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Description of appendages from three marine trachyleberidid species (Ostracoda, Crustacea) from Japan

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ABSTRACT – Three living trachyleberidid ostracod species, *Acanthocythereis munechikai* Ishizaki, *Actinocythereis kisarazuensis* Yajima and *Hirsutocythere hanaii* Ishizaki, were discovered in the Tsushima Straits, c. 120 km east of Tsushima Island (north Island), N 34° 46' E 130° 46' at a depth of 116 m. This is the first description of complete appendages for these genera. *J. Micropalaeontol.* 29(1): 5–16, May 2010.

KEYWORDS: *Acanthocythereis munechikai*, *Actinocythereis kisarazuensis*, *Hirsutocythere hanaii*, *Ostracoda*, *Trachyleberididae*

INTRODUCTION

Ostracods are small bivalved crustaceans (average adult length of c. 1 mm) abundantly found in the fossil record from the Ordovician onwards, as well as in a wide range of aquatic environments. The ostracod Family Trachyleberididae was defined by Sylvester-Bradley (1948) with a fossil record from the Cretaceous onwards (Whatley *et al.*, 1993). To date, 57 trachyleberidid species belonging to 22 genera have been described from Japan (Table 1). The Trachyleberididae has been classified into several subfamilies, such as Trachyleberidinae, Buntoniinae and Phacorhabdotinae. The heavily calcified trachyleberidid ostracod carapaces are found abundantly in Cenozoic sediments around Japan. Many Recent trachyleberidid species have a fossil record from the Neogene onwards. However, only four Trachyleberidid species with appendages have been recorded from Japan, *T. scabrocuneata* (Brady, 1880) (for illustrated appendages, see Harding & Sylvester-Bradley, 1953; Okubo, 1979), *T. ikeyai* (Tanaka, 2008), *Bicornucythere bisanensis* (Okubo, 1975) and *Pistocythereis bradyi* (Ishizaki, 1968) (for description of the appendages, see Okubo, 1979). The aim of this study is to describe three Japanese trachyleberidid ostracod species with their appendages.

MATERIAL AND METHODS

Surface sediments of the Tsushima Strait (St. 13) were collected using the Smith–McIntyre grab sampler during cruises by *TRV Toyoshio-maru* (November 15 – 20, 1999), c. 120 km east of Tsushima Island (north Island), N 34° 46' E 130° 46' at a depth of 116 m. A total of 36 ostracod species were identified in the sample (see Tanaka, 2008). To extract additional specimens with appendages, a spare sample of St. 13 was examined under a binocular microscope. As a result, seven cytheroidean ostracod species with appendages were recovered from 132 g of dry sediment: *Acanthocythereis munechikai* Ishizaki, 1981; *Actinocythereis kisarazuensis* Yajima, 1978; *Bradleya japonica* Benson, 1972; *Cytheropteron uchioi* Hanai, 1957; *Hirsutocythere hanaii* Ishizaki, 1981; *Munseyella oborozukiyo* Yajima, 1982; and *Trachyleberis ikeyai* Tanaka, 2008. Of these, three trachyleberidid species, *A. munechikai*, *A. kisarazuensis*, and *H. hanaii*, were analysed further. Dried specimens were softened in a 10% sodium tripolyphosphate solution. Dissections of appendages

were made in glycerine under a Nikon SMZ-U stereoscopic microscope, mounted in Neo-Shigal on glass slides, and covered. The appendages and valves were drawn with a camera lucida attachment and an Olympus BX41 stereoscopic microscope. Other carapaces were mounted on stubs and coated with gold using a JEOL ion sputter (JFC-1100), prior to being viewed using a JEOL JSM-6100 scanning electron microscope. All illustrated specimens are deposited in the University Museum, University of Tokyo (UMUT RA).

