European Journal of Taxonomy 856: 87–119
https://doi.org/10.5852/ejt.2023.856.2031

ISSN 2118-9773
www.europeanjournaloftaxonomy.eu
2023 · Kamenev G.M.

Research article

urn:lsid:zoobank.org:pub:4CB07147-51BF-42F2-9CD2-E921F4F2BBC1

Three new deep-sea species of Thyasiridae (Mollusca: Bivalvia) from the northwestern Pacific Ocean

Gennady M. KAMENEV

A.V. Zhirmunsky National Scientific Center of Marine Biology, Far Eastern Branch, Russian Academy of Sciences, Vladivostok 690041, Russian Federation.
Email: gennady.kamenev@mail.ru

urn:lsid:zoobank.org:author:AAF92FD9-F494-484B-BCE2-295979803862

Abstract. The Thyasiridae is one of the species-richest families in the abyssal and hadal zones of the northwestern Pacific Ocean. Many thyasirid species dominate benthic communities in terms of abundance and play an important role in the functioning of deep-sea ecosystems. Most of the thyasirid species in the region are new to science and have not been described. Based on the material collected from 1954 to 2016 by seven deep-sea expeditions, three new species of Thyasiridae (*Parathyasira coani* sp. nov., *P. pauli* sp. nov., and *Thyasira kharkovensis* sp. nov.) are described from the abyssal and hadal zones (3210–7540 m depth) of the Sea of Okhotsk, the Bering Sea, as well as the Kuril-Kamchatka and Japan trenches. The new species are remarkable among their congeners due to the combination of the following characters: an obliquely-rhomboidal shell with a weak and shallow posterior sulcus and a large prodissoconch with sculpture of lamellated folds. Comparisons with related species are provided.

Keywords. Bivalvia, taxonomy, northwestern Pacific, abyssal, hadal.

Kamenev G.M. 2023. Three new deep-sea species of Thyasiridae (Mollusca: Bivalvia) from the northwestern Pacific Ocean. *European Journal of Taxonomy* 856: 87–119. https://doi.org/10.5852/ejt.2023.856.2031

Introduction

Thyasirids are widespread in all world oceans, from shallow waters to depth exceeding 10 000 m (e.g., Filatova 1961; Belyaev 1989; Payne & Allen 1991; Coan *et al.* 2000; Oliver & Kelleen 2002; Allen 2008, 2015; Zelaya 2009, 2010; Coan & Valentich-Scott 2012; Valentich-Scott *et al.* 2014, 2020; Kamenev 2015, 2019, 2020; Oliver 2015). Recent studies have shown that thyasirids are one of the most species-rich families of bivalves in the Atlantic and the northwestern Pacific oceans at depths of more than 500 m (Allen 2008; Kamenev 2015, 2018a, 2019). They are often the dominant species in terms of abundance in deep-sea areas (Kamenev 2013, 2019, 2020; Kamenev *et al.* 2022). However, despite their significance in the deep-sea benthic communities, many thyasirids species have not been studied in detail (Allen 2008; Kamenev 2013, 2015, 2018a, 2019).

In the last decade, an international team of scientists has intensively sampled the deep-sea fauna of several northwestern Pacific areas, such as the Seas of Japan and Okhotsk, and the Kuril-Kamchatka Trench and adjacent abyssal plain (Malyutina & Brandt 2013; Brandt & Malyutina 2015; Malyutina *et al.* 2018; Brandt *et al.* 2020). These studies accounted for a rich bivalve fauna, with thyasirids being dominant in species richness. At least 14 thyasirid species were found at depths below 3000 m (Kamenev 2013, 2015, 2018a, 2019). In addition, no less than 10 thyasirid species were found in many trenches of the western Pacific at the depth of more than 6000 m (Belyaev 1989). None of the species have been identified to the species level, and most of them are most probably new to science. In recent years, a study of these species was started by the author of the paper. As a first step, three new species were described from the abyssal and hadal zones of the Kuril-Kamchatka Trench region (Kamenev 2020). This paper is a continuation of the previous study and addresses another three, morphologically similar deep-sea species which are described herein as new.

Material and methods

The material examined in this study was collected between 1954 and 1990 by expeditions of the P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences, Moscow (IO RAS) (RV Vityaz, cruise no. 19, 17 Oct.–29 Oct. 1954; RV Vityaz, cruise no. 45, 24 Apr.–10 Jul. 1969; RV Vityaz, cruise no. 59, 26 May–7 Jul. 1976; RV Akademik Mstislav Keldysh, cruise no. 22, 7 Jul.–27 Nov. 1990) from the Pacific abyssal plain adjacent to the Kuril-Kamchatka Trench, from the bottom of the Japan Trench, from the oceanic slope of the Kamchatka Peninsula, and from the bottom of the Commander Basin (Bering Sea), by the German–Russian deep-sea expeditions KuramBio (RV Sonne, cruise no. 223, 21 Jul.–7 Sep. 2012) and KuramBio II (RV Sonne, cruise no. 250, 16 Aug.–29 Sep. 2016) from the Pacific abyssal plain adjacent to the Kuril-Kamchatka Trench and in the hadal zone of the Kuril-Kamchatka Trench; and by the Russian–German deep-sea expedition SokhoBio from the bottom of the Kuril Basin (Sea of Okhotsk) (RV Akademik M.A. Lavrentyev, cruise no. 71, 6 Jul.–6 Aug. 2015). The new species of Thyasiridae described here were found in 30 samples at depths of 3210–7540 m. Samplings during the IO RAS expeditions were carried out by using an Okean grab (sampling area: 0.25 m^2), and Sigsbee and Galathea trawls (Monin 1983). During the KuramBio, KuramBio II, and SokhoBio expeditions a large box corer (sampling area: 0.25 m^2), epibenthic sledge, and Agassiz trawl were used (Brandt & Malyutina 2015; Malyutina *et al.* 2018; Brandt *et al.* 2020). All samples collected by the IO RAS were fixed in 4% buffered formaldehyde, transferred to 70% ethanol, and stored in the IO RAS Ocean Benthic Fauna collection (OBF). Samples collected by the KuramBio, KuramBio II, and SokhoBio expeditions were fixed in pre-cooled 96% ethanol, transferred to 70% ethanol, and stored in the Museum of the Institute of Marine Biology (MIMB), A.V. Zhirmunsky National Scientific Center of Marine Biology, Far Eastern Branch, Russian Academy of Sciences (NSCMB FEB RAS), Vladivostok. The type material of the new species described here was deposited in the collection of the MIMB, IO RAS OBF, and Senckenberg Museum Frankfurt, Germany (SMF).

Material considered for comparative purposes includes: the holotype of *Axinulus kelliaeformis* Okutani, 1962 (NSMT Mo (National Museum of Nature and Science, Tsukuba, Japan) 69697); the holotype and photos of paratype and additional specimens of *Axinulus obliquus* Okutani, 1968 (NSMT Mo 69719 and NSMT Mo 69720, respectively; photos by Dr H. Saito); the lectotype of *Axinus incrassatus succisa* Jeffreys, 1876 (USNM (Smithsonian Institution, National Museum of Natural History, Washington, USA) 61973, photos from USNM website); the lectotype of *Cryptodon obsoletus* Verrill & Bush, 1898 (USNM 159886, photos from USNM website); the holotype of *Parathyasira kaireiae* Okutani, Fujikura & Kojima, 1999 (NSMT Mo 71433); the holotype and paratype of *Thyasira* (*Parathyasira*) *biscayensis* Payne & Allen, 1991 (MNHN-IM-2000-38099 (Muséum national d´histoire naturelle, Paris, France) and MNHN-IM-2000-38100, respectively; photos by P. Maestrati); the holotype of *Thyasira borshengi* Okutani & Lan, 1999 (NSMT Mo 71306); the holotype of *Thyasira dearborni* Nicol, 1965 (holotype, USNM 653099, photos from USNM website); the holotype and three paratypes of *Thyasira hexangulata* Okutani, 1962 (NSMT Mo 69706 and NSMT Mo 69707, respectively); the holotype of *Thyasira imamurai* Okutani, 1962 (NSMT Mo 69701); the holotype of *Thyasira kawamurai* Habe, 1951 (NSMT Mo 38660); the holotype of *Thyasira magellanica* Dall, 1901 (USNM 122745, photos from USNM website); the holotype of *Thyasira miyadii* Habe, 1951 (NSMT 38581); the holotype and paratype of *Thyasira orecta* Bernard, 1982 (LACM (Natural History Museum of Los Angeles County, Los Angeles, USA) 1804 and NSMT Mo 60078, respectively); a paratype of *Thyasira phrygiana* Miloslavskaya, 1977 (LACM 2647). Information and photos from USNM website were provided with permission from the National Museum of Natural History, Smithsonian Institution, 10^{th} and Constitution Ave. N.W., Washington, DC 20560-0193 (http://www.nmnh.si.edu/).

Shell length (L), height (H), anterior end length (A), lunule length (LL), escutcheon length (EL), and shell width (W) were measured by using an ocular micrometer (Fig. 1). The ratios H/L, A/L, LL/L, EL/L, and W/L were determined.

For scanning electron microscopy, shells were cleaned in 50% water-diluted commercial bleach, washed in distilled water, dried, mounted in aluminum stubs with adhesive tape and coated with chromium. Photographs were obtained with a SIGMA 300VP (Carl Zeiss, Cambridge, UK). Anatomical descriptions come from ethanol fixed specimens. Microscopic observations of shells and bodies were performed in a Zeiss Discovery 8 stereo microscope at the Far Eastern Center of Electron Microscopy of NSCMB FEB RAS. Shell and body anatomy's terminology follows Payne & Allen (1991) and Oliver & Killeen (2002). When determining the taxonomic position of new species, I follow the diagnoses of the genera *Parathyasira* Iredale, 1930 and *Thyasira* Lamarck, 1818 provided by Kamenev (2020) and Oliver & Holmes (2006), respectively.

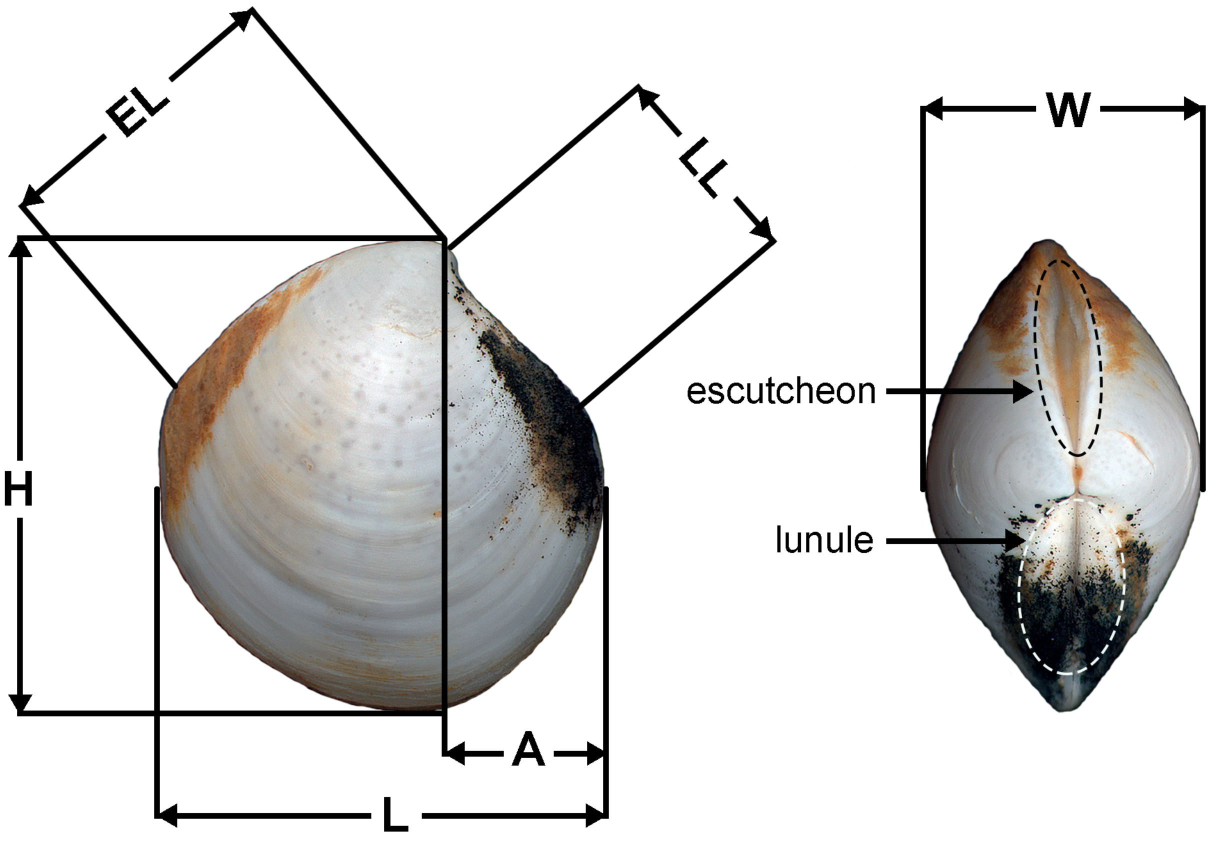

Fig. 1. Shell characters and measurements. Abbreviations: see Material and methods.

Abbreviations for anatomical terms

AA = anterior adductor muscle
AP = anterior pedal retractor muscle
EA = exhalant aperture
F = foot
H = heart
HE = heal
HG = hind gut
ID = inner demibranch
K = kidney
LBP = lateral body pouch
LP = labial palps
ME = mantle edge
MG = mid gut
NP = neck of lateral body pouch
OD = outer demibranch
PA = posterior adductor muscle
PPR = posterior pedal retractor muscle
S = stomach

Results

Taxonomy

Class Bivalvia
Order Lucinoida Gray, 1854
Superfamily Thyasiroidea Dall, 1900
Family Thyasiridae Dall, 1900

Genus ***Parathyasira*** Iredale, 1930

Type species

Parathyasira resupina Iredale, 1930.

Parathyasira coani sp. nov.
urn:lsid:zoobank.org:act:B88594C5-63A1-4111-909B-D2359BB41965
Figs 2–6, Table 1

Parathyasira sp. 2 – Kamenev 2015: 191.

Parathyasira sp. – Kamenev 2019: 6.

Diagnosis

Shell medium in size (to 7.5 mm in length), obliquely-rhomboidal, slightly drawn out anteriorly. Sculpture of closely spaced commarginal riblets and weak undulations. Second posterior fold weak. Posterior sulcus weak. Escutcheon long, deep. Lunule long, flat, weakly defined. Ligament well visible externally, long. Prodissoconch large (to 250 μm) with 5 lamellated folds. Lateral body pouches large, extensively lobed. Foot distally bulbous; bulbous portion not divided into two distinct parts; heel absent.

Table 1. *Parathyasira coani* sp. nov., shell measurements (mm), indices and summary statistics of indices.

Depository	L	H	A	LL	EL	W	H/L	A/L	LL/L	EL/L	W/L
Holotype MIMB 43813	7.1	7.0	2.8	2.5	4.7	4.4	0.99	0.39	0.35	0.66	0.62
Paratype MIMB 43815	6.8	7.0	2.8	3.3	4.5	4.1	1.03	0.41	0.49	0.66	0.60
Paratype SMF 367801	6.5	6.5	2.6	2.8	4.0	4.0	1.00	0.40	0.43	0.62	0.62
Paratype SMF 367801	5.8	5.8	2.5	2.5	3.2	3.1	1.00	0.43	0.43	0.55	0.53
MIMB 43816	7.5	7.3	3.1	3.5	5.2	5.2	0.97	0.41	0.47	0.69	0.69
MIMB 43816	6.9	7.3	2.9	3.5	4.6	5.0	1.06	0.42	0.51	0.67	0.73
MIMB 43819	6.5	6.2	3.0	2.7	4.0	3.6	0.95	0.46	0.42	0.62	0.55
MIMB 43819	5.7	6.0	2.1	2.0	3.5	3.2	1.06	0.37	0.35	0.61	0.56
MIMB 43819	5.7	5.7	2.0	2.1	3.7	3.0	1.00	0.35	0.37	0.65	0.53
MIMB 43819	5.6	5.5	2.2	2.0	3.3	3.0	0.98	0.39	0.36	0.59	0.54
Paratype MIMB 43814	5.6	6.0	2.2	2.5	3.7	3.8	1.07	0.39	0.45	0.66	0.68
MIMB 43818	5.5	5.4	2.4	2.0	3.5	2.6	0.98	0.44	0.36	0.64	0.47
MIMB 43818	5.4	5.6	2.0	2.3	3.5	2.6	1.04	0.37	0.43	0.65	0.48
MIMB 43819	5.4	5.8	2.1	1.7	3.4	3.0	1.07	0.39	0.32	0.63	0.56
MIMB 43816	5.3	5.3	2.3	2.2	3.4	3.4	1.00	0.43	0.42	0.642	0.64
MIMB 43816	5.1	5.2	1.9	1.7	3.2	2.7	1.02	0.37	0.33	0.63	0.53
MIMB 43818	5.1	4.9	2.2	2.0	3.1	2.6	0.96	0.43	0.39	0.61	0.51
MIMB 43819	5.0	5.1	2.1	2.0	3.3	3.0	1.02	0.42	0.40	0.66	0.60
MIMB 43819	4.9	4.7	2.0	1.7	3.2	2.4	0.96	0.41	0.35	0.65	0.49
MIMB 43819	4.7	4.8	2.0	1.8	2.8	2.4	1.02	0.43	0.38	0.60	0.51
MIMB 43819	4.6	4.6	1.9	1.5	2.7	2.3	1.00	0.41	0.33	0.59	0.50
MIMB 43816	4.2	4.4	1.7	1.8	2.4	2.4	1.05	0.41	0.43	0.57	0.57
MIMB 43816	4.2	4.2	1.5	1.7	2.5	2.0	1.00	0.36	0.41	0.60	0.48
MIMB 43819	3.9	4.0	1.6	1.3	2.5	2.0	1.03	0.41	0.33	0.64	0.51
MIMB 43820	3.2	3.2	1.3	1.1	1.9	1.7	1.00	0.41	0.34	0.59	0.53
MIMB 43819	2.8	2.8	1.1	1.0	1.6	1.4	1.00	0.39	0.36	0.57	0.50
Statistics	**L**	**H**	**A**	**LL**	**EL**	**W**	**H/L**	**A/L**	**LL/L**	**EL/L**	**W/L**
Mean	–	–	–	–	–	–	1.01	0.40	0.39	0.62	0.56
SE	–	–	–	–	–	–	0.03	0.02	0.04	0.03	0.06
Min	–	–	–	–	–	–	0.95	0.35	0.32	0.55	0.47
Max	–	–	–	–	–	–	1.07	0.46	0.51	0.69	0.73

Etymology

The species epithet honors Dr Eugene V. Coan, a well-known researcher of eastern Pacific bivalves who made an enormous contribution to the study of the bivalve fauna of the Pacific Ocean.

