

Permian Conchostraca from Continental Deposits in Eastern Europe (Volga-Kama Region) – First Taxonomic Results

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Abstract

In the past few years, several conchostracan Biozones have been established for the Permian continental deposits of northern Pangaea. However, the large number of species-level synonyms in the systematics of conchostracans reduce their usefulness for biostratigraphy.

The taxonomy and synonymy of the Middle and Upper Permian conchostracans are reviewed using a modern methodology for classification. Material for our research comes from the stratotype and parastratotype sections of the Urzhumian Stage of the East European Platform.

Only four species occur in these sections. Some specimens have a well preserved microsculpture on the valves, sexual dimorphism and various deformations of the growth lines on the valve. In some specimens, the microsculpture of the shell is preserved. Other specimens are deformed. A number of species have a pronounced sexual dimorphism. All of these features influence the determination of the systematic position of the conchostracans.

The conchostracans determined in the reference Urzhumian sections are also known in other regions of the world, which allows them to be used for correlation.

Keywords: Conchostraca, Middle Permian, biostratigraphy, paleontology, continental deposits

Introduction

Conchostracans (Crustacea: Branchiopoda) are an important fossil group for the study of continental deposits in the Volga-Kama region, and their study has a long tradition in Russia (e.g., [1], [2], [3], [4], [5], [6], [7]). The present report was motivated by initial revisions of the conchostracan taxonomy and newly collected conchostracan material from recent field work in the Permian and Triassic continental deposits of European Russia [8], Siberia, Germany [9], and Jordan [10].

This allows for a preliminary definition of conchostracan biozones for Permian continental deposits in northern Pangaea (e.g., [9]; [10]). The new data presented here on Middle and Late Permian conchostracans of the Volga-Kama region intends to contribute to both a better understanding of Middle to Late Permian conchostracan biostratigraphy, and a future refinement the definition of high-resolution biozonation.

Geological setting and stratigraphy

Material comes from the reference Middle and Late Permian sections, which are located in the Cheremushka and Monastery Ravines (Fig. 1, A-C) in the eastern part of the East European platform.

