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The first records of bransoniid rostroconchs (Bransoniidae, Rostroconchia, Mollusca) in the Pennsylvanian of the Russian Platform

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ABSTRACT. Several rostroconch specimens of the family Bransoniidae are discovered in the Pennsylvanian of the Russian Platform for the first time. All of them are assigned to the species *Hoarepora parrishi* (Worthen, 1890), which is the type species of *Hoarepora* Mapes in Mazaev, 2022. Until now, the distribution of this species has been restricted to the Morrowan – Missourian interval in the North American Midcontinent Basin. All studied specimens come from Moscovian and Gzhelian stages of two localities on the Russian Platform. Both shell morphology and taphonomy of this species are examined in detail. *H. parrishi* is redescribed, since the previous description lacks many specific characters. It is shown that *Conocardium missouriensis* Roundy in Girty, 1915 is a junior synonym of *C. parrishi* Worthen, 1890. The new occurrences significantly expands the geographical range of this species and supports the existence of biogeographical connections between the paleobasins of North America and the Russian Platform in the Pennsylvanian, and also increases the known geochronological range of *H. parrishi* by approximately two million years.

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Первые находки брансониидных ростроконхов (Bransoniidae, Rostroconchia, Mollusca) в пенсильвании Русской платформы

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РЕЗЮМЕ. Впервые в пенсильвании Русской платформы было найдено несколько экземпляров ростроконхов семейства Bransoniidae. Все они отнесены к виду *Hoarepora parrishi* (Worthen, 1890), который является типовым видом рода *Hoarepora* Mapes in Mazaev, 2022. До настоящего времени распространение этого вида ограничивалось интервалом моррован-миссурири пенсильвания бассейна Мидконтинент Северной Америки. Весь изученный материал происходит из двух местонахождений, возраст которых датируется московским и гжельским ярусом. Детально рассмотрена морфология и формы сохранности раковин этого вида. Дано новое описание *H. parrishi*, поскольку старое описание не отражало полный набор признаков этого вида. Показано, что *Conocardium missouriensis* Roundy in Girty, 1915 является младшим синонимом *C. parrishi* Worthen, 1890. Новые находки еще раз свидетельствуют об устойчивых биогеографических связях палеобассейнов Северной Америки и Русской платформы в московском веке, а также увеличивают время существования описанного вида примерно на два млн. лет.

Introduction

Rostroconchs of the family Bransoniidae from the Middle and Upper Pennsylvanian of the Russian Platform are described here for the first time. All studied specimens were identified as *Hoarepora parrishi* (Worthen, 1890). Until now, the distribution of this species has been restricted by the Morrowan – Missourian interval in the North American Midcontinent Basin. The material described here comes from the basal parts of the Myachkovian Substage (Moscovian Stage), as well as from the Rusavkian Substage (Gzhelian Stage). The stratigraphic units of North America and the Russian Platform are correlated as follows: Desmoinesian – terminal part of Kashirian, Podolskian, Myachkovian and most part of Krevyakinian Substages; Missourian – Krevyakinian, Khamovnikian and Dorogomilovian Substages; Virgilian – Rusavkinian, Pavlovoposadian, Noginskian, and Melekhovian Substages [Aretz *et al*., 2020]. The new records of this species significantly expand its geographical range and also increase the known geochronological range of the species to approximately two million years. Previously, some Pennsylvanian species of North American gastropods were described from the Russian Platform: *Goniasma lasallensis* (Worthen, 1890), *Orthonema salteri* (Meek et Worthen, 1860), and *O. marvinwelleri* Knight, 1934 [Mazaev, 2011]. Other North American species are also present in the yet undescribed part of the PIN collection no. 4471. All these records indicate close biogeographical connections between the Russian Platform basin and the North American Midcontinent Basin in the Pennsylvanian. Due to the particular type of preservation of the studied material, the data on the shell morphology of *Hoarepora parrishi* are significantly supplemented. It has also been shown that *Conocardium missouriensis* Roundy in Girty, 1915 is a junior synonym of *C. parrishi* (Worthen, 1890).

Abbreviations: PIN, Paleontological Institute, Russian Academy of Sciences, Moscow, Russia. ISGS, Illinois State Geological Survey, USA

Material

During the processing of rostroconch specimens of *Arceodomus* sp. found by the author in the section of the Akishinsky quarry in 2011, a fragmentary imprint of a shell of the genus *Hoarepora* was unexpectedly discovered. This was the first evidence that this genus, although very rare, occurs in the Middle Pennsylvanian in the Moscow Syncline of the Russian Platform. Later, a second external mould of a *Hoarepora* shell fragment was discovered during the processing of a collection of gastropods from the Shchelkovo quarry on one of the specimens with an external mould of a *Tretospira* gastropod. I collected this material in 1983-1993. Unfortunately, the section of the Shchelkovo quarry has now been flooded for more than 20 years. A targeted search for rostroconchs was carried out by the author in the Akishinsky quarry in the fall of 2022. As a result, eight *Hoarepora* specimens were found.

The Akishinsky quarry is located in the Ryazan region, 15 km west of the town of Kasimov. The quarry section reveals the terminal part of the Moscovian Stage: Korobcheevo, Domodedovo and Peski formations, which make up the entire Myachkonian Substage. Previously, six localities of a highly diverse mollusk fossil faunas were discovered in this section [Mazaev, 2011, fig. 4]. The rostroconchs described in this paper were collected from the base of a quarry section, locality no. PIN 4471/85. The limestones (packstones) are white, yellowish, lumpy, thin, medium-bedded, very soft, with an uneven surface, with green and crimson colored clay deposits on uneven surfaces. The limestones contain various fossils: foraminifera, solitary corals, benthic mollusks, nautiloids, brachiopods, and bryozoans. The thickness of the limestones and crimson colored clay is 0.6 m.

