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On the identity of "*Gari californica*" (Bivalvia: Psammobiidae) from the North-Western Pacific

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ABSTRACT. The validity of the north-western Pacific *Gari (Gobraeus) kazusensis* (Yokoyama, 1922) (Psammobiidae) previously synonymized with *Gari (Gobraeus) californica* (Conrad, 1849) from the eastern Pacific is established with a re-description of the former species provided with a detailed synonymy. Records of *G. kazusensis* from Kamchatka Peninsula and Kurile Islands are doubtful, and the geographical distribution of this species is limited to northern China, Korea, Japan and southern Primorye (north-western Sea of Japan).

Introduction

First discovered in the Possjet Bay [Golikov and Scarlato, 1967], *Gari kazusensis* (Yokoyama, 1922) is the only species of the genus *Gari* Schumacher, 1817 (Bivavia: Psammobiidae) inhabiting Russian waters of the Sea of Japan (East Sea). This species was originally described from the Pleistocene deposits of Japan [Yokoyama, 1922] and then recognized as a living species in Japanese and Korean waters [Sasaki, 1933; Lee, 1958]. However, later on some Japanese malacologists regarded *G. kazusensis* as a synonym of the western American species *Gari californica* (Conrad, 1849) [Nomura, Hatai, 1935, 1940; Kuroda, Habe, 1952] but then finally changed their opinion that the Asian species is distinct from American *Gari* (*Gobraeus*). Yamamoto and Habe [1959, p. 100] stated: "compared with the specimens of various stages of *P.* [*Psammocola*] *californica*, it is revealed that the Japanese species differs from that species in having the shell more elongate and more rounded at the anterior margin and with no radial ray on the surface". Since then, this viewpoint had prevailed in the Asian and Russian literature. In his review of the north-eastern American Psammobiidae, Coan [1973] considered *G. kazusensis* as a homologous species of *G. californica* in Japan, but, at the same time, he mentioned that the material at the United States National Museum did not convincingly confirm the differences between the two species. Finally, Bernard [1983], Coan [2000] and Coan et al. [2000] synonimized *G. kazusensis* with *G. californica*, thereby, extending the geographic range of the latter species into the western Pacific and establishing a new example of an amphi-Pacific species. The synonymy was followed by Lutaenko [2003, 2005]. In light of a number of such synonimizations in a comprehensive monograph by Coan et al. [2000], the problem of amphi-Pacific molluscan distributions, their proportion in the entire North Pacific fauna, and origins gain a wide biogeographic interest.

A comparative study on *G. californica* (52 lots, more than 60 specimens) and *G. kazusensis* undertaken here based on the collections of the California Academy of Sciences (San Francisco; hereafter CAS) and Zoological Museum, Far East National University (Vladivostok; ZMFU) revealed significant morphological differences between the two species and confirmed that there are two separate species of the subgenus in the northern Pacific Ocean (Table; Figs. 1-4).

Taxonomy

Family Psammobiidae J. Flemming, 1828

Genus *Gari* Schumacher, 1817

Type species: *Gari vulgaris* Schumacher, 1817 (by designation under ICZN plenary powers, 1970: Opinion 910) (= *Tellina gari* L., 1758 (supressed ICZN Opinion 910) = *Tellina truncata* L., 1767). Recent, Indo-Pacific.

The genus *Gari* contains nine subgenera and is close to *Soletellina* Blainville, 1824 and *Sanguinolaria* Lamarck, 1799 [Willan, 1993].

Subgenus *Gobraeus* T. Brown, 1844

Type species: *Solen vespertinus* Gmelin, 1791 (by monotypy) (= *Tellina depressa* Pennant, 1777). Recent, Europe.

