinskyi* from the Chimbulat quarry (localities nos. 4919/11, 4919/19, 4919/25) are also characterized by not entirely leached shells, with the outer layer re-crystallized and inseparable from the matrix. As was shown before (Mazaev, 2012, pl. 2), both the radial and comarginal elements of ornamentation of the inner layer outer surface represent narrow grooves, which is very different from the ornamentation of the shell outer layer. *Anetshella* collected in the Kremeshki quarry (locality no. 4919/6) and from outcrops in the village of Kamyshla (locality no. 4919/20), were represented by internal molds and imprints of the outer surface, because the shells were entirely leached.

Particular attention was paid to searching for juvenile forms. Several juvenile specimens of both species, sized > 5 mm, were found in the Chimbulat quarry (location 4919/25); they retain the outer shell layer intact but inseparable from the matrix. An attempt to separate the outer shell layer from matrix in one of specimens of *O. tschernyschewi* (specimen no. 4919/25-130) was relatively unsuccessful. The latex cast obtained (Figs. $5b^1$–$5b^6$) shows the shell shape, but not sculptural elements or the structure of the larval shell. The sculpture around the ventral opening and margins of the anterior gape demonstrate the outer surface of the inner layer, because some fragments of the outer surface remained there.

All casts were made using standard dental latex of moderate viscosity with added soot. Specimens were sprayed with ammonium chloride. Material was photographed using a Nikon 7000 camera, and modified using Helicon Soft Ltd software.

MORPHOLOGY

Dissoconch valves of brassoniids have distinctive carinae, the terminal parts of which extend into the ventral opening. In representatives of other families that have several carinae, this carina is referred to as the “primary carina.” The carina is always related to the ventral opening as it is formed by mantle surrounding the latter. This carina divides the surface of the dissoconch shell into two fields: anterior and rostral,