The locality is situated in the core of a cyclothem, corresponding to the Korobcheevo Formation. The cyclic structure of sections of the Moscow stage is associated with glacioeustatic fluctuations of the sea level during the Late Paleozoic Ice Age [Kabanov, 2003]. Cyclothems and subaerial exposition levels can be traced over vast distances of several hundred kilometers, which facilitates regional correlations. U–Pb SIMS dating of pyroclastic zircons from the tuffaceous bed at the Shchurovo-Korobcheevo boundary (= Podolskian-Myachkovian boundary) showed an age of 308.9 ± 2.3 Ma [Yashunsky *et al*., 2021].

All rostroconchs in this locality are in the same state of preservation: the inner layer is leached, the outer layer is attached to the matrix, and there is a body steinkern (a cast of the internal surface of the shell). In approximately half of the specimens, the outer layer of the shell is replaced by soft, chalky micrite. In some specimens, the micritized outer layer of the shell is easily separated from the rock. Three specimens out of eight were cleared of the outer layer, and impressions were taken using dental latex. Thus, it was possible to take casts reflecting the ornamentation of the external surface of outer layer of the shell. Latex casts of the internal surface of the outer layer were also made. The latter show details of the structure of the external surface of the inner shell layer.

A different type of preservation of the mollusk fauna was found in the Shchelkovo quarry (Moscow Region). All bioclasts in limestones of localities nos. PIN 4471/2, 4471/4, 4471/5 are completely leached [Mazaev, 2011, fig. 6]. Therefore, a latex cast made from a fragment of a external shell mould (Figs 3, D-F) very accurately shows the details of shell ornamentation. The studied specimen comes from locality no. PIN 4471/2 – basal part of Amerevo Formation (Rusavkinian Substage, Gzhelian Stage). This level correlates with the basal part of the Virgilian of North America [Aretz *et al*. 2020].

The material is housed in the Department of Scientific Organization of Collections of the Paleontological Institute of the Russian Academy of Sciences (PIN), collection no. PIN 4471.

Morphology, terminology and methods of measurement

To describe the shells of *Hoarepora*, I used the terminology and system of measurements (Fig. 1) adopted in a recent work on bransoniids [Mazaev, 2023b].

The shell valves of all bransoniid rostroconchs have a “primary carina”, - a distinct carina connecting the beak and ventral orifice. The term “primary carina” was erected by Caldwell and Chatterton [1995] for descriptions of morphologically and systematically diverse Silurian rostroconchs: *Mulceodens* Pojeta et Runnegar, 1976; *Nehedia* Johnston et Chatterton, 1983; and *Cassowarioides* Johnston et Chatterton, 1983. Later, this term was used in descriptions of various other rostroconch taxa [Hoare e*t al*, 2002; Mazaev, 2015, 2023b]. Rogalla [2005], Rogalla and Amler [2006 a, b, c], and Amler [2016] called this morphological element “körpercarina” (body carina).

