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Late Bajocian and Early Bathonian Ostracods of the Russian Plate. Part III. Genera *Camptocythere* Triebel and *Procytheridea* Peterson

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Abstract—A new species *Camptocythere* (*Anabarocythere*) *triangula* Tesakova, sp. nov. is described from the Upper Bajocian (*Michalskii* ammonite Zone) and the Lower Bathonian (*Besnosovi* ammonite Zone) of the Russian Plate (Sokur Borehole, Saratov Region). This species is presumed to be the ancestor of *C.* (*A.*) *muricata* Gerke et Lev, sp. nov. from the upper Bathonian–Callovian of northern Siberia, Timan-Pechora Province and the Barents Sea shelf, the first description of which is also published in this paper. The publication of the original description by O.M. Lev, expanded and supplemented by the author of this study, confers availability and validity of this species from the date of the present publication, and eliminated shortcomings in the stratigraphic literature, where until now *C.* (*A.*) *muricata* was a nomen nudum. The possible phylogenetic relationship between these species allows them to be considered indices of the corresponding lineage zones in the scale of evolution of the subgenus *C.* (*Anabarocythere*) Nikitenko. The species *Procytheridea*? *bajociensis* (Khabarova, 1955) is re-studied from the same deposits of the Sokur Borehole and the Lower Bathonian of the Obval Borehole (Penza Region). *P. concinna* Permjakova, 1974 and *P. ljubimovae* Permjakova, 1974 from the synchronous deposits in Ukraine were synonymized with this species after its revision. A neotype is designated for *P.*? *bajociensis* and an expanded and supplemented redescription is provided. The monospecific assemblages (or with the dominance of this taxon) with *P.*? *bajociensis*, are restricted to the Late Bajocian–Early Bathonian of the Russian Plate and Western Kazakhstan and suggest an extremely shallow coastal setting, possibly with unstable salinity.

Keywords: ostracods, new species, Middle Jurassic, Bajocian, Bathonian, Central Russia, Volga region

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INTRODUCTION

This paper is a continuation of the systematic study of ostracods from the Upper Bajocian and Lower Bathonian of the Russian Plate (RP) based on materials from the sections of the Volga Region and central regions of Russia, the results of which are partially published in the first and second parts of the study (Tesakova, 2022a, 2022b). They presented the results of the revision, as well as updated and expanded descriptions of the stratigraphically significant genera *Plumhoffia* Brand, 1990, *Pseudohutsonia* Wienholz, 1967 and *Procytherura* Whatley, 1970 (family Cytheruridae) and *Aaleniella* Plumhoff, 1963 (family Eucytheridae). For two species established by Khabarova (1955)—*Plumhoffia tricostata* (Khabarova, 1955) and *Pseudohutsonia clivosa* (Khabarova, 1955), neotypes were identified and updated redescriptions were made; seven others: *Aaleniella franzi, A. volganica, A.? ovoidea, Procytherura iyae, Acrocythere sokurensis, Nanacythere octum*, and *Trachycythere peculiaris* are described as new.

For four taxa left in open nomenclature (*Nanacythere* sp. 1, *N.* sp. 2, *Ljubimovella* sp. 1, and Gen. et sp. 8), information on the material and occurrences in the studied sections is given. All listed species (new ones and those proposed by T.N. Khabarova) are index taxa of assemblages established in the deposits of the terminal Bajocian and Lower Bathonian (*Michalskii* and *Besnosovi* ammonite zones) of the RP; their lower boundaries are defined by the first appearances of the index species.

This paper continues the monographic description of ostracods from the composite Sokur Section (Saratov Region) and the Obval Borehole (Penza Region), the location of which is shown in text-fig. 1 in the first part of the study (Tesakova, 2022a). One of the tasks is to revise and redescribe the stratigraphically important species *Procytheridea*? *bajociensis* (Khabarova, 1955). The taxon was proposed by Khabarova (1955, 1961) as a marker taxon for the Upper Bajocian–Lower Bathonian of the RP, as it was most abundant and frequent.

Another task is to establish and describe a new species of *Camptocythere* (see below), a genus often found in ostracod assemblages from the Lower and Middle Jurassic of the Northern Hemisphere. The origin of the genus *Camptocythere* Triebel, 1950 was geographically associated with the Arctic Boreal Paleobasin, and its distribution in the shelf and epicontinental seas of Laurasia was due to transgressions from the north.

The oil and gas exploration of the Russian Arctic played a big role in the study of the Jurassic microfauna of the region, including ostracods. The first descriptions of seven new species (including species of *Camptocythere*) from the Middle Jurassic of the Nordvik Region were published by Sharapova (1940). Later, based on borehole core material from the Jurassic and Lower Cretaceous of Lena–Yenisei Region, Gerke (1953) published preliminary descriptions of 33 ostracod species that could not be considered valid, but he analyzed their stratigraphic distribution that is important for prospecting. These studies were continued by O.M. Lev. She described a number of new taxa from the Lower and Middle Jurassic of the Nordvik and Leno-Olenek regions in single authorship or in joint authorship with A.A. Gerke (for those species that he had identified earlier, but did not have time to publish, including three species of *Camptocythere*) (Lev, 1958, 1961). However, a significant proportion of the new ostracods from Gerke's collection remained undescribed, although names for them were included in works on the stratigraphy of the northern regions of the former USSR (Runeva, 1961; Saks et al., 1963; etc.), resulting in several nomina nuda. These included four stratigraphically significant species: *Camptocythere scrobiculata* Gerke et Lev, *C. dextra* Gerke et Lev, *C. muricata* Gerke et Lev, and *C. laciniosa* Gerke et Lev, which appeared in the lists of stratigraphic complexes for the Middle and Upper Jurassic of Siberia (Lev, 1966; *Stratigrafiya* ..., 1976), and later in the names of beds with ostracods for the Timan-Pechora Province (TPP) (Lev and Kravets, 1982; *Prakticheskoe* ..., 1999) and the Barents Sea shelf (Repin et al., 2007; etc.). Modern requirements for stratigraphic schemes (the replacement of nomina nuda by valid taxa) facilitated the publication of the listed species without delay, and they were prepared for publication at about the same time by two different researchers. N.V. Kupriyanova included complete paleontological descriptions of four *Camptocythere* previously made by Lev, into a monograph written by a team of VNIIOkeangeologia employees and submitted it to "Rosgeolfond" as unpublished report, i.e., the text remained as manuscript names (Atlas..., 1995). However, B.L. Nikitenko redescribed *C. scrobiculata* and *C. dextra* as *C. (Camptocythere) scrobiculataformis* Nikitenko, 1994 and *C. (Anabarocythere) arangastachiensis* Nikitenko, 1994, and in subsequent stratigraphic schemes for the Middle Jurassic of northern Siberia, the TPP, and the Barents Sea shelf, these (already zonal) index taxa appeared under new names (Nikitenko, 1994, 2009; Devyatov et al., 1994; Basov et al., 2009; *Unifitsirovannaya*..., 2012).