The subgenus is distinguished from *Gari* s.s. by a general lack of sculpture, quadrate shape, moderate

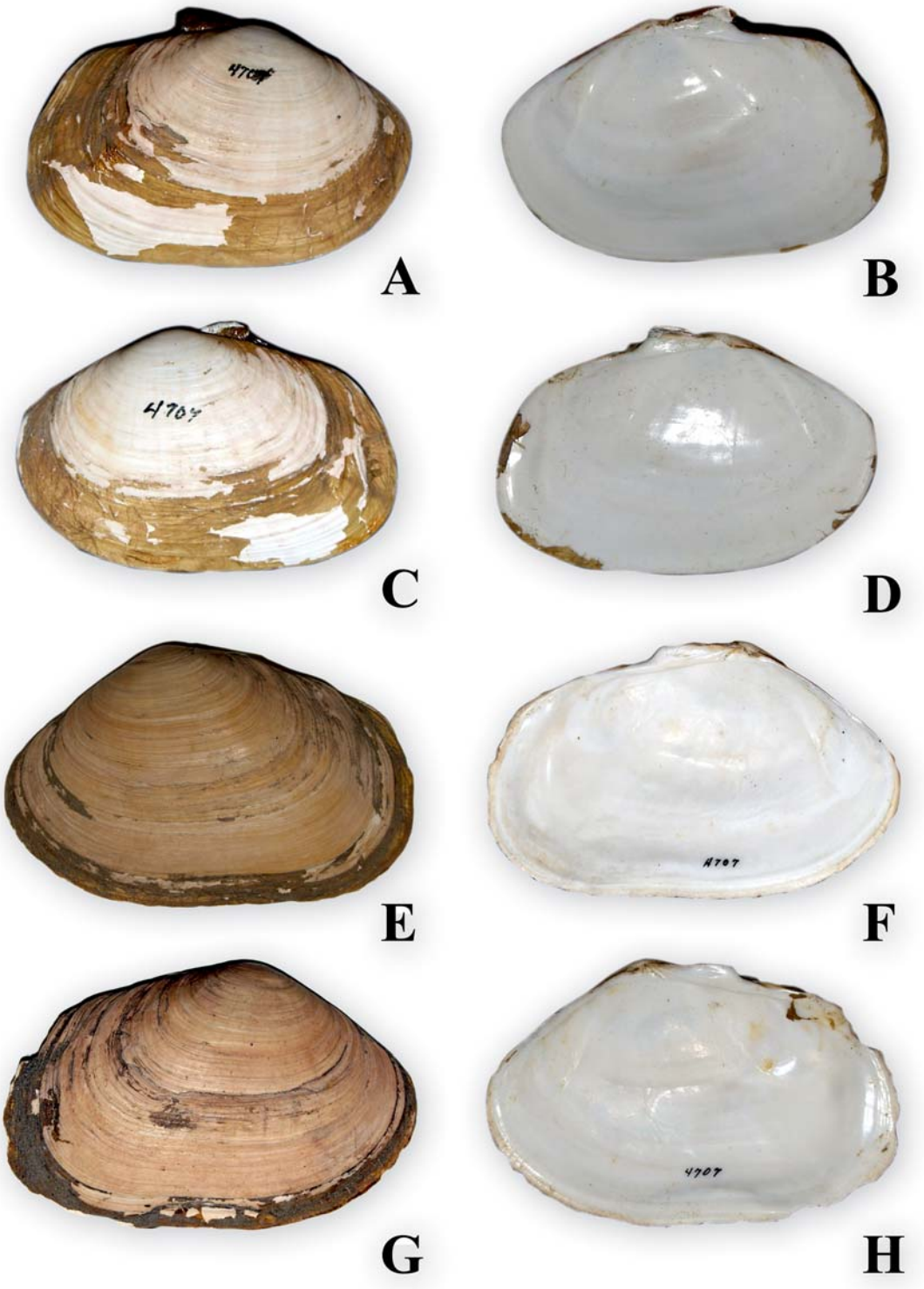

FIG. 1. A-D — *Gari* (*Gobraeus*) *californica* (Conrad, 1849), outer (A, C) and inner (B, D) views of the same shell, California, San Diego, CAS no. 4707, I.S. Oldroyd Colln., length 53.1 mm; E-H — *G.* (*G.*) *californica* (Conrad, 1849), outer (E, G) and inner (F, H) views of the same shell, California, San Diego, CAS no. 4707, I.S. Oldroyd Colln., length 97.5 mm.