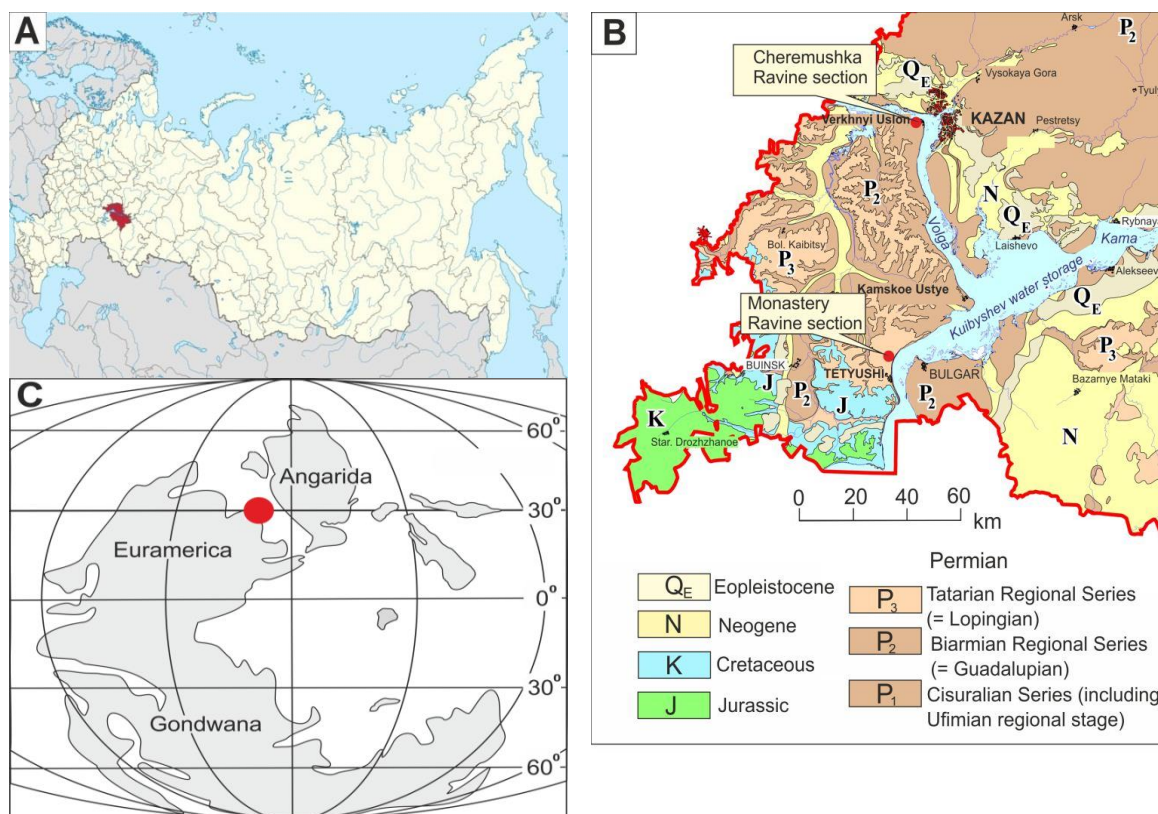


Fig. 1. A: Map of the Russian Federation, showing the location of the Tatarstan Republic. **B:** Geological map of the present study area showing the positions of the Cheremushka and Monastery Ravine sections on the right bank of the Volga river [11]; **C:** Middle Permian palaeogeographic situation showing the locations of the Cheremushka and Monastery Ravine sections [12].

The Cheremushka Ravine section represents the parastratotype of the Urzhumian Stage (Middle Permian) and is located on the right bank of the Volga River ($55^{\circ}46'48.8''$ N; $048^{\circ}55'32.2''$ E).

The section is predominantly composed of red-colored terrigenous sediments including subordinate interlayers of greenish-gray shales, marls, limestones, and dolomites (Fig. 2).

The Cheremushka section ranges from the Kazanian Regional Stage (tentatively Roadian, early Middle Permian) to the Urzhumian Regional Stage (tentatively Wordian, middle Middle Permian).

According to lithostratigraphic features, the Urzhumian Stage in the Cheremushka Ravine section (thickness about 75 m) is subdivided into the Sulitsa and Isheevo Formations [11].

The Monastery Ravine section represents the stratotype of the Urzhumian Stage (Middle Permian) and is located on the right bank of the Volga River ($55^{\circ}01'40.3''$ N; $048^{\circ}53'05.1''$ E) near the village of Monastyrskoe. The section is predominantly represented by reddish, fine-grained siliciclastic rocks with intercalation of fine-grained and coarse-grained sandstones, dolomites and limestones [13] (Fig. 2). This section (thickness about 180 m) is represented by the Urzhumian (tentatively Wordian), Severodvinian (tentatively Capitanian) and Vyatkian (tentatively Wuchiapingian) Regional Stages [14].

Five Formations are available for study in the section. The First, Second and most of the Third Formations belong to the Urzhumian Stage. Part of the Third and almost all of the Fourth Formations are included in Severodvinian Stage. The uppermost part of the Fourth and the entire Fifth Formations belong to the Vyatkian Stage.