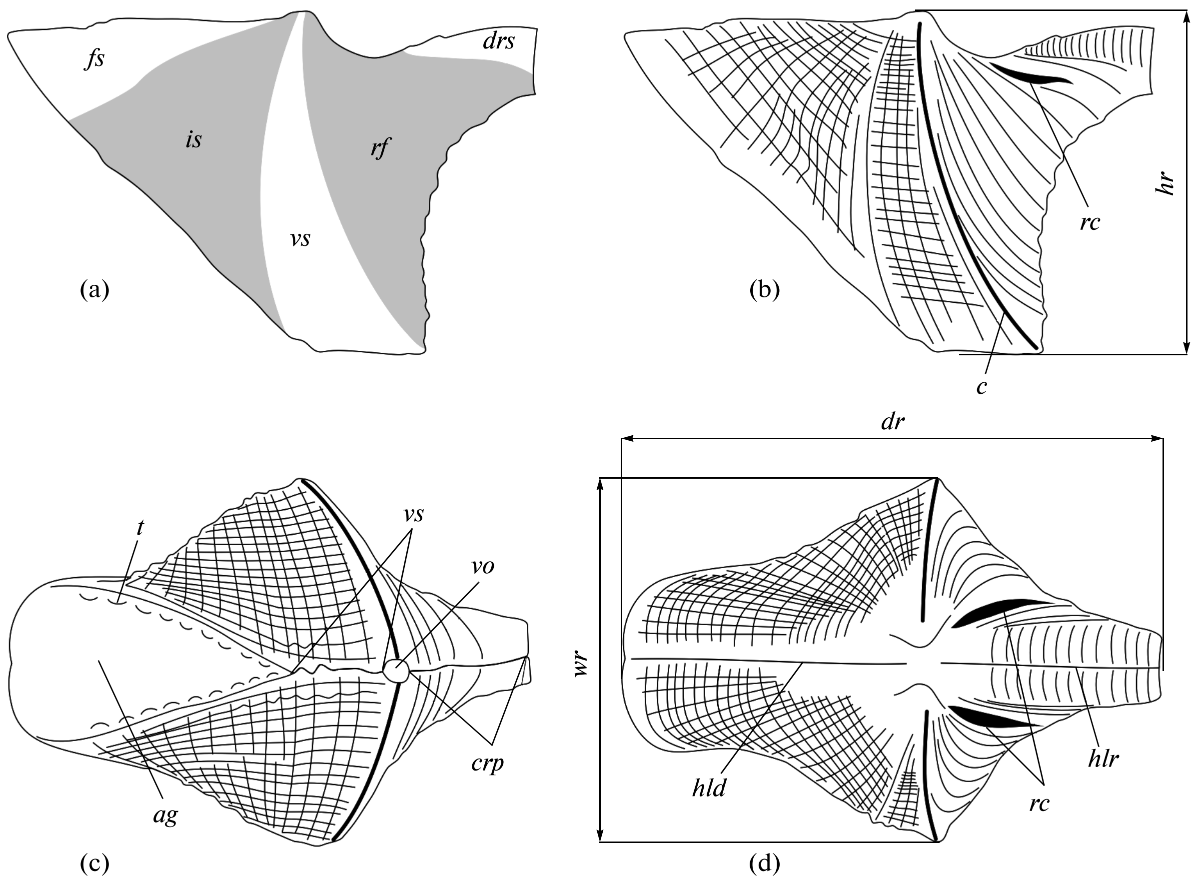


Fig. 3. Shell morphology in rostroconch genus *Oxyprora*; (a) zones of dissoconch: Explanations: (*drs*) dorsal rostrum surface; (*rf*) rostral face, anterior face is divided into three segments: (*fs*) frontal segment; (*is*) intermediate segment; (*vs*) ventral segment; (b–d) (*mmf*) main measurement and morphologic features of the shell; (*vh*) height; (*dr*) length; (*wr*) width; (c) carina; (*rc*) rostral clefts; (*t*) denticles; (*ag*) anterior gape; (*vo*) ventral opening; (*vc*) ventral commissure; (*crp*) commissure of the rostral plate; (*hld*) hinge line of dissoconch; (*hlr*) hinge line of rostrum.

which are very different is size, shape and ornamentation (Fig. 3a). The anterior field of the dissoconch is separated into three segments: ventral, intermediate and frontal. Each segment can be fairly clearly distinguished by ornamentation of shells that have lost the outer layer (Figs. 2a^1, 2b^2); however, on shells with remaining outer ornamentation, these segments can only be distinguished by changes in the relief of the frontal margin.

The ventral segment (Fig. 3a) is extended from the apex of the shell to the ventral commissure, limited posteriorly by the carina, and anteriorly by a more or less developed bend that in many genera of other families develops into the secondary carina. The terminal part of this bend marks the point of the commissure's disclosure into the anterior gape (Fig. 3c). The ventral segment is produced by a part of the mantle within the ventral commissure.

The intermediate segment (Fig. 3a) is the largest of three, extended from the apex of the shell to the lateral margin of the anterior gape, limited by ventral and frontal segments, and as a rule has a concave surface. It was produced by a part of mantle at the lateral margin of the anterior gape.

The frontal segment (Fig. 3a) is extended from the apex of the shell to the anterior margin, occupies a dorsolateral position, and is limited by the intermediate segment and by the hinge line in its dorsal part. It is characterized by a more or less convex cross-section in both the sagittal and transverse direction. It was produced by a part of the mantle at the frontal margin of the anterior gape.

The frontal segment approximately corresponds to the widely accepted term "snout." However, this word is more applicable to a description of a soft body; moreover, the part of shell (as in *Arceodomus*), which is described by this term and borders the anterior gape is very different from the rest of the anterior field in both shape and sculpture and usually involves development of long longitudinal folds. The "snout" of Conocardiidae only in part corresponds topologically to the frontal segment of Bransoniidae. In all representatives of the family Bransoniidae the longitudinal folds are absent; the anterior part of the shell has no outstanding features, so use of the word "snout" for this group is not entirely correct.

Oxyprora, like other bransoniids, has well developed rostral clefts (Figs. 3b, 3d). On the inner side of the outer layer these rostral clefts are seen as short and sharp longitudinal folds (Fig. $2a^4$). Their imprints were observed on the outer surface of the inner layer (Fig. $2a^2$, $2b^3$), though they are absent on the surface of the internal mold (Fig. $2a^3$).

Sculptural elements of the anterior and rostral fields of the dissoconch in *Oxyprora* are substantially different, as has already been mentioned. On the anterior field, both radial and comarginal ridges are equally developed, forming sharp reticulate ornamentation. On the rostral field there are only radial elements with a different profile and positioning. On shells without an outer layer (particularly on latex casts from the inner side of the outer layer) there is a different pattern (Fig. 2). Comarginal ridges on the outer surface of the inner layer are poorly developed.

Radial elements on the outer surface of the inner layer look like grooves and their distribution is not uniform. Radial grooves on the frontal and hinge segments are either nearly absent or are very thin, and are maximally developed on the intermediate segment. Around the rostral field there are relatively massive threadlike radial ridges that come together along the commissure.

The surface of the internal molds is smooth excluding the rostral field. The surface of the rostral field is covered by small radial ribs, the terminal ends of which adjoin to tops of denticles of the zigzag-like imprint of commissure; their position does not coincide with the position of the radial ridges of the outer surface (Pl. 3, fig. 2i; Pl. 4, fig. 1d).

The morphological features of juvenile specimens are poorly studied because of bad preservation. The sculpture of the outer layer, morphology of larval shell and details of transition into the dissoconch are all unknown. Structural characteristics of the inner layer surface generally coincide with those of adult specimens. The main differences include the absence of comarginal ridges (including the rostral field), and the more massive and sharply expressed radial elements on the intermediate segment of the anterior field. The frontal and ventral segments are nearly smooth, with very thin comarginal and radial grooves (Fig. $5a^1$).

An important trait of the juvenile shell morphology is sub-central position of rostrum on the rostral field (Figs. $5a^2$, $5b^4$, $5b^6$). Shell growth occurs mostly due to accretion along ventral and rostral commissures, and because of this, the rostrum in adults is shifted dorsally.