РИС. 1. A-D — *Gari* (*Gobraeus*) *californica* (Conrad, 1849), вид снаружи (A, C) и изнутри (B, D) одной и той же раковины, Калифорния, Сан-Диего, CAS № 4707, коллекция И.Ш. Олдройд, длина раковины 53,1 мм; E-H — *G.* (*G.*) *californica* (Conrad, 1849), вид снаружи (E, G) и изнутри (F, H) одной и той же раковины, Калифорния, Сан-Диего, CAS № 4707, коллекция И.Ш. Олдройд, длина раковины 97,5 мм.

posterior gape and lack of a posterior ridge [Willan, 1993]. There are two species in the temperate eastern Pacific Ocean: *G.* (*G.*) *californica* (Conrad, 1849) and *G.* (*G.*) *fucata* (Hinds, 1845) [Coan, 2000; Coan et al., 2000]. Worldwide, there are 13 species [Willan, 1993] that occur in Europe, west Africa, the eastern and western Pacific, and Australasia.

Gari (*Gobraeus*) *kazusensis* (Yokoyama, 1922)

Figs. 3A-G; 4

***Psammobia kazusensis* Yokoyama, 1922**: 136, pl. 9, fig. 4; Yokoyama, 1926: 210; Sasaki, 1933: 12, pl. 2, fig. 11.

Gari (*Gobraeus*) *californica;* Nomura, Hatai, 1935: 17; Coan, 2000 (part.): 3, fig. 2; Lutaenko, 2003: 19; Lutaenko, 2005: 74, pl. 7, figs. S, W (non Conrad, 1849).

Gari californica; Nomura, Hatai, 1940: 84; Kuroda, Habe, 1952: 20; Bernard, 1983 (part.): 47; Lutaenko et al., 2002: 30 (non Conrad, 1849).

Psammocola kazusensis; Lee, 1958: 9, pl. 6, figs. 9, 10, 13; Kira, 1959: 153, pl. 59, fig. 5; Yamamoto, Habe, 1959: 100, pl. 10, figs. 3, 4; Zhao et al., 1982: 121, pl. 17, fig. 5; Habe, 1970: 160, pl. 60, fig. 15; Kwon et al., 1993: 377, fig. 90-3 [as *kazuensis*].

***Psammocola kazusensis atsumiensis* Hayasaka, 1961:** 54, pl. 7, figs. 1, 2.

Gari (*Psammocola*) *kazusensis;* Golikov, Scarlato, 1967: 117, fig. 98.

Gobraeus kazusensis; Habe, 1977: 220, pl. 47, figs. 2, 3; Yamaguchi et al., 1987: 73, pl. C-24, fig. 12 [as *kazuensis*]; Qi et al., 1989: 207, pl. 12, fig. 9; Bernard et al., 1993: 98; Huang, 1994: 406; Tsichida, Kurozumi, 1995: 30, pl. 5, fig. 10; Xu, 1997: 180; Higo et al., 1999: 494; Matsukuma, 2000: 987, pl. 491, fig. 7; Kwon et al., 2001: 259, fig. 1053; Lee, Min, 2002: 164; Min et al., 2004: 451, fig. 1485; Wang, 2004: 293, pl. 159, fig. E; Min et al., 2005: 175, fig. 465; Xu, Zhang, 2008: 207, fig. 645.

Gari (*Gobraeus*) *kazusensis;* Oyama, 1980: 110, pl. 50, fig. 11; Scarlato, 1981: 367, text-fig. 190; Kafanov, 1991: 77; Scarlato, Kafanov, 1988: 940.

Gari kazusensis; Volova, Scarlato, 1980: 81, fig. 80; Evseev, 1981: 114; Yavnov, 2000: 135, photo; Kantor, Sysoev, 2005: 361; Evseev, Yakovlev, 2006: 91, photo.

Type material: A syntype of *Psammobia kazusensis* Yokoyama, 1922 is in the University Museum, University of Tokyo, no. CM21262 (one valve) (illustrated in: [Coan, 2000, fig. 2]), type locality — Upper Musashino Formation (Pleistocene) at Shito, Ichihara-gun, Chiba Pref., Japan; holotype (no. IGPS 78419, one valve) and a paratype (no. IGPS 78420, one valve) of *Psammocola kazusensis atsumiensis* Hayasaka, 1961 are in the Institute of Geology and Paleontology, Tohoku University, type locality — "*Tonna* Bed" and "*Mya* Bed" (Pleistocene) at Takamatsu, Atsumi Peninsula, Aichi Prefecture, Japan.

Material examined: more than 30 specimens (ZMFU and author's collection).