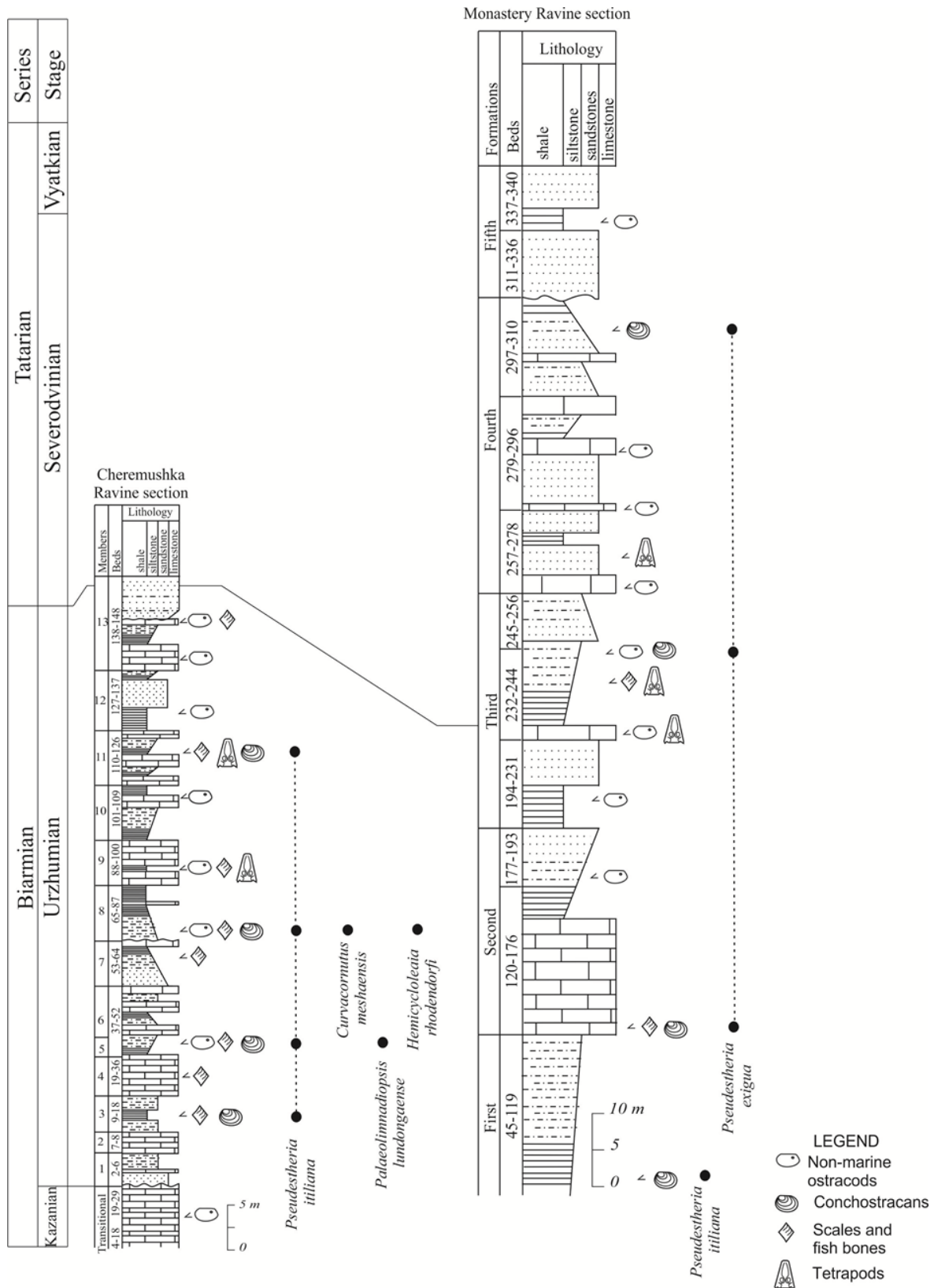


Fig. 2. Stratigraphic and lithological profiles of the Cheremushka and Monastery Ravine sections [15] showing occurrences and ranges of conchostracan taxa.

Method and material

A new collection of conchostracans was sampled from the Middle to Late Permian Cheremushka Ravine and Monastery Ravine sections during Russian-German field work in 2013-2016. About 250 newly collected conchostracans were studied and taxonomically determined based on their carapace

morphology, using the new methodology of conchostracan classification by Scholze and Schneider [8].

Drawings of conchostracan valves were prepared using a Leica MZ12 microscope with a mirror tube. Measurements of the main valve parameters involve the valve length, height (H), length of the dorsal margin, height of the larval valve, curvature parameter, points of the maximal curvature at the anterior, posterior and ventral margins, and position of the umbo in horizontal and vertical directions.