Shells of anetshelloid rostroconchs have a different structural plan, which has been described previously (Mazaev, 2012). The shell has one apex and develops into something bonnet-shaped but still has a commissure posteriorly. The rostral field is reduced to a narrow triangular plate and divided by the commissure (Pl. 4, fig. 2e). Growth rates of the rostral field along the commissure decrease strongly at gerontic growth stages, with increasing compensatory growth of rear parts of the rest of the shell that should topologically correspond to ventral segments of brassoniid dissoconch. This mechanism was explained by the difference in vectors of growth rates (Mazaev, 2012), and now this explanation is supported by observation of large shells that have reached gerontic stages. Because *Anetshella* lost the ventral opening, the above-indicated topological correspondence is somewhat conditional.

SYSTEMATICS

Until recently, the genus *Oxyprora* was included in the family Conocardiidae Miller, 1889 (Hoare et al., 2002; Hoare, 2006). However, shells of *Oxyprora* species lack longitudinal folds in the anterodorsal part of the shell and have a ventral opening. These features, as well as absence of a hood, correspond to the systematic diagnosis of the family Bransoniidae Pojeta et Runnegar, 1976. This genus has a relatively long rostrum that is not characteristic for other bransoniids. However: (1) the actual length of the rostra of the type species of *Bransonia* and *Pseudoconocardium* is not known because of poor preservation and (2) this feature has no taxonomic value above genus level. Numerous morphological traits place *Oxyprora* as a close relative of *Pseudoconocardium* Zavadowsky, 1960, *Bransonia* Pojeta et Runnegar, 1976, *Apotocardim* Hoare et al., 2002 and *Diedrorhynchus* Hoare et Peck, 2005, which presumably all represent the same phylogenetic lineage.

SYSTEMATIC PALEONTOLOGY

CLASS ROSTROCONCHIA

Order Conocardioida

Family Bransoniidae Pojeta et Runnegar 1976

Genus *Oxyprora* Hoare, Mapes et Vancey, 2002

Oxyprora: Hoare et al., 2002 p. 9.

Type species. *Conocardium parrishi* Worthen, 1890; United States, Missouri, Kansas; Pennsylvanian (upper Coal Measures).

Diagnosis. Dissoconch with distinctive carina, terminal parts of which border the ventral opening. The latter lying at the lowest point if the hinge line oriented horizontally. Ventral commissure relatively short. Anterior gape is long and wide. Rostral face moderately convex, strongly produced. Rostrum is moderately long. Rostral clefts well developed. Anterior face of dissoconch moderately convex on both frontal and ventral segments, and slightly concave on intermediate segment, ornamented by both radial and comarginal ridges that form reticulate pattern, whereas rostral face ornamented by only radial ridges.

Species composition. Eleven species: *O. carinatum* (Hall, 1856), *O. equilaterale* (Hall, 1856), *O. mesialis* (Weller, 1916), *O. missouriense* (Girty, 1915), *O. parrishi* (Worthen, 1890), *O. prattenatum* (Hall, 1856), *O. sayrei* (Elias, 1957), *O. pulchellum* (White et Whitfield, 1862) from the Carboniferous of North America; *O. digitatum* Branson, 1942 from the Carboniferous of central Europe; *O. capitanense* (Vendraso, Hoare et Bell, 2010) from the Permian (Capitanian Stage) of North America, *O. tschernyschewi* (Licharew, 1931) from the Permian (Kazanian Stage) of European Russia.

Comparison. *Oxyprora* differs from *Bransonia* Pojeta et Runnegar, 1976 by its more elongate rostrum; from *Pseudoconocardium* Zavodowsky, 1960 and *Apotocardium* Hoare, Mapes et Yancey 2001 by the lower position of the ventral opening (=shorter ventral commissure).

Remarks. The main difference between *Oxyprora* and *Bransonia* is the length of the rostrum. However, because of poor preservation of all described specimens of the type species *Bransonia wilsoni* Pojeta et Runnegar, 1976, the rostrum size in this species is unknown.

Hoare (2006) indicated eight species in the genus *Oxyprora* including one species described in open nomenclature. Because of bad preservation (absence of outer shell layer, broken rostra) the morphological traits of many species are not entirely clear. Certainly *Conocardium carinatum* Hall, 1856, that Hoare (2006) considered to belong to the genus *Hippocardia* Brown, 1943, should actually be included into the genus *Oxyprora*.

A Late Guadeloupian species *Minicardita capitanensis* described by M. Vendrasco et al. (2010) from the only specimen from West Texas is a juvenile form, evident mostly not from its size but from the sub-central position of rostrum. The sculpture of this specimen exhibits features particular to the surface of the inner layer; i.e., the outer shell layer of this specimen is eroded, although a weak outline of the larval shell is still visible. In respect to the type of sculptural structure and outline, this specimen is very close to the juvenile *O. tschernyschewi* described here (Fig. 5b^4, 5c) and is a very closely related species, or a synonym. Unfortunately a more detailed comparison is not possible because of the absence of adult specimens. This species clearly belongs to the genus *Oxyprora*.

