

A New Species of *Thyasira* Lamarck, 1818 (Bivalvia: Thyasiridae) from the Japan Sea

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Abstract: A new thyasirid bivalve, *Thyasira inadai* n. sp., is described from the Japan Sea. This species lives in the Japan Sea and Yellow Sea and can be separated from the relatively shallower-water dwelling *T. tokunagai* Kuroda & Habe, 1951 by having a larger shell, a long and narrow auricle, a medial flattened area, an excavated lunule demarcated by an incision, a narrow apical angle and a larger prodissococonch. Based on the size of the prodissococonch and on molecular data, *T. inadai* n. sp. is related to the north Atlantic species, *T. gouldii* (Philippi, 1845). This phylogenetic relationship is likely due to migration through the Bering Strait, which has opened since the latest Miocene.

Keywords: deep sea, Japan Sea, Yellow Sea, migration, Bering Strait

Introduction

Members of the thyasirid bivalve genus *Thyasira* have two demibranchs with chemoautotrophic bacteria and live in shallow to deep water (Dufour, 2005). In the seas around Japan, the following Recent species have been recorded; *T. tokunagai* Kuroda & Habe, 1951, *T. imamurai* Okutani, 1962, *T. japonica* (A. Adams, 1862), *T. oblonga* (A. Adams, 1862), *T. plicata* (A. Adams, 1862) and *T. ozawai* Yokoyama, 1926 (Ito, 1967, 1985, 1989; Ito *et al.*, 1986; Tsuchida & Hayashi, 1994; Higo *et al.*, 1999; Matsukuma, 2000; Okutani, 2017). The last species was based on one Pleistocene fossil but was recorded as living on the Japan Sea coast at 37°N by Kuroda & Habe (1952). *Thyasira japonica*, *T. oblonga*, and *T. plicata* were described in the genus *Cryptodon* Turton, 1822 by Adams (1862) from Okosiri [= Okushiri Island, Hokkaido] and Mino-Sima [= Mishima Island, Yamaguchi Prefecture]. However, according to Habe (1949), it is difficult to determine these species because Adams (1862) gave no illustration and only a brief description. Moreover, *Cryptodon* (*Clausina*) *suborbicularis* was also described from Amiva Bay [= Aniva Bay? in Sakhalin] by Adams (1862). Following Huber (2015: 396) they are here considered *nomina dubia*. Consequently, *T. tokunagai* and *T. imamurai* are the formally recognized Recent species of the genus in Japan.

On the other hand, *Thyasira gouldii* (Philippi, 1845) and *T. flexuosa* (Montagu, 1803) have been recorded from the Russian side of the Japan Sea (Scarlato, 1981; Lutaenko, 2005, 2014; Kamenev, 2013) and *T. tokunagai* has been recorded from the Korean side of the Japan Sea (Lutaenko & Norseworthy, 2012; Lutaenko, 2014). Coan *et al.* (2000) and Coan & Valentich-Scott (2012) considered *Thyasira barbarensis* (Dall, 1890) and possibly *T. tokunagai* to be synonyms of the North Atlantic species *T. flexuosa*. Huber (2015) claimed that *T. gouldii* and *T. flexuosa* from

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Primoriye should be identified as *T. barbarensis*, originally described from Santa Barbara Island (276 fathoms in depth) in California. Moreover, according to him, *T. tokunagai* is endemic to Japan, living in shallower water than *T. barbarensis*. However, he pointed out a slight difference in shell outline between *T. tokunagai* and *T. barbarensis*.

This taxonomic confusion is attributable to inadequate consideration until now of shell size, the size of the prodissoconch, the shape of the auricle, the condition of the lunule, the thickness of the periostracum and the living depth. We obtained seven Recent specimens from the southwestern part of the Japan Sea and two semifossil specimens from a seep site off Joetsu, Niigata Prefecture, central Honshu. As a result of examination of these specimens, they can be proposed as a new species.

In this paper, we describe a new species from Japan Sea and revise the taxonomy of the genus *Thyasira* in and around Japan.

Material and Methods

Specimens of *Thyasira* have been newly recovered from the following nine localities in two areas of the Japan Sea (Fig. 1, Table 1); one dead shell from each of seven localities of the southwestern part in Area 1, about 95 km northwest of Mishima Island, southwestern Japan Sea (Loc. T1 ~T6, 169–187 m; M1, 231 m) and two semifossil specimens from boring cores at the seep sites off Joetsu, Area 2, central part of the sea (J1, northwestern part of Umitaka Spur, Loc. 3307C in Amano *et al.* (2013), 930 m, 55 cm below the sea bottom; J2, southwestern part of Joetsu Knoll, Loc. 3317 in Amano *et al.* (2013), 1,021 m, 67 cm below the sea bottom). The stratigraphic position of the semifossil specimen was correlated with the peak period of the Holocene Glacial Retreat around 7 ka (Amano *et al.*, 2013).

All specimens treated herein are stored in the National Museum of Nature and Science, Tokyo (NMNS: Tsukuba, Ibaraki, Japan). Recent specimens are deposited in the Department of Zoology (NSMT-Mo) whereas semifossils are in the Department of Geology and Paleontology (NMNS PM). For comparisons with the Japan Sea specimens, we examined *T. tokunagai* and *T. ozawai*, including the type material stored at the Institute of Geology and Paleontology, Faculty of Science / The Tohoku University Museum of Tohoku University (IGPS: Sendai, Miyagi, Japan), the University Museum of the University of Tokyo (UMUT: Bunkyo Ward, Tokyo; UMUT CM: Cenozoic Mollusca) and NMNS. Also, we compared *T. flexuosa* [= *T. barbarensis* Dall, 1890] collected from Santa Barbara Channel in southern California which are stored at the Santa Barbara Museum of Natural History (SBMNH: Santa Barbara, California, U.S.A.) (SBNMH nos. 463660 and 471666).