Additionally, the biometric ratios were calculated and compared with ratio values of conchostracans in literature, to enable taxonomic determination to the genus and species level.

Most of the conchostracan specimens figured are housed in the Geological Museum of the Institute of Geology and Petroleum technologies of the Kazan Federal University (KFU) under the inventory numbers KFU 39/P04, KFU 39/P09, KFU 39/M05, KFU 39/M08, KFU 39/M16. The rest of this collection is housed in the Geological museum in the Institute of Geology at the TU Bergakademie Freiberg (FG) under the inventory numbers FG 664/P03, FG 664/P04, FG 664/M01, FG 664/M05, FG 664/M08.

Results

Occurrences of the genus *Pseudestheria* Raymond, 1946 were recorded at four different levels from the Urzhumian to the Severodvinian Regional Stages (Wordian to Capitanian) in the Monastery Ravine section. Among them, the species *Pseudestheria* cf. *itiliana* (Novojilov, 1950) (Fig. 3A, B) occurs in gypsified claystones of the First Formation (beds no. 11-12; Urzhumian Regional Stage), in the middle and upper parts of the Sulitsa Formation (beds no. 17-20; beds no. 37-39), and in the Urzhumian aged deposits of the lower (bed no. 68) and upper parts of Isheevo Formation (bed no. 128). Some individuals show well-preserved shell matrix with concentric ribs. *P.* cf. *itiliana* (Nov.) was first described by Novozhilov [3] as “*Loxopolygrapta itiliana*”. Its holotype came from deposits of the Urzhumian Regional Stage of a section on the right bank of the Volga River near the village of Monastyrskoe [3]. Most likely, it is identical to the locality where the material studied here was obtained and, therefore, the Monastery Ravine section serves as the type section of this species.

Well-preserved conchostracan valves of the species *Curvacornutus meshaensis* Novojilov, 1970 (Fig. 3C) and *Hemicycloleaia* cf. *rhodendorfi* (Novojilov, 1952) (Fig. 3D) were collected in the lower part of Isheevo Formation in the Green Shale Member (bed no. 68). The curved spine on the larval valves is characterized for *C. meshaensis* (Nov.). *H.* cf. *rhodendorfi* (Nov.) is rare in this section and the record of this species is, so far, based on three rather poorly preserved individuals showing two radial ribs. *H.* cf. *rhodendorfi* (Nov.) was collected in the Urzhumian deposits in the Cheremushka Ravine section. *H.* cf. *rhodendorfi* (Nov.), described here from the Cheremushka Ravine section, differs from *Kaltanleaia rhodendorfi* in the sense of Novozhilov [3: p. 1370] which has a third radial rib located directly on the dorsal margin of the valve. Since the here-studied *H.* cf. *rhodendorfi* (Nov.) is so far known only from three individuals of poor preservation, the question of the presence of a third radial rib should be answered in future studies when more material of this species has been collected in the Cheremushka Ravine section.

Rare specimens of *Palaeolimnadiopsis* cf. *lundongaense* (Novojilov, 1970) were found in brown claystones in the upper part of Sulitsa Formation (beds no. 37-39; Urzhumian Regional Stage). The species *P.* cf. *lundongaense* (Nov.) was defined by Novozhilov [6: p. 172-174] as “*Megasitum lundongaense*”, but it is here considered as to belong to the genus *Palaeolimnadiopsis* Raymond, 1946, because of a slightly developed concave recurvation of posterior growth lines below the dorsal margin of the valve. *P.* cf. *lundongaense* (Nov.) from the Cheremushka Ravine section (Fig. 3 E-F) differs from “*M. lundongaense*” by a lower number of growth lines and broader growth bands. Additionally, some of the recorded individuals have a larger size than “*M. lundongaense*”. Novozhilov [6] described the sexual dimorphism of “*M. lundongaense*”, and also accounts for the material here described from the Cheremushka section showing a slender and a stout morphotype for *P.* cf. *lundongaense* (Nov.). Novozhilov [6: p. 172-174] considered the more rounded forms as females (e.g., Fig. 3E) and longish forms as male individuals (e.g., Fig. 3F). However, Novozhilov

[6] also assigned the rounded forms to *Megasitum kaljugense* Nov., 1970 and the elongated forms to *Megasitum sotianum* Nov., 1970.