C. muricata was not included in the paper by Nikitenko (1994) and was replaced in the stratigraphic scales for northern Russia by another index species, *C. micra* Nikitenko, which was also a nomen nudum (Devyatov et al., 1994; Nikitenko, 2009; Basov et al., 2009; *Unifitsirovannaya*..., 2012).

For Beds with *C. micra* (JO15), Nikitenko (2009) indicated characteristic species with the same distribution as that of the index species: *C. (C.) muricata* and *C. (C.) laciniosa*. In the Upper Bathonian (*Variabile* ammonite Zone)—Callovian (*Lamberti* ammonite Zone) of northern Siberia, he identified two marker taxa *C. (C.) micra* and *C. (C.) muricata* (Nikitenko, 2009, text-figs. 86, 88), and for the Pechora Syneclise, both of the above and *C. (C.) laciniosa* (text-fig. 119)[1]. The image of the holotype of *C. (C.) micra* given in the monograph (Nikitenko, 2009, pl. o-5, figs. 2–5) does not allow us to consider this species name available, because its description has not been published anywhere, and the reference (Nikitenko, 2009, p. 57) to publication in Nikitenko (1994) is incorrect. Therefore, the problem of availability of *C. muricata* Gerke et Lev and *C. micra* Nikitenko is still relevant.

This paper contains the original description of the species *C. (A.) muricata*, made by Lev for the monograph (*Atlas*..., 1995) edited and supplemented with an extended stratigraphic distribution. Although this species has not yet been found in the author's material, it is directly related to the new Late Bajocian species *C. (A.) triangula* sp. nov. as part of the same lineage and, apparently, is its direct descendant.

The fourth taxon *C. laciniosa* Gerke et Lev, was described by the author from the Lower Callovian (*Elatmae* ammonite Zone and Subzone) of Saratov Region, as a new species of *C. (A.) starcevae* Tesakova, 2013 (Tesakova and Seltser, 2013), because E.M. Tesakova did not know about its existence at that time and did not have access to the manuscript with the original description and holotype images of *Camptocythere* from the Callovian of the Barents Sea shelf. Now, based on information on the distribution of *C. laciniosa* (*Atlas* ..., 1995; Basov et al., 2009; *Unifitsirovan-*

[1] It is strange that the three listed *Camptocythere* species were assigned to the nominative subgenus, since all of them show clear features of the subgenus *C. (Anabarocythere)* Nikitenko, 1994. Judging by the poor-quality images of *C. (C.) micra* (Nikitenko, 2009, pl. o-5, figs. 2–5), there were tubercles in the posterior part on both valves, as in *C. (A.) triangula* sp. nov., while *C. (C.) muricata* and *C. (C.) laciniosa* have well-developed spines. In this paragraph of the introduction, the taxonomy of B.L. Nikitenko is followed, but below in the main text these species are transferred by the present author to the subgenus *Anabarocythere*.

naya..., 2012), the stratigraphic and chorological range of *C. (A.) starcevae* can be emended.

While until recently it was considered to be confined to the Lower Callovian of the Saratov Region (Tesakova and Seltser, 2013), Nizhny Novgorod Region (Tesakova et al., 2020) and Kostroma Region (working collections of the author) of the RP, its range can now be expanded to the Upper Bathonian–Callovian of the TPP, the Barents Sea shelf and Siberia.

The dispersal of *C. (A.) starcevae* within the RP, that occurred later than in northern Russia, was determined by paleogeography, and based on its appearance in the sections, a nominative migratory zone with a narrow stratigraphic interval (*Elatmae* and *Subpatruus* ammonite zones) can be recognized in the RP. The relatively short existence of *C. (A.) starcevae* on the RP was most likely associated with strong competition with ostracods from other genera and families, which were absent in the Middle Jurassic in the paleoseas of the TPP, the Barents Sea shelf, and northern Siberia. The difference between the high diversity in the RP ostracod assemblages versus the low diversity characteristic of the Arctic paleobasins assemblages suggests differences in the oxygen regime at the bottom (which controlled the state of benthic fauna), which was determined by the different trophic levels of these paleoregions.

ABBREVIATIONS

The following abbreviations are used for scientific institutions mentioned in the text: VSU (Voronezh State University), GIN RAS (Geological Institute, Russian Academy of Sciences, Moscow), IG RAS (Institute of Geography, Russian Academy of Sciences, Moscow), IPGG SB RAS (A.A. Trofimuk Institute of Petroleum Geology and Geophysics, Siberian Branch, Russian Academy of Sciences, Novosibirsk), MSU (M.V. Lomonosov Moscow State University), NIIGA (Scientific Research Institute of Geology of the Arctic; later transformed into the All-Russian Research Institute of Geology and Mineral Resources of the World Ocean—VNIIOkeangeologiya, St. Petersburg), PIN RAS (A.A. Borissiak Paleontological Institute, Russian Academy of Sciences, Moscow), SNIGU (N.G. Chernyshevsky Saratov National Research State University), TsNIL (Central Research Laboratory) of the "Saratov-Neft" Co. (see Tesakova, 2022a), VNIGNI (All-Russian research geological oil institute, Moscow).

MATERIALS AND METHODS

The origin of the material and the methods of its study are described in detail in the first part of the study (Tesakova, 2022a).

Ostracod collections are housed at the Department of Regional Geology and Earth History, M.V. Lomonosov Moscow State University (Moscow), coll. nos. MGU Sokur, MGU Sokur-Ya, MGU Sokur-LG (Sokur Section), and no. MGU Pnz-12 (Obval Borehole).

SYSTEMATIC PALEONTOLOGY

The taxonomy of suprageneric taxa was adopted from the *Prakticheskoe*... (1999) and emended according to *International Code of Zoological Nomenclature* (1999). The terminology for various elements of ostracod shells follows *Prakticheskoe*... (1989). When measuring the parameters of complete shells or separate valves, the following abbreviations are accepted: L—length, AEH—the height of the anterior end, PEH—the height of the posterior end, W—width, L/H—length/maximum height ratio (here—to AEH), juv.—juvenile individual. The growth stages of ostracods are usually considered starting from sexually mature (where male or female are distinguished), and juvenile stages are marked with Roman numerals, where I is the penultimate stage, and VIII (IX) is the initial, youngest. When working with paleontological material (not abundant and not particularly well-preserved), it is convenient to refer juvenile specimens to combined age groups to minimize possible errors (for example, juv. I–II, juv. III–IV).