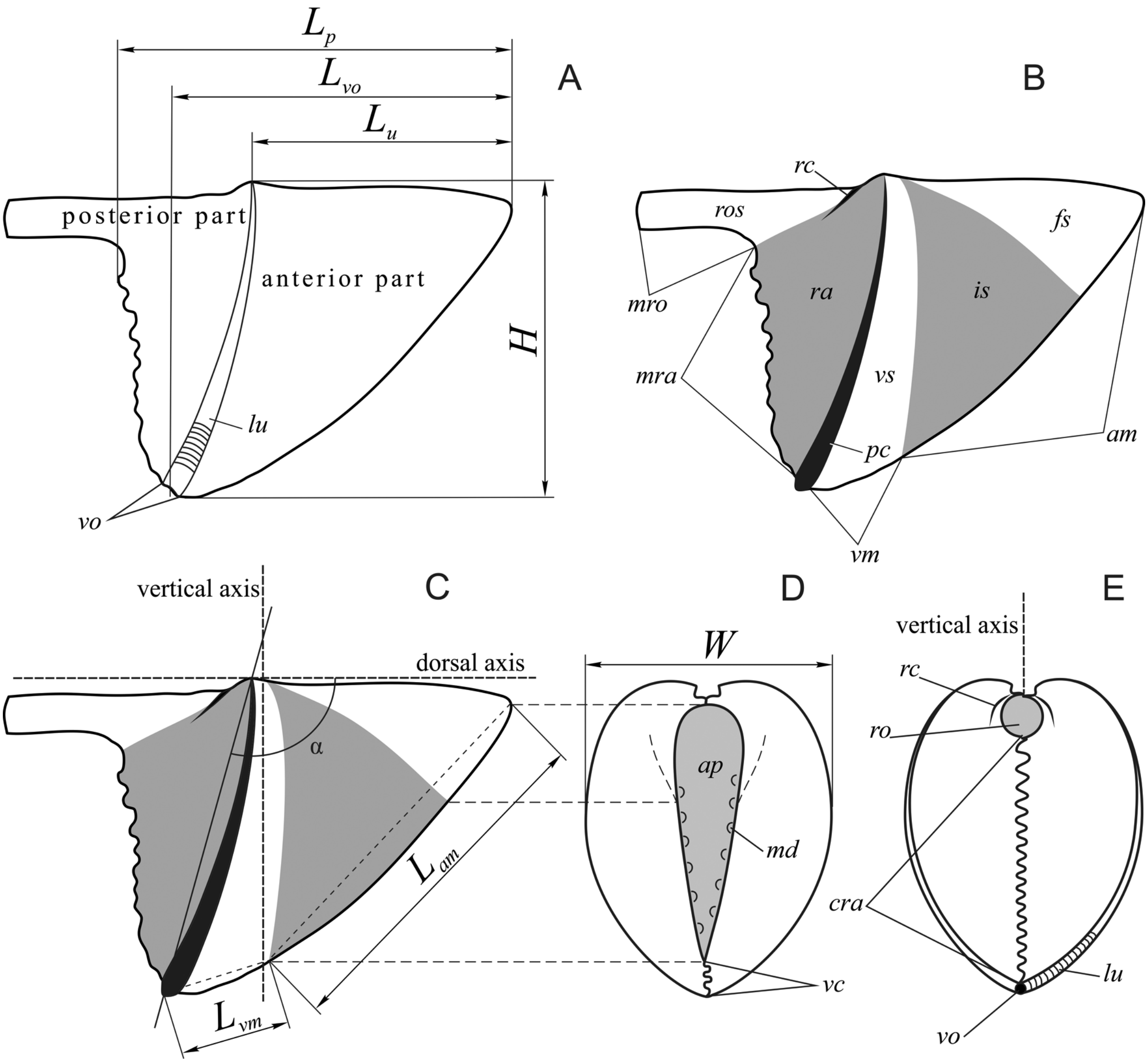

FIG. 1. Morphology and methods of measuring shells of rostroconchs of the family Bransoniidae. (A). L_p — (Length $_{\text{posterior end of the rostral area}}$) length of the projection onto the dorsal axis of the line connecting the anterior edge of the aperture and the border between the rostral field and the rostrum at the edge of the shell. L_{vo} — (Length $_{\text{ventral orifice}}$) length of the projection onto the dorsal axis of the line connecting the anterior edge of the aperture and the center of the ventral orifice. L_u – (Length $_{\text{umbo}}$) the length of the projection onto the dorsal axis of the line connecting the anterior edge of the aperture and the umbo. *H* — shell height. *lu* — lunulazone. *vo* — ventral orifice. (B). Zones of the anterior part of the shell: *fs* — frontal segment, *is* — intermediate segment, *vs* — ventral segment. Zones of the shell posterior part: *ra* — rostral area, *ros* — rostrum. Terminology of the shell margin: *am* — apertural margin, *vm* — ventral margin, *mra* — margin of the rostral area, *mro* — margin of the rostrum. *pc* — primary carina. *rc* — rostral cleft. (C). L_{am} — (Length $_{\text{aperture margin}}$) line length between the anterior and posterior margins of the aperture. L_{vm} — (Length $_{\text{ventral margin}}$) the length of the line connecting the border of the ventral and intermediate segments on the edge of the shell and the center of the ventral orifice. α — the inclination of the primary carina. (D). *W* — shell width. *ap* — aperture. *md* — marginal denticles. *vc* — ventral commissure (zigzag shape on the steinkern and straight on outer side of the shell). (E). *rc* — rostral cleft. *ro* — rostral orifice. *cra* — commissure of rostral area (zigzag shape on the steinkern and straight on outer side of the shell). *lu* — *lunulazone*. *vo* — ventral orifice.

РИС. 1. Морфология и методы замеров раковин ростроконхов семейства Bransoniidae. (A). L_p — длина проекции на дорсальную ось линии, соединяющей передний край апертуры и границу между ростральным полем и рострумом на крае раковины. L_{vo} — длина проекции на дорсальную ось линии, соединяющей передний край апертуры и центр вентрального отверстия. L_u – длина проекции на дорсальную ось линии, соединяющей передний край апертуры и макушку. *H* — высота раковины. *lu* — лунулозона. *vo* — вентральное отверстие. (B). Зоны передней части раковины: *fs* — фронтальный сегмент, *is* — промежуточный сегмент, *vs* — вентральный сегмент. Зоны задней части раковины: *ra* — ростральное поле, *ros* — рострум. Терминология края раковины: *am* — край апертуры, *vm* — вентральный край, *mra* — край рострального поля, *mro* — край рострума. *pc* — главное ребро. *rc* — ростральная щель. (C). L_{am} — длина линии между передним и задним краем апертуры. L_{vm} — длина линии, соединяющей границу вентрального и промежуточного сегментов на краю раковины и центр вентрального отверстия. α — угол наклона основного киля. (D). *W* — ширина раковины. *ap* — апертура. *md* — маргинальные зубчики. *vc* — вентральная комиссура (зигзагообразная на ядре и прямая на наружной поверхности раковины). (E). *rc* — ростральная щель. *ro* — ростральное отверстие. *cra* — комиссура рострального поля (зигзагообразная на ядре и прямая на наружной поверхности раковины). *lu* — лунулазона. *vo* — вентральное отверстие.