In the Monastery Ravine section, well-preserved valves of *Pseudestheria exigua* (Eichwald, 1860) occur in the deposits of the Second (M05, no. beds 5-7) and Third (M08, no. bed 54) formations (Urzhumian Stage). Additionally, juvenile forms of *P. exigua* were recorded in the Fourth Formation (M16, no. beds 14-15; Severodvinian Regional Stage). For the first time *P. exigua* was described by Eichwald [16] as the bivalve *Posidonomya exigua*. Eichwald characterized the genus *Posidonomya* Bronn, 1839 as "...a thin enlarged valve with concentric ribs; the extended ribs form a distinct angle at the anterior and posterior margins..." [16: p. 940] and described the species *P. exigua* as "small individuals with a straight dorsal margin and thin shell substance" [16: p. 941]. The specimens of *P. exigua* from the Monastery Ravine section have only growth lines on the thin shell substance, and their external outlines are more roundish.

Mass occurrences of this species were found in the fish layer (bed no. 54 of the Monastery Ravine section) in the upper part of the Urzhumian deposits of the Third formation. All samples have a shell substance with well-preserved microsculpture. Some samples have the soft body element presented on the conchostracan valve (Fig. 3, H-K). The various deformations of the growth lines on the anterior-ventral and the posterior-ventral margins are one of the main characteristics of this species.

According to [17] the photography of the microsculpture should be taken from different parts of the valve. As in (Fig. 4), pitted ornamentation is observed on the growth bands.