Order Podocopida Sars, 1865

Suborder Cytherocopina Gruendel, 1967

Superfamily Progonocytheroidea Sylvester-Bradley, 1948

Family Progonocytheridae Sylvester-Bradley, 1948

Subfamily Kirtonellinae Bate, 1963

Genus *Camptocythere* Triebel, 1950

Subgenus *Camptocythere (Anabarocythere)* Nikitenko, 1994

***Camptocythere (Anabarocythere) muricata* Gerke et Lev, sp. nov.**

Plate 8, fig. 1

Camptocythere muricata (nomen nudum): Lev, 1966, pp. 33, 35, 39, plate; Lev and Kravets, 1982, p. 67, text-fig. 1; *Atlas* ..., 1995, p. 147, pl. 2, figs. 4, 5; *Prakticheskoe* ..., 1999, p. 127, pl. III.3; Repin et al., 2007, p. 127, pl. 3; Nikitenko, 2009, text-figs. 86, 88, 119.

Etymology. From the Latin *muricata* (muricate, spiky; because of a spine on the left valve).

Holotype. NIIGA, no. 1267-170 complete shell of a female; Middle Siberia, Nordvik-Khatanga Region, Borehole K-441, depth 33–36 m; Middle Jurassic, Middle-Upper Bathonian, *Arcticoceras kochi* ammonite local Zone (Pl. 8, fig. 1).

Description. The shell is medium in size, ovoid-oval, short, strongly expanding at the anterior end. The shell is strongly and evenly convex, the valves converge smoothly towards both ends, but more gently towards the posterior end. The dorsal margin is relatively long, straight, slightly concave in the posterior half; at the transition to the anterior margin, it forms an obtuse, strongly rounded angle, and at the transition to the posterior one, it is also rounded, but less obtuse, or almost right angled. The ventral margin is not parallel to the dorsal, strongly convergent towards the posterior end, concave anteriorly, which is obscured in lateral view due to the overhanging valve convexity; it merges smoothly with both ends. The anterior end is much higher than the posterior, smoothly arcuately rounded, may be slightly oblique from above. The posterior end is low, rounded and somewhat oblique from below. In the posterior part of the left valve there is a short sharp spine, developed to varying degrees; there is no spine on the right valve. The surface is smooth with small pores. The hinge and muscle scars are typical for the genus.

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

	L	AEH	PEH	W	L/H
Holotype 1267-170 (female)	0.54	0.37	–	0.29	1.46
All specimens studied	0.50–0.53	0.32–0.33	–	0.25–0.31	–

V a r i a b i l i t y. The length of the spine on the left valve varies. The shell length of adult representatives exceeds the height by 1.4–1.5 times, sometimes up to 1.6 times.

C o m p a r i s o n. This species is distinguished as follows from species similar to the presence of spines: *C. (A.) spinulosa* (Sharapova, 1940) from the Bajocian of northern Siberia (Sharapova, 1940, p. 126, pl. 1, fig. 6; Nikitenko, 2009, pl. o-3, figs. 14–17), *C. (A.) praearangastachiensis* Nikitenko, 1994 from the upper part of the Lower Bajocian of northern Siberia (Nikitenko, 1994, p. 53, pl. 1, fig. 10; 2009, pl. o-4, figs. 1, 2), *C. (A.) arangastachiensis* from the Lower Bajocian–Lower Bathonian of northern Siberia and northern European Russia (Nikitenko, 1994, p. 53, pl. 1, figs. 11–15; 2009, pl. o-4, figs. 3–10; Basov et al., 2009; *Unifitsirovannaya* ..., 2012) and *C. (A.) starcevae* Tes., 2013 from the Lower Callovian of the RP (Tesakova and Seltser, 2013, p. 63, text-fig. 5, figs. 10, 11, 14, 15; Tesakova et al., 2020, text-fig. 3) and the Upper Bathonian–Callovian of northern Russia (*Atlas*..., 1995, pp. 148, pl. 2, figs. 1–3; Basov et al., 2009; Nikitenko, 2009; *Unifitsirovannaya*..., 2012), in a high anterior end, significantly exceeding the low posterior end. In addition, it differs from *C. (A.) spinulosa* and *C. (A.) starcevae* in the spine developed in the posterior part of only one valve (against the spines on both valves in the compared species). From *C. (A.) praearangastachiensis* and *C. (A.) arangastachiensis*, which also have only one spine, but on the right valve, it differs in the presence of a spine on the other (left) valve. A comparison with *C. (A.) triangula,* the most similar in shell form, is given in its description.

O c c u r r e n c e. Upper Bathonian–Callovian of Western Siberia, Timan-Pechora Province and the Barents Sea shelf.

M a t e r i a l. About 20 shells and separate valves of varying degrees of preservation.

Camptocythere (Anabarocythere) triangula **Tesakova, sp. nov.**

Plate 8, figs. 2–13

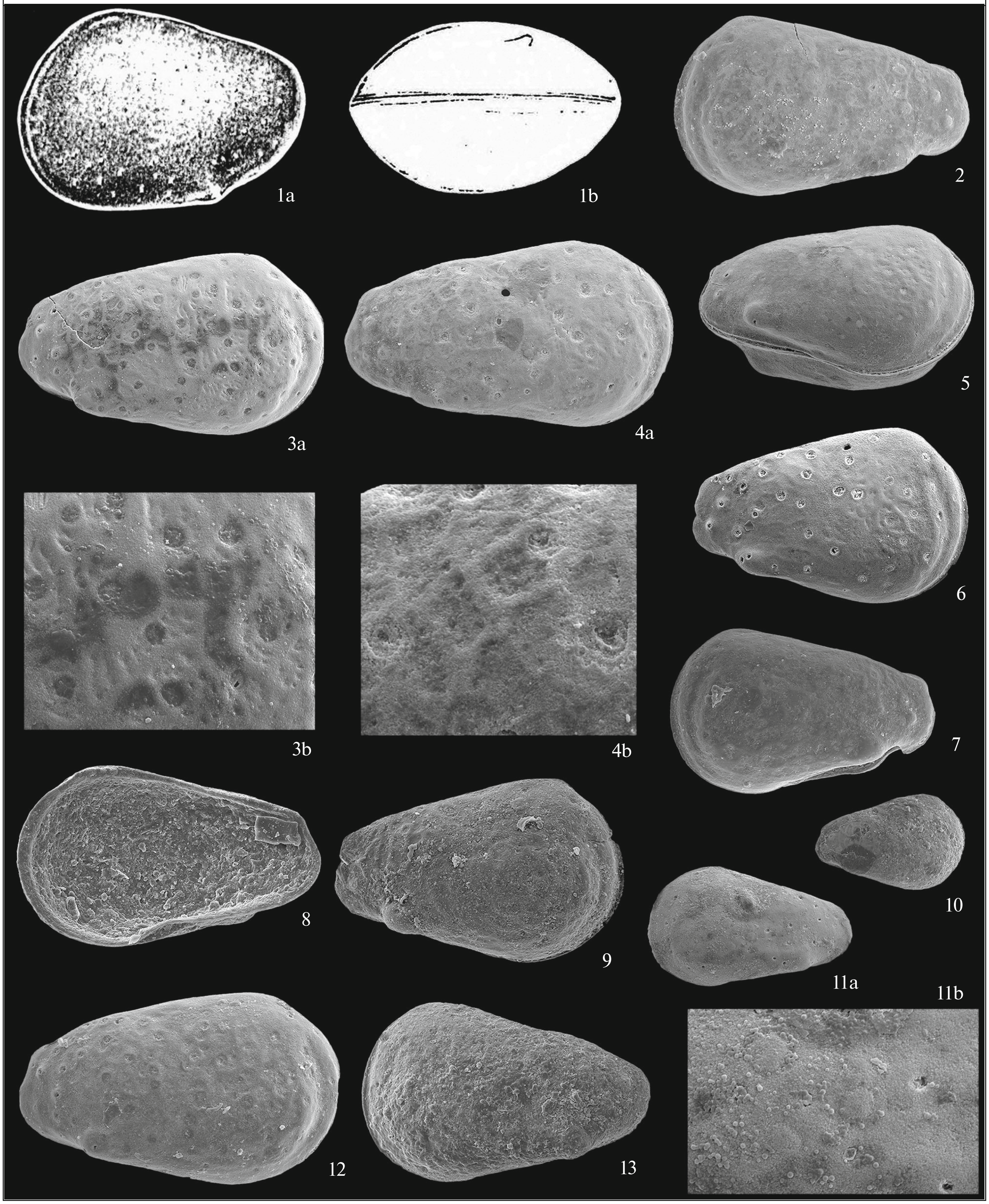
Gen. sp. 2: Shurupova et al., 2016, text-fig. 6/13.