Scanning electron microscopy (SEM) images and measurements of prodissoconchs were obtained using a model JSM-5310 (JEOL, Tokyo) at NMNS as described in Fukuda *et al.* (2022). The conchological terminology of the Thyasiridae mainly follows Oliver & Killeen (2002) and the term “medial flattened area” follows Kauffmann (1967).

Taxonomy

Family **Thyasiridae** Dall, 1900 (1895)

Genus ***Thyasira*** Lamarck, 1818

Type species: *Tellina flexuosa* Montagu, 1803 (by monotypy).

Diagnosis: Given slightly modified from Oliver & Holmes (2006) and Åström *et al.* (2017) as follows: Small, fragile shells, ovate to ovate-polygonal in outline with posterior sulcus; escutcheon variably expressed, absent to deep, with auricle producing submarginal sulcus. Hinge teeth lacking

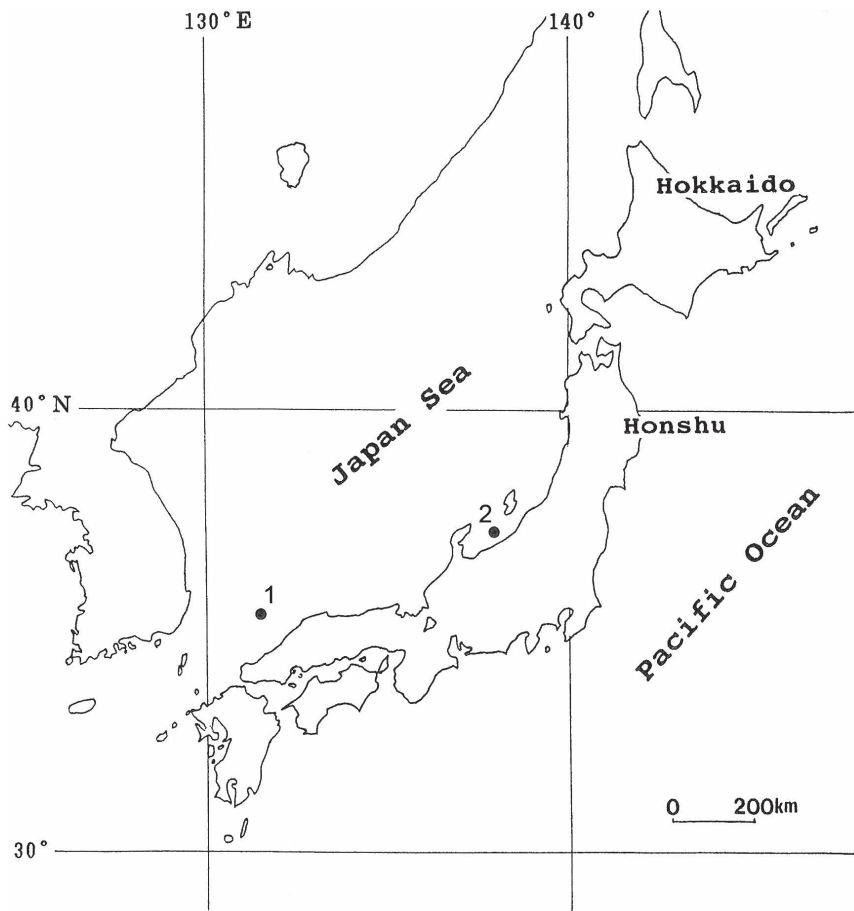


Fig. 1. Locality map of Recent and semifossil specimens. 1. Area 1. 2. Area 2.

Table 1. Sampling localities of *Thyasira inadai* n. sp.

Specimens	Type	Latitude	Longitude	Depth (m)	Area	Loc. no.
NSMT-Mo 79379	Holotype	35°31'52"N	130°43'17"E	231	1	M1
NSMT-Mo 79380	Paratype	35°25'55"N	130°41'42"E	169	1	T1
NSMT-Mo 79381	Paratype	35°26'10"N	130°42'00"E	171	1	T2
NSMT-Mo 79382	Paratype	35°26'01"N	130°42'06"E	173	1	T3
NSMT-Mo 79383	Paratype	35°26'15"N	130°42'10"E	172	1	T4
NSMT-Mo 79384	Paratype	35°29'55"N	130°47'52"E	187	1	T5
NSMT-Mo 79385		35°26'08"N	130°42'34"E	171	1	T6
NMNS PM 65750		37°27'00"N	138°01'00"E	930	2	J1
NMNS PM 65751		37°32'00"N	137°55'00"E	1,021	2	J2

or “cardinal” tubercle, ligament sunken. Weak sculpture of commarginal lines and growth stops, periostracum thin. Anterior adductor scar elongate, posterior adductor scar ovate, pallial line entire. Ctenidium with two demibranchs, lateral body pouches large and multilobed, foot vermiform, heel obsolete, toe developed.

Remarks: Based on Habe (1977), the genus *Thyasira* consists of the subgenera *Thyasira* (s. s.) and *Philis* Fischer, 1861. Both subgenera share two distinct folds in the posterior part of shells. Most Japanese malacologists treated *Philis* as a subgenus of *Thyasira* (e.g., Habe, 1951, 1977; Higo *et al.*, 1999; Okutani, 2017). However, Huber (2015) stressed the existence of a distinct “chondrophore” beneath the umbo and separated *Philis* as a genus from *Thyasira*. Although some *Thyasira* species has also a small node or “pseudoteeth” beneath the umbo as in *T. tokunagai* (Fig. 6A), based on our SEM observation, we follow the Huber’s opinion and separate *Philis* as an independent genus.

Parathyasira Iredale, 1924 differs from *Thyasira* by having one weak fold and rather wide area behind it. *Channelaxinus* Valentich-Scott & Coan in Coan & Valentich Scott (2012) differs from *Thyasira* by having a long, narrow, deep channel holding a ligament, no auricle and some rude commarginal ribs. *Conchocele* Gabb, 1866 differs from *Thyasira* by having a subquadrate shell with one distinct posterior sulcus and a truncated postero-dorsal margin.