Description: Shell ovate-subquadrate to ovate-elongate, moderately large, thin, eqivalve, rather flattened, white; outer surface rather smooth, with fine commarginal growth lines, slightly flattened near postero-dorsal margin; periostracum brownish, light in young specimens. Postero-dorsal and antero-dorsal margins broadly rounded but the former one sometimes nearly straight, ventral margin also nearly straight. Beaks small, low, placed nearly midpoint of dorsal margin. Nymph heavy, higher posteriorly. Right valve with anterior cardinal and narrow posterior cardinal teeth, left valve with narrow, weak anterior cardinal and narrow posterior cardinal teeth. Pallial sinus moderately deep, rounded, broad, nearly reaching to below the beaks. Adductor scars ovate, the anterior one more narrow and posterior broader.

Remarks: This species is clearly differentiated from *G. californica* by more elongated shell shape, broadly rounded anterior end, complete absence of radial color rays on shell surface and smaller size (Table, see also Figs. 1-3; holotype of *G. californica* is figured by Coan [2000, fig. 1]). Although additional molecular genetic analysis is needed to support this opinion, morphological differences are quite obvious.

Distribution and ecology: This species is known from Yellow and Bohai seas — Liaoning and Shan-

Table. Morphological comparison between *Gari californica* and *Gari kazusensis*

Таблица. Морфологическое сравнение *Gari californica* и *Gari kazusensis*

Morphological characters	*Gari californica*	Gari kazusensis
Shell convexity	Moderately inflated	Rather flattened
Color	Yellowish-tan with purple radial rays	White, no color rays present
Position of beaks from anterior end	36-40%	42-50%
Antero-dorsal margin	Rather short, nearly straight	Longer than in *G. californica*, more subparallel to ventral margin
Anterior end	Sharply rounded	Broadly rounded
Anterior cardinal of left valve	Moderate, nearly vertical	Narrow, weak, slightly posteriorly directed
Maximum size (length), mm	141.0 [Coan, 2000]	73.1 (up to 80 — [Yokoyama, 1922])