The distal part of the primary carina always ends in a groove. This groove is set across the valve margin and produced by mantle fold. Thus, the tube-like cavity of the ventral orifice, which is formed from the grooves of the left and right valves is produced by the mantle folds of the left and right mantle fields. The length and width of the grooves determines the volume of the so-called “tube” [Pojeta *et al*., 1972; Pojeta, Runnegar, 1976] (= “tube of ventral gape” [Caldwell, Chatterton, 1995]; = röhrenförmiger Tubus (tube shaped pipe) [Rogalla, 2005]). The increment of the shell in the groove area occurs in two directions: 1) inside the groove, contemporary with whole increment shell margin, thus the length of the primary carina increases; 2) in the distal part of the groove, from the outer shell surface, thus the thickness of the primary carina increases). As the shell grows the thickness of the primary carina increases somewhat faster than the thickness of the rest of the valve. If the rate of growth of shell material in the distal part of the groove increases even more, this will lead to the formation of a peculiar structure – a train, which has the traditional name the “hood” [Pojeta, Runnegar, 1976; see also Rogalla, 2005]. Hood may be hypertrophied in size in some Hippocardiidae. J. De C. Sowerby [1827] first noted the specific structure of the hood: “... this keel is of a cellular structure, the cells long and placed transversely”. This specific structure was later described and/or shown on chips and polished shell surfaces of some Hippocardiidae and Pseudobelaleidae [Pojeta, Runnegar, 1976; Amler, Bartholomäus, 1998; Hoare *et al*., 2002; Rogalla, 2005; Ebbestad *et al*., 2017]. The primary carina of some bransoniids is also formed with the longitudinal and transverse septa [Mazaev, 2023b]. Thus, the primary carina differs from the hood only in the degree of development (depth of the ventral orifice). Both the hood and primary carina are formed by the outer layer of the shell [Pojeta, Runnegar, 1976, p. 11; Mazaev, 2015; 2023b]. Usually, the outer layer of the shell is not preserved on most of the described specimens. However, there is a strip with lunulae on the attachment place of the hood or primary carina on the outer surface of the inner shell layer. Amler [2016] called this strip the “lunulazone”. The shape of the lunulae corresponds to the shape of the distal part of the groove (= the shape of the outer part of the ventral orifice on the left and right valve). As was noted by Ebbestad *et al*. [2017, p. 408, fig. 18 F], there is a correlations between the position of the lunulae on the strip and longitudinal septa of the hood.

In almost all specimens studied here, the primary carina lacks an outer layer. Even in those latex casts where the ornamentation of the outer layer of the shell is clearly visible, the primary carina is broken off (its outer layer remains in the rock) (*lu*: Figs 2A, D, E, H, L). On the external surface of the inner layer, at the site of primary carina, the lunulazone is observed. A completely preserved primary carina of the described species looks like a massive cord-like rib covered with thin commarginal thread-like ribs. A fragment of the primary carina is observed on a latex cast of a specimen from the Schelkovo quarry (Fig. 3E, F). The primary carina is also completely preserved on Bird’s specimen [Bird, 1968, pl. 13, fig. 3]. On this specimen, the primary carina bears scalloped varices. Bird [1968, p. 144] named this morphological feature “spiny umbonal ridge” and treated it as a distinguishing characteristics for *H. parrishi*. Although Roundy (see Girty [1915, p. 353]) does not show the varices in the stylized pencil drawing, he notes them in the description. Later, Sayre [1930, p. 109] also mentioned: “some specimens showing the nodes... on the umbonal ridge, while others lack any indication of nodes.” Varices on the primary carina were also noted on two specimens of the Middle Permian species *H. tschernyschewi* (Licharew, 1931) [Mazaev, 2015, figs 2 a^1, b^2]. Thus, this character may not be acceptable for identifying species-level taxa. Evidently, the development of varices is associated with changes in growth rate.

The surface of *Hoarepora* shells (= external surface of the outer layer) is well ornamented: the anterior part of the shell is covered with narrow and high radial and comarginal ribs, with the former dominating the latter. Differences (or similarities) in ornamentation on the ventral and intermediate segments are characters at the species-level. The sculpture on the rostral field is formed by cord-like radial ribs.

The external surface of the inner shell layer of *Hoarepora* shells looks different than that of the outer layer. The anterior part of the shell bears sharp radial ribs. The rostral area bears weak radial ribs, the surface of the rostrum is smooth. The U-shaped spaces between the radial ribs of the external surface of the inner layer on the anterior part of the shell are imprints of the ribs of the internal surface of the outer layer. The distal part of the ribs on the internal surface of the outer layer formed the marginal denticles. Therefore, the number and size of the ribs strictly correspond to the number and size of the marginal denticles on the valve edge. The marginal denticles are usually well developed along the internal edge of the intermediate segment and to a lesser extent along the edge of the frontal segment (Fig. 3A, D). The internal part of the ventral margin also bears marginal denticles, the size of which is the same as or different from the size of the marginal denticles of the aperture. The internal edge of the rostral field always bears small marginal denticles. However, the marginal denticles on ventral margin and margin of rostral fields is not observed due small sizes of studied here steinkerns (imprints of the internal surface of the shell).