***Thyasira inadai* n. sp.**

[New Japanese name: Inada-hanashi-gai]

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(Figs 2, 3A–N)

Thyasira tokunagai Kuroda & Habe — Ito, 1967: 67, pl. 9, fig. 3; Xu & Zhang, 2008: 121, fig. 353;

Amano *et al.*, 2013: figs 2-2a, b; Zhang *et al.*, 2016: 280, fig. 345 [non *T. tokunagai*].

Thyasira gouldi [sic] (Philippi) — Scarlato, 1981: 310, fig. 160 [non *T. gouldii*].

Thyasira (Thyasira) tokunagai Kuroda & Habe — Ito, 1985: 34, pl. 14, figs 1-1, 1-2; Tsuchida & Hayashi, 1994: 101, pl. 9, fig. 10 [non *T. tokunagai*].

Maorithyas miyadai (Habe) — Ito *et al.*, 1986: 30, pl. 45, fig. 3 [non *M. miyadai*].

Thyasira tokunagai [sic] Kuroda & Habe — Qi, 2004: 257, pl. 142G [non *T. tokunagai*].

Thyasira flexuosa (Montagu) — Lutaenko, 2005: 70, pl. 5, figs G–I; Kamenov, 2013: 133, figs 5P–U [non *T. flexuosa*].

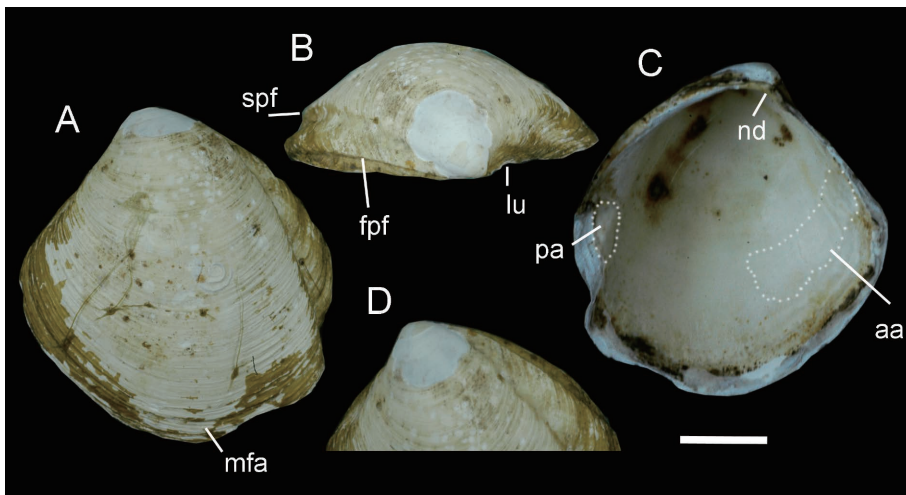


Fig. 2. Holotype of *Thyasira inadai* n. sp. Left valve, NSMT-Mo 79379, from Loc. M1. **A.** outer surface. **B.** dorsal view. **C.** inner surface. **D.** oblique view of outer surface. Abbreviations: aa, anterior adductor muscle scar; fpf, first posterior fold; lu, lunule; mfa, medial flattened area; nd, node; pa, posterior adductor muscle scar; spf, second posterior fold. Scale bar = 5 mm.