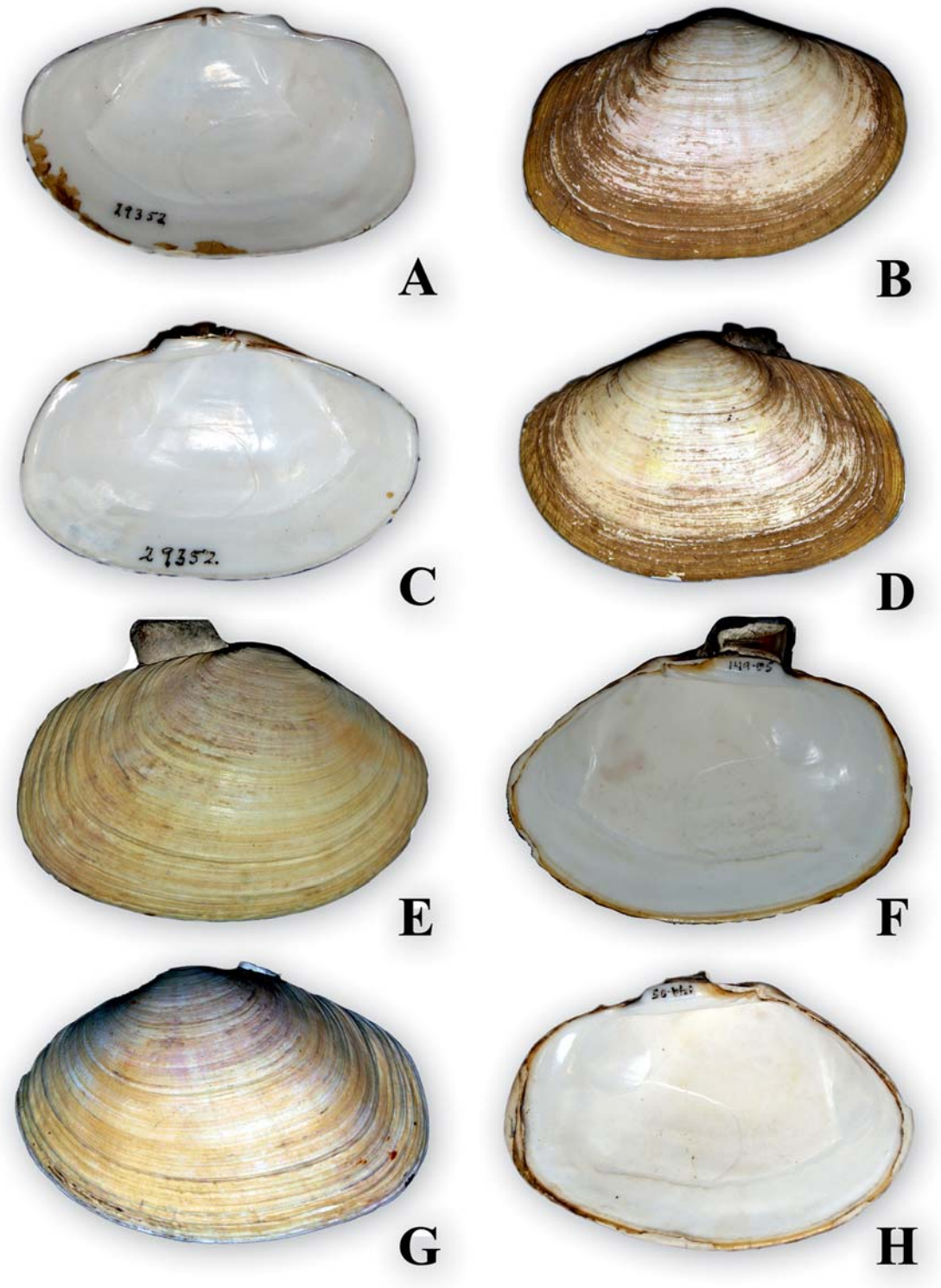

FIG. 2. A-D — *Gari* (*Gobraeus*) *californica* (Conrad, 1849), inner (A, C) and outher (B, D) views of the same shell, California, Monterey, CAS no. 29352, E. Rixford Colln., length 54.5 mm; E-H — *G.* (*G.*) *californica* (Conrad, 1849), outer (E, G) and inner (F, H) views of the same shell, California, Monterey Co., Pacific Grove, Hopkins Marine Station, CAS cat. no. 115850 (acc. no. 52575), M.K. Wicksten Colln., length 93.3 mm.

РИС. 2. A-D — *Gari* (*Gobraeus*) *californica* (Conrad, 1849), вид изнутри (A, C) и снаружи (B, D) одной и той же раковины, Калифорния, Монтерей, CAS № 29352, коллекция Э. Риксфорд, длина раковины 54,5 мм; E-H — *G.* (*G.*) *californica* (Conrad, 1849), вид снаружи (E, G) и изнутри (F, H) одной и той же раковины, Калифорния, округ Монтерей, Пасифик Гров, Морская станция Гопкинса, CAS № 115850 (№ поступления 52575), коллекция М.К. Викстен, длина раковины 93,3 мм.