SYSTEMATIC DESCRIPTIONS

Family **Trachyleberididae** Sylvester-Bradley, 1948

Genus *Acanthocythereis* Howe, 1963

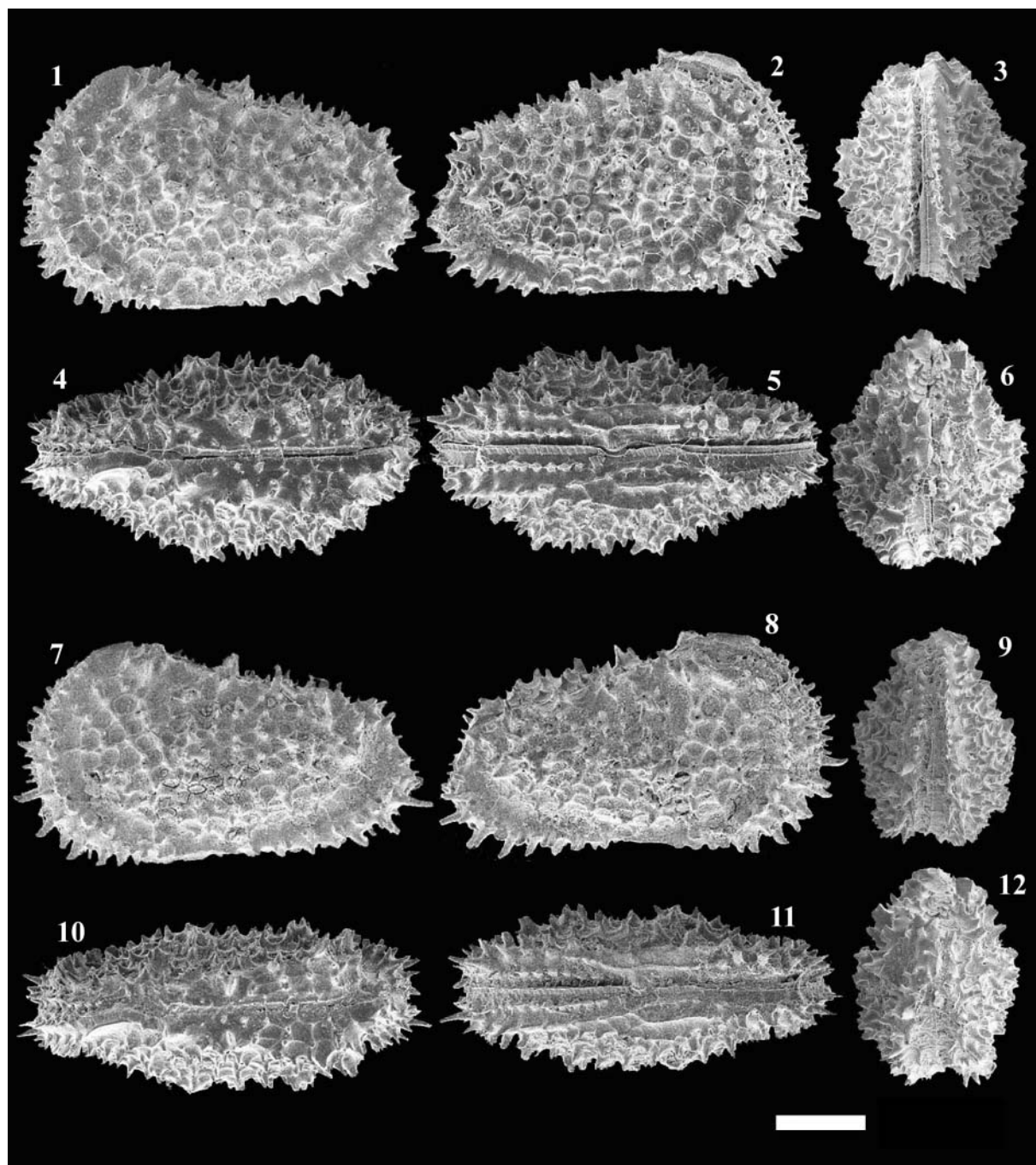
Acanthocythereis munechikai Ishizaki, 1981

(Pl. 1; Fig. 1)

- 1981 *Acanthocythereis munechikai* Ishizaki: 45, 46, pl. 9, figs 1, 2a–c, 3; pl. 14, fig. 8; pl. 15, figs 3 & 4.
- 1985 *Acanthocythereis munechikai* Ishizaki; Wang & Zhao: pl. 7, fig. 8.
- 1988 *Acanthocythereis munechikai* Ishizaki; Paik & Lee: pl. 2, fig. 16.
- 1988 *Acanthocythereis munechikai* Ishizaki; Zhao & Wang: pl. 2, fig. 14.
- 1988 *Acanthocythereis munechikai* Ishizaki; Wang *et al.*: 246, 247, pl. 18, figs 1–3.
- 1989 *Trachyleberis? zhoushanensis* Liu: 154, pl. 168, figs 9 & 10.
- 1992 *Acanthocythereis munechikai* Ishizaki; Ikeya & Suzuki: pl. 1, fig. 3.
- 1992 *Acanthocythereis munechikai* Ishizaki; Lee & Paik: pl. 4, fig. 8.
- 1998 *Acanthocythereis munechikai* Ishizaki; Irizuki *et al.*: fig. 6 (6).
- 2001 *Acanthocythereis munechikai* Ishizaki; Irizuki *et al.*: fig. 7 (14).
- 2001 *Acanthocythereis munechikai* Ishizaki; Nakao *et al.*: fig. 11 (13).
- 2007 *Acanthocythereis munechikai* Ishizaki; Hou & Gou: 454, pl. 172, figs 15 & 16.