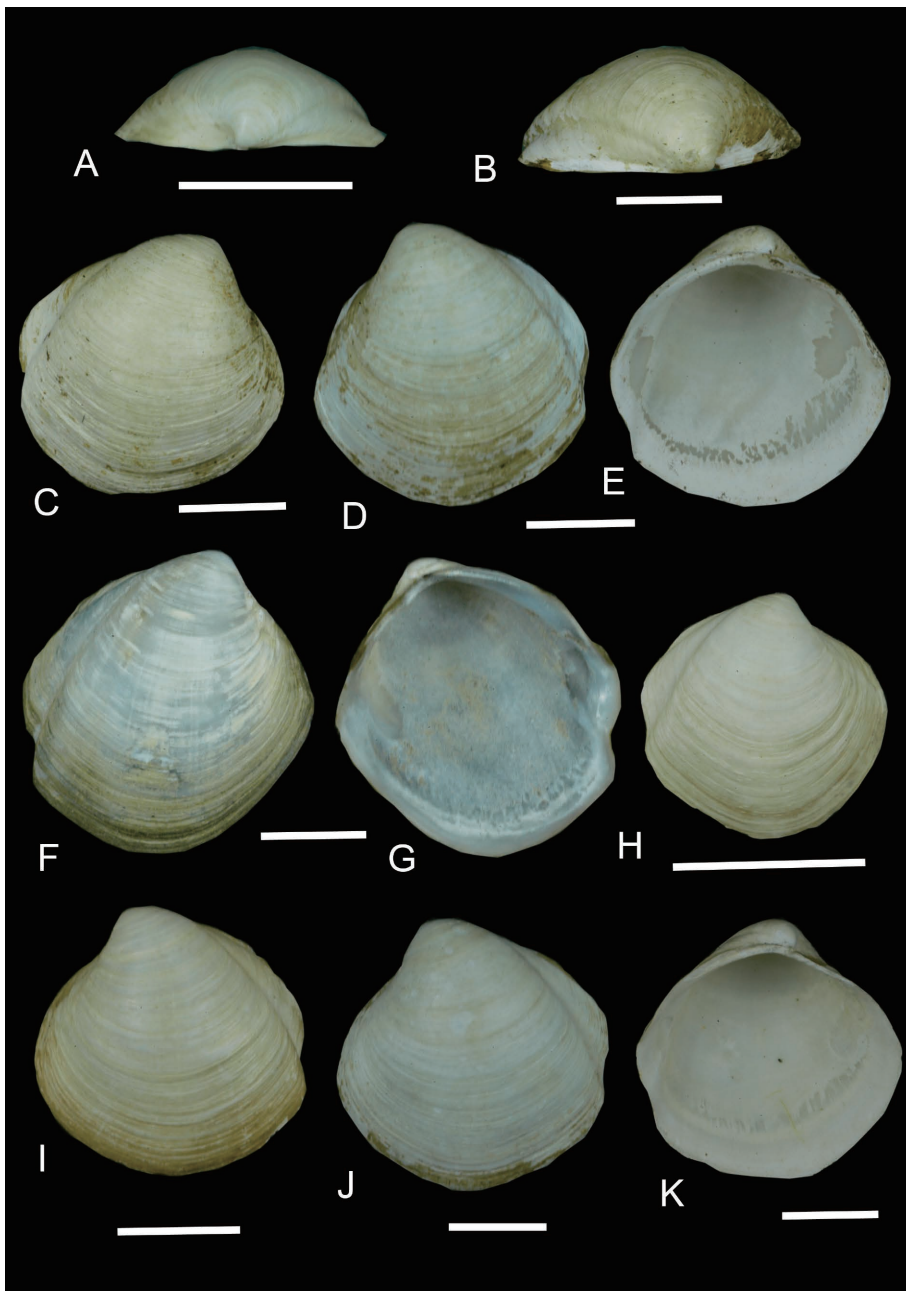


Fig. 3. A–E, H–N. Recent specimens of *Thyasira inadai* n. sp. from the southwestern part of Japan Sea (Area 1). A, H, paratype, right valve, NSMT-Mo 79380, from Loc. T1; B, D, E, paratype, left valve, NSMT-Mo 79382, from Loc. T3; C, paratype, right valve, NSMT-Mo 79383, from Loc. T4; I, paratype, left valve, NSMT-Mo 79384, from Loc. T5; J, K, paratype, left valve, NSMT-Mo 79381 from Loc. T2; F, G. Semifossil of *T. inadai* n. sp. from off Joetsu, central part of Japan Sea (Area 2), right valve, NMNS PM 65750, from Loc. J1. Scale bars = 5 mm.

? *Thyasira tokunagai* Kuroda & Habe — Amano *et al.*, 2012: figs 4-6a, b. [non *T. tokunagai* ?]

Type material: Holotype, a left valve, NSMT-Mo 79379, from Loc. M1, 35°31'52"N, 130°43'17"E, 231 m (Figs 2A–D); paratypes, a right valve, NSMT-Mo 79380, from Loc. T1, 35°25'55"N, 130°41'42"E, 169 m (Figs 3A, H; 4A, B), a left valve, NSMT-Mo 79381, from Loc. T2, 35°26'10"N, 130°42'00"E, 171 m (Figs 3J, K), a left valve, NSMT-Mo 79382, from Loc. T3, 35°26'01"N, 130°42'06"E, 173 m (Figs 3B, D, E), a right valve, NSMT-Mo 79383, from Loc. T4, 35°26'15"N, 130°42'10"E, 172 m (Fig. 3C), a left valve, NSMT-Mo 79384, from Loc. T5, 35°29'55"N, 130°47'52"E, 187 m (Figs 3I; 4C, D). All were collected from the Area 1 by commercial trawl fishery operating in southwestern part of the Sea of Japan (Tables 1, 2).

Other material examined: A right valve, NSMT-Mo 79385, from Loc. T6, 35°26'08"N, 130°42'34"E, 171 m; a right valve from the Holocene, NMNS PM 65750, from Loc. J1, 3307C, northwestern part of Umitaka Spur, off Joetsu, 37°27'00"N, 138°01'00"E, 930 m, 55 cm below the sea bottom (Figs 3F, G); a left valve from the Holocene, NMNS PM 65751, from Loc. J2, 3317, southwestern part of Joetsu Knoll, off Joetsu, 37°32'00"N, 137°55'00"E, 1,021 m, 67 cm below the sea bottom (Amano *et al.*, 2013; figs 2a, b) (Tables 1, 2).

Type locality: Southwestern Japan Sea, 35°31'52"N, 130°43'17"E, 231 m.

Distribution: ? Late Pliocene, Zukawa Formation in Toyama Prefecture (Amano *et al.*, 2012); Holocene, off Joetsu (930–1,021 m depth; Amano *et al.*, 2013); Recent, off Primoriye and Peter the Great Bay (18–1,075 m: Scarlato, 1981; Kamenev, 2013), off Awashima Island in Niigata Prefecture to southwestern part of Japan Sea side of Honshu (80–300 m: Ito, 1967, 1985; present study), Bohai Bay and Yellow Sea (11–84 m: Qi, 2004).