Oxyprora tschernyschewi (Licharew, 1931)

Plate 3, figs. 1, 2; Plate 4, fig. 1.

Conocardium sp. Chernyshev, 1890, p. 64; Licharew, 1924, p. 337.

Conocardium tschernyschewi: Licharew, 1931, p. 6, pl. 1, figs. 14, 19; Chernyshev, 1939, p. 132, pl. 31, figs. 12, 13.

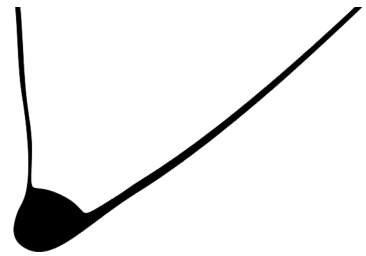


Fig. 4. Sagittal section of the outer layer of the left valve of the dissoconch of *Oxyprora tschernyschewi* (Licharew, 1931) around the ventral opening (drawing from specimen no. 4919/25-12 with simplifications): massive carina, separated from rostral surface by a wide shallow groove; the section shows the outer surface of the inner layer at the position of the carina should look like a flattened band with well-defined borders.

Lectotype CRGM, coll. no. 2933, specimen no. 10, fragment of the outer imprint of the shell and fragment of inner mold; Russia, near to Vel'sk town, Vym' river; Middle Permian, Kazanian Stage (collected by N. Lebedev).

Description (Figs. 2, 5a, 5b). The dissoconch is elongated and moderately wide, roundish on the frontal end; the structure of apices is not known, their position could be defined only by the positions of carinae that are either situated in the middle between the anterior and posterior ends of dissoconch or slightly shifted backwards. The primary carina is sharply defined and relatively massive, its projection on the sagittal surface resembles a weakly convex curve, the tangent line to this curve stands at about 15° to the vertical axis. The carina is separated from the rostral face by a wide, shallow groove. The ventral segment of the anterior face is flat, separated from the intermediate segment by a weak inflexion; the intermediate segment is moderately concave and gradually turns into a moderately convex frontal segment. The direction of depression coincides with the direction of radial sculpture. The outlines of lateral parts of the frontal segments of both valves of the dissoconch are parallel from the dorsal view. The dorsal sides of the dissoconch valves in cross-section at the apices are uniformly rounded and slightly flattened at the frontal margin. The rostral face is moderately convex, strongly produced. The rostral clefts are long, narrow and deep; they extend in a dorsal-lateral direction from the apices nearly to the middle of the rostrum length. The rostrum is moderately long, its axis is remarkably below the hinge axis, and is either parallel to it or orientated at about 15° angle, in most cases the rear end of the rostrum is slightly curved upwards. The commissure on the rostral face is very long, thin, nearly straight or sometimes slightly wavy, leaving a clear threadlike zigzagging imprint on the inner mold. The ventral commissure is short, very thin on the shell surface, nearly straight at the ventral opening and