Material examined

Holotype

PACIFIC OCEAN • abyssal plain adjacent to the southern part of the Kuril-Kamchatka Trench; 39°43.80′ N, 147°10.16′ E–39°42.49′ N, 147°09.37′ E; depth 5224–5215 m; 1 Sep. 2012; A. Brandt leg.; epibenthic sledge, RV Sonne, cruise no. 223, stn. 12-4; MIMB 43813.

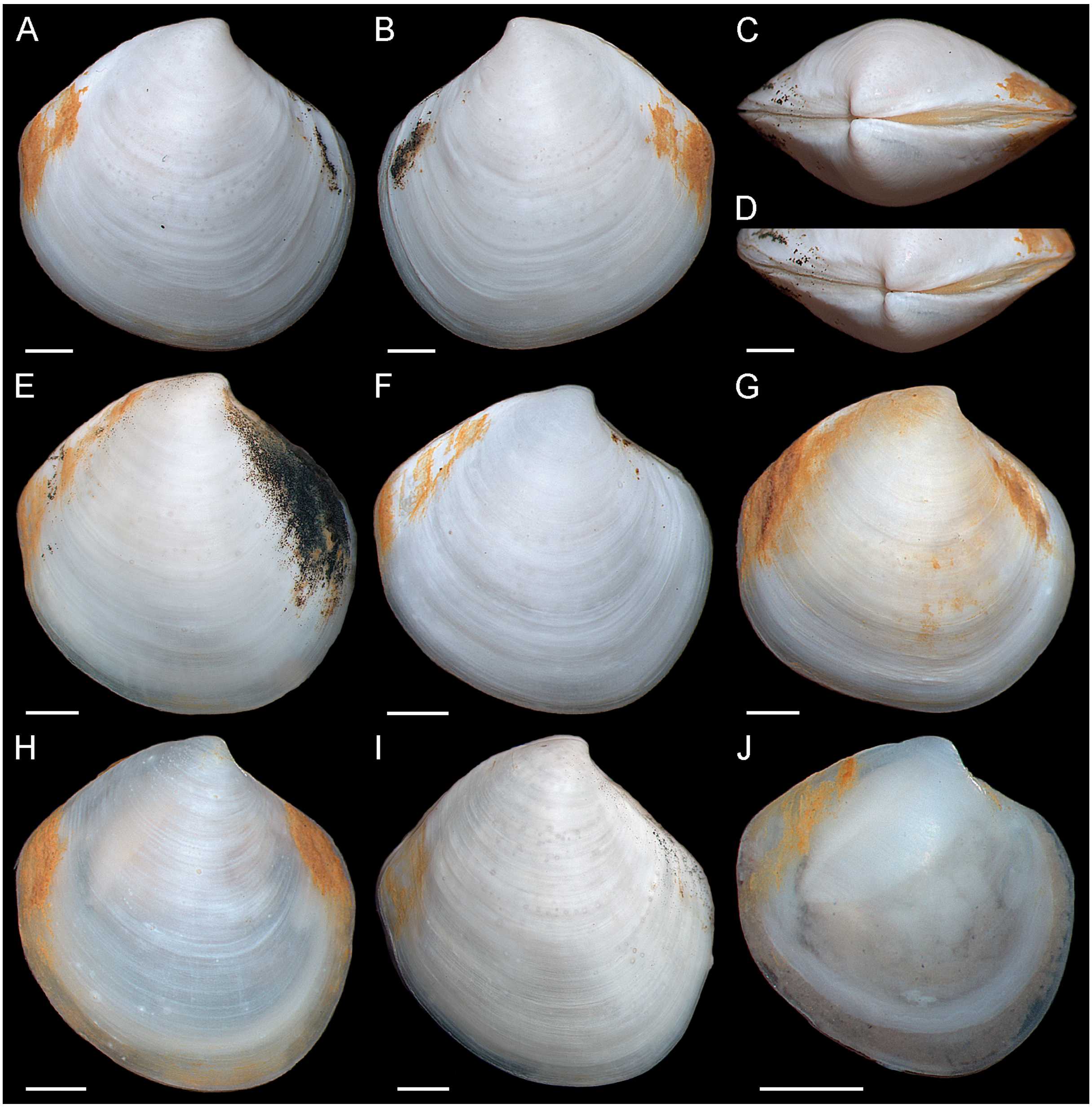

Fig 2. *Parathyasira coani* sp. nov. **A–D**. Holotype (MIMB 43813), exterior and dorsal views of both valves, shell length 7.1 mm. **E**. Paratype (SMF 367801), shell length 6.5 mm. **F**. Paratype (SMF 367801), shell length 5.8 mm. **G–J**. Variability of shell shape. **G**. Shell length 6.5 mm (MIMB 43819). **H**. Shell length 5.7 mm (MIMB 43819). **I**. Shell length 6.9 mm (MIMB 43816). **J**. Shell length 3.2 mm (MIMB 43820). Scale bars = 1 mm.

Paratypes

PACIFIC OCEAN • 2 specs; same locality as for holotype; 40°13.26′ N, 148°06.24′ E–40°12.37′ N, 148°05.43′ E; depth 5348–5350 m; epibenthic sledge; 30 Aug. 2012; A. Brandt leg.; RV Sonne, cruise no. 223, stn. 11-9; SMF 367801 • 1 spec.; same collection data as for preceding; MIMB 43814 • 1 spec.; same locality as for holotype; 40°13.10′ N, 148°06.45′ E–40°12.10′ N, 148°06.45′ E; depth 5351–5348 m; 31 Aug. 2012; A. Brandt leg.; epibenthic sledge, RV Sonne, cruise no. 223, stn. 11-12; MIMB 43815.

Other material

RUSSIA – **oceanic slope of the Kamchatka Peninsula** • 2 specs; 53°05.4′ N, 161°55.2′ E–53°07′ N, 161°56.1′ E; depth 4890–4984 m; 10 Aug. 1990; L.I. Moskalev and S.V. Galkin leg.; Sigsbee trawl; RV Akademik Mstislav Keldysh, cruise no. 22, stn. 2323; IORAS OBF collection Cat. BIV00044.

PACIFIC OCEAN – **abyssal plain adjacent to the Kuril-Kamchatka Trench** • 7 specs; 41°16′ N, 147°27.7′ E; depth 5210 m; 20 Aug. 1954; P.L. Bezrukov leg.; Okean grab (0.25 m^2); RV Vityaz, cruise no. 19, stn. 3102; IORAS OBF collection Cat. BIV00043 • 6 specs; same locality as for preceding; 40°13.26′ N, 148°06.24′E–40°12.37′ N, 148°05.43′ E; depth 5348–5350 m; 30 Aug. 2012; A. Brandt leg.; epibenthic sledge, RV Sonne, cruise no. 223, stn. 11-9; MIMB 43816 • 2 specs; same locality as for preceding; 40°13.33′ N, 148°06.48′ E–40°12.53′ N, 148°05.76′ E; depth 5348–5347 m; 30 Aug. 2012; K.V. Minin leg.; Agassiz trawl, RV Sonne, cruise no. 223, stn. 11-10; MIMB 43817 • 5 specs; same locality as for preceding; 40°13.10′ N, 148°06.45′ E–40°12.10′ N, 148°05.53′ E; depth 5351–5348 m; epibenthic sledge, RV Sonne, cruise no. 223, stn. 11-12; 31 Aug. 2012; A. Brandt leg.; MIMB 43818 • 13 specs; same locality as for preceding; 39°43.80′ N, 147°10.16′ E–39°42.49′ N, 147°09.37′ E; depth 5224–5215 m; A. Brandt leg.; epibenthic sledge, RV Sonne, cruise no. 223, stn. 12-4; 1 Sep. 2012; MIMB 43819 • 1 spec.; same locality as for preceding; 39°43.47′ N, 147°10.11′ E–39°42.54′ N, 147°09.51′ E; depth 5229–5217 m; 1 Sep. 2012; K.V. Minin leg.; Agassiz trawl, RV Sonne, cruise no. 223, stn. 12-5; MIMB 43820. – **Kuril-Kamchatka Trench** • 1 spec.; 45°56.587′ N, 152°54.251′ E–45°56.570′ N, 152°54.499′ E; depth 6204–6202 m; 26 Aug. 2016; K.V. Minin leg.; Agassiz trawl, RV Sonne, cruise no. 250, stn. 29; MIMB 43821 • 1 spec.; same locality as for preceding; 45°56.821′ N, 152°51.185′ E–45°56.834′ N, 152°50.943′ E; depth 6168–6164 m; 27 Aug. 2016; A. Brandt leg.; epibenthic sledge, RV Sonne, cruise no. 250, stn. 30; MIMB 43822.

Description

Shell. Medium in size (to 7.5 mm in length and 7.3 mm in height). Obliquely-rhomboidal, equivalve, subequilateral, white, thick, inflated (W/L = 0.56 ± 0.06), almost as long as high (H/L = 1.01 ± 0.03), slightly drawn out anteriorly; patches of silty and ferruginous deposit adhering to anterodorsal and posterodorsal shell margins (Fig. 2, Table 1). Periostracum thin, colorless, adherent. Dissoconch sculptured with closely spaced, thin, smoothed, commarginal riblets and weak, wide, irregular undulations. Microsculpture of small, densely spaced, wrinkles (Fig. 3C–D). Beaks small, raised, pointed, prosogyrate, anterior to midline (A/L = 0.40 ± 0.02) (Table 1). Anterodorsal shell margin long, slightly concave, sometimes straight, gently sloping from beaks, forming a rounded angle at transition to anterior margin. Anterior margin strongly curved, smoothly transitioning to ventral margin. Ventral margin strongly curved, sometimes slightly angulate. Posterodorsal margin long, convex, steeply sloping from beaks, forming distinct angle at transition to posterior margin. Posterior margin straight, sometimes slightly concave, smoothly transitioning to ventral margin. First posterior fold absent. Second posterior fold weak. Posterior sulcus weak and shallow. Escutcheon long (EL/L = 0.62 ± 0.03), narrow, deep (Figs 2C–D, 4A–D, Table 1). Auricle absent. Lunule long (LL/L = 0.39 ± 0.04), wide, flat, demarcated by weak, rounded ridges (Figs 2C–D, 4A–B, E, Table 1). Ligament opisthodetic, visible externally for more than a half of its total length, thick, evenly curved, long, three-fourths the length of escutcheon, lying in shallow, slightly curved, wide groove at surface of hinge plate (Figs 2C, 3F, J, 4A, C–D). Prodissoconch

Table 2 (continued on next page). Main differentiating characters of species of *Parathyasira* Iredale, 1930 lacking a shell micro-sculpture of calcareous spines.

Species	Shell	Sculpture	Anterodorsal margin	Posterodorsal margin	Lunule	Ligament	Prodissoconch length (µm) and sculpture	Heel of foot	References
P. coani sp. nov.	Obliquely-rhomboidal; drown out anteriorly, solid	Thin, commarginal ribs and weak, irregular undulations; micro-sculpture of densely spaced wrinkles	Long, slightly concave, gently sloping from beaks	Long, convex, steeply sloping from beaks	Long, weakly defined, wide, flat	Well visible externally, thick, long	235–250; sculptured with 5 lamellated folds	Absent	Present study
P. pauli sp. nov.	Rhomboidal; drown out anteriorly, solid	Thin, commarginal ribs and weak, irregular undulations; micro-sculpture of densely spaced pits	Long, straight, sloping rather steeply from beaks	Long, slightly convex, sloping steeply from beaks	Long, well defined, wide, strongly excavated, demarcated by ridges	Well visible externally, thick, long	252–260; sculptured with 6 lamellated folds	Absent	Present study
P. kaireiae Okutani, Fujikura & Kojima, 1999	Pyriform, with well developed posterior sulcus; high, solid	Conspicuous, commarginal ribs and weak, irregular undulations; micro-sculpture of densely spaced wrinkles	Long, straight or slightly concave, sloping steeply from beaks	Long, convex, sloping steeply from beaks	Long, weakly defined, flat	Long	No data	No data	Okutani *et al.* 1999
P. fragilis Kamenev, 2020	Rhomboidal; thin and fragile, transparent	Conspicuous, commarginal ribs and weak, irregular undulations; micro-sculpture of densely spaced pits	Long, straight, sloping very steeply from beaks, descending below mid-point of shell	Long, slightly convex, sloping very steeply from beaks	Long, weakly defined, wide, flat	Slightly visible externally, short	232; sculptured with 2 radial, wide, rounded folds and closely spaced shallow pits.	Distinct, small	Kamenev 2020
P. magellanica (Dall, 1901)	Subquadrate; translucent	Fine, low growth lines	Short, slightly convex or straight, sloping gradually from beaks	Long, slightly convex, sloping steeply from beaks	Small, weakly defined, narrow	Visible externally, long	120; initial part sculptured with 10–14 lamellated folds, sometimes bifurcated at base	Absent	Dall 1901; Zelaya 2009

Table 2. (continued).

Species	Shell	Sculpture	Anterodorsal margin	Posterodorsal margin	Lunule	Ligament	Prodissoconch length (μm) and sculpture	Heel of foot	References
P. dearborni (Nicol, 1965)	Rhomboidal; thin	Commarginal ribs composed by microscopic irregular corrugations and pustules	Long, straight or slightly concave, sloping steeply	Long, slightly convex, sloping steeply from beaks	Short, weakly defined	Visible externally, long	115; sculptured with 28 lamellated folds, symmetrically distributed with respect to main central axis	Absent	Nicol 1965; Zelaya 2009
P. dunbari (Lubinsky, 1976)	Pyriform; high, strongly asymmetric, solid	Conspicuous, commarginal ribs	Long, concave, sloping very steeply from beaks, descending below mid-point of shell	Long, convex, sloping very steeply from beaks	Large, well defined, strongly excavated, cordate	Visible externally, long	160; smooth	Absent	Lubinsky 1976; Oliver & Killeen 2002
P. equalis (Verrill & Bush, 1898)	Ovate to pyriform and diamond shaped; solid	Weak commarginal lines and growth stops, frequently with irregular dents, weak ridges and fine radial striae	Short, concave or straight, sloping steeply from beaks	Long, convex, sloping steeply from beaks	Small, weakly defined, excavated	Not visible externally, long	155–167; series folds or wrinkles radiating from the anterior end to apex	Absent	Verrill & Bush 1898; Payne & Allen 1991; Oliver & Killeen 2002
P. biscayensis (Payne & Allen, 1991)	Obliquely-rhomboidal; drown out anteriorly	Irregular indented commarginal growth lines and weak, irregular undulations	Long, almost straight, sloping steeply from beaks	Long, convex, sloping steeply from beaks	No data	Long	No data	Absent	Payne & Allen 1991; present study
P. marionensis (E. A. Smith, 1885)	Subquadrate	Fine, commarginal ribs	Long, concave, sloping gradually from beaks	Long, convex, sloping steeply from beaks	Short, narrow	No data	No data	No data	Smith 1885

large (length 235–250 µm), ovate in outline, with 5 thin, lamellated folds, extending from high and sharp apex, located in midline of prodissoconch (Figs 3H, 4F). Hinge plate thick, edentulous, with numerous, shallow pits (to 20 µm) under beaks (Fig. 3F–G, J–K). Muscle scars indistinct.