E t y m o l o g y. From the Latin *triangula* (triangle), for the triangular shape of the shell.

H o l o t y p e. MGU Sokur-Ya-172, right valve of a female; Saratov Region, Sokur Borehole, depth 19.5 m; Upper Bajocian, *Michalskii* ammonite Zone (Pl. 8, fig. 3)

D e s c r i p t i o n. The shell is medium-sized, rounded-triangular, short, strongly expanding at the anterior end. The shell is moderately and evenly convex, the valves converge smoothly towards both ends, but more gently towards the posterior end, and form a distinct ledge at the anterior end. Almost equivalve, but the left valve slightly overlaps the right one in the antero-dorsal and postero-dorsal angles. The dorsal margin is long and straight, slightly concave in the middle, and converges towards the posterior end. It merges smoothly with the anterior margin on the left valves, through a strongly rounded obtuse angle; on the right, too, smoothly, but with a slight ledge. It passes into the posterior margin on both valves, albeit smoothly, but at a much smaller angle or almost at a straight line, with a distinct ledge. The ventral margin is concave in the middle, which is masked by the convexity of the valve and is not noticeable in lateral view and converges towards the posterior end; goes smoothly on both ends. The anterior end is high, symmetrical, arcuately rounded; on the right valves it can be oblique at the top, but very weakly; narrowly flattened along the margin. Except for the cardinal angles, it has a narrow marginal selvage. The posterior end is low, short, box-shaped, with a distinct ledge in the upper part (where it meets with the dorsal margin); narrowly flattened along margin. On both valves, one small, rounded tubercle is developed in the postero-ventral part. Round sieve pores stand out on the surface of valves, including these tubercles, often surrounded (which is especially noticeable at the posterior end). Weakly reticulate ornamentation covers the entire surface of the valves, with the exception of the narrow, flattened part of the anterior end, and is represented by smoothed cells with low, rather weakly expressed, smoothed edges (muri). The size of the cells is the same over the entire surface, and their bottom (solum) is covered with small simple pores (several in each cell). The hinge and muscle scars are typical of the genus.

Plate 8



Dimensions in mm:

	L	AEH	PEH	L/H
Holotype Sokur-Ya-172 (female)	0.50	0.28	0.17	1.79
Specimen Sokur-Ya-184 (juv. I-II)	0.41	0.25	0.13	1.64
Specimen Sokur-Ya-189 (female)	0.56	0.31	0.18	1.81
Specimen Sokur-Ya-161 (juv. III-IV)	0.39	0.21	0.12	1.86
Specimen Sokur-Ya-165 (juv. III-IV)	0.37	0.22	0.11	1.68
Specimen Sokur-Ya-004 (juv. III-IV)	0.40	0.24	0.12	1.67
Specimen Sokur-Ya-126 (juv. I-II)	0.43	0.24	0.12	1.79
Specimen Sokur-63 (juv. III-IV)	0.39	0.24	0.11	1.63
Specimen Sokur-Ya-271 (juv. VII-VIII)	0.23	0.15	0.07	1.53
Specimen Sokur-Ya-263 (juv. V-VI)	0.32	0.19	0.10	1.68
Specimen Sok-LG-26 (female)	0.52	0.30	0.18	1.73
Specimen Sokur-Ya-084 (juv. I-II)	0.49	0.29	0.16	1.69

Variability. The sizes of adult representatives vary slightly (the length of the shells of females is 0.50–0.56 mm; L/H of females is 1.73–1.81) and prominence of ornamentation. *Sexual dimorphism* is expressed in the greater length of the shells and the higher posterior end in males; the L/H ratio is higher in males than in females.

Comparison. In the described species, the shape of the shells of middle-aged juveniles is most similar to that of adult representatives of *C. (A.) muricata*, from which it differs in the presence of rounded tubercles in the postero-ventral part of both valves, against a short spine on one (only the left) valve in *C. (A.) muricata*. By the same parameters (small size and rounded triangular shape), the shells of immature specimens of the new species are very similar to those of adult *C.* (*A.*) *starcevae* from the Upper Bathonian – Callovian of the TPP, the Barents Sea shelf, and northern Siberia (*Atlas* ..., 1995, p. 148, pl. 2, figs. 1–3; Nikitenko, 2009) and Lower Callovian of RP (Tesakova and Seltser, 2013, p. 63, text-fig. 5, figs. 10, 11, 14, 15; Tesakova et al., 2020, text-fig. 3), from which it differs in a lower posterior end, a box-shaped posterior end [vs. rounded in *C. (A.) starcevae*], the absence of one or two spines in the lower part of the anterior end, tubercles rather than spines in the posterior part of the valves, and weak reticulate ornamentation [versus distinct pitted-reticulate ornamentation in *C. (A.) starcevae*].

