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 (Bivalvia: 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] synonymized 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 synonymizations 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. Fleming, 1828
Genus Gari Schumacher, 1817


The genus Gari contains nine subgenera and is close to Solettella 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.
Gari kazusensis; Garia; eastern and western Pacific, and Australasia. Worldwide, there are 13 species [Willan, 1993] that occur in Europe, west Africa, the eastern and western Pacific, and Australia.

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

Psammocola kazusensis; Lee, 1959: 89, 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 kazusensis].

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 kazusensis]; Qi et al., 1989: 207, pl. 12, fig. 9; Bernard et al., 1993: 98; Huang, 1994: 406; Tschida, 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; Xiu, Zhang, 2008: 207, fig. 645.

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


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 Takehata, Atsumi Peninsula, Aichi Prefecture, Japan.

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

Description: Shell ovate-subquadrat to ovate-elongate, moderately large, thin, eqvalve, 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-
FIG. 2. A-D — *Gari* (*Gobraeus*) *californica* (Conrad, 1849), inner (A, C) and outer (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.
Higo et al. [1999] mentioned also Kurile Islands, Okhotsk Sea and Kamchatka; there is a record from “Petrovsklovsk, 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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Willan R.C. 1993. *Taxonomic revision of the family Psammobiidae (Bivalvia: Tellinoidea) in the Aus-
O видовой принадлежности “Gari californica” (Bivalvia: Psammobiidae) из северо-западной части Тихого океана

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РЕЗЮМЕ. Установлена валидность северо-тихоокеанского вида Gari (Gobraeus) kazusensis (Yokoyama, 1922) (Psammobiidae), 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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