Gross anatomy. Mantle edge thick, no obvious proliferation of glandular tissue on its anterior inner edge. Mantle fused posteriorly forming small exhalant aperture below posterior adductor muscle (Fig. 5A–C). Anterior adductor muscle elongate (Fig. 5J). Posterior adductor muscle small, ovate, 2 × as short and as narrow as anterior adductor muscle. Ctenidium wide, consisting of two demibranchs with fully reflected filaments (up to 80 filaments in specimen 7.5 mm in length); outer demibranch approximately half

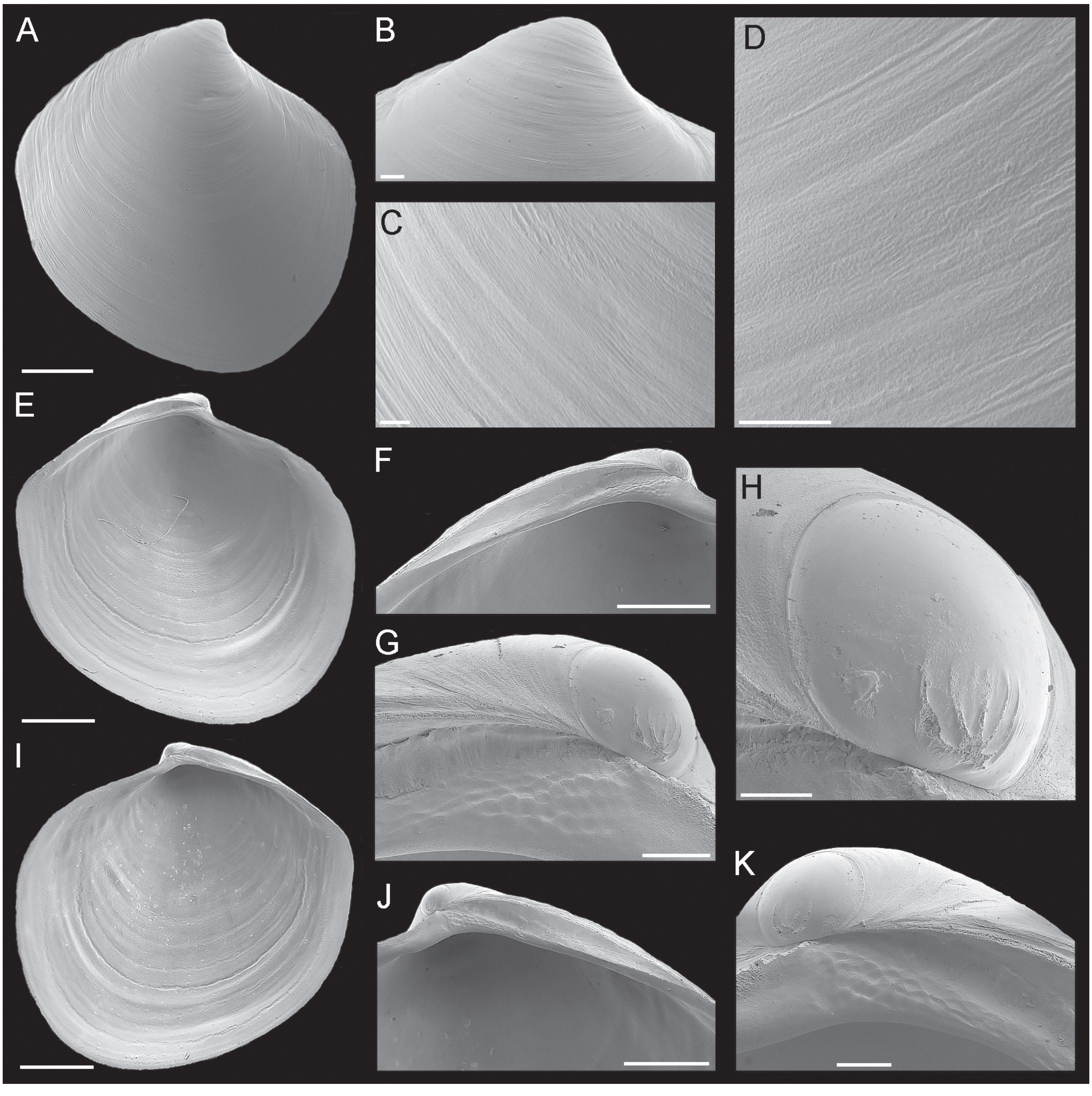

Fig 3. Scanning electron micrographs of *Parathyasira coani* sp. nov. (MIMB 43819). **A**. Exterior view of right valve. **B**. Sculpture of beak region. **C–D**. Sculpture of central shell part. **E**. Interior view of left valve. **F**. Hinge plate of left valve. **G**. Pits under beak of left valve. **H**. Prodissoconch. **I**. Interior view of right valve. **J**. Hinge plate of right valve. **K**. Pits under beak of right valve. Scale bars: A, E, I = 1 mm; F, J = 500 µm; B–D, G, K = 100 µm; H = 50 µm.

the size of inner demibranch. Demibranchs covering greater part of lateral body pouches (Fig. 5A–B). Labial palps relatively large (to 0.9 mm length) (Fig. 5F). Lateral body pouches large, extensively lobed; each lobe is a short and thick process; each pouch connecting to body by a rounded neck (Fig. 5B, E). Kidneys large, dorsoventrally elongated along posterodorsal shell margin, with numerous, red-brown or yellow, small (to 30 µm in diameter), different-size granules (Fig. 5G). Alimentary system with short oesophagus leading to a relatively large, elongate stomach; combined style sac and midgut strongly curved; hind gut forming anterior, deep, narrow loop producing rounded distinct angle, passing through heart and running posteriorly dorsal to kidney and posterior adductor muscle, opening at ventral side of posterior adductor muscle (Fig. 5H–J). Foot long, vermiform, distally bulbous, with muscular ring at junction with visceral mass. Bulbous portion not divided into two distinct parts; surface with numerous wrinkles; heel absent (Fig. 5B, D). Anterior and posterior pedal retractors wide, short, well developed.

Variability

In small specimens (up to 3 mm in shell length) the shell is relatively low, angular, with a strongly curved and anteriorly drawn-out ventral margin; the anterodorsal and posterodorsal margins gently sloping from beaks; the anterodorsal margin is concave (Fig. 2J). The shell shape and proportions, the length of the lunule and escutcheon, the degree of bending of shell margins vary among larger specimens (Fig. 2A–I, Table 1). Some of large specimens have a shell rather elongated dorsoventrally (Fig. 2I).

Distribution and habitat

Oceanic slope of the Kamchatka Peninsula (53°05.4′ N, 161°55.2′ E–53°07′ N, 161°56.1′ E), 4890–4984 m depth, abyssal plain adjacent to the southern part of the Kuril-Kamchatka Trench (39°42.49′ N, 147°09.37′ E–41°16′ N, 147°27.7′ E), 5210–5351 m depth (bottom temperature (6–8 m above bottom) 1.5–1.6 °C, salinity 34.7‰, oxygen 7.71–7.72 ml. l^{-1}) (Brandt *et al.* 2015), and in the Kuril-Kamchatka Trench (45°56.570′ N, 152°51.185′ E–45°56.834′ N, 152°50.943′ E), 6164–6204 m depth (Fig. 6).

Differential diagnosis

The genus *Parathyasira* currently includes 14 species (WoRMS Editorial Board 2022), among which 6 species (*P. resupina* Iredale, 1930, *P. neozelanica* Iredale, 1930, *P. verconis* (Cotton & Godfrey,

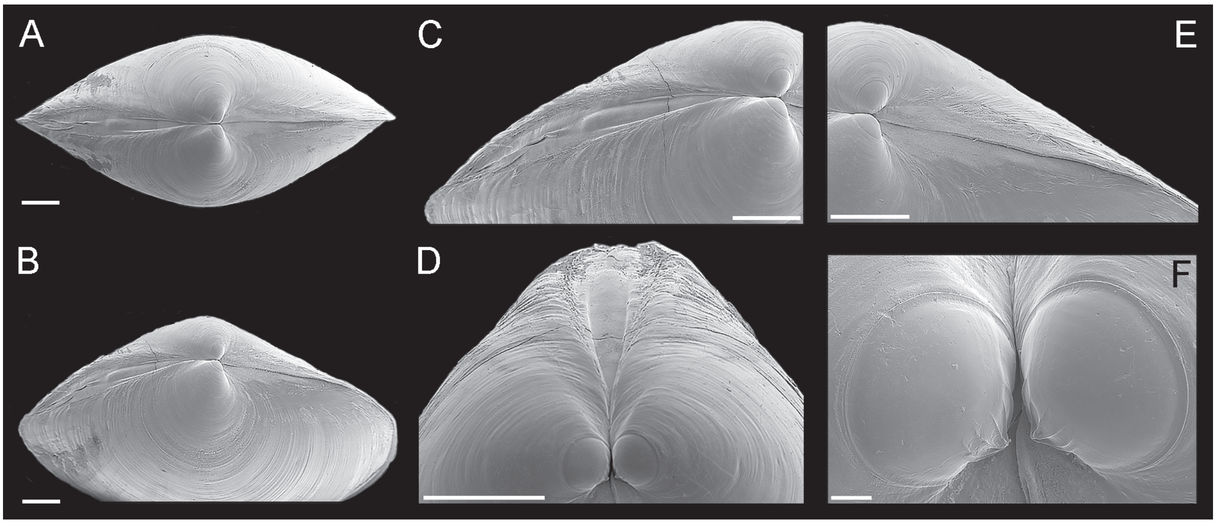

Fig. 4. Scanning electron micrographs of *Parathyasira coani* sp. nov. (MIMB 43819). **A–B**. Dorsal and oblique dorsal views of both valves. **C–E**. Dorsal and oblique views of posterodorsal and anterodorsal shell margins showing escutcheon and lunule. **F**. Prodissoconchs. Scale bars: A–E = 500 µm; F = 50 µm.

1938), *P. granulosa* (Monterosato, 1874), *P. subcircularis* (Payne & Allen, 1991), and *P. bamberi* P.G. Oliver, 2015) have a shell microsculpture consisting of calcareous spines arranged in dense radial rows (Oliver 2015). The new species described herein lacks this microsculpture. *Parathyasira coani* sp. nov. differs from most of other species of *Parathyasira* by having an anteriorly drawn-out shell, a flat, a non-excavated lunule, and a large prodissoconch with sculpture of lamellated folds (Table 2).

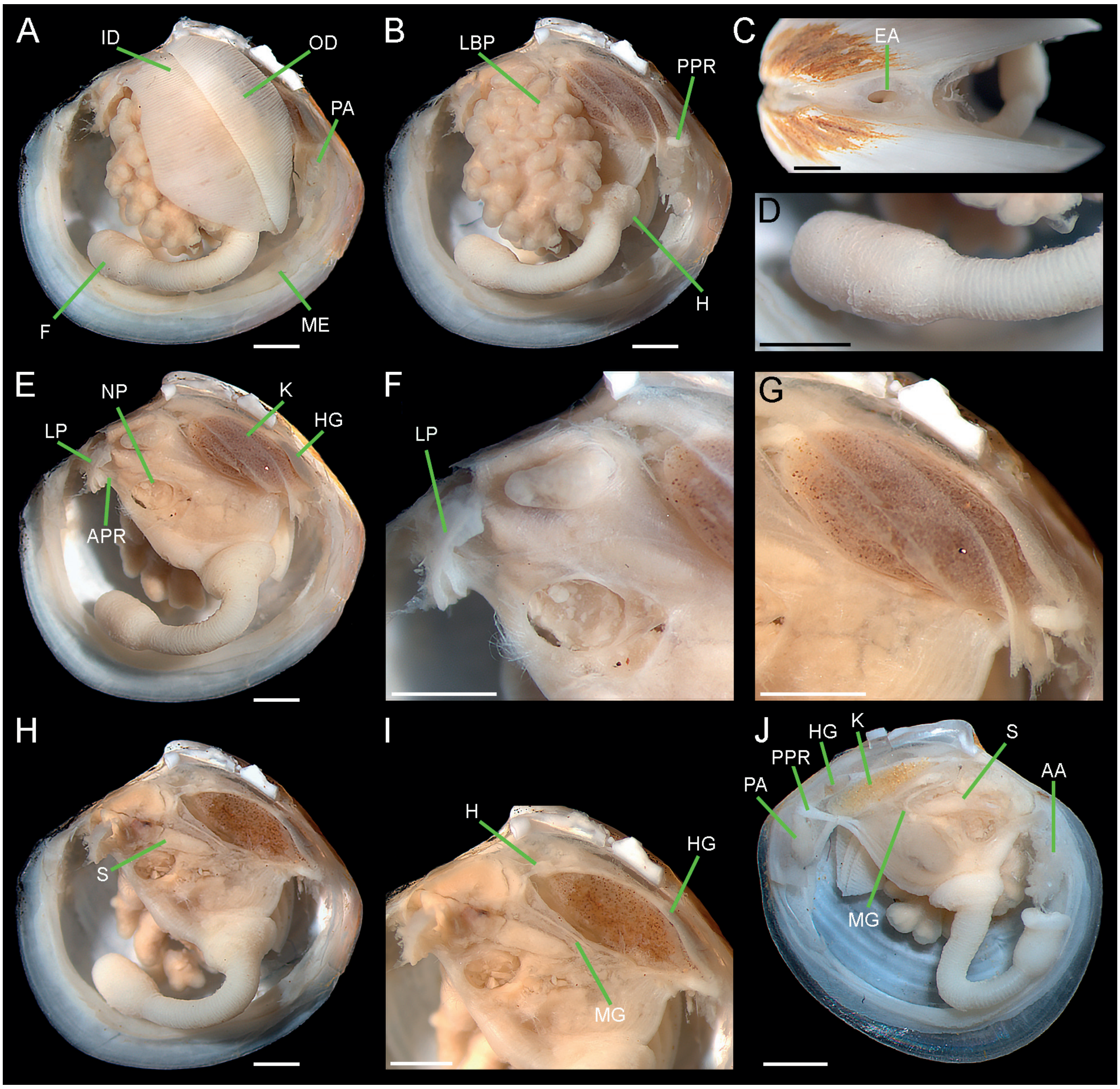

Fig. 5. *Parathyasira coani* sp. nov. **A**. Gross anatomy after removal of left valve, mantle, and anterior adductor muscle, shell length 7.5 mm (MIMB 43819). **B**. Gross anatomy after further removal of left ctenidium (MIMB 43819). **C**. Exhalant aperture (MIMB 43819). **D**. Bulbous portion of foot (MIMB 43819). **E**. Gross anatomy after further removal of left lateral body pouch (MIMB 43819). **F**. Labial palps (MIMB 43819). **G**. Kidney with granules (MIMB 43819). **H–I**. Digestive system (MIMB 43819). **J**. Gross anatomy of specimen with anterior adductor muscle after removal of right valve, mantle, right ctenidium, and right lateral body pouch, shell length 5.5 mm (MIMB 43818). Abbreviations: see Material and methods. Scale bars = 1 mm.

The new species is most similar to *Parathyasira biscayensis* (Payne & Allen, 1991) described from two specimens found in the Bay of Biscay (Atlantic Ocean) (4720 m) (Payne & Allen 1991) (Fig. 7A–C). However, in contrast to *P. biscayensis, P. coani* sp. nov. has only about half as many filaments in the gills, compared to almost similar-sized specimens of the former species, up to 80 (specimen 7.5 mm in length) vs 150 (specimen 8.2 mm in length), respectively, and a longer ligament. Moreover, in *P. biscayensis* the lunule is medially elevated, while in *P. coani* the lunule is flat. *Parathyasira coani* is similar to *Parathyasira fragilis* Kamenev, 2020 from which it differs in having a thick, opaque and white shell, a long and thick ligament, the greater part of which is well visible externally, the foot with a bulbous distal portion not differentiated into two parts, and a different sculpture of the prodissoconch (Table 2). *Parathyasira coani* is also similar to *Parathyasira dearborni* (Nicol, 1965) in shell shape and ratios, as well as in the shape of the lunule and escutcheon, but differs by lacking microscopic irregular

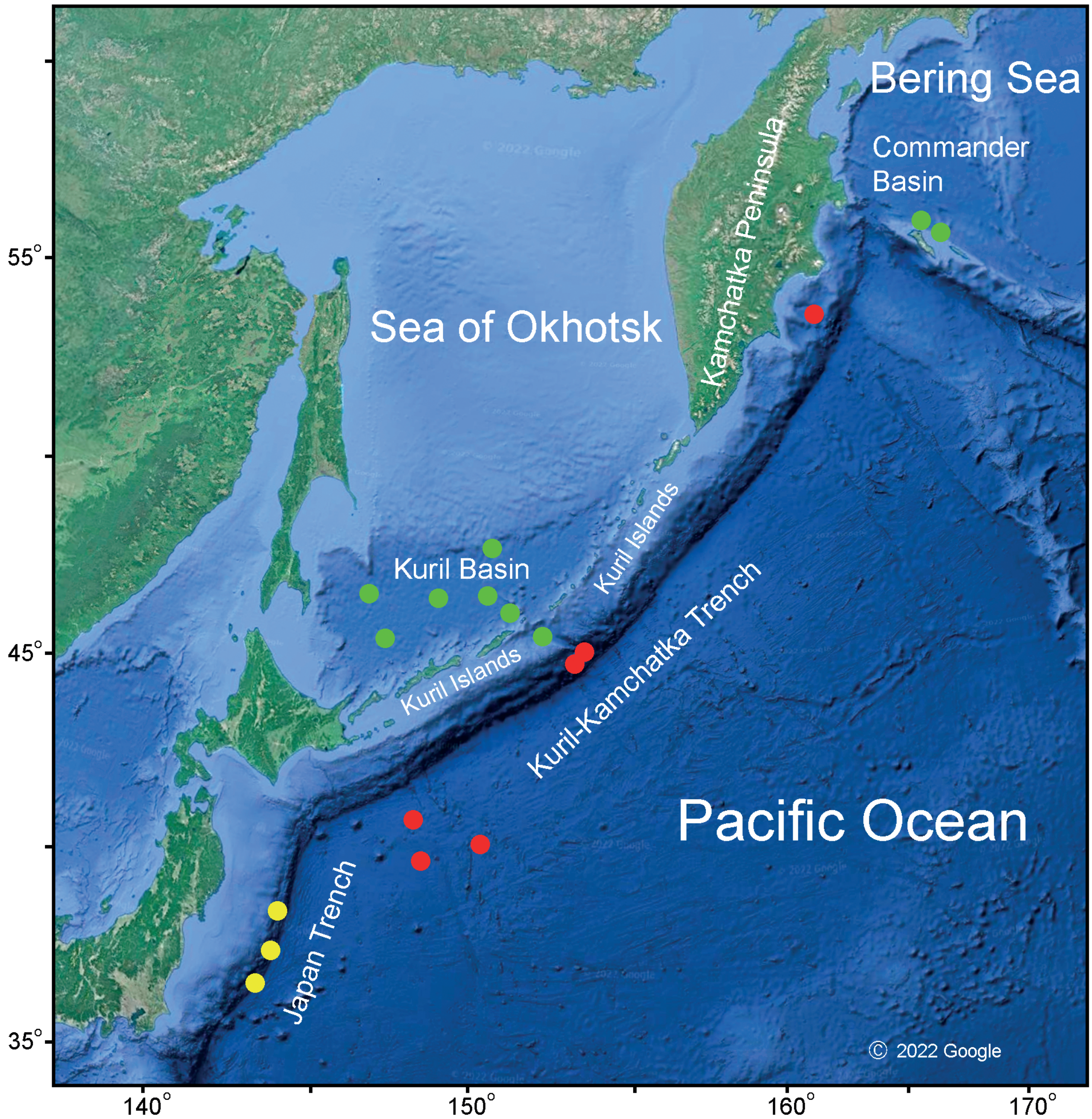

Fig. 6. The location of stations where the new species of Thyasiridae were found. *Parathyasira coani* sp. nov. (red spots); *Parathyasira pauli* sp. nov. (yellow spots); *Thyasira kharkovensis* sp. nov. (green spots). (Map data © 2022 Google).

corrugations and pustules on the shell and a second siphonal opening, by having a larger (more than 2 ×) prodissoconch with a different sculpture (Table 2), and the lateral body pouches with a greater number of folds.