Remarks. (1) The weak, poorly developed ornamentation of *C. (A.) triangula* is easily masked by overgrown micrite, completely hidden under it, and on such specimens, it is not distinguishable, and their surface seems to be smooth (Pl. 8, figs. 10, 11, 13). The ornamentation partially obscured by micrite, on the contrary, looks like a finely pitted or fine-meshed robust reticulum (Pl. 8, figs. 2, 9). Small simple pores do not appear on such specimens, and sieve pores may look different. For example, only the surrounded pores (or rather, their raised walls) will stand out on the surface in the form of single rounded tubercles at the posterior end (Pl. 8, figs. 2, 7, 13), and (or) the sieve plates will become overgrown with micrite, but the relatively large central pore will remain, and then the sieve pores will be perceived as rare small simple pores (Pl. 8, fig. 11a). Sieve pores completely overgrown with micrite may give the impression of pits (Pl. 8, figs. 2, 9) or, conversely, low round and completely flat plaques (Pl. 8, fig. 11b).

(2) Therefore, it should be emphasized that the most striking specific features of *C. (A.) triangula*, which practically do not change as a result of poor preservation and make it possible to identify specimens heavily overgrown with micrite, are: a very characteristic shell shape (rounded triangular, with a high, symmetrical and a rounded anterior end, greatly

Explanation of Plate 8

Accepted abbreviations to Plates 8 and 9: c—complete shell, rv—right valve, lv—left valve, juv.—juvenile.

Fig. 1. *Camptocythere (Anabarocythere) muricata* Gerke et Lev, sp. nov., Holotype NIIGA, no. 1267-170, c of a female; Central Siberia, Khatanga Depression, Nordvik, Borehole K-441, depth 33–36 m; Middle–Upper Bathonian (*Arcticoceras kochi* regional Zone): (1a) from the left, (1b) ventral view (drawings by A.A. Gerke).

Figs. 2–13. *Camptocythere (Anabarocythere) triangula* sp. nov.: (2) specimen Sokur-Ya-184, lv juv. I-II; depth 24.0 m; (3) Holotype Sokur-Ya-172; depth 19.5 m: (3a) rv of a female, (3b) fragment of the valve surface with sieve pores and simple pores at the solum of the cells; (4) specimen Sokur-Ya-189; depth 30.6 м: (4a) rv of a female, (4b) fragment of the valve surface with sieve pores and simple pores at the solum of the cells; (5) specimen Sokur-Ya-161, c juv. III-IV from the right; depth 15.6 m; (6) specimen Sokur-Ya-165, rv juv. III-IV; depth 22.2 m; (7) specimen Sokur-Ya-004, c juv. III-IV from the left; depth 31.0 m; (8) specimen Sokur-Ya-126, rv juv. I-II from inside; depth 25.5 m; (9) specimen Sokur-63, rv juv. III-IV; depth 33.6 m; (10) specimen Sokur-Ya-271, rv juv. VII-VIII; depth 28.5 m; (11) specimen Sokur-Ya-263; depth 33.0 m: (11a) lv juv. V-VI, (11b) fragment of valve surface with sieve pores overgrown with micrite; (12) specimen Sok-LG-26, rv of a female; depth 15.8 m; (13) specimen Sokur-Ya-084, lv juv. I-II; depth 17.8 m.

Specimens (2–13) come from the Sokur Borehole from the Upper Bajocian, *Michalskii* Zone. The dimensions of the depicted ostracods are given in the description of the species.

exceeding the low posterior end of the box shape), medium or small size and the presence of well-developed tubercles in the postero-ventral part of both valves. Based on the above characters, the new species can be compared with specimens of *C. (A.) micra* Nikitenko nom. nud. from the Upper Bathonian–Callovian of the central and northern parts of Western Siberia, illustrated by Nikitenko (2009, pl. o-5, figs. 2–5). Both compared species are very similar in rounded triangular shape and shell size, which is more related to middle-aged juveniles of *C. (A.) triangula*, as well as in the presence of tubercles in the postero-ventral part of both valves. They differ in ornamentation a well-developed pitted-reticulate sculpture with distinct thick muris covers the entire surface of the valves of *C. (A.) micra*, while *C. (A.) triangula* has weakly reticulate ornamentation with low muris.

(3) Analysis of the morphological similarities and differences between the species *C.* (*A.*) *triangula*, *C.* (*A.*) *muricata*, and *C.* (*A.*) *micra* makes it possible to single them out into one cluster and, based on the stratigraphic sequence, suggest related relationships: *C. (A.) triangula* → *C. (A.) micra* and *C. (A.) triangula* → *C. (A.) muricata*. Since the author of the article has no other information about the species *C. (A.) muricata* and *C. (A.) micra*, except for the description, photograph, and holotype drawing for the first one (*Atlas* ..., 1995, p. 147, pl. 2, fig. 4, 5), and four poor quality photographs for the second one (Nikitenko, 2009, pl. o-5, figs. 2–5), has no data on either microsculpture or the structure of pores (simple and sieve), or on their ontogenesis—the proposed lineages should be considered conditional until they are supported (or refuted) by new data.

O c c u r r e n c e. Upper Bajocian and Lower Bathonian of the Saratov Region.

M a t e r i a l. Complete shells and separate valves of good and satisfactory preservation from the Middle Jurassic of Saratov Region (the Sokur Borehole Section): 34 specimens from the Upper Bajocian (*Michalskii* Zone) and four shells from the Lower Bathonian (*Besnosovi* Zone).

Genus *Procytheridea* Peterson, 1954

Procytheridea? bajociensis (Khabarova, 1955)

Plate 9, figs. 1–17

Palaeocytheridea bajociensis: Khabarova, 1955, p. 196, pl. 1, fig. 3.

Procytheridea bajociensis: Pyatkova and Permjakova, 1978, p. 153, pl. 69, fig. 3.

Procytheridea concinna: Permjakova, 1974, p. 61, text-fig. 1/1; Pyatkova and Permjakova, 1978, p. 153, pl. 68, fig. 3, 4; Shurupova et al., 2016, text-fig. 5/17–20; Shurupova and Tesakova, 2017, text-fig. 3.

Procytheridea ljubimovae: Permjakova, 1974, p. 63, text-fig. 1/3; Pyatkova and Permjakova, 1978, p. 154, pl. 69, fig. 2; Shurupova et al., 2016, text-fig. 6/1–2; Shurupova and Tesakova, 2017, text-fig. 3.

H o l o t y p e. TsNIL “Saratovneft” Co., no. 82, left valve of a female; Volgograd Region, village of Zhirnoe; Middle Jurassic, Bajocian (Khabarova, 1955, pl. 1, fig. 3).

N e o t y p e. MGU Sokur-41, left valve of a female; Saratov Region, Sokur Borehole, depth 38.8 m; Upper Bajocian, *Michalskii* Zone (Pl. 9, fig. 8).