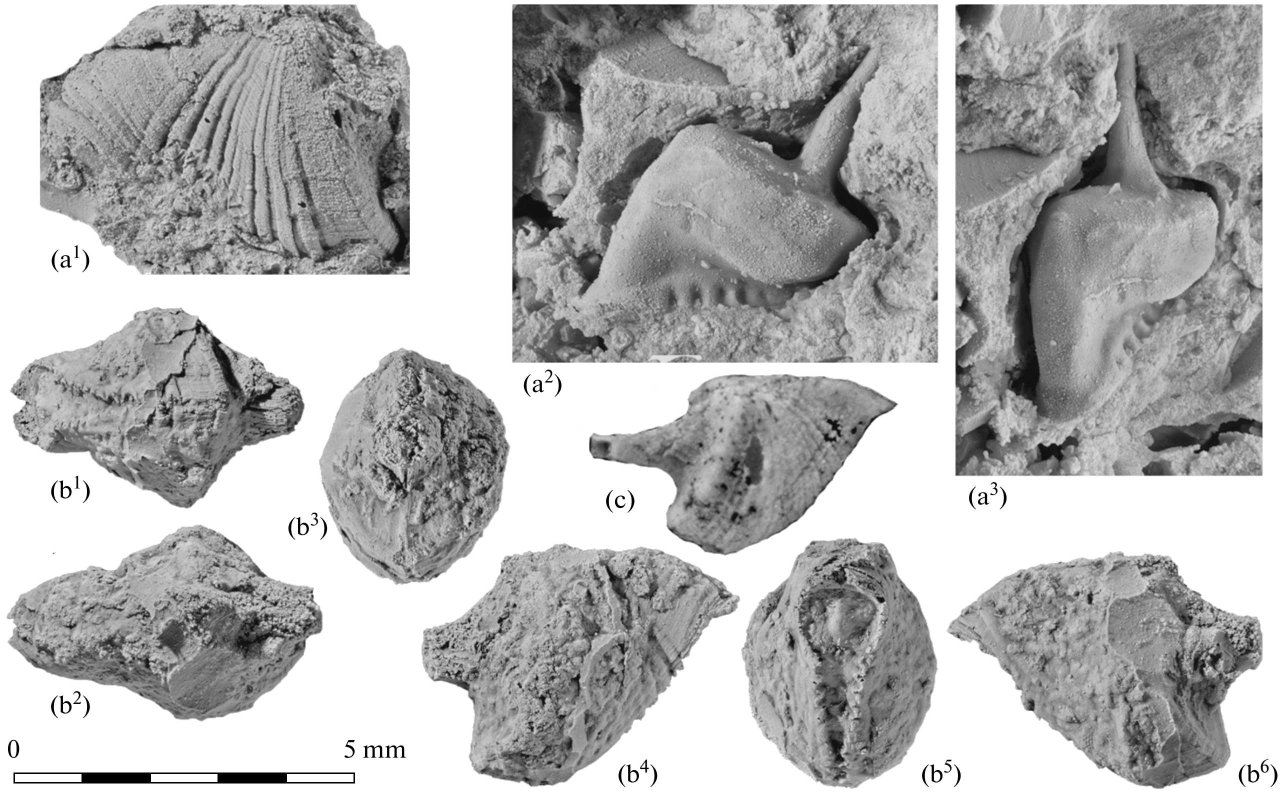


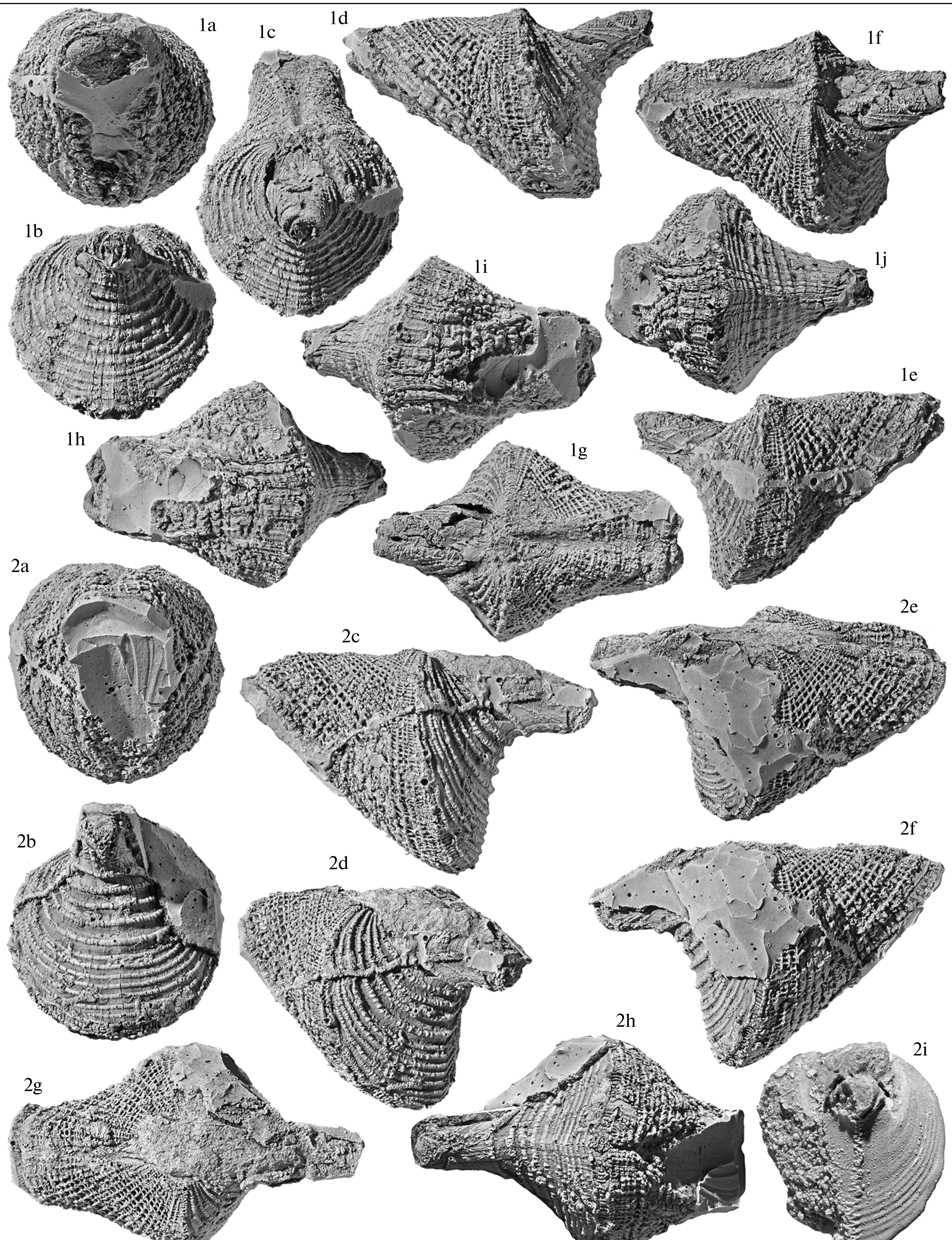
Fig. 5. Juvenile specimens of some species of the genus *Oxypropa*: (a, b) *Oxyprora tschernyschewi* (Licharew, 1931), ×9, Kirov Region, Chimbulat quarry, locality no. 4919/25: (a) specimen no. 4919/25-16: (a^1) latex cast from the inner surface of the outer layer (shell surface with eroded outer layer), (a^2, a^3) inner cast, the cavity between matrix and the inner cast left after dissolution of the inner layer of the shell, right-oblique view; (b) specimen no. 4919/25-130, latex cast from imprint with partially removed outer layer of the shell: (b^1) ventral view, (b^2) dorsal view, (b^3) posterior view, (b^4) right view, (b^5) anterior view, (b^6) left view; (c) *O. capitanensis* (Vendrasco et al., 2010), ×9 (after Vendrasco et al., 2010, text-fig. 1B)