Family	Genus	Species
Trachyleberididae Sylvester-Bradley, 1948	<i>Abrocythereis</i> Gou, 1983 (in Gou <i>et al.</i> , 1983)	<i>Abrocythereis ryukyuensis</i> Malz & Tabuki, 1988
	<i>Acanthocythereis</i> Howe, 1963	<i>Abrocythereis yajimae</i> Nohara, 1987 <i>Acanthocythereis ashiyaensis</i> Yamaguchi, 2007 (in Yamaguchi & Kamiya, 2007) <i>Acanthocythereis fujinaensis</i> Tanaka, 2002 (in Tanaka <i>et al.</i> , 2002) <i>Acanthocythereis izumoensis</i> Tanaka, 2002 (in Tanaka <i>et al.</i> , 2002) <i>Acanthocythereis japonica</i> Irizuki & Yamada, 2004 (in Irizuki <i>et al.</i> , 2004) <i>Acanthocythereis munechikai</i> Ishizaki, 1981 <i>Acanthocythereis mutsuensis</i> Ishizaki, 1971 <i>Acanthocythereis? niitsumai</i> (Ishizaki, 1971) <i>Acanthocythereis quadrata</i> Irizuki & Yamada, 2004 (in Irizuki <i>et al.</i> , 2004) <i>Acanthocythereis tsurugasakensis</i> Tabuki, 1986 <i>Actinocythereis kisarazuensis</i> Yajima, 1978
	<i>Actinocythereis</i> Puri, 1953 (Puri, 1953a in this reference)	
	<i>Alocopocythere</i> Siddiqui, 1971	<i>Alocopocythere? ishizakii</i> Nohara, 1987
	<i>Ambocythere</i> Van Den Bold, 1957	<i>Ambocythere uchimaensis</i> Nohara, 1987
	<i>Ambtonia</i> Malz, 1982	<i>Ambtonia? matsubarae</i> Yamaguchi, 2006 <i>Ambtonia obai</i> (Ishizaki, 1971) <i>Ambtonia shimanensis</i> Tanaka, 2002 (in Tanaka <i>et al.</i> , 2002) <i>Ambtonia takayasui</i> Tanaka, 2002 (in Tanaka <i>et al.</i> , 2002)
	<i>Amphileberis</i> Guan, 1978 (in Guan <i>et al.</i> , 1978)	<i>Amphileberis nipponica</i> (Yajima, 1978)
	<i>Australimoosella</i> Hartmann, 1978	<i>Australimoosella tomokoae</i> (Ishizaki, 1968) <i>Australimoosella hanaii</i> Yajima, 1992
	<i>Bicornucythere</i> Schornikov & Shaitarov, 1979	<i>Bicornucythere bisanensis</i> (Okubo, 1975)
	<i>Buntonia</i> Howe, 1935 (in Howe & Chambers, 1935)	<i>Buntonia hanaii</i> Yajima, 1978 <i>Buntonia parascorta</i> Ishizaki, 1983 <i>Buntonia scorta</i> Ishizaki, 1983 <i>Buntonia u-carinata</i> Ishizaki, 1983
	<i>Campylocythereis</i> Omatsola, 1971	<i>Campylocythereis? ukifune</i> Yajima, 1982
	<i>Celtia</i> Neale, 1973	<i>Celtia japonica</i> Ishizaki, 1981
	<i>Falsobuntonia</i> Malz, 1982	<i>Falsobuntonia hayamii</i> (Tabuki, 1986) <i>Falsobuntonia? waitaensis</i> Yamaguchi, 2007 (in Yamaguchi & Kamiya, 2007)
	<i>Hirsutocythere</i> Howe, 1951	<i>Hirsutocythere? akatsukiborensis</i> Yajima, 1992 <i>Hirsutocythere hanaii</i> Ishizaki, 1981 <i>Hirsutocythere? nozokiensis</i> (Ishizaki, 1963)
	<i>Isocythereis</i> Triebel, 1940	<i>Isocythereis? roochuensis</i> Nohara, 1987
	<i>Murrayina</i> Puri, 1954	<i>Murrayina japonica</i> Tabuki, 1986
	<i>Neocytheretta</i> Van Morkhoven, 1963	<i>Neocytheretta? iwasakii</i> (Nohara, 1987)
	<i>Pacambocythere</i> Malz, 1982	<i>Pacambocythere ishizakii</i> Nohara, 1987 <i>Pacambocythere japonica</i> (Ishizaki, 1968)
	<i>Pistocythereis</i> Gou, 1983 (in Gou <i>et al.</i> , 1983)	<i>Pistocythereis bradyformis</i> (Ishizaki, 1968) <i>Pistocythereis bradyi</i> (Ishizaki, 1968)
	<i>Robertsonites</i> Swain, 1963	<i>Robertsonites hanaii</i> Tabuki, 1986 <i>Robertsonites irizukii</i> Yamada, 2003 <i>Robertsonites japonicus</i> (Ishizaki, 1966) <i>Robertsonites leptoreticulata</i> Yamada, 2003 <i>Robertsonites reticulatus</i> Irizuki & Yamada, 2004 (in Irizuki <i>et al.</i> , 2004) <i>Robertsonites reticuliformus</i> (Ishizaki, 1966) <i>Robertsonites tsugaruana</i> Tabuki, 1986 <i>Robertsonites yatsukanus</i> Tanaka, 2002 (in Tanaka <i>et al.</i> , 2002)
	<i>Sinoleberis</i> Hu, 1979	<i>Sinoleberis tosaensis</i> (Ishizaki, 1968)
	<i>Trachyleberis</i> Brady, 1898	<i>Trachyleberis? funatsuensis</i> Yamaguchi, 2006 <i>Trachyleberis ikeyai</i> Tanaka, 2008 <i>Trachyleberis inouei</i> Yamaguchi, Nagao & Kamiya, 2006 <i>Trachyleberis ishizakii</i> Yasuhara <i>et al.</i> , 2002 <i>Trachyleberis mizunamiensis</i> Yajima, 1992 <i>Trachyleberis scabrocuneata</i> (Brady, 1880) <i>Trachyleberis shukunohorensis</i> Yajima, 1992 <i>Trachyleberis straba</i> Frydl, 1982