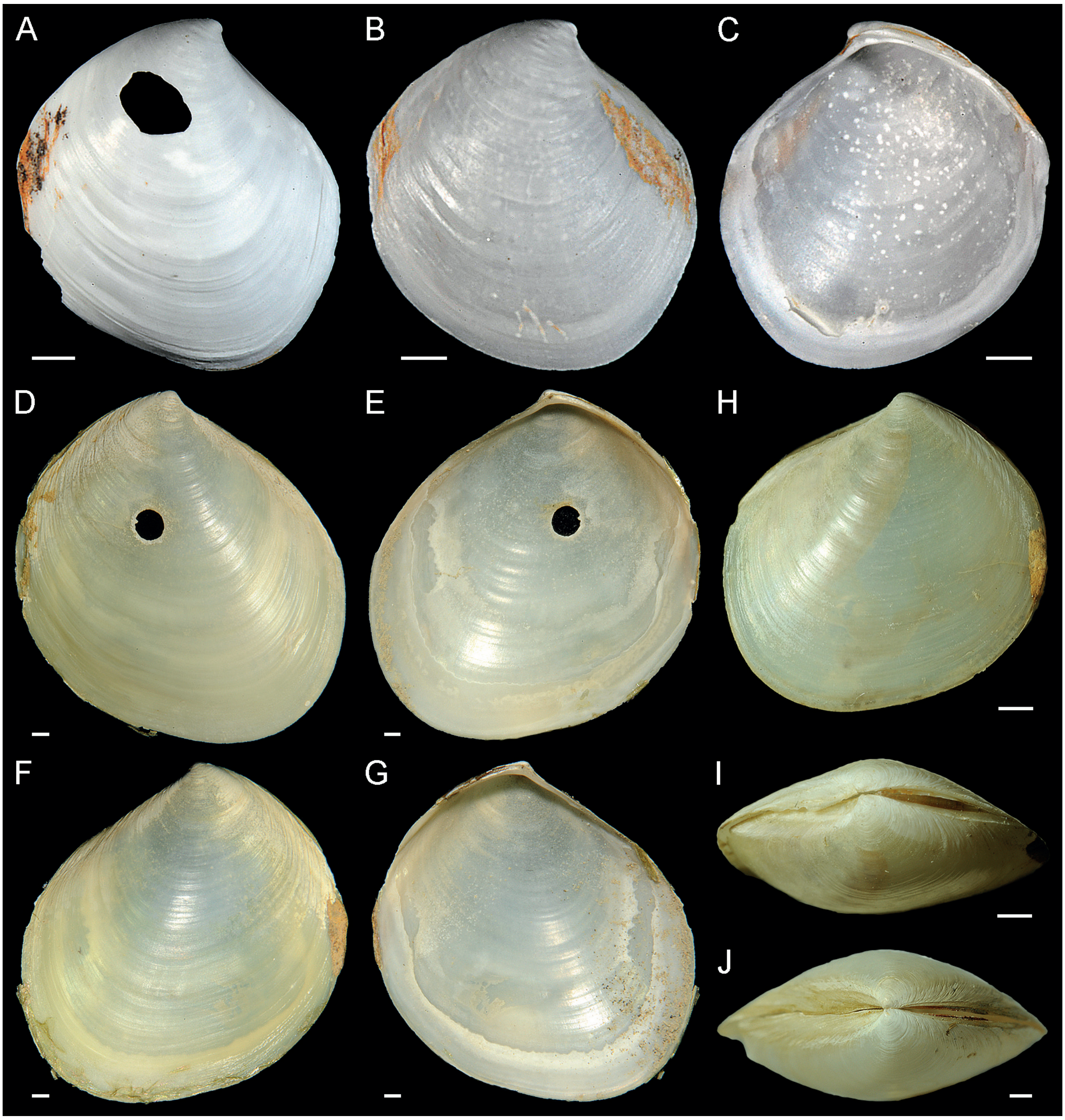

Fig. 7. A–C. *Parathyasira biscayensis* Payne & Allen, 1991. **D–J**. *Axinulus obliquus* Okutani, 1968. **A**. Holotype (MNHN-IM-38099), shell length 8.2 mm (photos by P. Maestrati (MNHN)). **B–C**. Paratype (MNHN-IM-38100), shell length 7.3 mm (photos by P. Maestrati (MNHN)). **D–G**. Holotype (NSMT Mo 69719), shell length 19.0 mm. **H–I**. Exterior and dorsal views of small specimen from the locality of the paratype (NSMT Mo 69720), shell length 10.0 mm (photos by Dr H. Saito (NSMT)). **J**. Dorsal view of paratype (NSMT Mo 69720), shell length 16.5 mm (photo by Dr H. Saito (NSMT)). Scale bars = 1 mm.

Remarks

To date, the benthic fauna of the Kuril-Kamchatka Trench is the most studied one, compared to other oceanic trenches (Belyaev 1989; Brandt *et al.* 2019, 2020), and the largest number of macrofaunal samples were collected with various sampling gears in its hadal zone. As a result of studying the entire material of bivalves collected in this trench (Kamenev 2019), *P. coani* sp. nov. was recorded only in two samples collected from the uppermost part of the trench slope at a depth of more than 6000 m. Outside of the Kuril-Kamchatka Trench, *P. coani* was found in many samples from the abyssal zone at depths less than 6000 m. Therefore, this species is probably a predominantly abyssal one and depths of slightly more than 6000 m are the lower limit of its vertical distribution. Apart from *P. coani*, seven bivalve species have a similar vertical distribution in the Kuril-Kamchatka Trench area (Kamenev 2019). As shown in the example of distribution of many macrofaunal species, depths of 6000–7000 m are a zone of transition between abyssal and hadal faunas and are the lower and upper boundaries of the vertical distribution of many abyssal and hadal macrofauna species, respectively (Belyaev 1989; Jamieson 2015; Kamenev 2019; Kamenev *et al.* 2022).

Parathyasira pauli sp. nov.
urn:lsid:zoobank.org:act:58D5A99F-1095-49BF-8A7E-F9E10B021422
Figs 6, 8–11, Table 3

Diagnosis

Shell medium in size (to 8.0 mm in length), rhomboidal, inflated, slightly drawn out anteriorly. Sculpture of closely spaced, commarginal ribs and conspicuous undulations. Shell surface microscopically pitted. Second posterior fold weak. Posterior sulcus indistinct. Escutcheon long, deep. Lunule long, strongly excavated, well defined. Ligament well visible externally, long. Prodissoconch large (to 260 µm), with 6 lamellated folds, extending from high and sharp apex. Lateral body pouches large, extensively lobed. Foot distally bulbous; bulbous tip not differentiated into two parts; heel absent.

Etymology

The species epithet honors Dr Paul Valentich-Scott, a well-known researcher of bivalves, who made an enormous contribution to the study of the bivalve fauna of the Pacific Ocean. His scientific works and personal assistance have been invaluably helpful in my studies of bivalves of the northwestern Pacific Ocean.

Material examined

Holotype

PACIFIC OCEAN – **Japan Trench** • 37°41.5′ N, 143°54.3′ E; depth 7370 m; 28 Jun. 1969; Z.A. Filatova leg.; Sigsbee trawl; RV Vityaz, cruise no. 45, stn. 6151; IORAS OBF collection Cat. BIV00039.

Paratypes

PACIFIC OCEAN • 1 spec.; same locality as for holotype; 37°38.9′ N, 143°58.3′ E; depth 7370–7350 m; 21–22 Jun. 1976; F.A. Pasternak leg.; Galathea trawl; RV Vityaz, cruise no. 59, stn. 7500; IORAS OBF collection Cat. BIV00040 • 1 spec.; same collection data as for preceding; MIMB 43823.

Other Material

PACIFIC OCEAN – **Japan Trench** • 1 spec.; 36°44′ N, 143°19′ E; depth 7540 m; 23 Jun. 1976; F.A. Pasternak leg.; Galathea trawl; RV Vityaz, cruise no. 59, stn. 7503; IORAS OBF collection Cat. BIV00042 • 11 specs; same locality as for preceding; 38°38′ N, 144°06′ E; depth 7500 m; 27 Jun. 1976; F.A. Pasternak leg.; Okean grab (0.25 m^2); RV Vityaz, cruise no. 59, stn. 7511; IORAS OBF collection Cat. BIV00041.

Table 3. *Parathyasira pauli* sp. nov., shell measurements (mm), indices and summary statistics of indices.

Depository	L	H	A	LL	EL	W	H/L	A/L	LL/L	EL/L	W/L
Holotype IORAS OBF collection Cat. BIV00039	7.6	8.2	2.9	4.0	5.3	4.8	1.08	0.38	0.53	0.70	0.63
IORAS OBF collection Cat. BIV00041.	5.0	5.1	1.8	1.8	3.4	2.6	1.02	0.36	0.36	0.68	0.52
IORAS OBF collection Cat. BIV00041	4.7	4.7	1.9	1.7	2.8	3.0	1.00	0.40	0.36	0.60	0.64
IORAS OBF collection Cat. BIV00041	4.5	4.5	2.0	2.0	2.8	2.4	1.00	0.44	0.44	0.62	0.53
IORAS OBF collection Cat. BIV00041	4.5	4.5	1.8	2.0	2.8	2.2	1.00	0.40	0.44	0.62	0.49
IORAS OBF collection Cat. BIV00041	4.5	4.5	1.8	2.0	2.8	2.4	1.00	0.40	0.44	0.62	0.53
IORAS OBF collection Cat. BIV00041	4.4	4.4	1.7	1.5	2.7	2.5	1.00	0.37	0.34	0.61	0.57
IORAS OBF collection Cat. BIV00041	4.2	4.4	1.7	1.2	2.3	2.2	1.05	0.41	0.27	0.55	0.52
IORAS OBF collection Cat. BIV00041	4.1	4.0	1.6	1.2	2.3	2.2	0.98	0.39	0.29	0.56	0.54
IORAS OBF collection Cat. BIV00041	4.0	3.9	1.6	1.7	2.4	–	0.98	0.40	0.43	0.60	–
IORAS OBF collection Cat. BIV00041	3.5	3.4	1.3	1.3	2.0	1.1	0.97	0.37	0.37	0.57	0.31
IORAS OBF collection Cat. BIV00041	3.3	3.3	1.4	1.4	2.0	1.3	1.00	0.42	0.42	0.61	0.39
IORAS OBF collection Cat. BIV00042	3.2	3.2	1.4	1.0	1.8	1.6	1.00	0.44	0.31	0.56	3.20
IORAS OBF collection Cat. BIV00041	2.5	2.4	1.2	0.9	1.5	1.0	0.96	0.48	0.36	0.60	0.40
IORAS OBF collection Cat. BIV00041	1.9	1.7	0.8	0.6	0.9	–	0.90	0.42	0.32	0.47	–
Statistics	**L**	**H**	**A**	**LL**	**EL**	**W**	**H/L**	**A/L**	**LL/L**	**EL/L**	**W/L**
Mean	–	–	–	–	–	–	0.99	0.41	0.38	0.60	0.51
SE	–	–	–	–	–	–	0.03	0.02	0.06	0.04	0.07
Min	–	–	–	–	–	–	0.90	0.36	0.29	0.47	0.31
Max	–	–	–	–	–	–	1.08	0.48	0.53	0.70	0.64

Description

SHELL. Medium in size (to 8.0 mm in length and 8.4 mm in height). Rhomboidal, equivalve, subequilateral, white, thick, inflated (W/L = 0.51 ± 0.07), nearly as long as high (H/L = 0.99 ± 0.03), slightly drawn out anteriorly; patches of silty and ferruginous deposit adhering to anterior and posterior shell margins

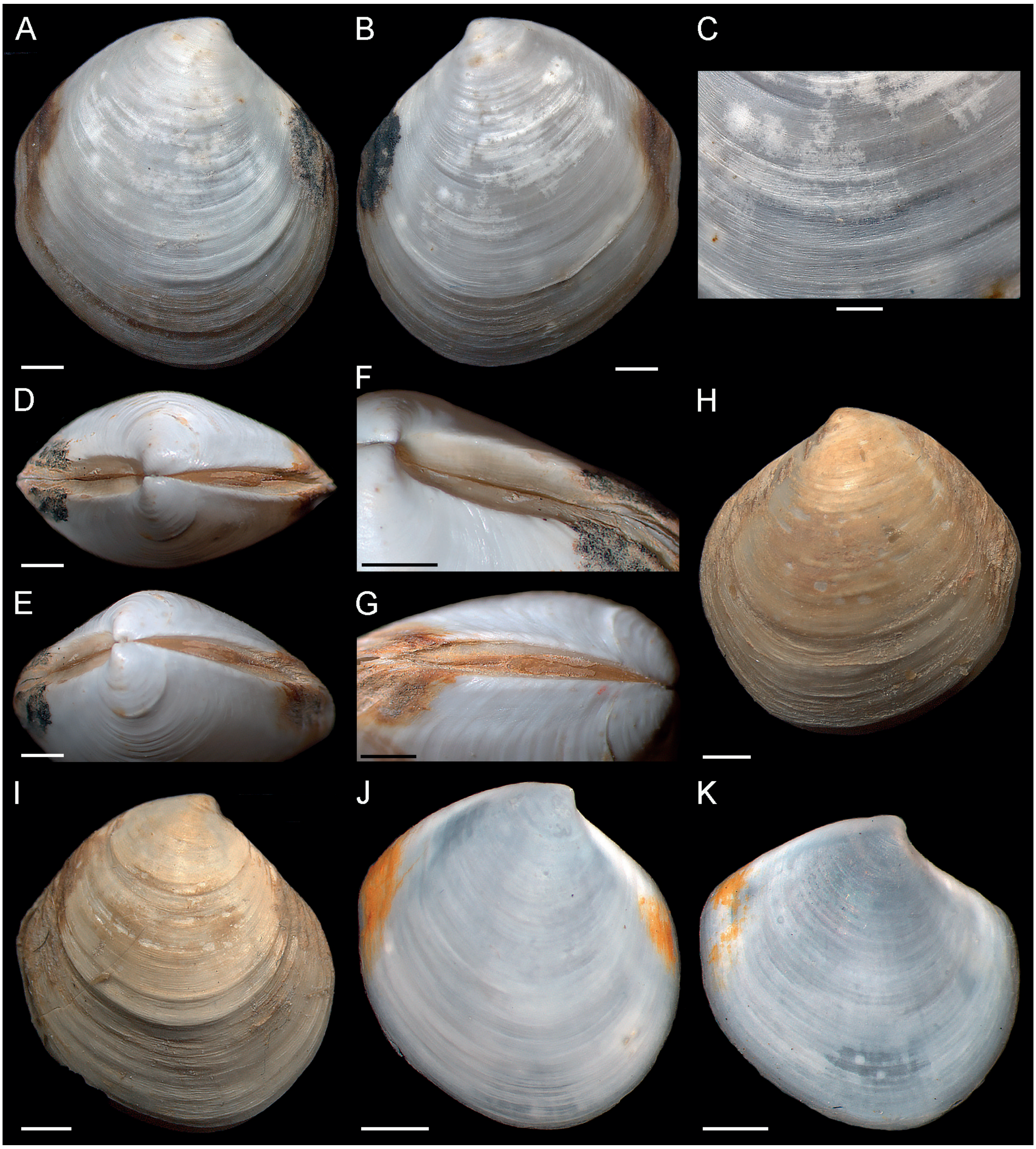

Fig. 8. *Parathyasira pauli* sp. nov. **A–G**. Holotype (IORAS OBF collection Cat. BIV00039), exterior and dorsal views of both valves, shell length 7.6 mm. **H**. Paratype (MIMB 43823), shell length 7.0 mm. **I**. Paratype (IORAS OBF collection Cat. BIV00040), shell length 6.5 mm. **J–K**. Variability of shell shape (IORAS OBF collection Cat. BIV00041). **J**. Shell length 4.9 mm. **K**. Shell length 3.8 mm. Scale bars: A–B, D–K = 1 mm; C = 500 µm.

(Fig. 8, Table 3). Periostracum thin, colorless, adherent. Dissoconch sculptured with closely spaced, thin, commarginal ribs and conspicuous, irregular undulations, more conspicuous near ventral margin (Figs 8C, 9A–B). Micro-sculpture of small (to 3 μm), shallow, closely spaced pits (Fig. 9C–D). Beaks small, raised, pointed, prosogyrate, anterior to midline (A/L = 0.41 ± 0.02) (Fig. 9B, Table 3). Anterodorsal shell margin long, straight, sloping rather steeply from beaks. Anterior shell margin curved, smoothly transitioning to ventral margin. Ventral margin strongly curved (Fig. 8H–K). Posterodorsal shell margin long, slightly convex, sloping steeply from beaks, forming distinct angle at transition to posterior margin. Posterior margin slightly concave, sometimes straight, smoothly transitioning to ventral margin. First posterior fold absent. Second posterior fold weak. Posterior sulcus weak, narrow and shallow. Escutcheon