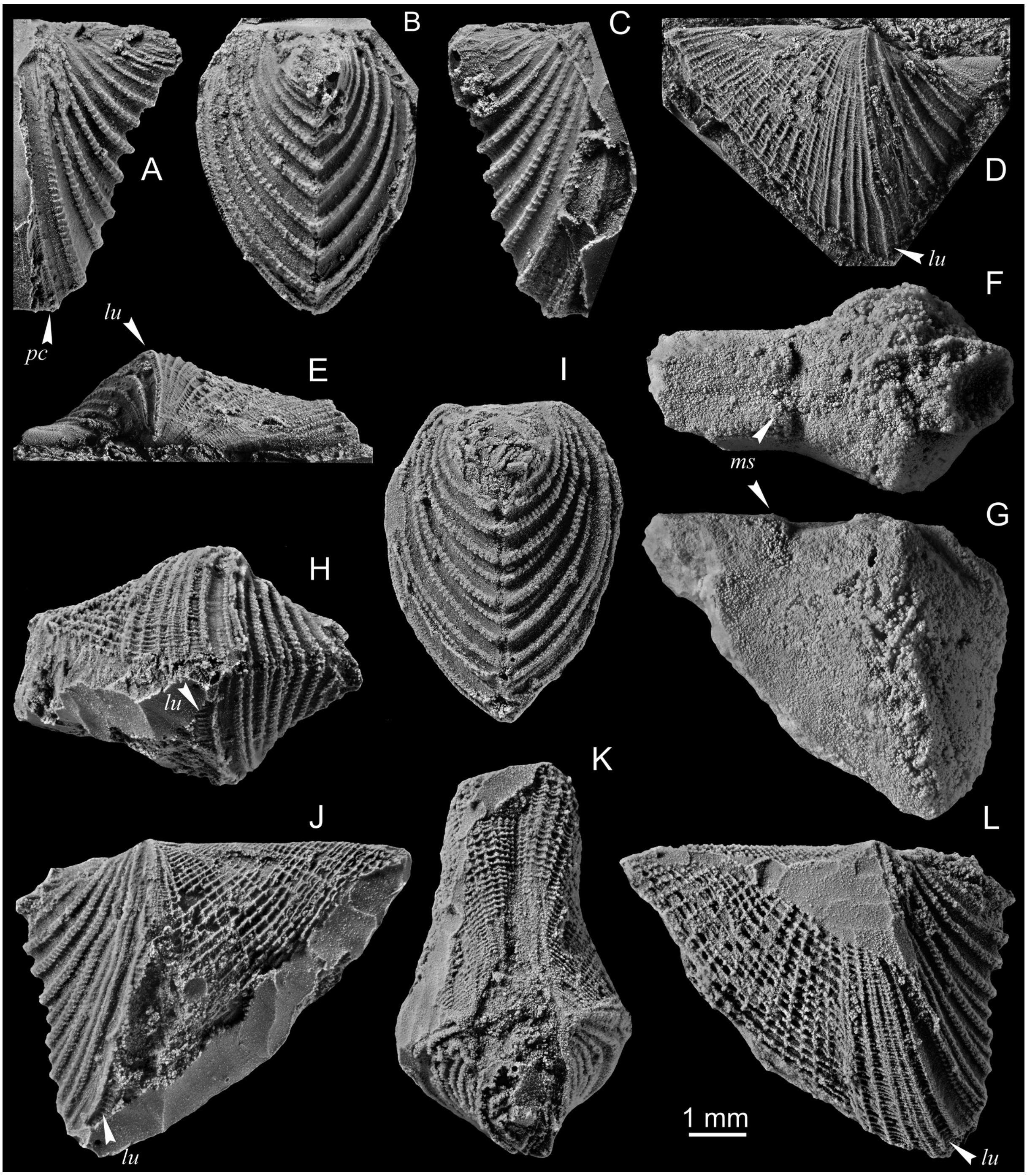

FIG. 2. *Hoarepora parrishi,* Akishino quarry, Korobcheevo Formation, x9. A—C. PIN 4471/85-259, latex cast posterior part of the shell, external surface of the outer shell layer: left (A), posterior (B), right (C) views. D, E. PIN 4471/85-258, latex cast of the left valve, external surface of the outer shell layer: left (D), dorsal (E) views. F—L. PIN 4471/85-257. (F, G) steinkern, imprint of the internal surface of the shell: dorsal (F), left (G) views; (H—L) latex cast of the external surface of the outer shell layer: ventral (H), posterior (I), right (J), dorsal (K), left (L) views. Explanations: (*lu*) — lunulazone, (*ms*) — posterior part of the muscle scar.

РИС. 2. *Hoarepora parrishi,* Акишинский карьер, коробчеевская свита, x9. A—C. ПИН 4471/85-259, слепок из латекса задней части раковины, внешняя поверхность наружного слоя раковины, ракурсы: левый (A), задний (B), правый (C). D, E. ПИН 4471/85-258, слепок из латекса левой створки, внешняя поверхность наружного слоя раковины, ракурсы: левый (D), дорсальный (E). F—L. ПИН 4471/85-257. (F, G) ядро, слепок внутренней поверхности раковины, ракурсы: дорсальный (F), левый (G); (H—L) слепок из латекса внешней поверхности наружного слоя раковины, ракурсы: вентральный (H), задний (I), правый (J), дорсальный (K), левый (L). Объяснения: (*lu*) — лунулазона, (*ms*) — задняя часть мускульного отпечатка.

The internal surface of the *Hoarepora* shells are smooth, devoid of any septa, longitudinal and transverse folds. Two small transverse grooves are observed on the dorsal sides of the frontal segments of one specimen. These grooves are the posterior border of muscle scars, expressed as small depressions on the internal surface of the shell (*ms*: Figs 2F, G). Homologous muscle scars, but slightly shifted forward, have been shown on the molds of *Apotocardium lanterna* (Branson, 1965) [Hoare *et al.*, 2002, fig. 12.7], *A. snideri* (Morgan, 1924) [Hoare *et al.*, 2002, fig. 15.15], *A. obliquum* (Meek and Worthen, 1875) [Hoare *et al.*, 2002, fig. 17.27]. Hoare *et al*. [2002, p. 19], following Pojeta and Runnegar [1976, p. 19], interpreted them as scars of the pallial-protractor muscles. The position of these scars topologically is consistent with the position of muscle scars in the upper conical cavities in the snout of *Arceodomus* Pojeta and Runnegar, 1976 [Mazaev, 2023a, fig. 10, b[3]].

The methods for measuring *Hoarepora* shells used in this work were previously proposed for bransoniids [Mazaev, 2023b].