Table 1. Trachyleberidid ostracods described from Japan.



Explanation of Plate 1.

figs 1–12. Scanning electron photomicrographs of the carapaces of *Acanthocythereis munechikai* Ishizaki, 1981, female (1–6; UMUT RA30558) and male (7–12; UMUT RA30559) from the Tsushima Strait, southwestern Japan: **1, 7**, left lateral view; **2, 8**, right lateral view; **3, 9**, anterior view; **4, 10**, dorsal view; **5, 11**, ventral view; **6, 12**, posterior view. Scale bar 100 μ m.

Description. Valve sub-quadrate in lateral view (Pl. 1, figs 1, 2, 7, 8). Anterior margin evenly rounded with conical spines, especially anteroventrally; dorsal margin straight, sloping toward posterior with several conical spines; posterior margin truncated near middle, slope nearly straight above, convex below with several long conical spines; ventral margin concave in middle. Strong sexual dimorphism; male elongated in lateral view; female carapace inflated laterally in anterior, dorsal and

posterior views. Eye tubercle absent. Surface ornamented by polygonal reticulations with conical and clavate spines. Row of prominent clavate spines at base of anterodorsal corner running nearly parallel to anterior margin. In dorsal and ventral views, lateral outline fusiform-shaped (Pl. 1, figs 4, 5, 10, 11). In anterior and posterior views, carapace subovate, broadest near mid-height (Pl. 1, figs 3, 6, 9, 12). Marginal pore canals straight and/or curved with median swellings; 53 anterior, 21 ventral and



Fig. 1. The valve and the male soft parts of *Acanthocythereis munechikai* Ishizaki, 1981: **A**, male left valve (UMUT RA30560); **B–J**, soft parts of the male (UMUT RA30561) – **B**, antennule, **C**, antenna, **D**, mandible, **E**, distal segment of maxillula, **F**, branchial plate of maxillula, **G**, first thoracic leg, **H**, second thoracic leg, **I**, third thoracic leg, **J**, copulatory organ. Scale 1, 100 μ m for **A**; scale 2, 100 μ m for **B–J**.

17 posterior pore canals (Fig. 1A). Duplicature developed. Hinge holamphidont: left valve, anterior element with auxiliary tooth in large elongate socket; anteromedian element a smooth tooth, posteromedian element a bar; posterior element an elongated socket. Four elliptical adductor scars in vertical row (upper two semi-circular, others elliptical). Two elliptical mandibular scars. Small anteromedian depression in front of adductor scars.

Antennule (Fig. 1B): six articulated segments. Length ratio between distal segments 85: 60: 25: 17: 20: 30. Exoskeletons developed, especially segments 2–5. First segment with long setules on middle anterior margin and posterior proximal margin, small bunch of short setules anterior distal end. Second

segment with plumose seta posterior distal end, and middle posterior margin; long setules proximal half of anterior margin; small bunch of short setules anterior distal end. Third segment with seta anterior distal end, row of small bunches of short setules on distal end. Fourth segment with long seta and relatively stout seta on anterior distal end, numerous short setules anterior margin, long seta centre. Fifth segment ledge anterior distal end with 4 setae: 2 long setae, 1 relatively stout seta and 1 short seta. Sixth segment distal end with 3 long setae, 1 relatively short seta with club-like structure at distal end.

Antenna (Fig. 1C): four articulated segments. Length ratio between distal segments 40: 12: 51: 8. Exoskeletons developed, especially broad in third and fourth segments. First segment

with row of numerous short setules outer lateral side. Second segment with short 2-segmented (actually 3 segments, but first and second fused), exopodite with several long setules at base and long plumose seta posterior distal end. Third segment with paired setae anterior margin, 1 relatively long seta and 2 short setae, one of which shows paddle-like shape at the distal end, numerous short setules one-third from distal end, and pair of unequal setae (outer seta longer and stouter) and row of small bunches of short setules distal end. Fourth segment with stout clawlike seta anterior margin distal end and 2 setae (claw-like stout seta and relatively fine seta) ledge posterior margin.