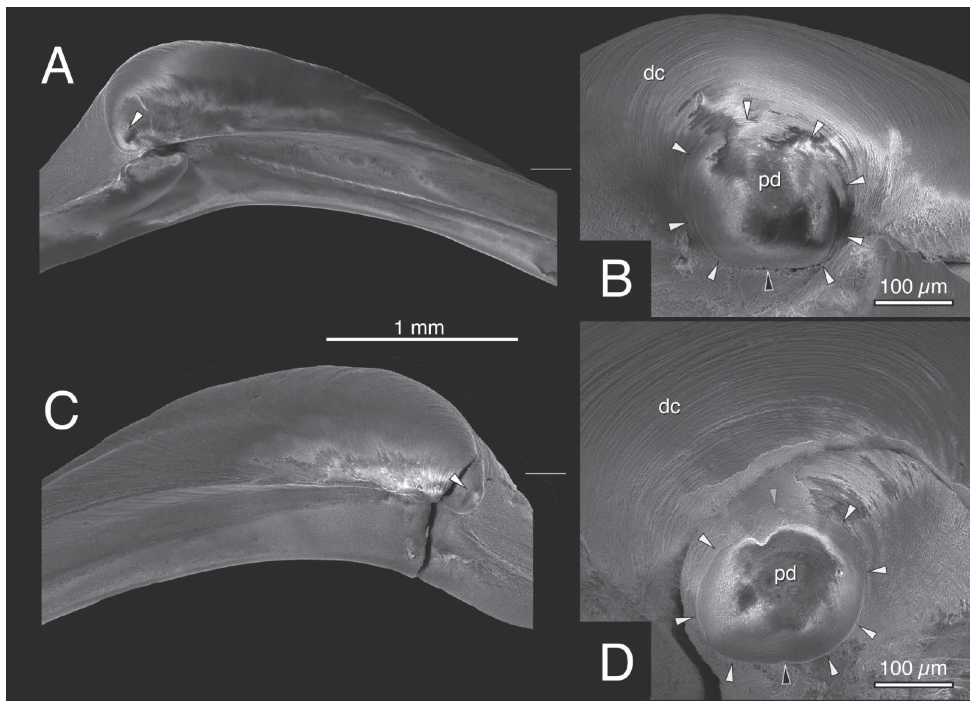


Fig. 4. *Thyasira inadai* n. sp. SEM micrographs showing hinge plate (A, C) and prodissoconch (B, D) morphology. Recent specimens from Area 1. **A, B.** Paratype, right valve, NSMT-Mo 79380, from Loc. T1. **C, D.** Paratype, left valve, NSMT-Mo 79384, from Loc. T5. White and black arrowheads show boundary between prodissoconch (pd) and dissoconch (dc) and a hollow at posterior margin, respectively.

Table 2. Measurements of *Thyasira inadai* n. sp. * anterior length before beak.

Specimens	Type	Length (mm)	Height (mm)	AL (mm)*	Thickness (mm)	Valve	Loc.
NSMT-Mo 79379	Holotype	16.8	17.0	6.4	5.9	left	M1
NSMT-Mo 79380	Paratype	7.9	7.8	4.2	2.9	right	T1
NSMT-Mo 79381	Paratype	13.0	12.5	5.1	4.6	left	T2
NSMT-Mo 79382	Paratype	12.5	12.1	4.6	4.5	left	T3
NSMT-Mo 79383	Paratype	11.7	12.2	4.8	5.3	right	T4
NSMT-Mo 79384	Paratype	11.6	11.4	3.7	3.9	left	T5
NSMT-Mo 79385		12.2	11.9	5.6	4.5	right	T6
NMNS PM 65750		13.1	14.1	4.2	4.6	right	J1
NMNS PM 65751		10.2	9.1	3.2	2.8	left	J2

Diagnosis: Large-sized and rather thin-shelled *Thyasira* with long but narrow auricle attaining ventral end of first posterior fold, distinct lunular incision, distinct medial flattened area, pale brown to brown periostracum and large prodissoconch attaining 229 μ m in length.

Description: Shell large for genus, attaining more than 16.8 mm in length, rather thin, subcircular or ovate ($H/L = 0.96$ to 1.07), moderately inflated. Antero-dorsal margin steeply sloping, nearly straight to slightly concave, making right angle with ventral margin; postero-dorsal margin broadly arcuate and gently sloping; ventral margin well rounded. Apical angle about 100° to 110° . Beak produced above dorsal line, inflated, located centrally to anterior one-third of shell length ($AL/L = 0.31$ to 0.53). Second posterior fold and sulcus distinct, making wide posterior area. First posterior fold sharper than second one, making narrow and long auricle reaching ventral end of first posterior fold. Medial flattened area sometimes observed (Figs 2A, 3F). Anterior dorsal area rather flat and lunule shallow to deeply excavated, demarcated by lunular incision (Figs 2B, 3B). Prodissococonch ovate, smooth, rather large for genus, attaining 229.0 μ m (206.4 and 229.0 μ m, paratypes of NSMT-Mo 79380 and Mo-79384, respectively; average 217.7 μ m, $N = 2$) with a sinus on dorsal margin (Figs 4B, D). Periostracum thin and pale brown to brown in color. Hinge plate narrow with relatively large node in front of flattened area beneath umbo on left valve (Figs 2C, 4C). Anterior adductor muscle scar variable in shape, subquadrate gourd-shaped (Figs 2C, 3E) to quadrate (Figs 3G, K), slightly detached from pallial line. Posterior adductor muscle scar ovate. Pallial line entire and serrated especially on anterior half.

Measurements (in mm): see Table 2.

Etymology: This new species is named after Mr. Akira Inada (Takatsuki City, Osaka Prefecture) who collected and donated the type specimens to the authors.

Remarks: Some Recent specimens from the Japan Sea and Yellow Sea, and some Holocene semifossils from off Joetsu were sometimes mistakenly identified as *Thyasira tokunagai* by some Japanese and Chinese authors (Ito, 1967, 1985; Tsuchida & Hayashi, 1994; Xu & Zhang, 2008; Amano *et al.*, 2013; Zhang *et al.*, 2016). They have rather large shells, a narrow auricle, a smaller apical angle, a medial flattened area and an excavated lunule which are shared with *T. inadai* n. sp. Qi (2004) also described *T. tokamagai* [*sic*: a misspelling of *T. tokunagai*] from the Bohai Sea and Yellow Sea in China. However the illustrated specimen has a long auricle and smaller apical angle (about 110°) which are characteristics of *T. inadai* n. sp., not of *T. tokunagai*.

Thyasira flexuosa and *T. gouldii* are living species in the Atlantic Ocean, but were also recorded from the Peter the Great Bay and off Primoriye, northern part of the Japan Sea (Scarlato, 1981; Lutaenko, 2005; Lutaenko & Noseworthy, 2012; Kameney, 2013). However, these Japan Sea specimens should be identified as *T. inadai* n. sp. on the basis of their long and narrow auricle,

similar apical angle (about 110°) and medial flattened area.

