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Pearl Mussels (Bivalvia, Margaritiferidae, *Dahurinaia*) from the Amur River Basin

V. V. Bogatov

Institute of Biology and Soil Sciences, Far East Branch, Russian Academy of Sciences, Vladivostok, 690022 Russia
e-mail: vibogatov@rumbler.ru

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Abstract—Four species of pearl mussels inhabit the Amur River basin: *Dahurinaia prozarovae* Bog. et Star. in: Bog et al., 2003; *D. dahurica* (Midd, 1850); *D. ussuriensis* Bog., Proz. et Star., 2003; and *D. tiunovae* Bog. et Star., 1988. The name of *Dahurinaia transbaicalica* Klishko, 2008 is shown to be a synonym for *D. ussuriensis*. The finding of *D. sujfunensis* Moskv., 1973 in the Upper Amur basin turned out to be questionable.

Keywords: Amur basin, Margaritiferidae, *Dahurinaia*
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Until recently it was considered that in the Amur basin there are four species of pearl mussels of the genus *Dahurinaia* (Bogatov et al., 2003) differing in the curvature of the "frontal" (or more precisely maximum convex) section of the valves: *D. prozorovae* Bog. et Star. in: Bogatov et al., 2003; *D. dahurica* (Midd., 1850); *D. ussuriensis* Bog., Proz. et Star., 2003; and *D. tiunovae* Bog. et Star., 1988 (the order of the mentioned species corresponds to the increase in valve convexity).

Recently, Klishko in the journal *Zoological Herald* (2008) published a paper on pearl mussels collected in the upper part of the Amur basin (Ingoda, Omon, Argul, Budumkan, Ilya, and Unda rivers) and in the closed Arei Lake that in the Pleistocene was connected with the Amur basin. The author of the paper discovered in this region six species of pearl mussels, among which, besides those listed above, she mentioned *D. sujfunensis* Moskv., 1973, previously known only from the basin of the Razdolnaya River (south of Primorskii krai) and a species new to science *D. transbaicalica* Klishko, 2008 found in Arei Lake and the Ingoda and Onon rivers. The study by Klishko of the shell morphology, hinge apparatus, and soft body of Amur pearl mussels demonstrated allegedly reliable features of similarity in this species of the genus *Dahurinaia* with species of the European genus *Margaritifera*. In addition, the recorded high modern taxonomic diversity of pearl mussels (6 species) and known findings of fossil forms of this group of mollusks enabled Klishko to speak about Transbaikalia as "a possible center of their origin and evolutionary development" (p. 299).

Note that Klishko determined species identification of pearl mussels independently, and to support the correctness of the performed determination, she provided drawing of the contours of frontal sections of valves of all six species found with reference to the paper by Bogatov et al. (2003). The shape of curvature of the frontal section of valves is determined using the modified comparative method (Bogatov and Starobogatov, 1992; Bogatov and Kolpakov, 2003; Bogatov et al., 2005; Bogatov, 2007), and by many malacologists is considered to be species specific (Logvinenko and Starobogatov, 1971; Shikov and Zatravkin, 1991; etc.). Furthermore, the paper provides three tables on the ratio of the main shell measurements—length, width, height near apexes, and height near the ligament—in *D. transbaicalica* sp. (separately for lacustrine and river forms), *D. tiunovae*, and *D. ussuriensis* (Table 1, p. 298); interspecies and intraspecific rated differences of phenotypes (Table 2, p. 300); and values of criteria of significance of differences with respect to phenotype in all the species of the genus found (Table 3, p. 301). Photographs of shells, the hinge, scars of muscles, and the soft body of the holotype and paratypes of the new species are presented.

The results provided by Klishko cast doubt upon the reliability of species identification of the collected material. The author exclusively studied large individuals in which the ratios of the main measurements of shells were compared to the corresponding values calculated for medium-sized shells of pearl mussels (Bogatov et al., 2003; Starobogatov et al., 2004), which is incorrect. In particular, in the paper by Klishko, the length of shells in *D. ussuriensis* exceeded 13 cm; in *D. tiunovae*, 17 cm; and in *D. transbaicalica*, 16.3 cm. Moreover, the lengths of shells in the holotype and paratype of the new species deposited at the Zoological Institute of the Russian Academy of Sciences under nos. 1 and 2 of the systematic catalog comprised 18.4 and 18.6 cm, respectively. In the

papers by Bogatov et al. (2003) and Starobogatov et al. (2004), according to which Klishko identified species, the length of shells of pearl mussels did not go beyond 6–11 cm.