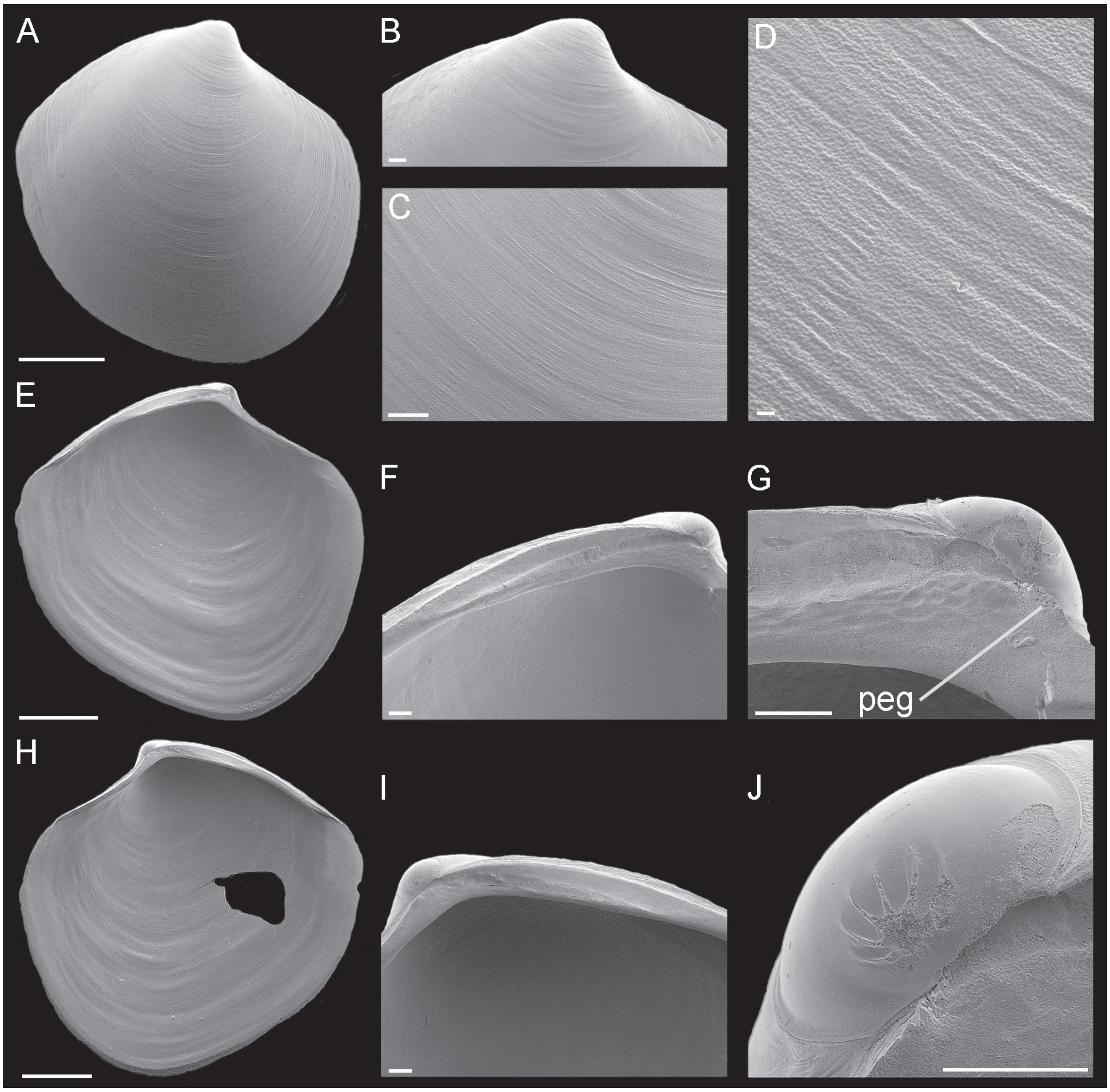

Fig. 9. Scanning electron micrographs of *Parathyasira pauli* sp. nov. (IORAS OBF collection Cat. BIV00041). **A**. Exterior view of right valve. **B**. Sculpture of beak region. **C–D**. Sculpture of central shell part. **E**. Interior view of left valve. **F**. Hinge plate of left valve. **G**. Pits under beak of left valve. **H**. Interior view of right valve. **I**. Hinge plate of right valve. **J**. Prodissoconch. Abbreviation: see Material and methods. Scale bars: A, E, H = 1 mm; B–C, F–G, I–J = 100 μm; D = 10 μm.

long (EL/L = 0.60 ± 0.04 (Table 3), narrow, deep, demarcated by rounded ridge (Figs 8D, G, 10D). Auricle absent. Lunule long (LL/L = 0.38 ± 0.06), wide, well defined, strongly excavated, demarcated by rounded, strong ridges (Figs 8D–F, 10A–C). Ligament opisthodetic, partly sunken in shallow, slightly curved groove close to margin of hinge plate, well visible externally along its almost entire length, thick, long about half the length of escutcheon (Figs 8D–E, 9F–I). Prodissoconch large (length 252–260 µm), well distinct, ovate in outline, convex, with 6 thin, narrow, lamellated folds, extending from high and sharp apex, located in mid-line of prodissoconch (Figs 9J, 10G–H). Hinge plate thick, edentulous, with small flattened peg beneath beak in each valve, and sometimes numerous, shallow, elongate pits (to 40 µm) beneath beak and ligamental groove (Fig. 9F–G). Muscle scars indistinct.

Gross anatomy. Mantle thin; edges unfused except limited interconnection at posterior ventral margin with small exhalant aperture below posterior adductor. Anterior adductor muscle elongate (Fig. 11). Posterior adductor muscle small, 2 × as small as anterior one, oval. Ctenidium thin, wide, composed of both inner and outer demibranchs with fully reflected filaments (up to 45 filaments in specimen 4.3 mm in length); outer demibranch is less than half size of inner demibranch. Labial palps relatively large (to 0.5 mm in length in specimen 4.3 mm long) with small zone of sorting ridges close to junction with ctenidium (Fig. 11C). Lateral body pouches large, extensively lobed; lobes short and thick, with rounded tips; each pouch connecting to body by large, rounded neck at base of stomach (Fig. 11B, E). Kidneys large, situated below hind gut, without granules (Fig. 11E–G). Oesophagus short; stomach large, strongly elongated; combined style sac and midgut strongly curved, lying over the stomach; hind gut running posteriorly dorsal to kidney and posterior adductor muscle (Fig. 11G). Foot long, vermiform, distally

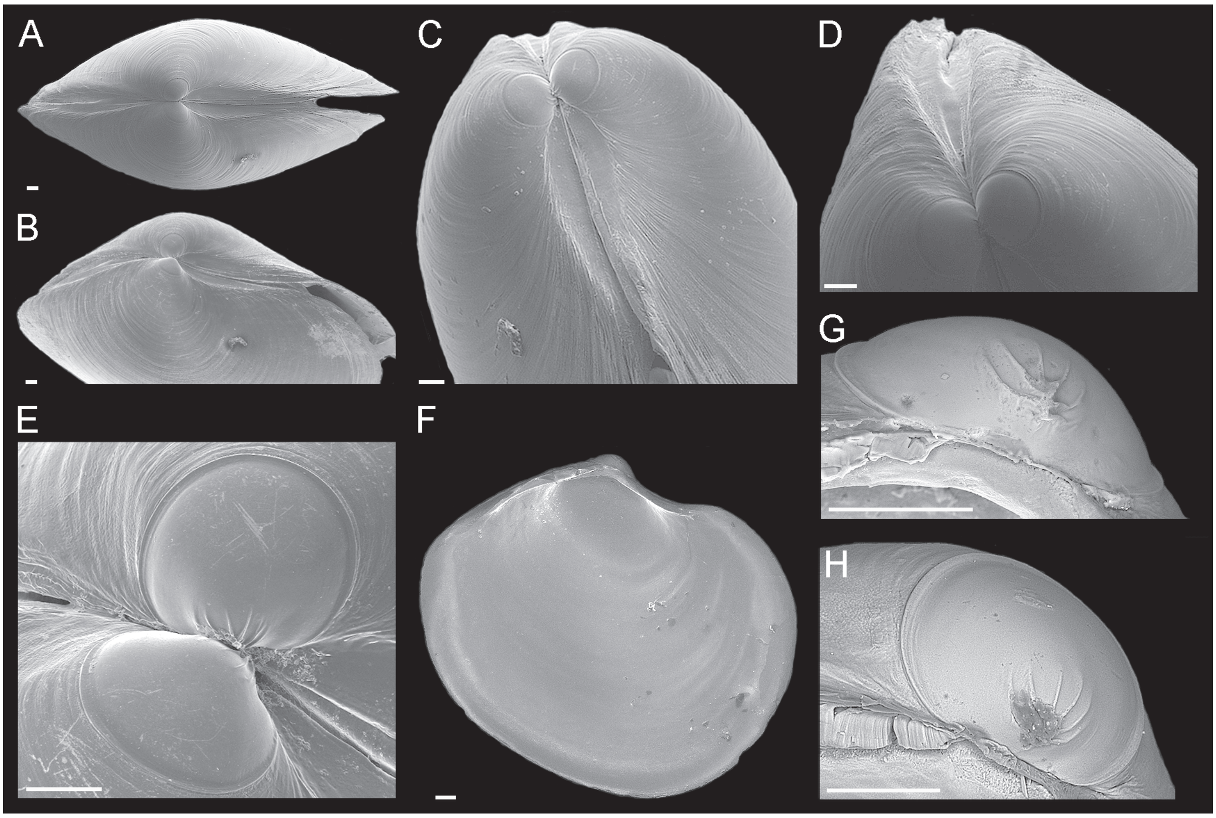

Fig. 10. Scanning electron micrographs of *Parathyasira pauli* sp. nov. (IORAS OBF collection Cat. BIV00041). **A–B**. Dorsal and oblique dorsal views of both valves. **C**. Lunule. **D**. Escutcheon. **E**. Prodissoconchs. **F**. Interior view of left valve of young specimen, shell length 1.3 mm. **G–H**. Prodissoconchs of different specimens. Scale bars = 100 µm.

bulbous, with muscular ring at junction with visceral mass. Bulbous tip not divided into two distinct parts; surface with numerous warts; heel absent (Fig. 11D). Anterior and posterior pedal retractors wide, short, well developed.

Variability

In small specimens (up to 4–5 mm in shell length) the shell is low, angulate with a strongly curved and anteriorly drawn-out ventral margin; the anterodorsal and posterodorsal margins are sloped gently from beaks; the anterodorsal margin is concave (Figs 8K, 9A, E, H). In larger specimens, the degree of obliqueness and relative length of the anterodorsal and posterodorsal shell margins vary (Fig. 8H–J).

Distribution and habitat

The Japan Trench (36°44′ N, 143°19′ E–38°38′ N, 144°06′ E), 7350–7540 m depth (Fig. 6).

Differential diagnosis

As was the case of *P. coani* sp. nov., this species differs from most species of *Parathyasira* in having an obliquely-rhomboidal shell with a long anterodorsal margin and a large prodissoconch with sculpture of lamellated folds (Table 2), and in lacking the dissoconch of calcareous spines. *Parathyasira pauli* sp. nov. is most similar to *P. coani* from which it differs in having a deeply excavated lunule, shorter

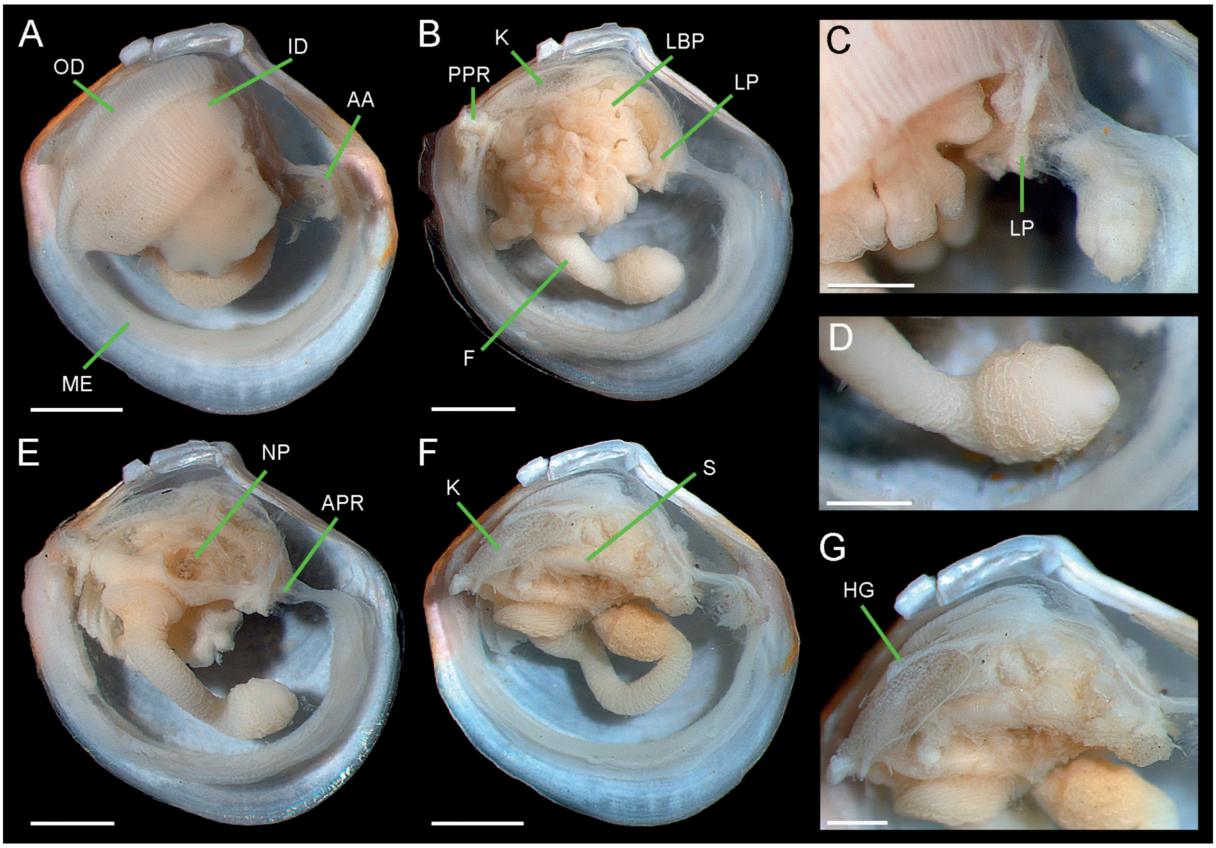

Fig. 11. *Parathyasira pauli* sp. nov. (IORAS OBF collection Cat. BIV00041). **A**. Gross anatomy after removal of right valve and mantle, shell length 4.3 mm. **B**. Gross anatomy after removal of right valve, mantle, ctenidium, and anterior adductor muscle, shell length 4.3 mm. **C**. Labial palps. **D**. Bulbous portion of foot. **E**. Gross anatomy after further removal of right lateral body pouch. **F–G**. Digestive system. Abbreviations: see Material and methods. Scale bars: A–B, E–F = 1 mm; C–D, G = 500 µm.

ligament, small flattened peg beneath beak at the hinge plate. In addition, the prodissoconch of *P. pauli* has six lamellated folds versus five lamellated folds in *P. coani* The new species is also similar to *P. dearborni*, from which it differs in having a strongly excavated lunule, a less distinct posterior sulcus, a twice as large prodissoconch with a different number and position of lamellated folds and in lacking corrugations and pustules in the dissoconch and a second siphonal opening (Table 2). Furthermore, *P. pauli* is similar to *P. biscayensis* (Fig. 7A–C) but differs from it in having a deeply excavated lunule. *Parathyasira pauli* differs from a large species (to 12.3 mm in length), *Parathyasira kaireiae* Okutani, Fujikura & Kojima, 1999, which was also found in the Japan Trench (depth of 5343–6390 m) (Okutani *et al.* 1999; Fujikura *et al.* 2002; Okutani & Fujikura 2002), in having a smaller and rhomboidal shell with a weak posterior sulcus and excavated lunule (Table 2).

Genus ***Thyasira*** Lamarck, 1818

Type species

Tellina flexuosa Montagu, 1803.

Thyasira kharkovensis sp. nov.
urn:lsid:zoobank.org:act:5E4F1FDC-5A7D-47BA-9FE5-B1F700D80C60
Figs 6, 12–16, Table 4

Parathyasira sp. 1 – Kamenev 2018a: 234.

Diagnosis

Shell small (to 7.4 mm in length), obliquely pyriform, transparent, flattened, drawn out anteriorly. Sculpture of thin, commarginal riblets and weak undulations. Posterior folds weak. Posterior sulcus weak, as a flattened, narrow area. Escutcheon long, shallow. Auricle low. Lunule short, flat, weakly defined. Ligament partially visible externally, long. Prodissoconch large (to 200 µm), with 7 thin, lamellated folds, radiating from short, plicate ridge. Lateral body pouches large, extensively lobed. Foot long, distally bulbous; bulbous portion not divided into two parts; heel distinct.

Etymology

The species epithet honors the city of Kharkov, where I was born, grew up, and was educated.

Material examined

Holotype

RUSSIA • Sea of Okhotsk, Kuril Basin floor; 48°02.512′ N, 149°59.911′ E–48°02.353′ N, 149°59.805′ E; depth 3350 m; 21 Jul. 2015; K.V. Minin leg.; Agassiz trawl, RV Akademik M.A. Lavrentyev, cruise no. 250, stn. 6-9; MIMB 43824.

Paratypes

RUSSIA • 2 specs; same collection data as for holotype; MIMB 43825 • 2 specs; same collection data as for holotype; SMF 367802.