becoming wavy closer to the anterior gape. The entire surface of the anterior field is covered by clear radial ridges. The height of each ridge in cross-section exceeds its width by almost twice; the lateral margins of ridges are nearly flat and parallel. There are at least 20 radial ridges between the carina and hinge margin. The ridge that approximately coincides with the point of transition of the ventral commissure into the anterior gape and separates the ventral segment from the intermediate segment; also it defines a weak inflection separating intermediate and ventral segments. On the ventral segment there are 4 to 5 radial ridges. The comarginal ridges cover the entire anterior field of the dissoconch and have approximately the same size and cross-section as the radial ridges, and are situated with slightly narrower intercostal spaces, the reticulate structure is shaped like distinctive deep tetragonal fossae. The rostral field is ornamented by massive radial threadlike ribs that come together along the commissure, forming a single smooth curve when viewed from behind. The surface of the ribs is rugose. The intercostal spaces are smooth and wide, their width exceeds 1.5–2 times the thickness of the ridges. The ridges and intercostal spaces are narrow at the ventral opening,

Explanation of Plate 3

Figs. 1 and 2. *Oxyprora tschernyschewi* (Licharew, 1931), ×4: (1) specimen no. 4919/25-10, latex cast from the inner imprint of the shell; Kirov Region, Chimbulat quarry, Upper Kazanian Substage: (1a) anterior view, (1b) posterior view, (1c) oblique posterior view, (1d) left view, (1e) right view, (1f) oblique left view, (1g) dorsal view, (1h) ventral commissure view, the commissure frames the ventral opening, (1i) ventral commissure view turned on axis; the point of the commissure's disclosure and anterior gap are clearly visible, (1j) ventral view, the carinae are sub-vertically oriented; (2) specimen no. 4919/25-11, the same locality: (2a–2h) latex cast of the outer shell imprint: (2a) anterior view, (2b) posterior view, (2c) view from the left, (2d) view posterior view from the left, (2e) right view turned on axis, dorsal parts of frontal segments rounded in cross-section, (2f) right view, (2g) dorsal view, (2h) ventral view, carinae absent, in their place imprint of the inner shell layer shaped as two ribbed bands with an imprint of the ventral opening at their convergence point; (2i) inner cast, posterior view.

Plate 3



and become wider closer to the posterior end. There are about 12 ridges in total; the last pair of ridges extends from the rostral clefts through the lateral surface of the rostrum to its posterior ventral end. The dorsal surface of the rostrum is channelized in cross-section and consists of two parts separated by a clear hinge margin. Near the rostral clefts there are up to 3 very thin and closely situated radial costae that follow the clefts by thin and unevenly distributed scalloped comarginal threads. The anterior gape is very large, its maximum width in the anterior part represents approximately a half of the shell width. The inner lateral margins of the gape have about eight weakly expressed denticles that can be visible on internal molds as a wavy surface. The anterior margins of the gape are smooth. Growth lines are clearly observed on the rostral field as very thin grooves and folds, and on the anterior face they are expressed as crude ridges corresponding to delays in growth.

Dimensions in mm. (L) length, (W) width, (H) height as shown in Figs. 3b, 3d.

Specimen no.	L	W	H
4919/25-10	13.5	9.3	8.6
4919/25-11	15.5	9.7	10.1

Variability. In all studied specimens the angle of inclination of rostrum in respect to the hinge line is different. In the specimen 4919/25-25 the axis of rostrum is parallel to the axis of the hinge margins or even slightly tilted downwards, which is visible by comparing rostral face.

Comparison. This species is very close to the Pennsylvanian species *Oxyprora missouriensis* (Girty, 1915), from which it differs by development of same-sized radial ribs (absence of intercalary radial ribs). As was mentioned before, juvenile shells of *O. tschernyschewi* do not differ significantly from those of *O. capitanensis* (Vendrasco et al., 2010), but insufficient material prohibits more detailed comparison.