Mandible (Fig. 1D): five segmented. Length ratio between 2 protopodite segments and 3 endopodite segments 51: 14: 10: 15: 16. Basal segment (coxa, first segment of protopodite) with about 6 teeth, 1 seta anterior distal margin. Second segment of protopodite (basis) with exopodite consisting of 5 setae, and 2 plumose setae posterior distal margin. First segment of endopodite with 2 long feather-like setae, 1 short comb-like seta, and 1 simple seta ventral distal end, plumose seta dorsal distal end. Second segment of endopodite with a pair of unequal setae (long plumose seta and short comb-like seta) posterior distal margin, and 7 long fine setae anterior distal end. Third segment of endopodite bearing 3 simple setae and 1 plumose seta.

Maxillula (Figs 1E, F): extremely thin branchial plate (exopodite) with 16 plumose setae (Fig. 1F). Basal podomere bearing palp and 3 masticatory processes (Fig. 1E). Palp 2-segmented. Proximal segment with 3 setae anterior distal end. Distal segment with 1 stout seta and 7 setae on distal end and near inner masticatory lobe, respectively. Outer masticatory process with 7 setae on distal end. Each of the middle and inner masticatory processes with 4 setae.

Thoracic legs (Figs 1G–I): all three legs 4-segmented and similar in shape. Length ratio between distal segments 60: 55: 38: 35 in first thoracic leg, 67: 59: 40: 38 in second thoracic leg, 40: 43: 20: 23 in third thoracic leg. Distal margin of each segment sometimes covered with many short setules. Exoskeletons developed on both margins of each segments. First segment with two setae anterior margin and 1 or 2 plumose seta(e) anterior distal end. Second segment bearing plumose seta on anterior distal end. Fourth segment bearing large terminal claw.

Copulatory organ of male (Fig. 1J): basal capsule rounded. Exoskeleton developed along anterior margin. Subtriangular supporting lobe (distal lobe) developed on distal end of basal capsule. Ductus ejaculatorius well developed and twisted at one-half from distal end. One long linguiform clasping apparatus posterior side of ductus ejaculatorius.

Remarks. The genus *Acanthocythereis* was defined by Howe (1963) from the middle Eocene Cook Mountain Formation in Louisiana, USA. It was distinguished from *Trachyleberis* Brady, 1898 in having web-like reticulations between spines and in lacking the muscle scar node. The present species differs from *Acanthocythereis* sp. 1 reported from the Pacific coast of south-west Japan, by Zhou (1995), in its caudal process more protruded ventrally. The specimens figured by Zheng (1994) as *A. munechikai* have a different posterior outline and surface ornamentation compared to those described by Ishizaki (1981). The fossil specimen figured by Irizuki *et al.* (2001) has more prominent reticulation.

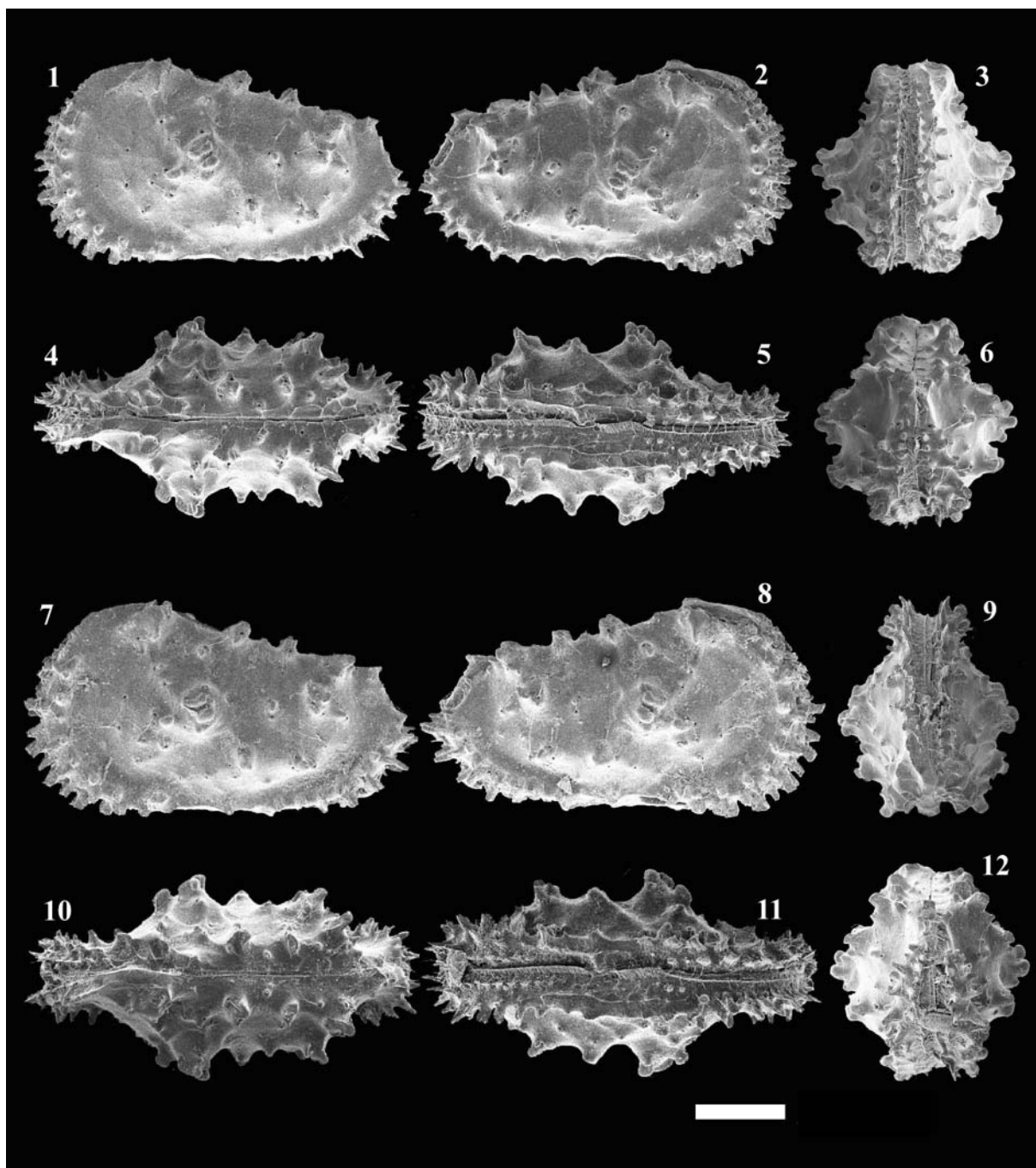
Genus *Actinocythereis* Puri, 1953a
Actinocythereis kisarazuensis Yajima, 1978
 (Pl. 2, Fig. 2)