Ito *et al.* (1986) illustrated a thyasirid under the name of *Maorithyas miyadai* (Habe, 1951) from off the Noto Peninsula in Ishikawa Prefecture. However, it has a subcircular shell, rather distinct first and second posterior folds and a long but narrow auricle, which are not recognized in *M. miyadai* but are present in *T. inadai* n. sp.

Thyasira tokunagai Kuroda & Habe, 1951 is a similar species to *T. inadai* n. sp. It was originally identified as *T. gouldii* (Philippi, 1845) by Yabe & Nomura (1925: 94, pl. 23, figs 6a, b), based on a fossil from the Upper Pleistocene Tokyo Formation at Shinagawa in Tokyo, for which Kuroda & Habe (1951: 86) proposed the new name *tokunagai*. The nomenclatural act by Kuroda & Habe (1951) satisfies the International Code of Zoological Nomenclature (Art. 13.1.2) and is valid; however, the description or definition of characters that purport to differentiate the taxon was only given as “... our shells [= *T. gouldii sensu* Yabe & Nomura, 1925] show two [flexure: *sensu* Yabe & Nomura, 1925 = *fold* in this study]” in Yabe & Nomura (1925: 94). Since there are many species having this “character,” it is difficult to distinguish *tokunagai* from others, even considering the measurements of the largest specimen given in Yabe & Nomura (1925: length = 6.5 mm, height = 7.0 mm, width = 2.5 mm). Although we think it is appropriate to treat Kuroda & Habe (1951)’s *tokunagai* as a *nomen dubium*, we leave the nomenclatural issue unresolved for consideration in another work and herein continue to use the name *tokunagai* as in the past. Sato *et al.* (2016) selected as lectotype IGPS no. 13786 illustrated by Yabe & Nomura (1925, pl. 23, figs 6a, b) because Kuroda & Habe (1951) had not designated any type specimens. However, in the box of IGPS no. 13786, other conspecific specimens are included. We renumbered the lectotype as IGPS no. 13786A, which was illustrated by Sato *et al.* (2016), and made other paralectotype specimens clearly distinguishable from the lectotype (IGPS no. 13786B-1 to 13786B-5).

As the result of examination of the lectotype specimen of *T. tokunagai* (IGPS no. 13786A: Figs 5A, F, G) and three paralectotype specimens (IGPS nos 13786B-1, 2, 3: Figs 5C–E, H; here renumbered), *T. tokunagai* differs from *T. inadai* n. sp. by having a small shell (maximum 7.0 mm long), short but wide auricle, deep sub-marginal sulcus, no medial flattened area, no excavated lunule and a wide apical angle (about 120°). Our SEM observation of four specimens from the Upper Pleistocene Tokyo Formation (NMNS PM 65752–65755; collected during the construction of the Toei Subway Asakusa Line at Narihira-1-chōme, Sumida Ward in 1959 by the late Ichiro Yamaura: see Kawabe *et al.*, 2018) found further differences. The prodissococonchs of *T. tokunagai* are clearly smaller (149.4–156.3 µm in length, average 153.7 µm in length, N = 4; Figs 6B, E) than that of *T. inadai* n. sp. (Figs 4B, D) and the sinus at the center of the dorsal margin is absent in *T. tokunagai* (Figs 6B, E) unlike *T. inadai* n. sp. (Figs 4B, D: black arrowheads). The morphology of the hinge area also differs. There is a clear node beneath the umbo of the left valve in *T. inadai* n. sp. (Figs 2C, 4C), whereas inverted V-shaped “pseudoteeth” are present in the right valve of *T. tokunagai* (Fig. 6A).

Thyasira barbarensis (Dall, 1890), living in the eastern Pacific, is similar to our new species in shell size (17 mm in length) and in having a produced beak, a medial flattened area and a narrow auricle. However, based on our observation of images of the holotype (*Cryptodon barbarensis* Dall, 1890, Smithsonian Institution, <https://collections.nmnh.si.edu/media/?ark=ef26ab76d9444c899bb52cdc133a01f6>, on March 23, 2022) and the specimens from the Santa Barbara Channel, this species can be separated from *T. inadai* n. sp. in having a thin shell that is transparent near the beak and a sharper second posterior fold as in *T. tokunagai*. Moreover, the prodissococonchs of *T. barbarensis* from Santa Barbara Channel are smaller than that of *T. inadai* n. sp. (157.1–170.7 µm in length; average 164.0 µm in length; N = 4; personal communication by Kelvin Barwick).

The Atlantic species *Thyasira flexuosa* (Montagu, 1803) has a moderately large size [12 mm long; Oliver & Killeen, 2002], a narrow auricle and an excavated lunule. However, this Atlantic species has a smaller prodissococonch (162–177 µm; Oliver & Killeen, 2002), thin periostracum, no