Remarks. Juvenile shells essentially differ from adults in the sub-central position of the rostrum, the relatively short anterior field in respect to the rostral field, and the strongly convex dorsal surface of the frontal segments. The structure of the outer sculpture, of the rostral clefts and of the larval shell are all unknown. The surface of the inner layer has no comarginal elements; the radial elements are developed mostly on the intermediate segment as massive, strong radial ridges separated by deep, narrow intercostal gaps. Terminal parts of these gaps correspond to at least five clearly-defined massive teeth. The anterior gape is relatively narrow, elongate, drop-shaped when expanded between the frontal segments, the inner surface of the margins of the anterior gape is smooth in the frontal part.

There is one specimen (no. 4919/25-137, Pl. 4, fig. 1) that was initially interpreted as deformed, because it has a brachiopod shell stuck in the hinge line between the valves of the anterior field of the dissoconch, whereas the dissoconch valves from apices to anterior margins were opened along the margin of the hinge. However, after the specimen was treated and casts taken it became obvious that the dissoconch valves and surface of mold have no physical damage. If it is true, we are dealing with an aberrant specimen that received some mechanical damage during metamorphosis. This finding is interesting for clarification of particularities of shell growth (because the dissoconch valves went on growing in the open condition), as well as for reconstruction of the epifaunal life style of this mollusk.

Occurrence. East European Platform; Middle Permian, Kazanian Stage.

Material. Thirty-two specimens in coll. PIN no. 4919: 5 specimens from locality no. 4919/19 and 1 specimen from locality no. 4919/26, Chimbulat quarry, lower part of reef buildup; 26 specimens from locality no. 4919/25, Chimbulat quarry, upper part of reef buildup; 2 specimens in CRGM, coll. no. 2933.

Order Anetshelloida

Family Anetshellidae Mazaev, 2012

Genus *Anetshella* Mazaev, 2012

***Anetshella golowkinskyi* (Netchaev, 1894)**

Plate 4, fig. 2

Emarginula? sp.: Golowkinsky, 1868, p. 109, pl. 5, figs. 11, 12.
Lepetopsis golowkinskyi: Netchaev, 1894, p. 327, pl. 12, figs. 54, 55.
Lepetopsis? *golowkinskyi*: Licharew, 1939, p. 153, pl. 37, figs. 25, 26.
Anetschella golowkinskyi: Mazaev, 2012, p. 21, pl. 1, figs. 1, 2, pl. 2, figs. 1–4.

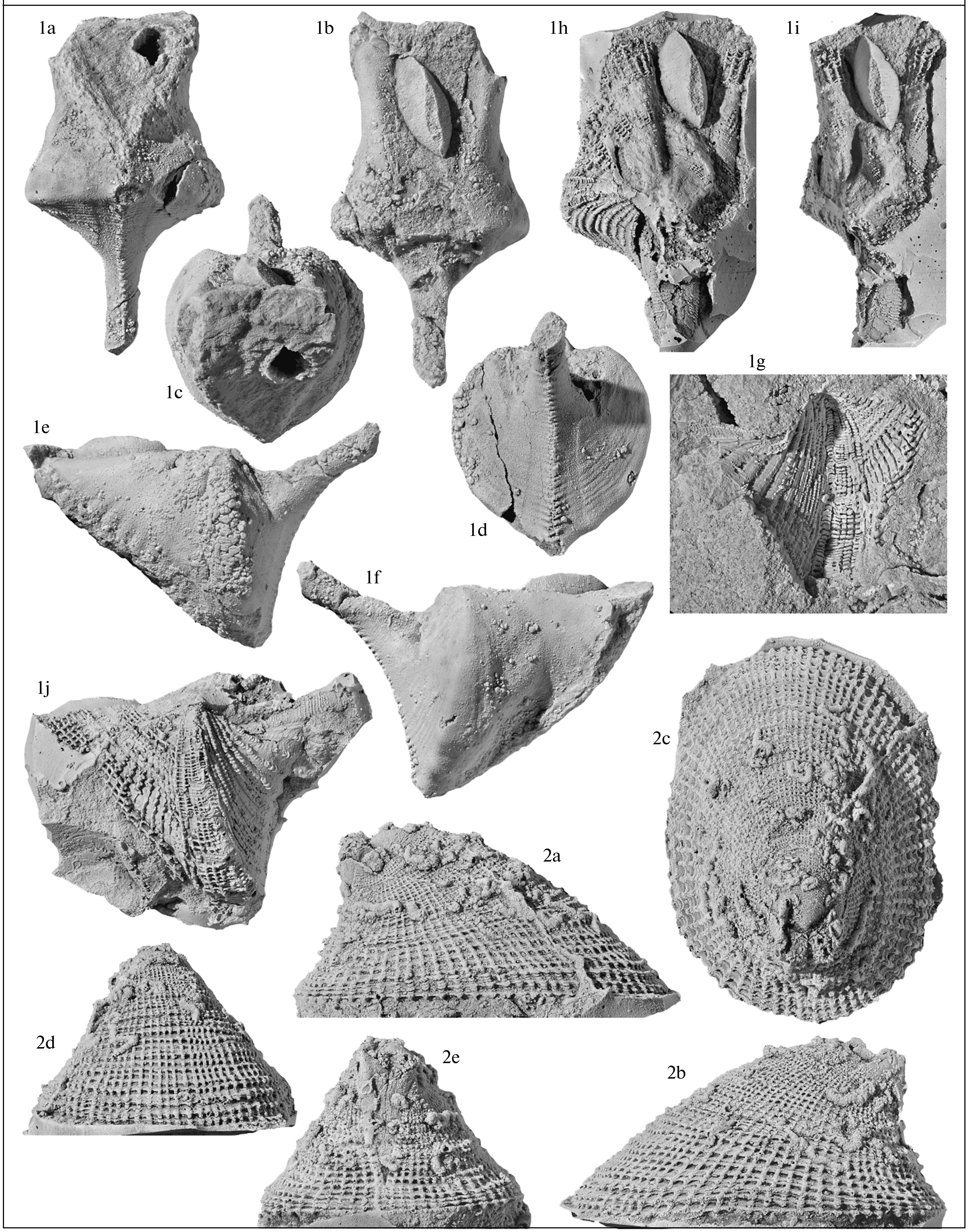
Description. See Mazaev (2012, p. 21).