- 1978 *Actinocythereis kisarazuensis* Yajima: 399, 400, pl. 49, figs 3a, b; text-fig. 9; fig. 1.
 1985 *Actinocythereis kisarazuensis* Yajima; Wang & Zhao: pl. 7, fig. 10.
 1988 *Actinocythereis kisarazuensis* Yajima; Zhao & Wang: pl. 2, fig. 15.
 1988 *Actinocythereis kisarazuensis* Yajima; Wang *et al.*: 247, pl. 18, figs 6 & 7.
 1989 *Actinocythereis spinosa* Liu: 155, pl. 169, fig. 5.
 1992 *Actinocythereis kisarazuensis* Yajima; Ikeya & Suzuki: pl. 1, fig. 5.
 2007 *Actinocythereis kisarazuensis* Yajima; Hou & Gou: 451, 452, pl. 179, fig. 10; pl. 204, fig. 8.
 2008 *Actinocythereis kisarazuensis* Yajima; Tanaka: fig. 2q.

Description. Valve sub-quadrate in lateral view (Pl. 2, figs 1, 2, 7, 8). Anterior margin evenly rounded with clavate spines, especially anteroventrally; dorsal margin straight, sloping toward posterior with several clavate spines; posterior margin truncated near middle, slope nearly straight above, convex below with several long conical spines; ventral margin concave in middle. Weak sexual dimorphism; male slightly elongated in lateral view; female carapace slightly inflated laterally in anterior view. Eye tubercle present. Surface ornamented by several clavate spines. Row of 7 clavate spines runs nearly parallel to anterior margin. Lateral outline fusiform-shaped in dorsal and ventral views, anterior end more pointed than posterior (Pl. 2, figs 4, 5, 10, 11). Carapace subhexagonal in anterior and posterior views, broadest near mid-height (Pl. 2, figs 3, 6, 9, 12). Marginal pore canals straight and/or curved; 59 anterior, 14 ventral, and 16 posterior pore canals (Fig. 2A). Duplicature developed. Hinge holamphidont: right valve anterior element with stepped tooth; anteromedian element a large elongate socket, posteromedian element a crenulated socket; posterior element a round tooth. Four elliptical adductor scars in vertical row. Two elliptical mandibular scars. A deep anteromedian depression in front of adductor scars, corresponding to the external subcentral tubercle.

Antennule (Fig. 2B): six articulated segments. Length ratio between distal segments 62: 40: 15: 15: 14: 21. Exoskeletons developed, especially segments 2–5. First segment with row of short setules outer lateral side, two rows of short setules near distal end, and long setules on posterior proximal margin. Second segment with plumose seta on posterior distal end, long setules near proximal anterior margin; small bunch of short setules on anterior distal end. Third segment with seta on anterior distal end and row of small bunches of short setules on distal end. Fourth segment with long seta and stout seta anterior distal end with numerous short setules anterior margin, long seta centre. Fifth segment ledge anterior distal end with 4 setae: 2 long setae, 1 relatively stout seta, and 1 short seta. Sixth segment distal end with 3 long setae and 1 relatively short seta with club-like structure at the distal end.