The ratio of parameters (L_p/L_{vo}) characterizes the general inclination of the edge of the rostral field.

Using the average value of these two parameters, as well as the height, the shell elongation coefficient (K_{shl}) can be calculated:

$$K_{shl} = 0.5(L_p+L_{vo})/H$$

Due to the allometric growth of rostroconchs and measurement error, this coefficient cannot be constant. However, the parameters of this coefficient may differ among different species.

In general, in bransoniids, the length of the aperture varies over a very wide range, and less so at genus level. To assess this characteristic, the coefficient of elongation of the aperture (K_{apl}) is used:

$$K_{apl} = 0.5(L_p+L_{vo})/L_{am}$$

The discreteness of the values of the aperture elongation coefficient allows the diagnosis of bransoniids not only at the species level, but also at the genus level.

An equally important characteristic of species and genera is the ratio of the length of the aperture to the length of the ventral margin (L_{am}/L_{vm}).

Taxonomy

Class Rostroconchia Pojeta, Runnegar, Morris et Newell, 1972
Order Conocardiida Neumayr, 1891
Superfamily Hippocardioidea Pojeta et Runnegar, 1976
Family Bransoniidae Pojeta et Runnegar, 1976
Genus *Hoarepora* Mapes in Mazaev, 2022

Oxyprora Hoare *et al*., 2002: 9.
Oxyprora – Mazaev, 2015: 26.
Hoarepora Mapes in Mazaev, 2022: 107.
Hoarepora – Mazaev, 2023b: S73.

Type species. *Conocardium parrishi* Worthen, 1890, by original designation. USA, Missouri, Kansas; Pennsylvanian.

Diagnosis. See Mazaev, 2023b: S73.

Genus composition. One species from the Mississippian: *H. prattenanum* (Hall, 1856), North America. One species from the Pennsylvanian: *H. parrishi* (Worthen, 1890), North America and Eastern Europe. Three species from the Permian: *H. capitanensis* (Vendrasco *et al*., 2010), North America; *H. tschernyschewi* (Licharew, 1931), *H. uralica*, Mazaev, 2023, Eastern Europe and the Urals, respectively.

Remarks. The generic name *Oxyprora* was shown to be preoccupied, so a new replacement generic name – *Hoarepora* Mapes in Mazaev, 2022 was proposed [Mazaev, 2022].

Hoarepora parrishi (Worthen, 1890)
(Figs 2, 3)

Conocardium parrishi Worthen, 1890: 112, pl. 20, fig. 7; Keyes, 1894: 124, pl. 46, fig. 6a, b; Beede, 1900: 164, pl. 20, fig. 9; Sayre, 1930: 109, pl. 9, figs. 20, 20a–20c; Bird, 1968: 144, pl. 13, fig. 3.
not *Pseudoconocardium parrishi* – Hoare, Sturgeon, Kindt, 1978: 1033, pl. 2, figs. 1–7.
not *Pseudoconocardium parrishi* – Hoare, Sturgeon, Kindt, 1979: 60, pl. 17, figs. 1–6, pl. 18, fig. 1.
Oxyprora parrishi – Hoare, Mapes, Yancey, 2002: 9, fig. 7.1; Rogalla, Amler, 2006d: 44.
Conocardium missouriensis Roundy in Girty, 1915: 353, pl. 28, figs. 3, 3a–3c; Sayre, 1930: 109; Bird, 1968: 144
Pseudoconocardium missouriensis – Hoare, Sturgeon, Kindt, 1978: 1033, pl. 2, figs. 8, 9; Hoare, Sturgeon, Kindt, 1979: 61, pl. 18, figs. 2, 3.
Oxyprora missouriensis – Hoare, Mapes, Yancey, 2002: 13, figs. 7.2–7.17

Type material. Holotype ISGS 13284.

Type locality. Locality unknown, Missourian Drum? Limestone, Pennsylvanian; Kansas City, Missouri, USA.

Material examined. Russian Federation: (1) Ryazan' Region, Kasimov district, Akishino quarry, base of section, locality PIN 4471/85, Middle Pennsylvanian, Moscovian Stage, Myachkonian Substage, Korobcheevo Formation, eight specimens; (2) Moscow Region, Schelkovo quarry, base of limestone section, locality PIN 4471/2, Upper Pennsylvanian, Gzhelian Stage, Rusavkinian Substage, Amerevo Formation, one specimen.

Distribution. Morrowan – Missourian interval in the North American Midcontinent Basin. Myachkovian – Rusavkinian interval on the Russian Platform.

Description. Rostrum subparallel to dorsal axis. The aperture in the region of the frontal segment is wide, evenly narrowing in the region of the interme-