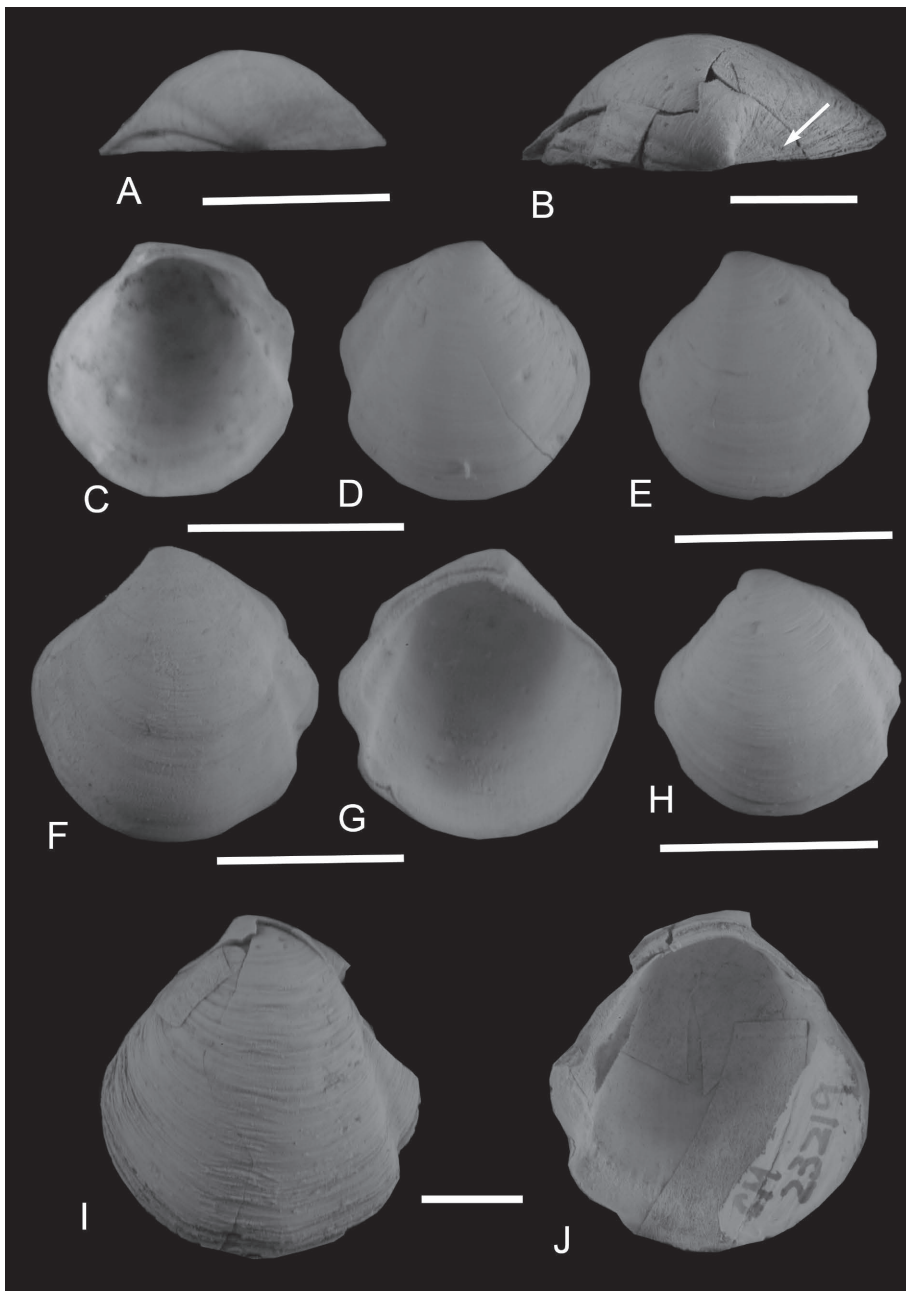


Fig. 5. Type specimens of *Thyasira tokunagai* Kuroda & Habe, 1951 and *Thyasira ozawai* Yokoyama, 1926 covered by ammonium chloride. **A, C–H.** *Thyasira tokunagai* from the Upper Pleistocene Tokyo Formation at Shinagawa in Tokyo Metropolis; **A, F, G,** lectotype, left valve, IGPS no. 13786A; **C, D,** paralectotype, right valve, IGPS no. 13786B-3; **E,** paralectotype, left valve, IGPS no. 13786B-2; **H,** paralectotype, left valve, IGPS no. 13786B-1. **B, I, J.** *Thyasira ozawai* from the Lower Pleistocene Sawane Formation in Niigata Prefecture; **holotype,** left valve, UMUT CM 23219. White arrow shows a lunule incision. Scale bars = 5 mm.

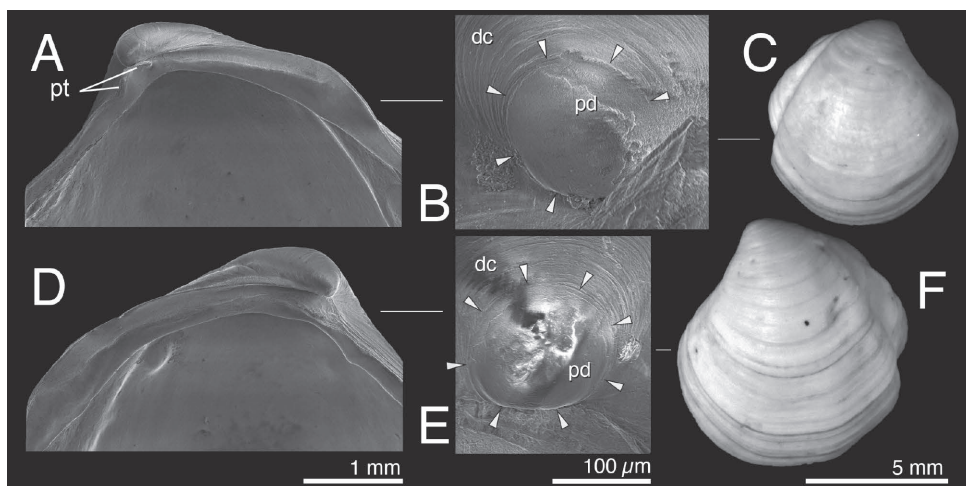


Fig. 6. *Thyasira tokunagai* Kuroda & Habe, 1951. Fossil specimens from the Upper Pleistocene Tokyo Formation. **A, D.** SEM micrographs of hinge plates showing “pseudoteeth” (pt) in right valve. **B, E.** SEM micrographs of externals of prodissoconchs. **C, F.** External images under normal light. A–C, right valve, NMNS PM 65753; D–F, left valve, NMNS PM 65752. White arrowheads show boundary between prodissoconch (pd) and dissoconch (dc).

medial flattened area, a shorter auricle and a shallower posterior sulcus than *T. inadai* n. sp.

Thyasira gouldii (Philippi, 1845), living in the Atlantic Ocean, can be easily separated from *T. inadai* n. sp. in having a smaller shell (10 mm in length: Oliver & Killeen, 2002), a larger apical angle, a short auricle and no sunken lunule.