D e s c r i p t i o n. The shell is large and medium-sized, shaped like an elongated parallelepiped with rounded angles, moderately convex, with parallel sides and a narrow, flattened part of the anterior and posterior ends. The convex part of the valve flattens sharply at the anterior and posterior ends, forming identical ledges (Pl. 9, figs. 13–16). The left valve is larger than the right one and overlaps it along the entire contour, except for the anterior end. The greatest length is observed at mid-height; the greatest height is at the beginning of the anterior end; in females, the width of the shells is practically the same in the anterior and posterior halves (Pl. 9, figs. 14–16), while in males it prevails very slightly in the posterior part (Pl. 9, fig. 13). The dorsal margin is straight in the inside view, but it looks convex in three places in the outside view: in the region of the hinge ears and in the posterior half of the valve; accordingly, two depressions are observed between the convexities. Due to the strongly developed hinge ears on the left valve, the undulation of the dorsal margin is more pronounced on this valve, and weaker on the right one. The dorsal margin passes into the posterior margin with a ledge on both valves; in the anterior, with a ledge only on the left valve, on the right one, without a ledge, smoothly. The ventral margin is not parallel to the dorsal margin, converges towards the posterior end and is slightly concave in the middle; passes smoothly into the anterior and posterior margins. The high anterior end is evenly and smoothly rounded; slightly sloping dorsally on the left valves, distinctly sloping on the right, with a notch. The posterior end is lower, shorter, more strongly sloping from above on the right valve and has a rounded triangular shape, in contrast to the rounded-subquadratic shape on the left. The eye tubercle is absent.

The entire surface of the valve, except for the narrow, flattened part of the anterior and posterior ends, the ventral and dorsal sides, and the antero-dorsal angle with the hinge ears, is covered with a smoothed reticulate (loop-like) sculpture, expressed in rounded-angular cells with thick, low and gently sloping muris. The cells are medium-sized, and size remains the same across the valve. The cell muris, merging, can form short, irregular, weakly expressed ribs. Such ribs are most clearly visible on the periphery of the valve, especially in its posterior half: two or three thin arcuate ribs can be seen along the postero-dorsal angle and posterior end. Another indistinct but thicker rib emphasizes the inflection of the valve at the anterior end. Two or three thin longitudinal ribs are developed on the ventral side. On the outer side of the valve above the muscle scars, a small oblong, low and smooth node is formed. The cell solums are covered with numerous “punctate pits” (Permjakova, 1974, p. 64) or "pore canal apertures" (Khabarova, 1955, p. 197), which were also observed in some specimens from the author's collection (Pl. 9, fig. 6b). Sieve pores are present, with the main pore shifted to the periphery. They, like cells, are surrounded by thick walls and raised above the valve, which is especially well visible in its posterior half (in the form of low tubercles with a crater at the top) (Pl. 9, figs. 8, 9, 12).

The hinge of the right valve is represented by large marginal teeth, each subdivided into nine well-separated toothlets (Pl. 9, fig. 7), and a narrow median groove of uniform width, finely crenulated, with a distinct large pit adjoining the anterior tooth. On the left valve, the elements of the hinge have the opposite expression. In the middle (concave) part of the ventral margin on the right valve, there is a rhomboid notch (Pl. 9, figs. 7, 10), which includes a thickened part of the ventral margin of the left valves. The marginal zone is wide and developed along the entire free margin. The adductor scars are represented by four elongate-rounded scars arranged in a subvertical row, slightly convex towards the posterior end, where the size of the scars decreases from bottom to top. Other muscle scars (mandibular, antennal, etc.) in the form of large, rounded spots (sometimes doubled and tripled) are very distinct and clearly visible in the upper half of the valve above the adductor and in front of the adductor (Pl. 9, fig. 7).

Dimensions in mm:

	L	AEH	PEH	W	L/H
Neotype Sokur-41 (female)	0.69	0.41	0.26	–	1.68
Specimen Sokur-36 (female)	0.71	0.42	0.30	–	1.69
Specimen Sokur-Ya-033 (female)	0.67	0.37	0.23	–	1.81
Specimen Sokur-7 (female)	0.60	0.34	0.23	–	1.76
Specimen Sokur-Ya-148 (female)	0.66	0.38	0.24	–	1.74
Specimen Sokur-2 (female)	0.72	0.40	0.28	–	1.80
Specimen Sokur-3 (female)	0.73	0.39	0.27	–	1.87
Specimen Sokur-40 (female)	0.67	0.35	0.23	–	1.91
Specimen Sokur-157 (female)	0.69	0.42	0.26	–	1.64
Specimen Sokur-Ya-079 (male)	0.70	0.35	0.28	–	2.00
Specimen Pnz-12-52 (female)	0.69	0.40	0.29	–	1.73
Specimen Sokur-Ya-096 (male)	0.74	0.36	0.28	–	2.06
Specimen Sokur-Ya-025 (male)	0.71	–	–	0.27	–
Specimen Sokur-Ya-026 (female)	0.67	–	–	0.32	–
Specimen Sokur-38 (female)	0.68	–	–	0.31	–
Specimen Sokur-1 (female)	0.68	–	–	0.34	–
Specimen Sokur-124 (male)	0.76	0.39	0.34	–	1.95

Variability. The size of the cells and their shape vary slightly, from rounded to angular with three or four muris. Additional septa may develop inside the cells, as a result of which the cells transform into small, rounded pits grouped in two or five (Pl. 9, fig. 3). The riblets resulting from the fusion of cell muris can be quite distinct, and then the following will be noticeable: semicircular, which outlines the anterior end; forked, originates at the anterior hinge ear, tends downward, bifurcates, and the anterior branch turns obliquely and reaches the middle of the anterior end, and the posterior branch can reach the upper point of the muscle node; two or three concentric ribs at the posterior end; one to three short subhorizontal or sinuous ones in the posterior half of the valve (Pl. 9, figs. 8, 9, 12, 17).