Other material

RUSSIA – **Bering Sea** • 6 specs; 55°13.2′ N, 167°29.07′ E–55°12′ N, 167°26.7′E; depth 3957 m; 31 Jul. 1990; L.I. Moskalev and S.V. Galkin leg.; Sigsbee trawl, RV Akademik Mstislav Keldysh, cruise no. 22, stn. 2309; IORAS OBF collection Cat. BIV00045 • 6 specs; same locality as for preceding; 55°36.1′ N, 167°23.04′ E–55°35′ N, 167°24.5′E; depth 4294 m; 5 Aug. 1990; L.I. Moskalev and S.V. Galkin leg.; Sigsbee trawl, RV Akademik Mstislav Keldysh, cruise no. 22, stn. 2316; IORAS OBF collection Cat. BIV00046 – **Sea of Okhotsk** • 1 spec.; 46°08.745′ N, 145°59.760′ E; depth 3304 m;

9 Jul. 2015; G.M. Kamenev leg.; box corer, RV Akademik Mstislav Keldysh, cruise no. 71, stn. 1-3; MIMB 43826 • 2 specs; same locality as for preceding; 46°08.875′ N, 145°59.336′ E–46°08.839′ N, 145°59.165′ E; depth 3307 m; 10 Jul. 2015; A. Brandt leg.; epibenthic sledge, RV Akademik Mstislav Keldysh, cruise no. 71, stn. 1-8; MIMB 43827 • 3 specs; same locality as for preceding; 46°09.037′ N, 146°00.465′ E–46°09.020′ N, 146°00.269′ E; depth 3307 m; 10 Jul. 2015; A. Brandt leg.; epibenthic sledge, RV Akademik Mstislav Keldysh, cruise no. 71, stn. 1-9; MIMB 43828 • 7 specs; same locality as for preceding; 46°40.961′ N, 147°28.283′ E–46°40.877′ N, 147°28.499′ E; depth 3353–3352 m; 13 Jul. 2015; A. Brandt leg.; epibenthic sledge, RV Akademik Mstislav Keldysh, cruise no. 71, stn. 2-7; MIMB 43829 • 2 specs; same locality as for preceding; 47°12.046′ N, 149°36.901′ E; depth 3366 m; 16 Jul. 2015; G.M. Kamenev leg.; box corer, RV Akademik Mstislav Keldysh, cruise no. 71, stn. 4-4; MIMB 43830 • 5 specs; same locality as for preceding; 47°12.132′ N, 149°37.136′ E–47°11.991′ N, 149°36.990′ E; depth 3366 m; 17 Jul. 2015; A. Brandt leg.; epibenthic sledge, RV Akademik Mstislav Keldysh, cruise no. 71, stn. 4-9; MIMB 43831 • 4 specs; same locality as for preceding; 47°12.039′ N, 149°36.950′ E–47°12.177′ N, 149°36.726′ E; depth 3366 m; A. Brandt leg.; epibenthic sledge, RV Akademik Mstislav Keldysh, cruise no. 71, stn. 4–10; 17 Jul. 2015; MIMB 43832 • 1 spec.; same locality as for preceding; 48°03.258′ N, 150°00.581′ E–48°03.141′ N, 150°00.432′ E; depth 3347 m; 20 Jul. 2015; A. Brandt leg.; epibenthic sledge, RV Akademik Mstislav Keldysh, cruise no. 71, stn. 6-6; MIMB 43833 • 1 spec.; same locality as for preceding; 48°03.234′ N, 150°00.468′ E–48°03.078′ N, 150°00.351′ E; depth 3350–3351 m; 21 Jul. 2015; A. Brandt leg.; epibenthic sledge, RV Akademik Mstislav Keldysh, cruise no. 71, stn. 6-7; MIMB 43834 • 5 specs; same locality as for preceding; 48°02.512′ N, 149°59.911′ E–48°02.353′ N, 149°59.805′ E; depth 3350 m; 21 Jul. 2015; K.V. Minin leg.;

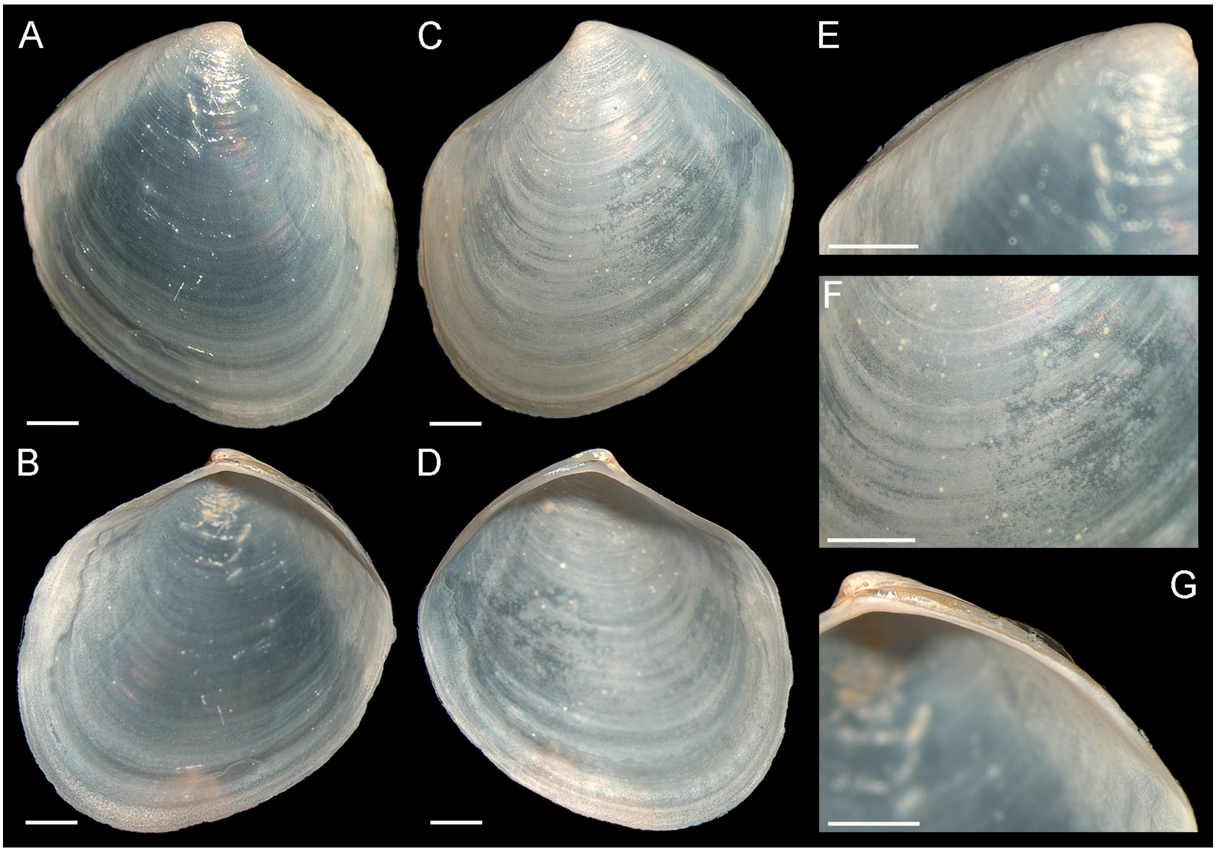

Fig. 12. *Thyasira kharkovensis* sp. nov., holotype (MIMB 43824). **A–D**. Exterior and interior views of both valves, shell length 7.4 mm. **E**. Auricle. **F**. Sculpture of central part, left valve. **G**. Hinge plate and ligament, right valve. Scale bars = 1 mm.

Agassiz trawl, RV Akademik Mstislav Keldysh, cruise no. 71, stn. 6-9; MIMB 43835 • 2 specs; same locality as for preceding; 46°56.952′ N, 151°04.975′ E; depth 3300 m; 21 Jul. 2015; G.M. Kamenev leg.; box corer, RV Akademik Mstislav Keldysh, cruise no. 71, stn. 7-1; MIMB 43836 • 7 specs; same locality as for preceding; 46°56.556′ N, 151°05.013′ E–46°56.753′ N, 151°05.017′ E; depth 3299 m; 22 Jul. 2015; A. Brandt leg.; epibenthic sledge, RV Akademik Mstislav Keldysh, cruise no. 71, stn. 7-3; MIMB 43837 • 3 specs; same locality as for preceding; 46°57.466′ N, 151°05.068′ E–46°57.326′ N, 151°05.050′ E; depth 3300 m; 22 Jul. 2015; A. Brandt leg.; epibenthic sledge, RV Akademik Mstislav Keldysh, cruise no. 71, stn. 7–4; MIMB 43838 • 6 specs; same locality as for preceding; 45°36.792′ N, 146°22.589′ E–45°36.902′ N, 146°22.484′ E; depth 3210 m; 1 Aug. 2015; A. Brandt leg.; epibenthic sledge, RV Akademik Mstislav Keldysh, cruise no. 71, stn. 11-6; MIMB 43839.

PACIFIC OCEAN – **oceanic slope of the Kuril Islands** • 2 specs; 46°16.082′ N, 152°02.060′ E; depth 3432 m; 27 Jul. 2015; G.M. Kamenev leg.; box corer, RV Akademik Mstislav Keldysh, cruise no. 71, stn. 9-1; MIMB 43840.

Description

Shell. Small (to 7.4 mm in length and 7.6 mm in height), obliquely-ovate to obliquely pyriform, equivalve, subequilateral, grayish white, very thin, fragile, translucent, flattened (W/L = 0.48 ± 0.04), slightly longer than high (H/L = 0.98 ± 0.03), drawn out anteriorly; small quantities of ferruginous deposit may adhere to anterodorsal shell margin (Figs 12–13, Table 4). Periostracum thin, transparent, adherent. Sculpture of

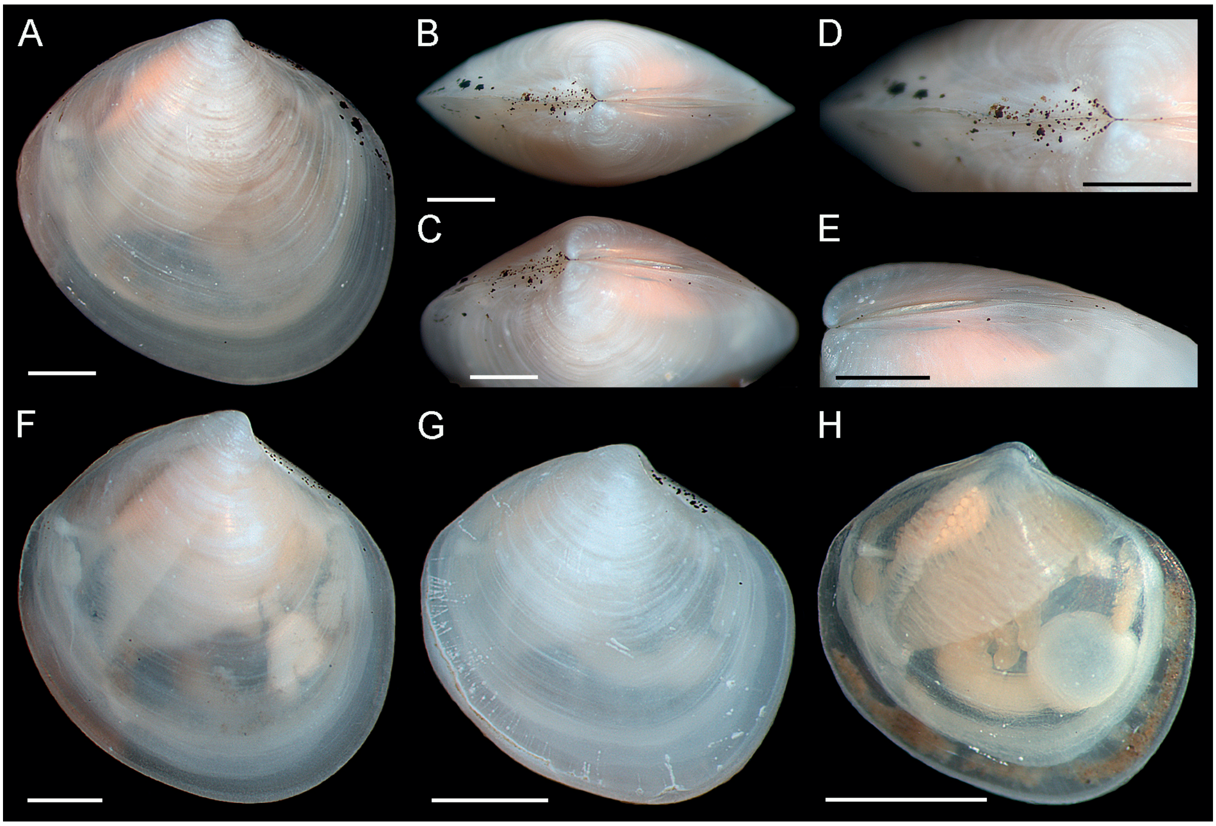

Fig. 13. *Thyasira kharkovensis* sp. nov. **A–E**. Paratype (MIMB 43825), exterior of right valve and dorsal views of both valves, shell length 5.5 mm. **D**. Lunule. **E**. Escutcheon with auricle. **F**. Paratype (MIMB 43825), shell length 5.2 mm. **G–H**. Variability of shell shape. **G**. Shell length 3.3 mm (MIMB 43835). **H**. Shell length 2.3 mm (MIMB 43832). Scale bars = 1 mm.

Table 4. *Thyasira kharkovensis* sp. nov., shell measurements (mm), indices and summary statistics of indices.

Depository	L	H	A	LL	EL	W	H/L	A/L	LL/L	EL/L	W/L
Holotype MIMB 43824	7.4	7.6	3.3	3.1	4.5	4.0	1.03	0.45	0.42	0.61	0.54
Paratype SMF 367802	6.1	6.0	2.6	3.3	2.0	3.5	0.98	0.43	0.54	0.33	0.57
Paratype MIMB 43825	5.5	5.4	2.6	1.7	3.2	1.7	0.98	0.47	0.31	0.58	0.31
Paratype MIMB 43825	5.2	5.4	2.2	1.8	3.1	2.5	1.04	0.42	0.35	0.60	0.48
Paratype SMF 367802	5.0	5.1	2.3	1.6	2.8	2.4	1.02	0.46	0.32	0.56	0.48
MIMB 43832	5.2	5.2	2.0	1.5	3.0	2.9	1.00	0.39	0.29	0.58	0.56
MIMB 43831	5.0	4.9	2.2	1.5	2.8	2.3	0.98	0.44	0.30	0.56	0.46
MIMB 43835	4.7	4.7	2.0	1.7	2.6	2.2	1.00	0.43	0.36	0.55	0.47
MIMB 43827	4.7	4.7	1.9	1.6	2.8	2.3	1.00	0.40	0.34	0.60	0.49
MIMB 43832	4.6	4.6	2.0	2.3	1.5	2.6	1.00	0.44	0.50	0.33	0.57
MIMB 43836	4.2	4.2	1.8	1.2	2.6	2.2	1.00	0.43	0.29	0.62	0.52
MIMB 43836	4.2	4.2	1.8	1.2	2.6	2.2	1.00	0.43	0.29	0.62	0.52
MIMB 43830	4.0	3.9	1.8	1.3	2.2	2.0	0.98	0.45	0.33	0.55	0.50
MIMB 43831	3.9	3.8	1.8	1.3	2.3	1.8	0.97	0.46	0.33	0.59	0.46
MIMB 43830	3.8	3.7	1.7	1.3	2.2	1.8	0.97	0.45	0.34	0.58	0.47
MIMB 43835	3.7	3.7	1.5	1.4	2.2	1.6	1.00	0.41	0.38	0.60	0.43
MIMB 43835	3.3	3.1	1.5	1.2	1.8	1.5	0.94	0.46	0.36	0.55	0.46
MIMB 43835	2.6	2.4	1.1	0.9	1.4	1.2	0.92	0.42	0.35	0.54	0.46
MIMB 43832	2.3	2.2	1.2	0.6	1.2	1.1	0.96	0.52	0.26	0.52	0.48
MIMB 43832	2.3	2.2	1.2	0.6	1.1	1.0	0.96	0.52	0.26	0.48	0.44
MIMB 43831	1.9	1.6	1.0	0.5	0.9	0.8	0.84	0.53	0.26	0.47	0.42
Statistics	**L**	**H**	**A**	**LL**	**EL**	**W**	**H/L**	**A/L**	**LL/L**	**EL/L**	**W/L**
Mean	–	–	–	–	–	–	0.98	0.45	0.34	0.54	0.48
SE	–	–	–	–	–	–	0.03	0.03	0.05	0.05	0.04
Min	–	–	–	–	–	–	0.84	0.39	0.26	0.33	0.31
Max	–	–	–	–	–	–	1.04	0.53	0.54	0.62	0.57

thin, commarginal riblets and weak, narrow, irregular undulations (Fig. 12F). Central part of shell with microscopic (to 3 µm), irregular, densely spaced granules (Fig. 14C–D). Beaks small, raised, pointed, prosogyrate, slightly anterior to midline (A/L = 0.45 ± 0.03). Anterodorsal shell margin straight, sloping rather steeply from beaks, smoothly transitioning to anterior margin. Anterior shell margin slightly convex, smoothly transitioning to ventral margin. Ventral margin strongly curved. Posterodorsal shell margin slightly convex, sloping rather steeply from beaks, forming weak, rounded angle at transition to posterior margin. Posterior shell margin straight or slightly convex, smoothly transitioning to ventral margin. Posterior folds weak. Posterior sulcus weak, shallow, as flattened, narrow area. Escutcheon long (EL/L = 0.54 ± 0.05), narrow, shallow, demarcated by low ridges (Figs 13B–C, E, 15A–D). Auricle weak, low, only slightly projecting (Figs 14E, 15C–D). Lunule relatively short (LL/L = 0.34 ± 0.05), flat (Fig. 13B–D). Ligament opisthodetic, visible externally for more than half of its length, thin, almost as long as entire length of escutcheon, lying in shallow, almost straight, narrow groove in hinge plate

(Fig. 14F–I). Prodissoconch large (length 189–200 µm), distinctly separated from dissoconch, ovate in outline, with 7 thin, lamellated folds (posterior fold sometimes bifurcated, central fold sometimes indistinct), radiating from a short, higher and wider, plicate ridge, located in mid-line of prodissoconch (Fig. 15E–F). Hinge plate thin, edentulous, sometimes with numerous, shallow, elongate pits (to 50 µm) beneath beak and ligamental groove (Fig. 14J). Muscle scars indistinct.