Explanation of Plate 4

Fig. 1. *Oxyprora tschernyschewi* (Licharew, 1931), specimen no. 4919/25-137, ×4; Kirov Region, Chimbulat quarry, Upper Kazanian Substage; (1a–1f) inner cast: (1a) ventral view, imprint of the ventral opening is seen, anterior gape broadly expanded, (1b) dorsal view, a brachiopod shell squeezed between dissoconch valves, (1c) anterior view, (1d) posterior view, (1e) left view, (1f) right view, (1g) imprint of the left valve in matrix, outer shell layer partially preserved, (1h–1j) latex cast from the inner shell imprint: (1h) dorsal view, sagittal surface of rostrum vertically oriented, (1i) dorsal view, sagittal surface of the larval shell oriented nearly vertically, (1j) right view, the carina absent with a ridge on its place is an imprint of the outer surface of inner layer.

Fig. 2. *Anetschella golowkinskyi* (Netchaev, 1894), specimen no. 4919/25-589, latex cast, ×4; Kirov Region, Kremeshki quarry, Upper Kazanian Substage: (2a) right view, (2b) left view, (2c) dorsal view, (2d) anterior view, (2e) posterior view, rostral field forms narrow triangular area

Plate 4



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

Specimen no.	Shell height	Aperture length	Aperture width
4919/6-589	8.3	17.3	12.3

V a r i a b i l i t y. There are variations in shell height and width with respect to aperture length, as well as in length of triangular plate of the rostral surface. In one of the largest specimens (specimen no. 4919/25-105) this triangular plate occupied approximately one third of the posterior slope.

O c c u r r e n c e. East European Platform; Middle Permian, Kazanian Stage.

M a t e r i a l. A total of 27 specimens in coll. no. 4919 (PIN): 1 specimen from locality no. 4919/21, quarry near the village of Bima, Upper Kazanian Substage; 12 specimens from locality no. 4919/6, Kremeshki quarry, upper part of section, Upper Kazanian Substage; 3 specimens from locality 4919/11, Chimbulat quarry, lower part of reef buildup, Upper Kazanian Substage; 1 specimen from locality no. 4919/19 and 6 specimens from locality no. 4919/25, Chimbulat quarry, upper part of reef buidup, Upper Kazanian Substage; 4 specimens from locality no. 4919/20, village of Kamyshla, outcrop at Fire Station, Lower Kazanian Substage, Upper Kamyshla Beds; 4 specimens from Netchaev's collection, KSU; 1 specimen from CRGM coll. no. 8185.

CONCLUSIONS

Rostroconchs in the Kazan paleobasin are represented by only two species: *Oxyprora tschernyschewi* and *Anetshella golowkinskyi.* Possibly, the first species to immigrate was *Oxyprora tschernyschewi*, which is extremely similar to *O. capitanensis* from West Texas (Vendrasco et al., 2010). It is important that during the Pennsylvanian and Early Permian on the territory of the East European Platform there were only representatives of family Conocardiidae, whereas Bransoniidae appeared here later, during the Kazanian Stage of the Middle Permian. The taxonomic composition of rostroconchs from northeastern Asia is very different (Zavodowsky, 1960, 1970) and has much in common with the Australian rostroconchs. Because *Anetschella* is not known from other paleobasins, it probably evolved from *O. tschernyschewi* in the warm and shallow paleobasin of the East European Platform, which was mostly isolated but possibly with permanently or temporarily open north passages.

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