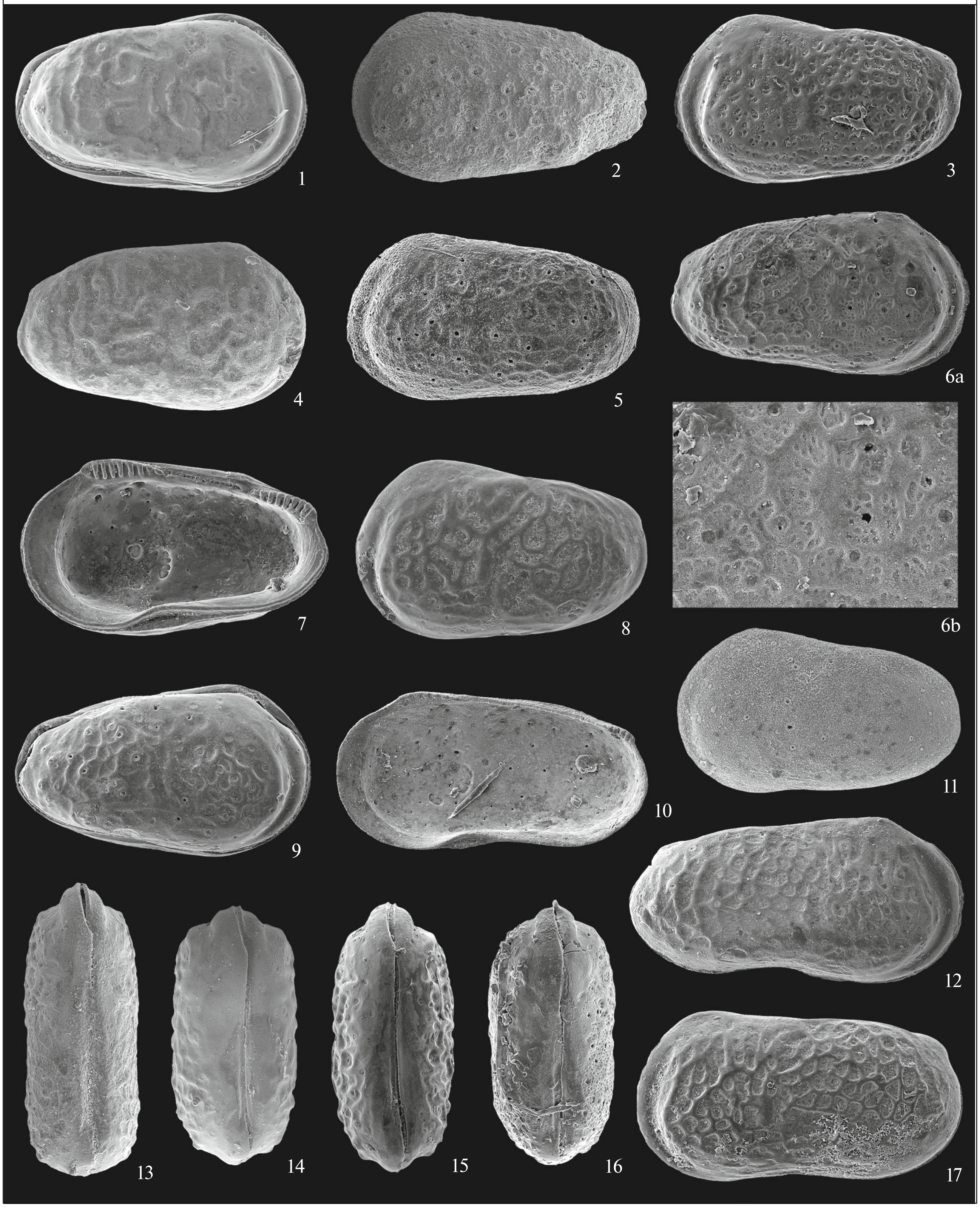
Sexual dimorphism. Males (Pl. 9, figs. 10, 12, 13, 17) differ from female (Pl. 9, figs. 1–9, 11, 14–16) in the longer shell; higher posterior end (almost equal in height to the anterior one); parallel dorsal and ventral margins (as opposed to converging towards the posterior end in females), and in the lower anterior hinge ear. The length of the shells of females varies rather strongly (0.60–0.73 mm), while those of males vary less (0.70–0.76 mm); the L/H ratio varies within 1.64–1.91 in females and 1.92–2.06 in males. The longer shell of males makes it possible to have a larger number of cells in the posterior half of the valve compared to females. Differences between females and males appear on the shells only when sexual maturity is reached.

Age variability. Juvenile representatives are distinguished by shorter shells, which converge more strongly towards the posterior end, and a smaller number of cells in the posterior half of the valve (these parameters are maximum in the youngest individuals and decrease with age).

Comparison. This species is distinguished from *P. ukrainica* Permjakova (Permjakova, 1969, p. 36, pl. 1, fig. 3; Pyatkova and Permjakova, 1978, p. 155, pl. 70, fig. 1), a single species known from the Upper Bajocian (*S. niortense* and *G. garantiana* ammonite zones) of the Dnieper–Donets Depression and the northwestern vicinity of the Donets Basin, similar in loop-shaped sculpture and hinge morphology, by a longer and less convex shell with almost parallel lateral sides, an anterior end almost not oblique from above, a higher posterior end, and the presence of sieve pores.

Remarks. (1) The species is assigned to the genus *Procytheridea* solely by the similarity of the hinge, which is not a sufficient condition for assign-

Plate 9



Explanation of Plate 9

Figs. 1–17. *Procytheridea? bajociensis* (Khabarova, 1955): (1) specimen Sokur-36, c of a female from the right; depth 39.3 m; (2) specimen Sokur-Ya-033, c of a female from the left; depth 5.5 m; (3) specimen Sokur-7, lv of a female; depth 55.1 m; (4) specimen Sokur-Ya-148, rv of a female; depth 31.5 m; (5) specimen Sokur-2, lv of a female; depth 56.3 m; (6) specimen Sokur-3; depth 56.3 m: (6a) rv of a female, (6b) fragment of the valve surface with sieve pores and cells, the solum of which is covered with simple pores; (7) specimen Sokur-40, rv of a female from inside; depth 38.8 m; (8) neotype Sokur-41, lv of a female; depth 38.8 m; (9) specimen Sokur-157, c of a female from the right; depth 4.4 m; (10) specimen Sokur-Ya-079, rv of a male from inside; depth 10–12 m; (11) specimen Pnz-12-52, lv of a female; (12) specimen Sokur-Ya-096, rv of a male; depth 13.3 m; (13) specimen Sokur-Ya-025, c of a male, dorsal view; depth 20.5 m; (14) specimen Sokur-Ya-026, c of a female, dorsal view; depth 20.5 m; (15) specimen Sokur-38, c of a female, dorsal view; depth 39.3 m; (16) specimen Sokur-1, c of a female, dorsal view; depth 56.3 m; (17) specimen Sokur-124, lv of a male; depth 18.2 m.

All specimens except for (11), come from Saratov Region, Sokur Borehole; no.: fig. 1, 3–8, 10, 12–17 from the Upper Bajocian, *Michalskii* Zone, fig. 2, 9 from the Lower Bathonian, *Besnosovi* Zone; (11) Penza Region, Obval Borehole, depth 354.5–355.0 m; Lower Bathonian. The dimensions of the depicted ostracods are given in the description of the species.

ment. The rounded rectangular shell shape, parallel sides, high posterior end, and loop-shaped ornamentation of *P.? bajociensis* does not correspond to the generic characters in the original description, which relied on Callovian specimens from North America: "Shell ovate to subtriangular-ovate; hinge margin ... converging toward ventrum... Anterior margin broadly rounded...; posterior margin narrowly rounded... Surface moderately to strongly reticulate, with longitudinal elements of reticulum frequently developed into ridges; median valve surface on some specimens tends to be flattened or slightly undulating" (Peterson, 1954, p. 171; Howe et al., 1961, p. 330).