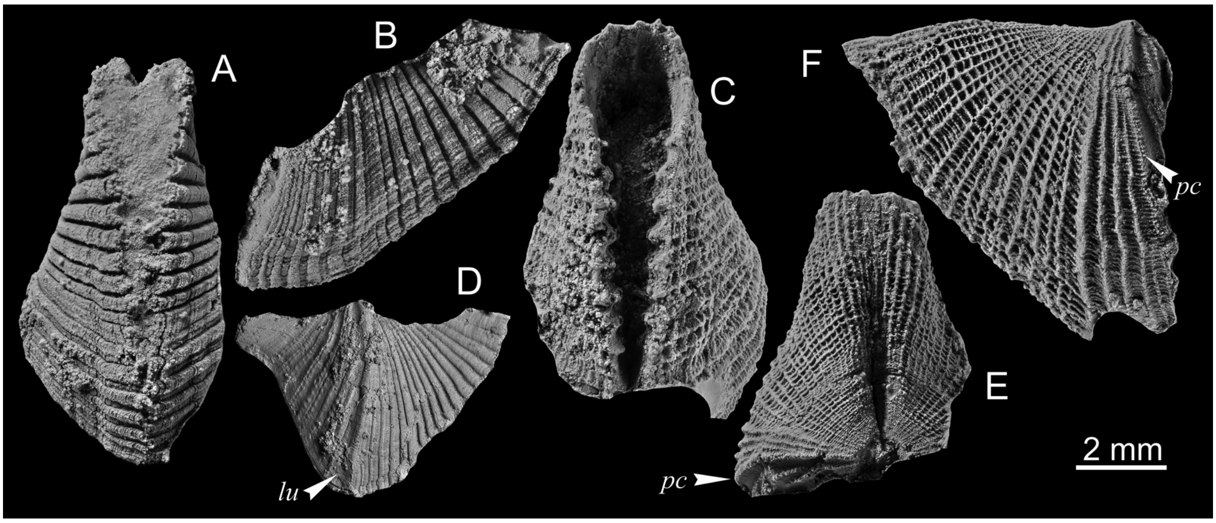

FIG. 3. *Hoarepora parrishi,* x6: A, B. ПИН 4471/85-92 Akishino quarry, Korobcheevo Formation, latex cast, external surface of the inner shell layer: apertural (A), left (B) views. C. ПИН 4471/85-262, same locality, external surface of the inner shell layer. D—F. ПИН 4471/2-148, Schelkovo quarry, Amerevo Formation, latex cast of the external surface of the outer shell layer: apertural (D), dorsal (E), left (F) views. Explanations: (*lu*) — lunulazone, (*pc*) — primary carina.

РИС. 3. *Hoarepora parrishi,* x6: A, B. ПИН 4471/85-92, Акишинский карьер, коробчеевская свита, слепок из латекса наружной поверхности внутреннего слоя раковины, ракурсы: (A) с устья, (B) слева. C. ПИН 4471/85-262, Местонахождение то же, слепок из латекса наружной поверхности внутреннего слоя раковины. D—F. ПИН 4471/2-148, Щелковский карьер, амеревская свита, слепок из латекса наружной поверхности внешнего слоя раковины, ракурсы: (D) с устья, (E) дорсальный, (F) слева. Пояснения: (*lu*) — лунулазона, (*pc*) — основной киль.

diate segment. The right and left edges of the aperture bear at least eight marginal denticles. The frontal segment is separated from the intermediate segment by a shallow and relatively wide depression; the ventral segment differs in the type of ornamentation, sometimes ventral segment slightly elevated above the intermediate segment. Primary carina cord-like, slightly curved. On most specimens with the outer surface of the shell preserved, the primary carina is broken off, and in its place, there is a lunulazone of moderate width with rough, transverse, almost straight growth lines. The rostral area is triangular, generally slightly concave. The edge of the rostral field is sharply wavy, and deep U-shaped bends are formed between the ends of the radial ribs. The contour line along the sharply protruding ends of the radial ribs is almost straight. The ornamentation on the frontal and intermediate segments is the same, the radial and commarginal ribs are high and narrow, forming rectangular cells. Radial ribs are taller and more massive. The number of radial ribs is at least 10; second-order additional radial ribs may be present. The ventral segment has at least four radial ribs. The radial ribs on the ventral segment are massive, noticeably higher than the comarginal ones. The commarginal ribs are thin and frequent, hence, the cells on the ventral segment are narrower than on the intermediate and frontal segments. Primary carina is ornamented with commarginal ribs of the ventral segment. The rostral field is ornamented with massive cord-like radial ribs. The ribs are separated by wide U-shaped intercostal spaces. The external surface of the inner layer of the shell on the frontal and intermediate segments is ornamented with at least 11 wide radial ribs separated by narrow grooves. On the ventral segment, the width of the grooves is comparable to the width of the ribs. The number of ribs, at least four, increases with growth. On the rostral field, the radial ribs are low, narrow, without clear boundaries, covered with low tubercles, and grouped in pairs. Each pair is separated by a wide intercostal space. The increase in the number of radial ribs on the rostral field and ventral segment occurs along the primary carina.

Dimensions. Measurement methods and designations are shown in Fig. 1, *pr* – type of preservation: *ol* – external surface of outer layer. Dimensions in mm: (Table 1).

Remarks. The external outlines of the shells of *H. parrishi* and *H. tschernyschewi* (Licharew, 1931) almost coincide. To compare the shells of the two species, measurements were taken of specimens of *H. tschernyschewi*: (Table 2).

The similarity of these species in the proportions of the shell, in the sculptural elements of the outer and inner layers of the shell (with the exception of the ventral segment), may indicate a close or even direct relationship of the two species. Some specimens of both species exhibit scalloped varices [Bird, 1968, pl. 13, fig. 3; Mazaev, 2015, figs. 2, a1, b2].

Table 1. Dimensions of shells of the *Hoarepora parrishi*.

Табл. 1. Измерения раковин *Hoarepora parrishi*.

No.	pr	L_p	L_{vo}	L_u	L_{am}	L_{vm}	H	W	L_p/L_{vo}	K_{shl}	L_u/H	K_{ahl}	L_{am}/L_{vm}	α
4471/85-257	ol	6.8	5.5	4.5	6.1	1.8	5,5	4.2	1.24	1.12	0.82	1.01	3.39	101°
4471/85-258	ol	5.5	4.0	3.5	4.4	1.3	4.0	–	1.38	1.19	0.88	1.08	3.38	97°
4471/85-264	ol	7.5	6.6	5.3	–	–	5.5	4.0	1.14	1.28	0.96	–	–	97°

Table 2. Dimensions of shells of the *Hoarepora tschernyschewi*.