Gross anatomy. Mantle thin, transparent; mantle edge free except at junction with gill axis (Fig. 16). Anterior adductor muscle large, strongly elongated, curved almost parallel to anterior shell margin. Posterior adductor muscle 3 × as short as anterior, oval. Ctenidium thin, wide, both demibranchs with fully reflected filaments (up to 60 filaments in specimen 5.2 mm in length); outer demibranch about half depth of inner demibranch (Fig. 16A, D–E). Labial palps relatively large (to 0.8 mm in length) (Fig. 16B). Lateral body pouches large, extensively lobed; numerous lobes thick, cloven or single;

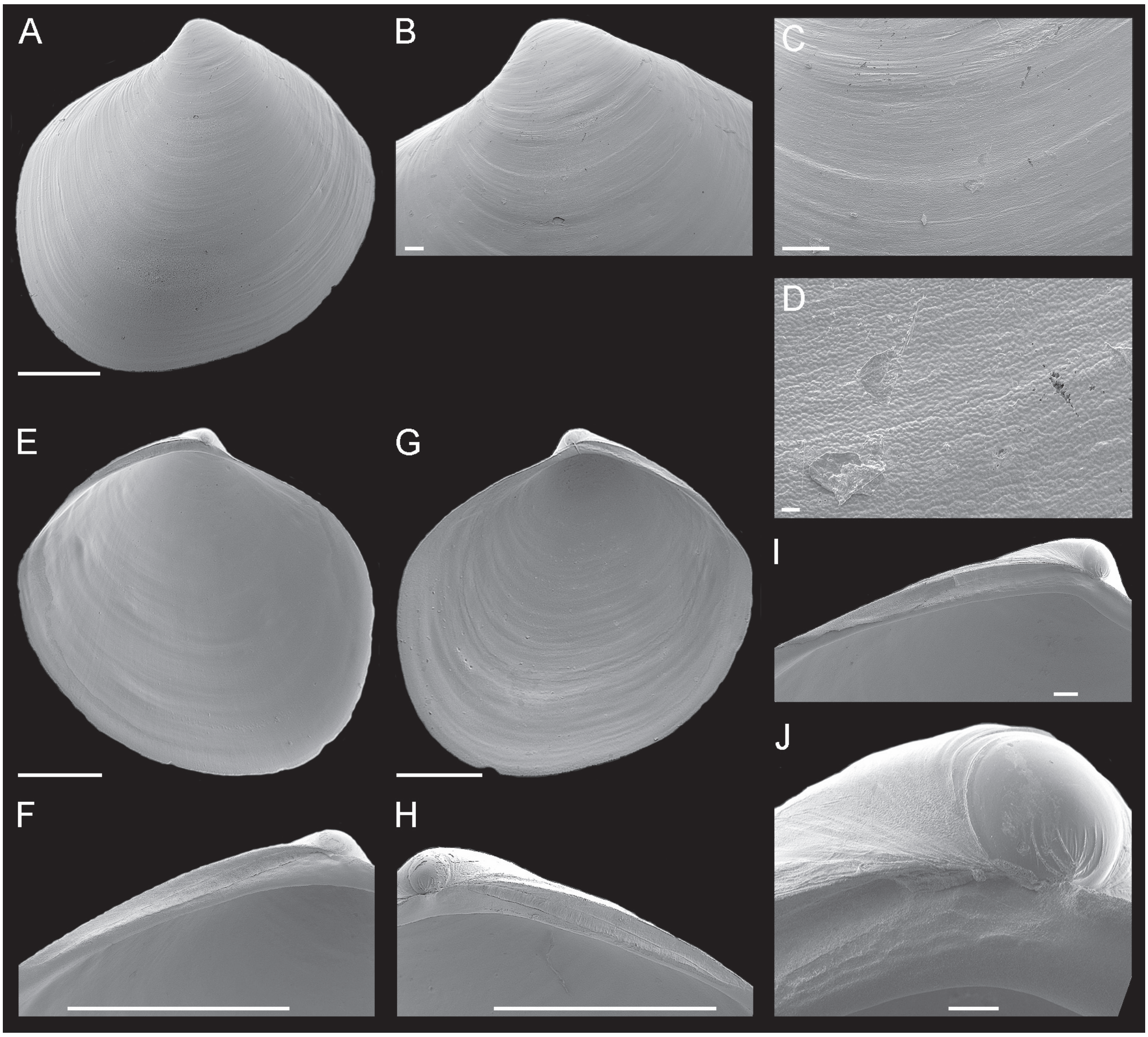

Fig. 14. Scanning electron micrographs of *Thyasira kharkovensis* sp. nov. (MIMB 43836). **A**. Exterior view of left valve. **B**. Sculpture of beak region. **C–D**. Sculpture of central shell part. **E**. Interior view of left valve. **F**. Hinge plate of left valve. **G**. Interior view of right valve. **H**. Hinge plate of right valve. **I**. Hinge plate of right valve with pits. **J**. Pits under beak of left valve. Scale bars: A, E–H = 1 mm; B–D, I = 100 µm; J = 50 µm.

each pouch connecting to body by a wide neck (Fig. 16D–E). Kidneys extremely large, dorsoventrally elongated along entire posterodorsal shell margin, with numerous, pink or orange, large (to 100 µm in diameter), different-size granules well visible through transparent shell (Figs 14, 16D–H). Oesophagus short; stomach large, strongly elongated; combined style sac and midgut strongly curved, lies over stomach; hind gut forming anterior loop dorsal to style sac, running posteriorly dorsal to kidney and posterior adductor muscle. Food remains present in hindgut (Fig. 16G–H). Foot long, vermiform, distally bulbous, with muscular ring at junction with visceral mass. Bulbous tip not divided into two parts; surface with numerous, longitudinal, curved gathers; heel small (Fig. 16C, E). Anterior and posterior pedal retractors wide, long, well developed.

Variability

In small specimens (up to 5 mm in shell length), the shell is relatively low, angulate, with a strongly curved and anteriorly drawn-out ventral margin, and weakly defined lunule with valve margin junction raised; anterodorsal and posterodorsal margins are sloped more gently from beaks (Fig. 13G–H). In larger specimens, the shell shape and proportions do not vary.

Distribution and habitat

Kuril Basin floor (Sea of Okhotsk) (45°36.792′ N, 146°22.589′ E–48°03.258′ N, 150°00.581′ E), 3210–3366 m depth (bottom temperature (1 m above bottom) 1.85–1.88°C, salinity 34.6%, oxygen 1.73–1.87 ml. l^{-1}) (Kamenev 2018; Kamenev *et al.* 2022), Commander Basin floor (Bering Sea) (55°12′ N, 167°26.7′ E–55°36.1′ N, 167°23.04′ E), 3957–4294 m depth, and oceanic slope of the Kuril Islands opposite the Bussol Strait (46°16.082′ N, 152°02.060′ E), 3432 m depth (Fig. 6).

Differential diagnosis

The new species described herein differs from the vast majority of species of *Thyasira* in having an obliquely-pyriform, anteriorly drawn-out, non-sulcate shell, with very narrow, indistinct posterior folds, large prodissoconch with thin, lamellated folds, strongly elongated, narrow adductor muscles,

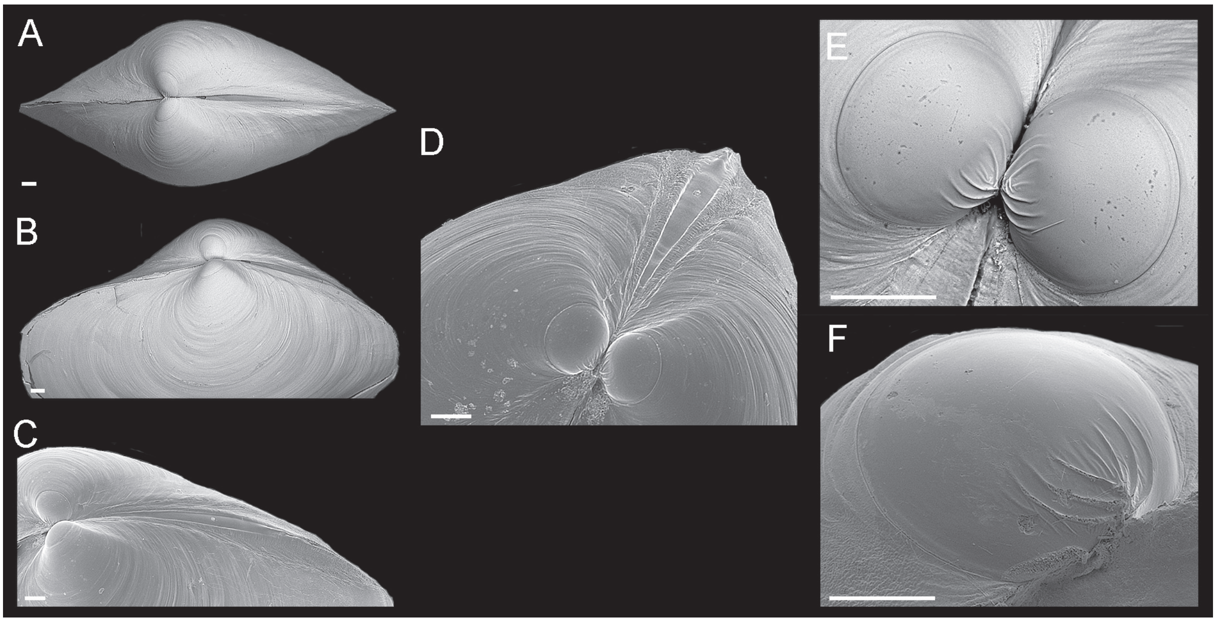

Fig. 15. Scanning electron micrographs of *Thyasira kharkovensis* sp. nov. **A–B**. Dorsal and oblique dorsal views of both valves (MIMB 43835). **C–D**. Escutcheon with auricle (MIMB 43835). **E**. Prodissoconchs. (MIMB 43835). **F**. Prodissoconch (MIMB 43826). Scale bars = 100 µm.

and a heel of foot. *Thyasira kharkovensis* sp. nov. is most similar in shell shape to *Axinulus obliquus* Okutani, 1968 (Fig. 7D–J) clearly differing in having a narrower escutcheon and thinner ligament, a shorter, indistinct and non-excavated lunule. *Axinulus obliquus* was described as *Axinulus obliqua* Okutani, 1968 following only examination of the morphology of the shell (Okutani 1968). The main character that distinguishes *Axinulus* from most genera in the family Thyasiridae is the presence of a single demibranch in the ctenidium (Oliver & Killeen 2002; Zelaya 2010; Oliver 2015; Kamenev 2020).

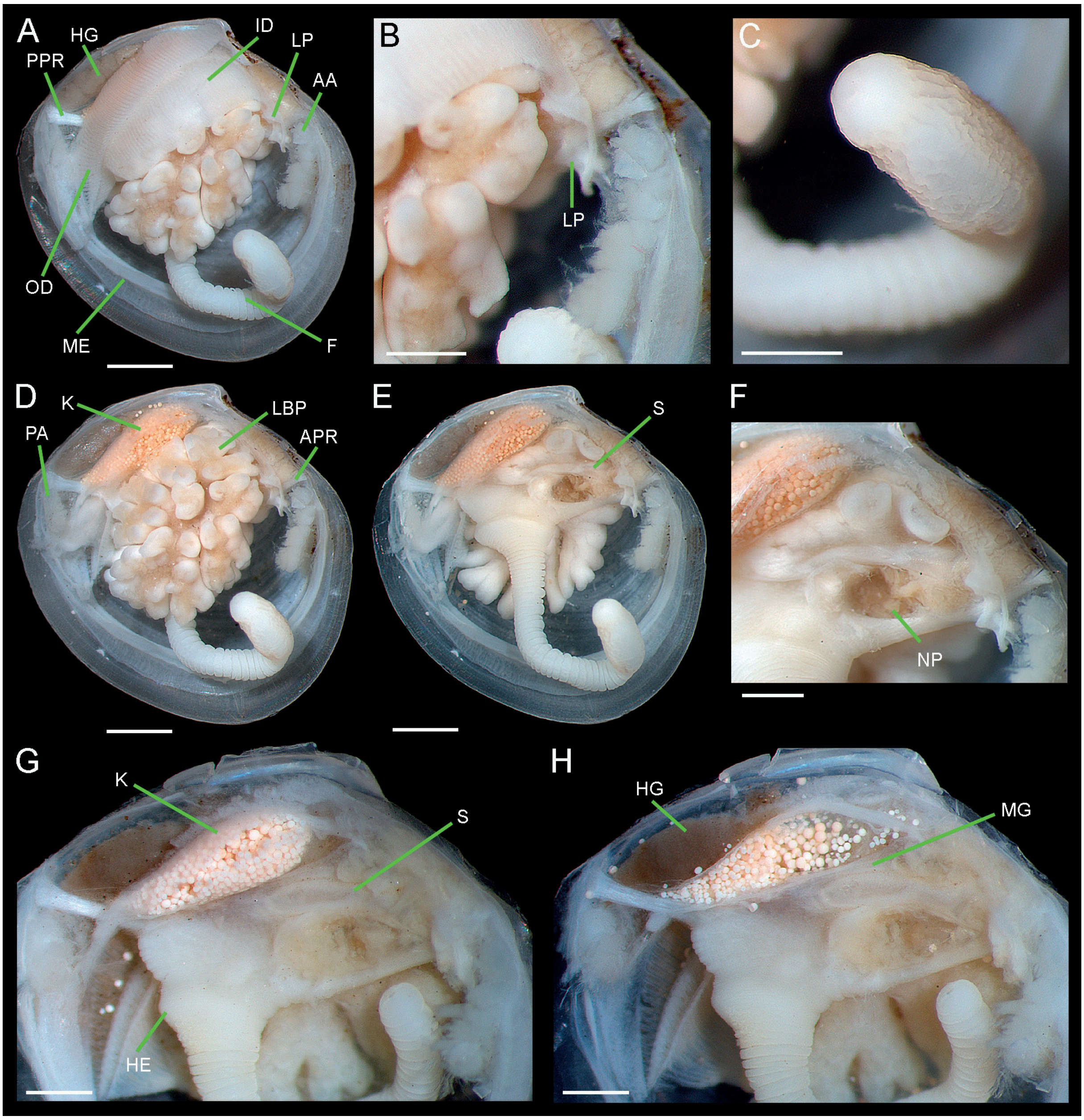

Fig. 16. *Thyasira kharkovensis* sp. nov. **A**. Gross anatomy after removal of right valve and mantle, shell length 5.2 mm (MIMB 43830). **B**. Labial palps (MIMB 43830). **C**. Bulbous portion of foot (MIMB 43830). **D**. Gross anatomy after further removal of right ctenidium (MIMB 43830). **E–F**. Gross anatomy after further removal of right lateral body pouch (MIMB 43830). **G–H**. Digestive system, shell length 4.5 mm (MIMB 43826). Abbreviations: see Material and methods. Scale bars: A, D–E = 1 mm; B–C, F–H = 500 µm.

I assumed that very probably the ctenidium of this species consists of two demibranchs, and after further anatomical investigation *A. obliquus* could be placed in the genus *Thyasira* (Kamenev 2020). Based on my assumption, *A. obliquus* was listed in the WoRMS Editorial Board (2022) under the name of *Thyasira obliqua* (Okutani, 1968). On the other hand, the WoRMS Editorial Board (2022) classifies the status of *A. obliquus* as a "taxon inquirendum". Unfortunately, it is currently not possible to examine the gills of *A. obliquus*, because only dry material is deposited at the NSMT (Dr Hiroshi Saito, pers. comm.). Therefore, the species still falls under the category of a taxon of uncertain taxonomic validity.

Thyasira kharkovensis sp. nov. resembles *T. obsoleta* (Verrill & Bush, 1898), *T. succisa* (Jeffreys, 1876), and *T. debilis* (Thiele, 1912), from which it differs in having a more flattened, thin and fragile shell, a longer escutcheon, a lower auricle, a longer well-visible externally ligament, and a much larger prodissoconch (the prodissoconch length of *T. obsoleta, T. succisa,* and *T. debilis* does not exceed 165 µm) (Payne & Allen 1991; Oliver & Killeen 2002; Zelaya 2009) with lamellated folds. In addition, the new species described herein lacks the pseudocardinal tubercle in the right valve described for *T. succisa* and *T. debilis* (Payne & Allen 1991; Oliver & Killeen 2002; Zelaya 2009). On the whole, because of its obliquely pyriform, non-sulcate shell with narrow, indistinct posterior folds *T. kharkovensis* sp. nov. does not correspond to the diagnosis of the genus *Thyasira*. Consequently, *T. kharkovensis* is assigned to *Thyasira* sensu lato.

Remarks

Thyasira kharkovensis sp. nov. was recorded in the Sea of Okhotsk and on the oceanic slope of the Kuril Islands at 9 of 10 stations at depths less than 4000 m. However, this species was not found any of the 24 stations conducted in the Kuril-Kamchatka Trench area by the KuramBio (2012), SokhoBio (2015) and KuramBio II (2016) expeditions at depths greater than 5000 m (Kamenev 2015, 2018a, 2019). Probably, *T. kharkovensis* sp. nov. does not occur at depths greater than 5000 m, preferring the upper abyssal zone. Previous studies showed that the deep-sea benthic fauna of the Sea of Okhotsk is closely related to the western Pacific fauna. Many species from various groups of animals that were discovered on the Kuril Basin floor (Sea of Okhotsk) were also found at the Pacific side of the Kuril Islands (e.g., Alalykina 2018, Downey *et al.* 2018; Fukumori *et al.* 2018; Kamenev 2018a; Malyutina & Brandt 2018; Mironov *et al.* 2018; Ostermair *et al.* 2018). A number of studies showed that the deep-sea Pacific fauna mainly penetrates into the Sea of Okhotsk through the deep straits of the Kuril Islands, primarily through the wide and deepest Bussol Strait (depth of 2318 m) (Ushakov 1953; Savilov 1961; Kamenev 2018a; Mironov *et al.* 2018). Most of deep-sea bivalve species from the Sea of Okhotsk were found in the Pacific Ocean to depths of 4000 m (Kamenev 2018a; Kamenev *et al.* 2022). In the Pacific Ocean, at depths greater than 5000 m, only two out of 25 species found in the abyssal zone of the Sea of Okhotsk were recorded (Kamenev 2018a, 2019). Perhaps, *T. kharkovensis* lives in the upper abyssal zone on the oceanic slopes of the Kuril Islands and the Kamchatka Peninsula. It also penetrated into the Bering Sea through the wide and deep Kamchatka Strait (depths of more than 4000 m) and was found on the floor of the Commander Basin located opposite the Kamchatka Strait. The Bering Sea has three deep-water basins (Commander, Bowers, and Aleutian basins) connected to one another. It is possible that *T. kharkovensis* lives on the floor of all the basins of the Bering Sea and has a continuous distributional range from the Asian to American continent along the Aleutian Islands, inhabiting the slope of the islands. For example, the deep-sea propeamussiid bivalve *Catillopecten squamiformis* (Bernard, 1978) has a similar geographic and vertical distribution in the northern Pacific (Kamenev 2018b).

Discussion

Analysis of the distribution of deep-sea bivalves and thyasirids in the Atlantic Ocean showed that out of 79 thyasirid species found in the Atlantic at depths exceeding 500 m only four species are confined solely to the abyssal zone (Payne & Allen 1991; Allen 2008). Most species of thyasirids occur on the slope and were recorded at depths less than 3000 m. Down slope migration was reported for many thyasirid species (Payne & Allen 1991).

Recent studies of the benthic fauna of the deep-sea ecosystems of the northwestern Pacific Ocean have shown that thyasirids are the most species-rich bivalve family in the abyssal and hadal zones (Kamenev 2015, 2018a, 2019, 2020). Many thyasirid species were found to be dominant in abundance in the abyssal benthic communities of the Seas of Japan and Okhotsk and in the hadal communities of the Kuril-Kamchatka, Japanese, Javanese, Philippine, and Kermadec trenches (Belyaev & Mironov 1977; Belyaev 1989; Kamenev 2013, 2018a, 2019, 2020; Allen 2015; Kamenev *et al.* 2022). To date, no less than 20 species of thyasirids are known in the northwestern Pacific Ocean, which were found only in the abyssal and hadal zones (Belyaev & Mironov 1977; Belyaev 1989; Okutani *et al.* 1999; Okutani 2000; Allen 2015; Kamenev 2015, 2018a, 2019, 2020). Thus, in contrast to the Atlantic Ocean, a species-rich deep-sea thyasirid fauna most likely lives in the northwestern Pacific Ocean solely at depths of more than 3000 m.