(2) The state of preservation of the material greatly affects the diagnosis of such features as the presence and location of simple pores on the shell [described by Khabarova in *P. bajociensis* (1955, p. 197), and by Permjakova only in *P. ljubimovae* (1974, p. 64)], sieve pores (not described by either Khabarova or Permjakova), loop-like ribs and their prominence. Ostracod skeletons from the author's collections were covered with a crust of micrite, which obscures and closes simple pores (Pl. 9, figs. 1, 2, 5, 9, 17), and smoothes the ribs, to the point that the surface of the valves seems almost smooth (Pl. 9, fig. 11); or, on the contrary, forms a robust appearance of the ribs, simultaneously leveling the cells (Pl. 9, figs. 1, 4). The micrite layer is often replete with sponge drillings, which, of course, differ in size and shape from simple pores, but divert attention from them and allow them to be overlooked if the latter nevertheless are visible from under the micrite.

Therefore, the species *P. concinna* Permjakova, 1974 and *P. ljubimovae* Permjakova, 1974 differ from each other ["... *P. ljubimovae* differs from *P. concinna* in punctate sculpture and a network of ribs, while in the latter the surface of the valves is covered with distinct randomly arranged cells" (Permjakova, 1974, p. 64)] and from *P. bajociensis* (Khabarova) ["In the described species [*P. concinna*], the lateral surfaces of the shell are covered with rounded, distinct cells arranged randomly, and not concentrically, as in *P. bajociensis*. ... the described species has a distinct cellular sculpture, without punctation..." (Permjakova, 1974, p. 62)] are associated with no more than a different degree of preservation of the material described by these authors. For the same reason, I also initially distinguished between the species *P. concinna* (Shurupova et al., 2016, text-figs. 5/17–20) and *P. ljubimovae* (Shurupova et al., 2016, text-fig. 6/1–2). By the way, the representatives identified by me as *P. concinna* (Pl. 9, fig. 5) were the worst preserved and constituted practically monospecific assemblages of shallow water.

Paleocology. Eurybiont species within the upper subtidal zone. During ostracod migrations, this species was the first to immigrate, and formed monospecific communities. Such assemblages possibly indicated extremely shallow basin and, possibly, variable salinity.

Occurrence. Upper Bajocian and Lower Bathonian of the Dnieper-Donets Depression and the northwestern margin of the Donets Basin, the Volga Region (Povolzhye) (Saratov and Volgograd regions) and the central regions of the RP (Penza Region), Western Kazakhstan.

Material. One valve from the Upper Bajocian(?) and 18 separate valves of well-preserved and satisfactory preserved females and males from the Lower Bathonian (*G. bathonica* ostracod Zone), Obval Borehole (Penza Region); 422 well-preserved valves and shells from the Upper Bajocian (*Michalskii* Zone) and 43 well-preserved separate valves and complete shells from the Lower Bathonian (*Besnosovi* Zone) from the Sokur Borehole (Saratov Region).

CONCLUSIONS

A new species *Camptocythere (Anabarocythere) triangula* sp. nov. is described from the Upper Bajocian (*Michalskii* Zone) and Lower Bathonian (*Besnosovi* Zone) from the Sokur composite Section (Saratov Region, RP). It was presumably an ancestor of *C. (A.) muricata* Gerke et Lev, sp. nov. from the Upper Bathonian–Callovian of northern Siberia, the TPP, and the Barents Sea shelf (the first description of which is published here for the first time). The species *C. (A.) muricata* was named and included in the lists of stratigraphically significant ostracods, but was not formally described (Gerke, 1953). Its paleontological description, co-authored with A.A. Gerke, was made by O.M. Lev, but not published (*Atlas* ..., 1995). The publication of the original description of Lev, expanded and supplemented by the present author confers the availability of this species and eliminates shortcomings in the stratigraphic literature, where *C. (A.) muricata* was previously illustrated as a nomen nudum.

Morphological analysis suggested (but did not confirm) a phylogenetic relationship between these two *Camptocythere* species, which gives grounds to consider them index taxa of the corresponding lineage zones in the scale based on evolution of the subgenus *Anabarocythere*. Another nomen nudum cited in the literature, *C. (A.) mikra* Nikitenko (Nikitenko, 2009), which was probably also related to *C. (A.) triangula*, perhaps even more closely than *C. (A.) muricata*. However, it is not yet possible to resolve this issue more definitely, as well as to describe the species and make it available, relying only on poor quality photographs (Nikitenko, 2009, pl. o-5, figs. 2–5).

The species *Procytheridea? bajociensis* (Khabarova, 1955) was revised based on specimens from the same deposits of the Sokur Section and the Lower Bathonian of the Obval Borehole (Penza Region). The revision of this taxon made it possible to synonymize under it *P. concinna* Permjakova, 1974 and *P. ljubimovae* Permjakova, 1974 from synchronous deposits of Ukraine, identify the neotype, and provide an extended and supplemented redescription. Wide stratigraphic and lateral distribution of *P.? bajociensis*, the abundance of its representatives in all the sections studied by Khabarova, allowed her to propose this species as an index for the Upper Bajocian–Lower Bathonian of the Volga Region (Khabarova, 1955, 1961). Indeed, high ecological plasticity determines the omnipresence and high abundance of this taxon in the indicated stratigraphic interval throughout the entire RP and Western Kazakhstan (Khabarova, 1955, 1961; Permjakova, 1974; Pyatkova and Permjakova, 1978; Tesakova, 2014, 2015; Shurupova et al., 2016; Shurupova and Tesakova, 2017), but modern requirements for stratigraphic scales need them to be more detailed, so new stratigraphic units recognized should correspond to narrower intervals. Thus *P.? bajociensis* has lost its leading role as a stratigraphic index, while it was passed to other ostracods (in particular, *Camptocythere*), but its ubiquitous status opens up other possibilities. It was this species that were the first to occupy new sea areas, so the monospecific assemblages of *P.? bajociensis* (or assemblages where it predominates) mark not only the Late Bajocian time, but also an extremely shallow coastal setting, possibly with unstable salinity. I.e., the beds identified in the section based on the first appearance of this taxon are of a paleoecological nature, while the species acquired the status of an index of a particular environment.

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CONFLICT OF INTEREST

The author declares that she has no conflicts of interest.

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