Antenna (Fig. 2C): four articulated segments. Length ratio between distal segments 30: 11: 35: 6. Exoskeletons developed,



Explanation of Plate 2.

figs 1–12. Scanning electron photomicrographs of the carapaces of *Actinocythereis kisarazuensis* Yajima, 1978, female (1–6; UMUT RA30562) and male (7–12; UMUT RA30563) from the Tsushima Strait, southwestern Japan: **1, 7**, left lateral view; **2, 8**, right lateral view; **3, 9**, anterior view; **4, 10**, dorsal view; **5, 11**, ventral view; **6, 12**, posterior view. Scale bar 100 μ m.

especially in broad third and fourth segments. First segment with two unequal rows of numerous short setules outer lateral side. Second segment with short 2-segmented (actually 3 segments, but first and second fused) exopodite, 2 long setules at base of exopodite and a long plumose seta posterior distal end, numerous setules outer lateral side. Third segment with a pair of setae (1 short plumose seta and 1 long simple seta) along

anterior margin, posterior margin with one relatively long seta and 2 short setae, one of which shows paddle-like shape at distal end, a pair of unequal setae (outer seta longer and stouter) and a row of small bunch of short setules on distal end. Fourth segment with stout claw-like seta along anterior margin distal end and 2 setae (claw-like stout seta and relatively fine seta) on ledge on posterior margin.

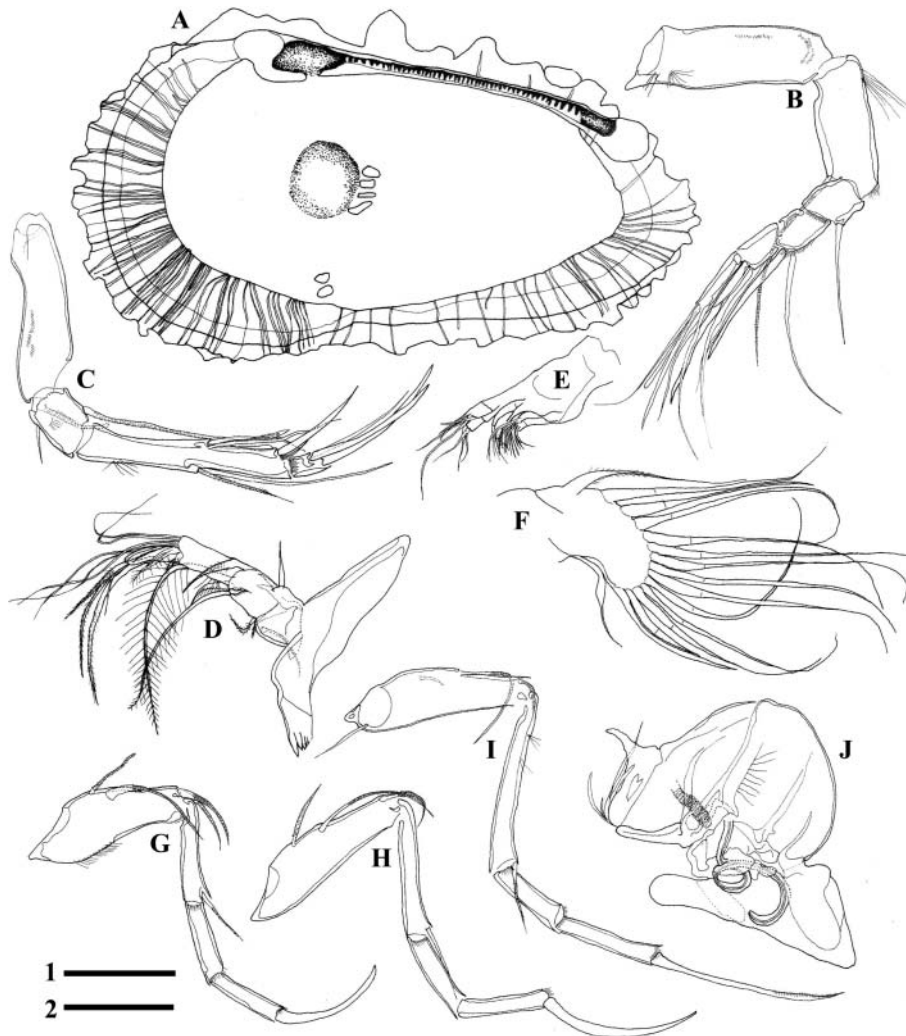


Fig. 2. The valve and the male soft parts of *Actinocythereis kisarazuensis* Yajima, 1978: **A**, male right valve (UMUT RA30564); **B–J**, soft parts of the male (UMUT RA30565) – **B**, antennule, **C**, antenna, **D**, mandible, **E**, distal segment of maxillula, **F**, branchial plate of maxillula, **G**, first thoracic leg, **H**, second thoracic leg, **I**, third thoracic leg, **J**, copulatory organ. Scale 1, 100 µm for **A**; scale 2, 100 µm for **B–J**.