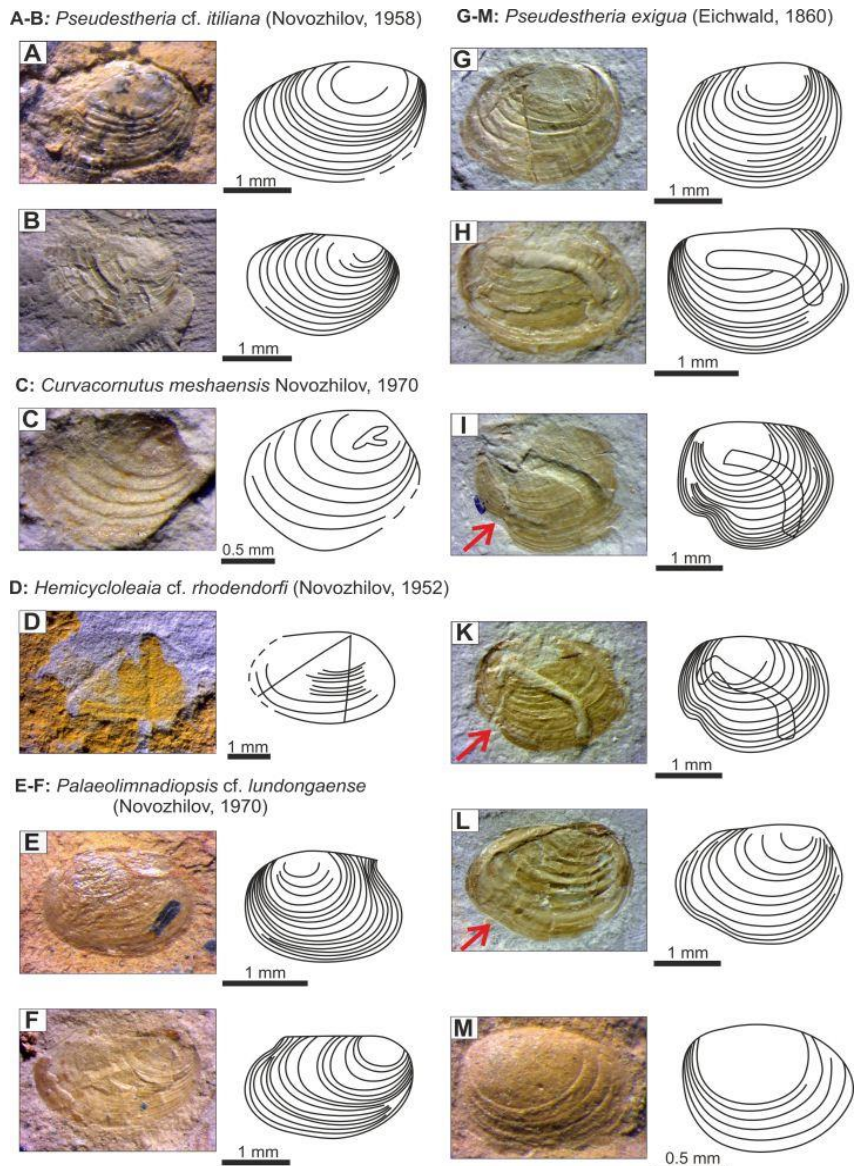


Fig. 3. Conchostracans from the Urzhumian to Severodvinian Regional stages (middle Middle Permian to early Late Permian) of the Cheremushka and Monastery ravine sections. **A:** *Pseudestheria* cf. *itiliana* (Nov.) (KFU 39/P09/6/1). **B:** *Pseudestheria* cf. *itiliana* (Nov.) (FG 664/M01/8/1) well preserved internal casts. **C:** *Curvacornutus meshaensis* (Nov.) (FG 664/P04/21/2) curved spine at the larval valve. **D:** *Hemicycloleaila* cf. *rhodendorfi* (Nov.) (KFU 39/P04/4/3) valve with two prominent radial ribs. **E:** *Palaeolimnadiopsis* cf. *lundongaense* (Nov.) (39/P04/1/1) stout morphotype. **F:** *Palaeolimnadiopsis* cf. *lundongaense* (Nov.) (KFU 39/P04/1/2) slender morphotype. **G:** *Pseudestheria exigua* (Echw.) (KFU 39/M08/24/1) valve with well-preserved shell substance. **H:** *Pseudestheria exigua* (Echw.) (FG 664/M08/15/1) body elements preserved as internal cast. **I:** *Pseudestheria exigua* (Echw.) (KFU 39/M08/9/3) body elements preserved as impression. **K:** *Pseudestheria exigua* (Echw.) (KFU 39/M08/8/3) body elements preserved as internal cast. Red arrows mark concave bending caused by deformation at the anterior ventral margin. **L:** *Pseudestheria exigua* (Echw.) (KFU 39/M08/22/1) the red arrow marks the same deformation at the posterior ventral margin. **M:** *Pseudestheria exigua* (Echw.) (KFU 39/M16/2/1), juvenile individual of the same species.