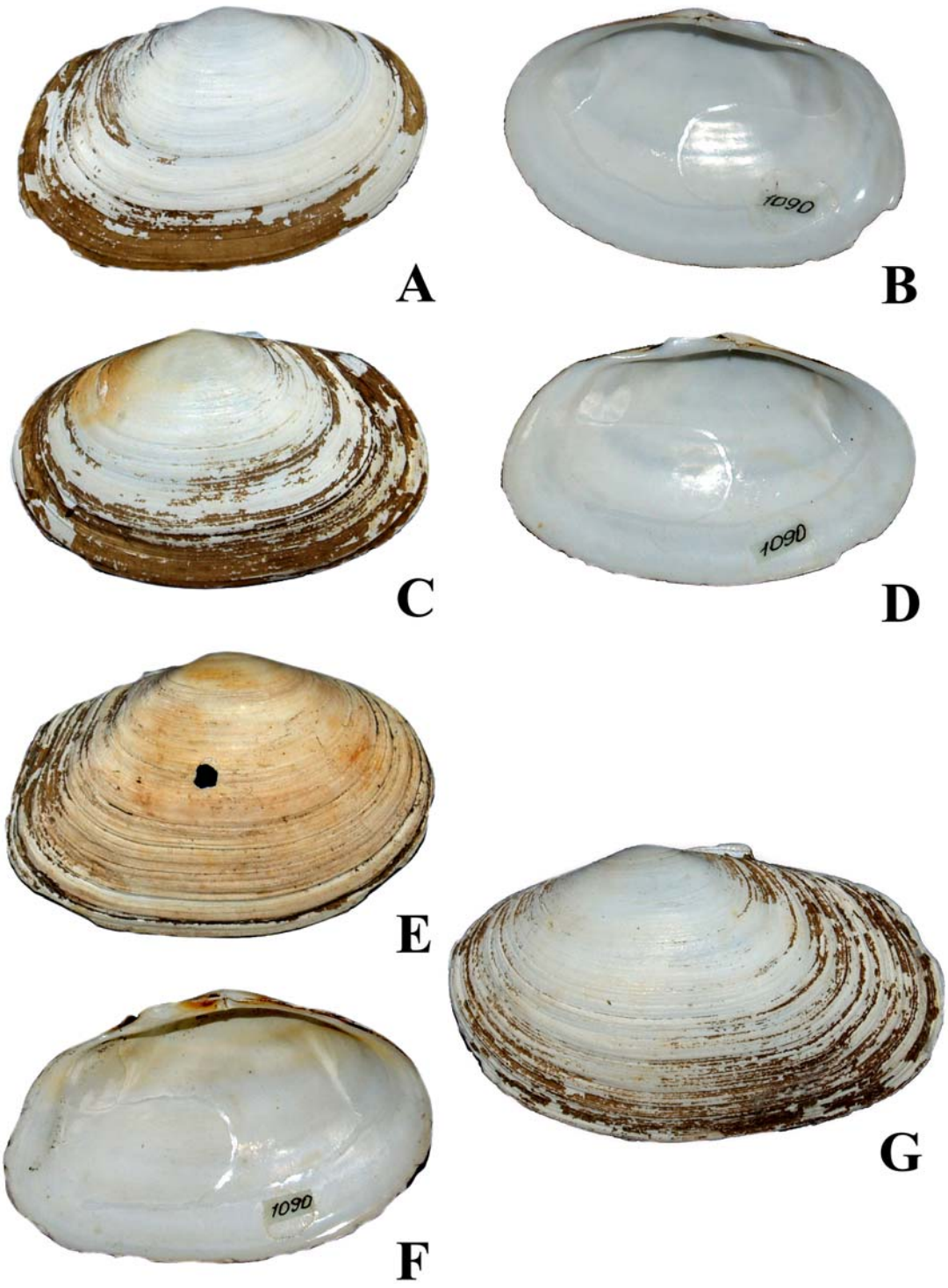

FIG. 3. *Gari* (*Gobraeus*) *kazusensis* (Yokoyama, 1922), outer (A, C) and inner (B, D) views of the same shell, Sea of Japan, Peter the Great Bay, Reineke Isl., ZMFU no. 10857/Bv-1090, length 52.0 mm; E-F — *G.* (*G.*) *kazusensis* (Yokoyama, 1922), outer (E) and inner (F) views of the same shell, Sea of Japan, Peter the Great Bay, Reineke Isl., ZMFU no. 10857/Bv-1090, length 63.4 mm; G — *G.* (*G.*) *kazusensis* (Yokoyama, 1922), outer view, Sea of Japan, Ussuriysky Bay, Sukhodol Bay, Inst. Mar. Biol. FEB RAS Colln., length 74.3 mm.

FIG. 3. A-D — *Gari* (*Gobraeus*) *kazusensis* (Yokoyama, 1922), вид снаружи (A, C) и изнутри (B, D) одной и той же раковины, Японское море, залив Петра Великого, о-в Рейнеке, ZMFU № 10857/Bv-1090, длина раковины 52,0 мм; E-F — *G.* (*G.*) *kazusensis* (Yokoyama, 1922), вид снаружи (E) и изнутри (F) одной и той же раковины, Японское море, залив Петра Великого, о-в Рейнеке, ZMFU № 10857/Bv-1090, длина раковины 63,4 мм; G — *G.* (*G.*) *kazusensis* (Yokoyama, 1922), вид снаружи, Японское море, Уссурийский залив, бухта Суходол, коллекция ИБМ ДВО РАН, длина раковины 74.3 мм.