The identification of big mussels with respect to the ratio of the main measurements of the shell has serious limitations because of the allometric growth of these invertebrates (growth with a change in the body shape). It is known to specialists that the values of such indexes used in keys characterize mature individuals having, as a rule, medium sizes. The results of measurements of young and old shells in this case are taken into account. Furthermore, since the variation curve reflecting the change in the given characters is close to the normal distribution (Alimov and Bogatov, 1975), the keys usually include indexes in the range of ± 1 to ± 2 of standard deviation, which embraces, accordingly, 68 to 95% of the sample. With an increase in the sizes of pearl mussels, the relative convexity of their shells noticeably increases (Sergeeva et al., 2008). Thus, the values of the ratios of the main measurements of shells cited by Klishko cannot coincide with those from the keys (Bogatov et al., 2003; Starobogatov et al., 2004).

Since the ratios of the main measurements of the shell can be used only for a preliminary determination of big bivalves, subsequently such identifications should be clarified according to more reliable criteria, first, according to the curvature of the frontal section of the shell. In the paper by Klishko, the drawing from the paper by Bogatov et al. (2003) with contours of the frontal section of valves of *Dahurinaia* is presented. This section is more correct to name the maximum convex section since it passes from the apex through points maximally distant at different moments of the time of the shell formation from the commissural plane. Into this drawing, the author inserted the contour of a section of *D. transbaicalica* dissecting the valve from the apex perpendicular to the longitudinal axis of the shell. This is evidenced by the coincidence of the shape of the integrated contour of the new species with the profile of the left valve of the holotype (frontal view), whose photo is presented in Fig. 1b (p. 294). Since it is known that, in pearl mussels, the maximum convex section passes at a considerable angle to the longitudinal axis of the shell, in the drawing by Klishko, the incommensurable contours turned out to be combined, as a result of which the new species *D. transbaicalica* turned out to be a possessor of "the most convex" shell among all Amur species.

To verify the correctness of determination of the holotype and paratype of *D. transbaicalica* deposited at the Zoological Institute, Russian Academy of Sciences, we performed analysis of the contours of their maximum convex sections. Since it is impossible to fix, using a common binocular, the contours of valves whose length exceeds 14–15 cm, their identification was performed using modeling clay casts according to methods described in the paper by Bogatov (2007). As a result, the obtained contours of maximum convex

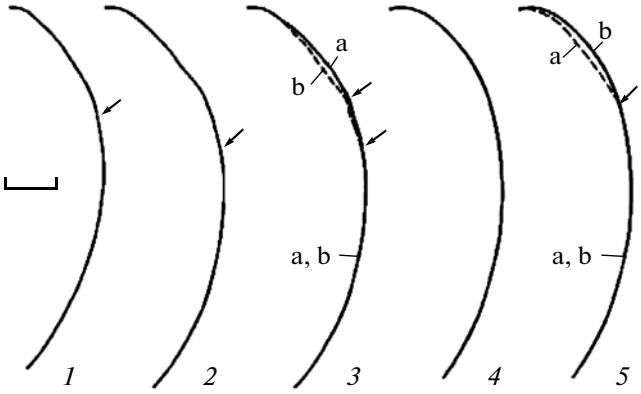

Fig. 1. External contours of maximum convex sections of shells of the type specimens from the genus *Dahurinaia*: (*1*) holotype of *D. transbaicalica*; (*2*) paratype of *D. transbaicalica*; (*3*) holotype (a) and paratype (b) of *D. transbaicalica*; (*4*) holotype of *D. ussuriensis*; (*5*) holotypes of *D. transbaicalica* (a) and *D. ussuriensis* (b). Arrows designate boundaries of corroded and uncorroded sites of the shell. Scale is 1 cm.

sections of the holotype and paratype of *S. transbaicalica* completely coincided with the corresponding contour of the holotype of *D. ussuriensis* (Fig. 1). In addition, the holotypes of *D. transbaicalica* and *D. ussuriensis*, despite the difference in their sizes, turned out to be identical in the shape of the shell and hinge (Fig. 2). Hence, it follows that the name of the species *D. transbaicalica* Klishko, 2008 is a synonym for *S. ussuriensis*, and, according to all the main distinguishing features, the holotype and paratype of *D. tranbaicalica* by no means exhibits similarity with the European genus *Margaritifera*.