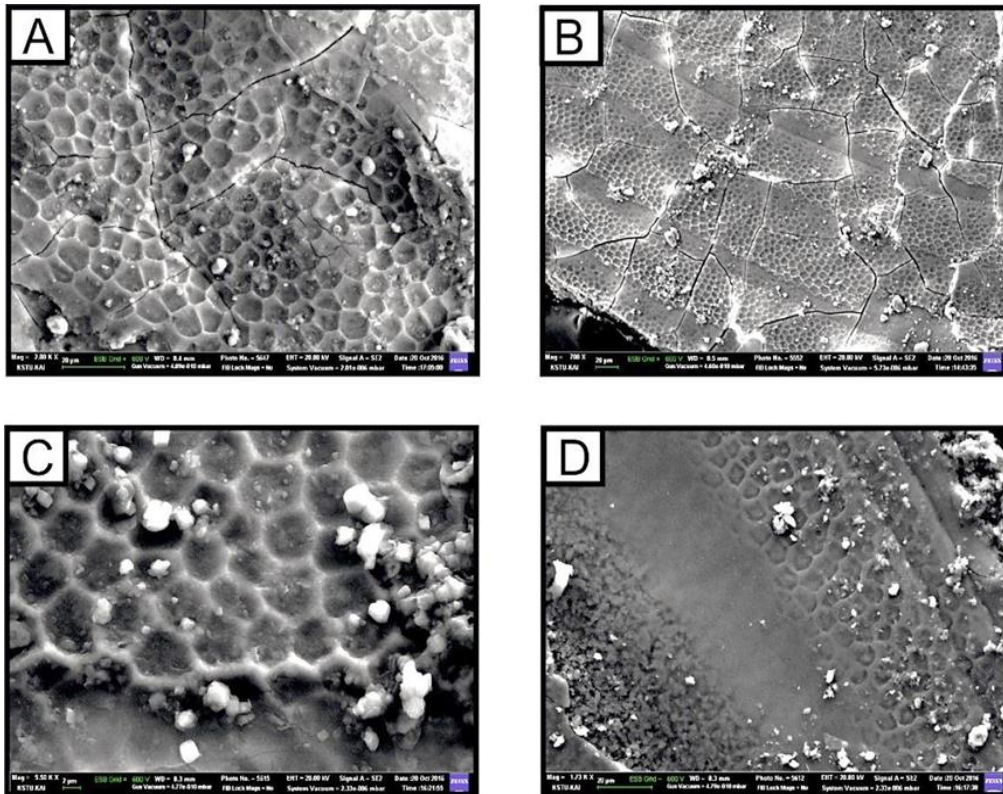


Fig. 4. Pitted microstructures (ornamentation) on the growth bands of the species *Pseudestheria exigua* (Eichwald, 1860) from the Monastery Ravine section (**A:** Middle part of the valve; outcrop M05, bed no. 6. **B:** Ventral part of the valve; outcrop M05, bed no. 7. **C:** Ventral part of the valve; outcrop M08, bed no. 54. **D:** Posterior part of the valve; outcrop M08, bed no. 54).

Discussion

The Cheremushka and Monastery ravine sections were comprehensively studied for several decades. Silantiev *et al.*, [11], [12], [15], Mouraviev *et al.*, [13] have made a geochemical, paleomagnetic, and palaeontological analysis in these sections. Earlier, non-marine bivalve valves, fish scales, tetrapods, plants, and paleosols were studied in detail [11]. These indicate the general importance of both sections for interdisciplinary studies of Middle Permian continental sedimentary deposits.

Other regions (e.g., Central Europe) have several problems for the study continental deposits; e.g., stratigraphic gaps, poor fossil content, missing correlation between isolated sections [9]. This makes the Cheremushka and Monastery Ravine sections the key-sections for the continental Middle Permian.

The occurrences of *Pseudestheria itiliana* in both the Cheremushka and Monastery Ravine sections might indicate a biostratigraphic correlation between the intervals of these two sections. The

study of conchostracans from the Volga-Kama region (from collections and newly sampled material) is an ongoing project, which will result in future biostratigraphic subdivisions, definition of biozones, and enabling regional to interregional biostratigraphic correlations.

This will contribute to a comprehensive palaeoenvironmental and stratigraphic synthesis of these two key sections.

Conclusions

The results demonstrate the high value of conchostracans for the biostratigraphy and palaeoenvironment of continental deposits. Some species, such as *Pseudestheria itiliana* (Nov.), allow correlation between the sections. The diagnoses of some conchostracan genera had not been exactly determined. There is a necessity for the revision of Russian collections (such as, Novozhilov's and Molin's collections deposited in the Paleontological Institute, Russian Academy of Sciences) by using an improved methodology for taxonomic classification.

A current problem is the low number of beds yielding conchostracans, as well as an often-low number of individuals collected. Consequently, the current problems can only be solved when more conchostracan material including other faunas has been systematically collected through ongoing fieldwork. It is important to research drill-cores to search for the fossils, because oil and gas fields are confined to these locations.

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