Табл. 2. Измерения раковин *Hoarepora tschernyschewi*.

No.	Pr	L_p	L_{vo}	L_u	L_{am}	L_{vm}	H	W	L_p/L_{vo}	K_{shl}	L_u/H	K_{ahl}	L_{am}/L_{vm}	α
5538/25-10	ol	11.4	10.4	7.9	10.4	3.5	8.8	9.3	1.10	1.24	0.90	1.05	3.0	107°
5538/25-11	ol	11.6	9.5	7.7	9.8	3.1	10	9.7	1.22	1.06	0.77	1.08	3.2	100°

H. parrishi superficially strongly resembles *H. tschernyschewi*, but differs in the L_{am}/L_{vm} ratio (3.38-3.39 and 3.0-3.2, respectively), the closer position of the commarginal ribs on the outer surface of the outer layer of the anterior part of the shell, especially on the ventral segment, as well as wider paired radial ribs, separated by wide intercostal spaces on the outer surface of the inner layer.

H. parrishi differs from *H. uralica* Mazaev, 2023 in the L_{am}/L_{vm} ratio (3.38-3.39 and 1.94-2.29, respectively), the K_{ahl} elongation coefficient (1.01-1.08 and 1.17-1.29, respectively), the wavy shape of the margin of the rostral field, almost cord-like paired radial ribs with pronounced tubercles on the rostral field of the outer surface of the inner layer.

Discussion

Hoare *et al.* [2002, fig. 7.1] indicated that specimen No. 13284, Illinois State Geological Survey was the holotype of *Conocardium parrishi* because the specimen "matches exactly with the size and description given by Worthen [1890, p. 9]". The suggested holotype comes from the Missourian Drum? Limestone, locality unknown. The image of the holotype was made by Hoare *et al.* from the same angle as that of Worthen. The holotype is turned with its rostral field towards the observer, and the ventral segment is almost invisible. The holotype is represented by the right valve, which lacks the outer layer of the shell. On the rostral field and the anterior part of the shell, the radial ribs of the external surface of the inner layer are clearly visible; commarginal elements are expressed only in the form of growth lines.

After Worthen established *C. parrishi*, the species was described by many authors. However, only Bird's specimen has very well-preserved sculptural elements on the external surface of the outer shell layer [Bird, 1968, pl. 13, fig. 3]. The reticulate sculpture on the anterior part of the shell is formed by radial and commarginal ribs. Previously, Sayre [1930] also described a reticulate sculpture on the anterior part of the shell of *C. parrishi*. In his opinion, the reticulate sculpture was also illustrated by Worthen. However, in all images prior to Bird's work, the commarginal elements are represented precisely by the growth lines on the external surface of the inner layer, and not by the commarginal ribs of the external surface of the outer layer.

Sayre [1930], Branson [1965, p. 250], and then Bird [1968] placed another species –*C. missouriensis* Roundy in Girty, 1915 in synonymy with *C. parrishi*. The types of *C. missouriensis* and *C. parrishi* come from the same locality and horizon. Hoare *et al.* [2002, p. 13, fig. 7.10-7.13] provided images of the holotype of *C. missouriensis* (which is very different from Girty's original image) and stated: "The holotype lacks most of the outer portion of the outer shell layer". Thus, the original image of *C. missouriensis* is a reconstruction (stylized pencil drawing) [Girty, 1915, pl. 28, figs 3, 3b]. Interestingly, Roundy did not compare his new species with *C. parrishi* [Roundy in Girty, 1915].

Hoare *et al.* [1978, 1979] did not accept the synonymy of *C. missouriensis* and *C. parrishi*. The authors placed both species within the genus *Pseudoconocardium* Zavodowsky, 1960, and noted that they differ in the ornamentation on the anterior part of the shell. Later specimens identified as *P. parrishi*

[Hoare e*t al*., 1978, pl. 2, figs. 1–7; Hoare *et al*., 1979, pl. 17, figs. 1–6, pl. 18, fig. 1] were redefined as *Pseudobigalea crista* Hoare, Mapes et Brown, 1982 [Hoare *et al*., 1982].

Hoare *et al*. [2002] established the genus *Oxyprora* Hoare, Mapes, et Yancey, 2002, with the type species *C. parrishi* Worthen, 1890. The authors again stated that "*O. parrishi* differs from *O. missouriensis* by having smaller and more bifurcated costae on the rostral face and finer lirae on the body and snout" [Hoare *et al*., 2002, p. 13]. The term "finer lirae" probably meant commarginal elements of ornamentation. All specimens with reticulate ornamentation on the anterior part of the shell were attributed by the authors to *O. missouriensis* [Sayre, 1930, pl. 9, figs. 20, 20a – 20c; Bird, 1968, pl. 13, fig. 3; Hoare *et al*., 1978, pl. 2, figs. 8, 9; Hoare *et al*., 1979, pl. 18, figs. 2, 3]. Apparently for the same reason, specimens from the Dickerson Shale, Lazy Bend Formation, Texas, were also identified as *O. missouriensis* [Hoare *et al*., 2002, figs. 7.2 – 7.7]. As a result, *O. missouriensis* included specimens with a preserved outer shell layer, and *O. parrishi* included specimens almost devoid of the outer shell layer.

The material described here demonstrates the structure of the external surfaces, both the outer and inner layers of the shell. In this work, *C. missouriensis* is accepted as a junior synonym of *C. parrishi*.

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