In connection with the re-identification of *D. transbaicalica*, noteworthy is the indication by Klishko of allegedly reliable differences between phenotypes of the six species of *Dahurinaia* singled out by her at a high level of significance. The discussed "phenotypes" were characterized by the author mainly by the ratios of the main measurements of the shell (6 characters of 10) and by secondary qualitative characters: the shape of the front teeth, manifestation of a pedal keel, and the presence and shape of papillae on siphons. It is obvious that the phenotypes distinguished by Klishko cannot be considered to be proof of not only the correctness of species identification of the Upper Amur pearl mussels, but also of the idea that the number of species is equal to six. On the one hand, it is not clear according to what criterion the studied groups of mollusks were separated; on the other hand, obtaining reliable differences between species with respect to the ratio of the main measurements of the shell is always problematic because of the absence of chiatus with respect to the given parameters (Sergeeva et al., 2008; Bogatov, 2009). Additionally, *D. ussuriensis* = *D. transbaicalica* can by no means be a possessor of the most

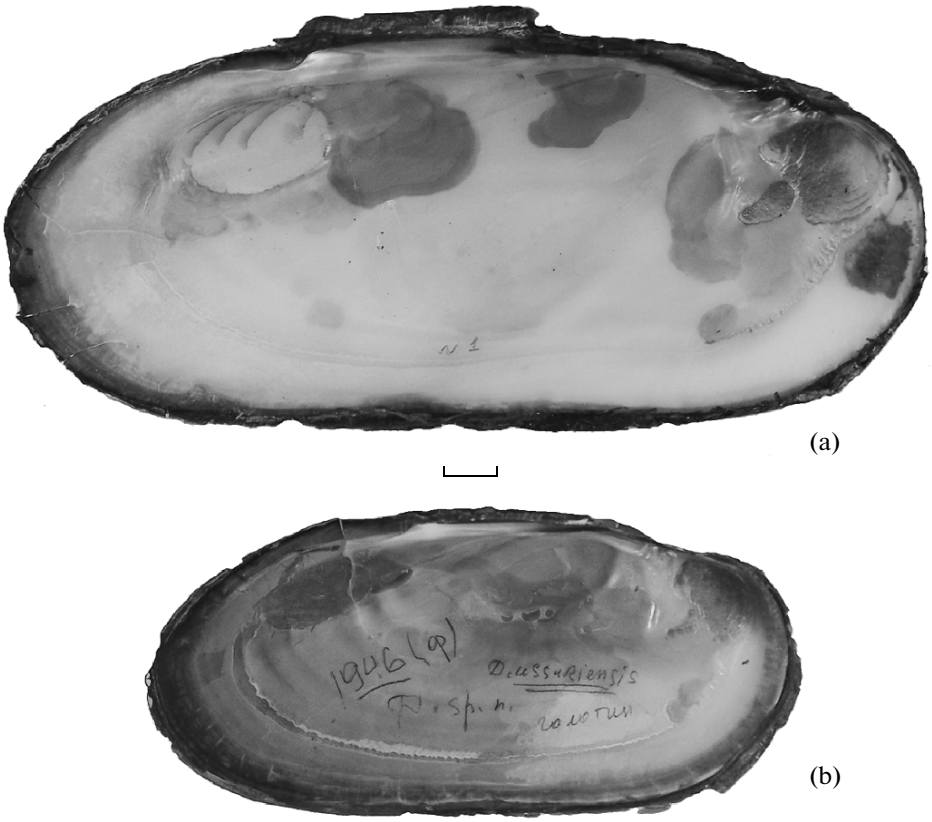

Fig. 2. View from within left valves of holotypes of *Dahurinaia transatlantica* (a) and *D. ussuriensis* (b). Scale is 1 cm.

convex shell among Amur pearl mussels since it is inherent to *D. tiunovae* (Bogatov and Zatravkin, 1988; Bogatov et al., 2003). Considering the above, we find it highly unlikely that in Transbaikalia a finding was made of the poorly studied species *D. suffuensis* whose single known population dwells in the south of Primorskii krai, beyond the Amur basin. Between the Amur basin and basins of rivers of the south of Primorskii krai, no common species of big bivalves has been found as yet, which is explained by the historic development of these basins. The indication of a finding in the upper reaches of the Amur of *D. suffuensis* cannot be considered reliable also because species identification of the collection material available to Klishko was performed on the basis of measurements of shells of different sizes whose values are known to be different, as well as on the basis of comparison of incommensurable contours of the strictly transverse (applied by Klishko) and maximum convex (cited in the papers by Bogatov et al. (2003)) sites of the left valves.

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