The sculpture of the prodissoconch of many thyasirid species is a good diagnostic character to separate and identify a number of species of the family Thyasiridae (Zelaya 2009; Kamenev 2020). In most thyasirids, the prodissoconch is smooth (Oliver & Killeen 2002; Oliver & Holmes 2007). However, some species from different regions of the world oceans have a prodissoconch sculpture of differently arranged lamellate folds or ridges (Table 2) (Oliver & Killeen 2002; Zelaya 2010; Kamenev 2013, 2020). Thus, in most of these species, curved prominent radial folds are symmetrically arranged along the main central axis of the prodissoconch (Zelaya 2010; Kamenev 2013, 2020). Moreover, the number of the radial folds, as a rule, differs greatly among species, thus being a good diagnostic character. Therefore, the presence of the radial folds on the prodissoconch of the species described herein, as well as their number, provide an additional character to distinguish them from one another and from most species of thyasirids

Parathyasira coani sp. nov. and *T. kharkovensis* sp. nov. were found in different areas of the vast northwestern Pacific region, suggesting their wide distribution in this part of the ocean. At present, the bivalve fauna of the bottom of the Kuril Basin of the Sea of Okhotsk, the Kuril-Kamchatka Trench, the oceanic abyssal plain adjacent to the Kuril-Kamchatka Trench have been studied quite well (Filatova 1964, 1971; Okutani 1968, 2000; Kamenev 2015, 2018a, 2019). It is possible that after a more detailed study of the fauna of the bathyal and abyssal zones of the oceanic slopes of the Japanese, Kuril, and Aleutian Islands, as well as the hadal zone of the Izu–Ogasawara, Japan, and Aleutian trenches, the ranges of these species may be expanded significantly.

Acknowledgments

I am very grateful to Drs A.V. Gebruk, E.M. Krylova, all the staff of the Laboratory of Ocean Bottom Fauna (IO RAS), and to Drs H. Saito (NMNS) and L.T. Groves (LACM) for arrangement of my work with the bivalve mollusk collections and their great help during this research; to Dr H. Saito (NMNS) for the photographs of paratypes and additional material of *A. obliquus*; to Philippe Maestrati and Virginie Héros (MNHN) for their help in studying of the type material of *T. biscayensis* and the photographs of the holotype and paratype of this species. Thanks to Prof. Dr A. Brandt (Senckenberg Research Institute and Natural History Museum, and Goethe University Frankfurt, Frankfurt), chief scientist of the KuramBio and KuramBio II expeditions, and to Dr M.V. Malyutina (NSCMB FEB RAS), chief scientist of the SokhoBio expedition and coordinator of the Russian team of the KuramBio and KuramBio II expeditions, for their invitation to join the deep-sea expeditions, and to the scientific staff of the expeditions and to the ship's crews for their assistance during the expeditions; to Ms T.N. Koznova (NSCMB FEB RAS) for her help in translating of the manuscript into English; to the Section Editor Dr Thierry Backeljau, Desk Editor Eva-Maria Levermann, and three anonymous reviewers for the valuable and important comments and corrections on the manuscript. This research was supported by the Ministry of Science and Higher Education of the Russian Federation (Grant No. 13.1902.21.0012, Agreement No. 075-15-2020-796).

References

Allen J.A. 2008. Bivalvia of the deep Atlantic. *Malacologia* 50 (1–2): 57–173. https://doi.org/10.4002/0076-2997-50.1.57

Allen J.A. 2015. Bivalves collected from the bottom of the Philippine Trench, including a new species of *Axinulus* (Thyasiroidea). *Journal of Conchology* 42: 175–18.

Belyaev G.M. 1989. *Deep-Sea Oceanic Trenches and their Fauna.* Nauka Press, Moscow. [In Russian.]

Belyaev G.M. & Mironov A.N. 1977. Bottom fauna of the West Pacific deep-sea trenches. *Proceedings of P.P. Shirshov Institute of Oceanology* 108: 7–24. [In Russian.]

Brandt A. & Malyutina MV. 2015. The German-Russian deep-sea expedition KuramBio (Kurile Kamchatka biodiversity studies) on board of RV *Sonne* in 2012 following the footsteps of the legendary expeditions with RV *Vityaz*. *Deep-Sea Research Part II: Topical Studies in Oceanography* 111: 1–9. https://doi.org/10.1016/j.dsr2.2014.11.001

Brandt A., Elsner N.O., Malytina M.V., Brenke N., Błażewicz M., Golovan O.A., Lavrenteva A.V. & Riehl T. 2015. Abyssal macrofauna of the Kuril-Kamchatka Trench area (Northwest Pacific) collected by means of a camera-epibenthic sledge. *Deep-Sea Research Part II: Topical Studies in Oceanography* 111: 175–187. https://doi.org/10.1016/j.dsr2.2014.11.002

Brandt A., Alalykina I., Brix S., Brenke N., Błażewicz M., Golovan O.A., Johannsen N., Hrinko A.M., Jażdżewska A.M., Jeskulke K., Kamenev G.M., Lavrenteva A.V., Malyutina M.V., Riehl T. & Lins L. 2019. Depth zonation of Northwest Pacific deep-sea macrofauna. *Progress in Oceanography* 176: 102131. https://doi.org/10.1016/j.pocean.2019.102131

Brandt A., Brix S., Riehl T. & Malyutina M. 2020. Biodiversity and biogeography of the abyssal and hadal Kuril-Kamchatka trench and adjacent NW Pacific deep-sea regions. *Progress in Oceanography* 181: 102232. https://doi.org/10.1016/j.pocean.2019.102232

Coan E.V. & Valentich-Scott P. 2012. *Bivalve Seashells of Western North America. Marine Bivalve Mollusks from Baja California to Northern Peru.* Santa Barbara Museum of Natural History Press, Santa Barbara.

Coan E.V., Scott P.V. & Bernard F.R. 2000. *Bivalve Seashells of Western North America. Marine Bivalve Mollusks from Arctic Alaska to Baja California.* Santa Barbara Museum of Natural History Press, Santa Barbara.

Dall W.H. 1901. Synopsis of the lucinacea and of the American species. *Proceedings of the United States National Museum* 23: 779–833. https://doi.org/10.5479/si.00963801.23-1237.779

Downey R.V., Fuchs M. & Janussen D. 2018. Unusually diverse, abundant and endemic deep-sea sponge fauna revealed in the Sea of Okhotsk (NW Pacific Ocean). *Deep Sea Research Part II: Topical Studies in Oceanography* 154: 47–58. https://doi.org/10.1016/j.dsr2.2018.02.005

Filatova Z.A. 1961. Some new data of bivalve mollusks of the Java Trench. *Oceanologya* 1: 133–135. [In Russian.]

Filatova Z.A. 1964. A new species of bivalve molluscs from the ultraabyssal of the Pacific. *Zoological Journal* 43: 1866–1868. [In Russian.]

Filatova Z.A. 1971. On some mass species of bivalve mollusks from the ultra-abyssal zone of the Kuril-Kamchatka Trench. *Proceedings of P.P. Shirshov Institute of Oceanology* 92: 46–60. [In Russian.]

Fujikura K., Fujiwara Y., Kojima S. & Okutani T. 2002. Micro-scale distribution of mollusks occurring in deep-sea chemosynthesis-based communities in the Japan Trench. *Venus* 60: 225–236. https://doi.org/10.18941/venus.60.4_225

Fujiwara Y., Kato C., Masui N., Fujikura K. & Kojima S. 2001. Dual symbiosis in the cold-seep thyasirid clam *Maorithyas hadalis* from the hadal zone in the Japan Trench, western Pacific. *Marine Ecology Progress Series* 214 :151–159. https://doi.org/10.3354/meps214151

Fukumori H., Hasegawa K. & Kano Y. 2018. Abyssal gastropods in the Sea of Okhotsk (Vetigastropoda and Caenogastropoda). *Deep Sea Research Part II: Topical Studies in Oceanography* 154: 187–196. https://doi.org/10.1016/j.dsr2.2017.09.013

Huber M. 2015. *Compendium of Bivalves 2. A Full-color Guide to the Remaining Seven Families. A Systematic Listing of 8'500 Bivalve Species and 10'500 Synonyms.* ConchBooks, Harxheim.

Jamieson A.J. 2015. *The Hadal Zone: Life in the Deepest Oceans.* Cambridge University Press, Cambridge. https://doi.org/10.1017/CBO9781139061384

Kamenev G.M. 2013. Species composition and distribution of bivalves in bathyal and abyssal depths of the Sea of Japan. *Deep-Sea Research Part II: Topical Studies in Oceanography* 86–87: 124–139. https://doi.org/10.1016/j.dsr2.2012.08.004

Kamenev G.M. 2015. Composition and distribution of bivalves of the abyssal plain adjacent to the Kuril-Kamchatka Trench (Pacific Ocean). *Deep-Sea Research Part II: Topical Studies in Oceanography* 111: 188–197. https://doi.org/10.1016/j.dsr2.2014.08.005

Kamenev G.M. 2018a. Bivalve molluscs of the abyssal zone of the Sea of Okhotsk: species composition, taxonomic remarks, and comparison with the abyssal fauna of the Pacific Ocean. *Deep-Sea Research Part II: Topical Studies in Oceanography* 154: 230–248. https://doi.org/10.1016/j.dsr2.2017.10.006

Kamenev G.M. 2018b. Four new species of the family Propeamussiidae (Mollusca: Bivalvia) from the abyssal zone of the northwestern Pacific, with notes on *Catillopecten squamiformis* (Bernard, 1978). *Marine Biodiversity* 48: 647–676. https://doi.org/10.1007/s12526-017-0821-1

Kamenev G.M. 2019. Bivalve mollusks of the Kuril-Kamchatka Trench, Northwest Pacific Ocean: species composition, distribution and taxonomic remarks. *Progress in Oceanography* 176: 102127. https://doi.org/10.1016/j.pocean.2019.102127

Kamenev G.M. 2020. Three new deep-sea species of Thyasiridae (Mollusca: Bivalvia) from the abyssal plain of the northwestern Pacific Ocean and hadal depths of the Kuril-Kamchatka Trench. *PeerJ* 8: e10405. https://doi.org/10.7717/peerj.10405

Kamenev G.M., Mordukhovich V.V., Alalykina I.L., Chernyshev A.V. & Maiorova A.S. 2022. Macrofauna and nematode abundance in the abyssal and hadal zones of interconnected deep-sea ecosystems in the Kuril Basin (Sea of Okhotsk) and the Kuril-Kamchatka Trench (Pacific Ocean). *Frontiers in Marine Science* 9: 812464. https://doi.org/10.3389/fmars.2022.812464

Lubinsky I. 1976. *Thyasira dunbari* n. sp. (Bivalvia: Thyasiridae) from the Canadian Arctic Archipelago. *Journal of the Fisheries Research Board of Canada* 33: 1667–1670. https://doi.org/10.1139/f76-212

Malyutina M.V. & Brandt A. 2013. Introduction to SoJaBio (Sea of Japan Biodiversity Studies). *Deep-Sea Research Part II: Topical Studies in Oceanography* 86–87: 1–9. https://doi.org/10.1016/j.dsr2.2012.08.011

Malyutina M.V. & Brandt A. 2018. First records of deep-sea Munnopsidae (Isopoda: Asellota) from the Kuril Basin of the Sea of Okhotsk, with description of *Gurjanopsis kurilensis* sp. nov. *Deep-Sea Research Part II: Topical Studies in Oceanography* 154: 275–291. https://doi.org/10.1016/j.dsr2.2017.12.006

Malyutina M.V., Chernyshev A.V. & Brandt A. 2018. Introduction to the SokhoBio (Sea of Okhotsk Biodiversity Studies) expedition 2015. *Deep-Sea Research Part II: Topical Studies in Oceanography* 154: 1–9. https://doi.org/10.1016/j.dsr2.2018.08.012

Mironov A.N., Minin K.V., Dilman A.B. & Smirnov I.S. 2018. Deep-sea echinoderms of the Sea of Okhotsk. *Deep-Sea Research Part II: Topical Studies in Oceanography* 154: 342–357. https://doi.org/10.1016/j.dsr2.2017.10.003

Monin A.S. (ed.) 1983. *Research Vessel "Vityaz" and his Expeditions 1949–1979.* Nauka Press, Moscow. [In Russian.]

Nicol D. 1965. A new *Thyasira* (Pelecypoda) from the Ross Sea, Antarctica. *Nautilus* 78: 79–80. https://doi.org/10.5962/bhl.part.24542

Okutani T. 1968. Bathyal and abyssal Mollusca trawled from Sagami Bay and the south off Boso Peninsula by the R/V Soyo-Maru, 1965–1967. *Bulletin of the Tokai Regional Fisheries Research Laboratory* 56: 7–55.

Okutani T. 2000. *Marine Molluscs in Japan.* Tokai University Press, Tokyo.

Okutani T. & Fujikura Y. 2002. Abyssal gastropods and bivalves collected by Shinkai 6500 on slope of the Japan Trench. *Venus* 60: 211–224.

Okutani T., Fujikura K. & Kojima S. 1999. Two new hadal bivalves of the family Thyasiridae from the plate convergent area of the Japan Trench. *Venus* 58: 49–54.

Oliver P.G. 2015. Deep-water Thyasiridae (Mollusca: Bivalvia) from the Oman Margin, Arabian Sea, new species and examples of endemism and cosmopolitanism. *Zootaxa* 3995 (1): 252–263. https://doi.org/10.11646/zootaxa.3995.1.21

Oliver P.G. & Holmes A.M. 2006. New species of Thyasiridae (Bivalvia) from chemosynthetic communities in the Atlantic Ocean. *Journal of Conchology* 39 (2): 175–183.

Oliver P.G. & Holmes A.M. 2007. A new species of *Axinus* (Bivalvia: Thyasiroidea) from the Baby Bare seamount, Cascadia Basin, NE Pacific with a description of the anatomy. *Journal of Conchology* 39 (4): 363–375.

Oliver P.G. & Killeen I.J. 2002. The Thyasiridae (Mollusca: Bivalvia) of the British Continental Shelf and North Sea oil fields: an identification manual. Studies in Marine Biodiversity and Systematics from the National Museum of Wales. *BIOMÔR Reports* 3: 1–73.

Ostermair L., Brandt A., Haszprunar G., Jörger K.M. & Bergmeier F.S. 2018. First insights into the solenogaster diversity of the Sea of Okhotsk with the description of a new species of *Kruppomenia* (Simrothiellidae, Cavibelonia). *Deep Sea Research Part II: Topical Studies in Oceanography* 154: 214–229. https://doi.org/10.1016/j.dsr2.2017.12.008

Payne C.M. & Allen J.A. 1991. The morphology of deep sea Thyasiridae (Mollusca: Bivalvia) from the Atlantic Ocean. *Philosophical Transactions of the Royal Society, Series B* 334 (1272): 481–562. https://doi.org/10.1098/rstb.1991.0128

Sasaki T., Okutani T. & Fujikura K. 2005. Molluscs from hydrothermal vents and cold seeps in Japan: a review of taxa recorded in twenty recent years (1984–2004). *Venus* 64: 87–133.

Sattarova V.V. & Aksentov K.I. 2018. Geochemistry of mercury in surface sediments of the Kuril Basin of the Sea of Okhotsk, Kuril-Kamchatka Trench and adjacent abyssal plain and northwest part of the Bering Sea. *Deep-Sea Research Part II: Topical Studies in Oceanography* 154: 24–31. https://doi.org/10.1016/j.dsr2.2017.09.002

Savilov A.I. 1961. Ecologic characteristics of the bottom communities of invertebrates in the Okhotsk Sea. *Proceedings of P.P. Shirshov Institute of Oceanology* 46: 3–84. [In Russian.]

Smith E.A., Thomson C.W. & Murray J. 1885. Report on the Lamellibranchiata collected by H.M.S. Challenger during the years 1873–76. *In*: Thomson C.W. & Murray J. (eds) *Report of the Scientific Results of the Voyage of H.M.S. Challenger During the Years 18730–76 Under the Command of Captain George S. Nares and Captain Frank Tourle Thomson. Zoology.* Neill, Edinburg / Dublin. https://doi.org/10.5962/bhl.title.109677

Ushakov P.V. 1953. *The Fauna of the Sea of Okhotsk and Conditions of Life in it.* Academy of Sciences of USSR Press, Leningrad. [In Russian.]

Valentich-Scott P., Powell C.L., Lorenson T.D. & Edwards B.E. 2014. A new genus and species of Thyasiridae (Mollusca, Bivalvia) from deep-water, Beaufort Sea, northern Alaska. *ZooKeys* 462: 11–26. https://doi.org/10.3897/zookeys.462.6790

Valentich-Scott P., Coan E.V. & Zelaya D. 2020. *Bivalve Seashells of Western South America. Marine Bivalve Mollusks from northern Perú to Southern Chile*. Santa Barbara Museum of Natural History Monographs, Santa-Barbara.

Verrill A.E. & Bush K.J. 1898. Revision of the deep-water Mollusca of the Atlantic coast of North America, with descriptions of new genera and species. Part. I. Bivalvia. *Proceedings of the United States National Museum* 20: 775–901. https://doi.org/10.5479/si.00963801.20-1139.775

WoRMS Editorial Board. 2022. World Register of Marine Species. Available from https://www.marinespecies.org [accessed 28 May 2022]. https://doi.org/10.14284/170

Zelaya D.G. 2009. The genera *Thyasira* and *Parathyasira* in the Magellan region and adjacent Antarctic waters (Bivalvia: Thyasiridae). *Malacologia* 51: 271–290. https://doi.org/10.4002/040.051.0204

Zelaya D.G. 2010. New species of *Thyasira*, *Mendicula*, and *Axinulus* (Bivalvia, Thyasiroidea) from Sub-Antarctic and Antarctic waters. *Polar Biology* 33: 607–616. https://doi.org/10.1007/s00300-009-0736-9

Manuscript received: 2 June 2022
Manuscript accepted: 20 October 2022
Published on: 25 January 2023
Topic editor: Tony Robillard
Section editor: Thierry Backeljau
Desk editor: Eva-Maria Levermann

Printed versions of all papers are also deposited in the libraries of the institutes that are members of the *EJT* consortium: Muséum national d'histoire naturelle, Paris, France; Meise Botanic Garden, Belgium; Royal Museum for Central Africa, Tervuren, Belgium; Royal Belgian Institute of Natural Sciences, Brussels, Belgium; Natural History Museum of Denmark, Copenhagen, Denmark; Naturalis Biodiversity Center, Leiden, the Netherlands; Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; Leibniz Institute for the Analysis of Biodiversity Change, Bonn – Hamburg, Germany; National Museum, Prague, Czech Republic.