Thyasira ozawai Yokoyama, 1926, named from the Lower Pleistocene Sawane Formation in Sado Island, Niigata Prefecture, based on one imperfect specimen (Figs 5B, I, J), compares well with *T. inadai* n. sp. because *T. ozawai* has a large shell (15 mm in length, 16.4 mm in height), a medial flattened area and a lunular incision. All these characters are observed in *T. inadai* n. sp. However, its indistinct lunular incision within a wide, slightly concave lunular area (Fig. 5B) and the incompleteness of its auricle prevent us from synonymizing it with *T. inadai* n. sp.

Thyasira subexcavata Yabe & Endo in Yabe & Nomura (1925) from the Miocene Taga Group in Ibaraki Prefecture has a similar outline, medial flattened area and excavated lunule to *T. inadai* n. sp. However, *T. subexcavata* has only one fold and a truncated posterior margin, suggesting generic placement in *Conchocele*.

Coan *et al.* (2000, 2012) and Valentich-Scott *et al.* (2020) synonymized *Thyasira wajampolkana* Krishtofovich, 1936, from the Lower to Middle Miocene Kavran Series in western Kamchatka, with the American *T. flexuosa* [= *T. barbarensis*]. The species has a similar shell shape and size (15.3 mm in length) to *T. inadai* n. sp. and a narrow and long auricle. However, it is uncertain whether this species can be synonymized with *T. inadai* n. sp. because it has narrower apical angle (90°) and the condition of lunule and inner part of shell is unknown.

Discussion

In total, three species of *Thyasira* now live in and around Japan; *T. tokunagai*, *T. imamura* and *T. inadai* n. sp. Among these, *Thyasira inadai* n. sp. is in the upper sublittoral depth to upper bathyal depth (11–1,075 m) of the Japan Sea, Bohai Bay and Yellow Sea and has not been found on the Pacific side (see above). On the other hand, the smaller species *T. tokunagai* is endemic to the Japanese region, as stated by Huber (2015). It has been recorded from the sublittoral to uppermost

bathyal depth (3–250 m) in the Japan Sea and Pacific Ocean around Japan, and Japan Sea side of Korea (Kuroda *et al.*, 1971; Ito *et al.*, 1986; Min *et al.*, 2004; Lutaenko & Noseworthy, 2012; Lutaenko, 2014; Lutaenko *et al.*, 2021). *Thyasira imamurai* is very different from the above two species in having an elongate shell and posteriorly located beak. It lives in the deep Pacific Ocean (730–1,205 m) from Kyushu to Miyake Island in Tokyo (Okutani, 1962, 1968; Tsuchida, 1994).

Based on the molecular data (nuclear 18S rRNA and mitochondrial cytochrome oxidase subunit I) by Fukasawa *et al.* (2017), “*Thyasira* sp.” [= probably *T. inadai* n. sp.] from Joetsu Knoll (TT1, 986 m; TT32, 986 m) is closely related to another “*Thyasira* sp.” from Inatori (INT-2, ca. 200 m) in Sagami Bay. Moreover, “*Thyasira* sp.” from TT1 and INT-2 are included in the same clade as *T. gouldii* and *T. polygona* (Jeffreys, 1864) and are closely related to *T. flexuosa*, based on nuclear 18S rRNA. On this evidence, *T. inadai* n. sp. may also live in rather deep water off the Pacific side of Honshu.

Based on the shell morphology and molecular phylogeny, *T. inadai* n. sp. is probably related to North Atlantic species such as *T. gouldii*, *T. polygona* and *T. flexuosa*. The size of the prodissoconch in *T. inadai* n. sp. falls within the range of that of *T. gouldii* (205–270 µm in length: Oliver & Killeen, 2002). As described above, *T. flexuosa* has a smaller prodissoconch than *T. inadai* n. sp. and *T. gouldii*. Such similarity in the size of the prodissoconch is concordant with the molecular data because *T. inadai* n. sp. and *T. gouldii* are more closely related than *T. flexuosa*.

It has been established that the Bering Strait opened in the latest Miocene and migrations of many marine organisms occurred (MacNeil, 1965; Strauch, 1972; Vermeij, 1991, 2001; Marincovich & Gladenkov, 1999). *Thyasira alaskana* Kauffman, 1969 has been found in the Upper Miocene or Pliocene Nuwak Formation on the Arctic slope of Alaska. It is very similar to the Atlantic and boreal species group of *Thyasira sarsi* (Philippi, 1845). Although no fossil record of the *T. gouldii* – *T. inadai* n. sp. clade exists from the Alaskan Arctic slope, it likely took part in the migration through the Bering Strait. However, the direction is uncertain because there is taxonomic confusion among fossils. *T. inadai* n. sp. in the Yellow Sea and Bohai Bay might have migrated through the Japan Sea during the Pleistocene ice ages as other cold-water species did (Amano, 2005).

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日本海産ハナシガイ属（二枚貝綱：ハナシガイ科）の 1 新種

天野和孝・芳賀拓真

要 約

日本海からハナシガイ科ハナシガイ属の 1 新種, *Thyasira inadai* n. sp. イナダハナシガイ（新称）を発見し、記載した。種小名は稲田 陽氏に因む。本種は日本海と黄海に生息し、完新統の個体が新潟県上越市沖から知られる。本新種は、より浅海域に生息する *Thyasira tokunagai* Kuroda & Habe, 1951 ハナシガイとはより大きな殻を持つこと、長く、狭い耳状突起、殻中央部の平坦面、溝で境されくぼむ小月面、狭い殻頂角、より大きな胎殻により区別される。本新種は胎殻や分子生物学的観点から北大西洋に生息する *Thyasira gouldii* (Philippi, 1845)（ゲールドハナシガイ, 新称）に近縁である。こうした系統関係の近縁性は中新世末期に開いたベーリング海峡を通じた移動による。