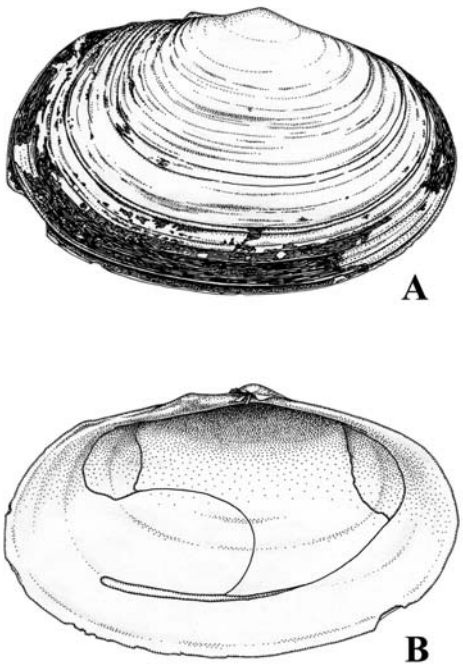

FIG. 4. *Gari* (*Gobraeus*) *kazusensis* (Yokoyama, 1922), outer (A) and inner (B) views of the same shell, Sea of Japan, Peter the Great Bay, Reineke Isl., ZMFU no. 10857/Bv-1090, length 52.0 mm.

РИС. 4. *Gari* (*Gobraeus*) *kazusensis* (Yokoyama, 1922), вид снаружи (A) и изнутри (B) одной и той же раковины, Японское море, залив Петра Великого, о-в Рейнеке, ZMFU № 10857/Bv-1090, длина раковины 52,0 мм.

dong Provinces of China [Qi et al., 1989; Bernard et al., 1993; Wang, 2004]; Korea [Lee, Min, 2002]; Japan (north-eastern Kyushu, central Honshu and Hokkaido) [Higo et al., 1999]; Russian waters of the Sea of Japan (only Peter the Great Bay) [Scarlato, 1981; Lutaenko, 2003; 2005]. Higo et al. [1999] mentioned also Kurile Islands, Okhotsk Sea and Kamchatka; there is a record from "Petropavlovsk, Kamchatka" [Coan, 2000; as *G. californica*], but this seems very doubtful: long-term collecting by Russian institutions in Kamchatka and Sakhalin areas does not confirm these high-boreal records. Detailed intertidal studies (1967-1991, 61 regions, 23 expeditions) in all Russian Far Eastern seas did not reveal this species in any areas except for Peter the Great Bay [Kussakin et al., 1997]. Evseev [2000] did not find *G. kazusensis* in southern Kurile Islands during subtidal surveys. This species was not even found in middle and northern Primorye along the continental coast of the Sea of Japan [Evseev, 1981; Lutaenko, 1999; Kolpakov, 2006]. Taken together, these observations limit the species to the subtropical-lowboreal geographical zone.

G. kazusensis inhabits intertidal zone of the Yellow and Bohai seas, on coarse sand and gravelly bottoms [Bernard et al., 1993; Wang, 2004]; on sandy mud bottom in the upper subtidal zone in Japan [Matsukuma, 2004]; on gravel down to 69 m in the north-eastern Kyushu [Nomura, Hatai, 1940] and down to 83 m in Otsuchi Bay (Iwate Pref.) [Tsuchida, Kurozumi, 1995]. In the Russian Far Eastern seas, it is known from both intertidal and upper subtidal zones.

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О видовой принадлежности "*Gari californica*" (Bivalvia: Psammobiidae) из северо-западной части Тихого океана

К.А. ЛУТАЕНКО

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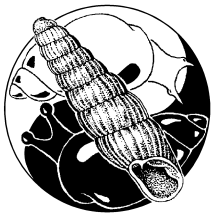
РЕЗЮМЕ. Установлена валидность северо-тихоокеанского вида *Gari (Gobraeus) kazusensis* (Yokoyama, 1922) (Psammibiidae), который ранее был синонимизирован с восточно-тихоокеанским *Gari (Gobraeus) californica* (Conrad, 1849); даны его переописание и детальная синонимия. Находки *G. kazusensis* на Камчатке и Курильских островах представляются сомнительными, а распространение вида ограничено северным Китаем, Кореей, Японией и южным Приморьем.



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