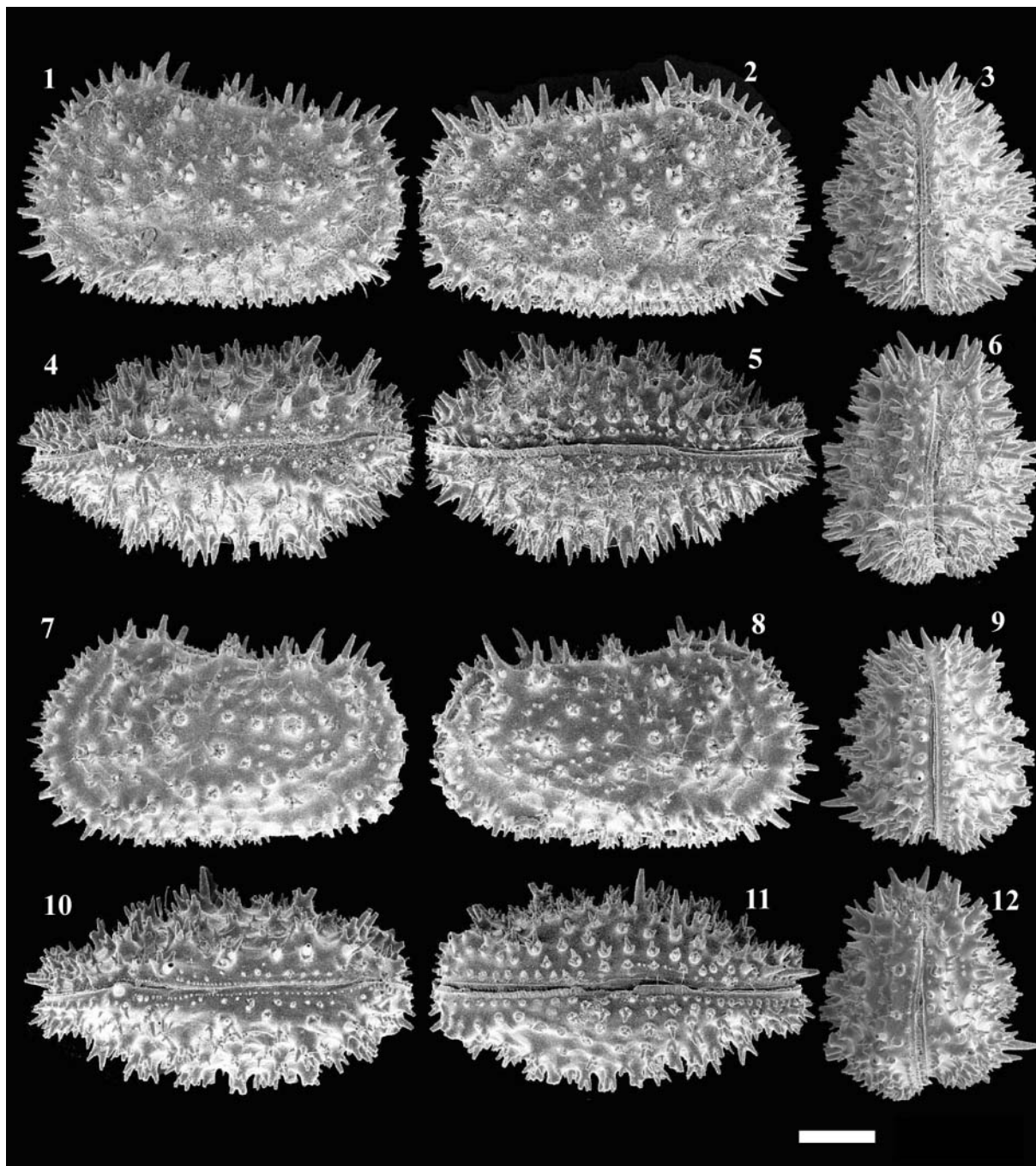
Mandible (Fig. 2D): five segmented. Length ratio between 2 protopodite segments and 3 endopodite segments 80: 14: 17: 21: 19. Basal segment (coxa, first segment of protopodite) with six teeth. Second segment of protopodite (basis) with exopodite consisting of five setae, and 2 plumose setae posterior distal margin. First segment of endopodite with 2 long feather-like setae, 1 short comb-like seta, and 1 short plumose seta ventral distal end, stout plumose seta dorsal distal end. Second segment of endopodite with a pair of unequal plumose setae posterior distal margin, and 5 long fine setae and 2 short setae anterior distal end. Third segment of endopodite bearing 3 plumose setae and 1 simple seta.

Maxillula (Figs 2E, F): extremely thin branchial plate (exopodite) with 15 plumose setae (Fig. 2F). Basal podomere bearing palp and 3 masticatory processes. Palp 2-segmented. Proximal segment with 3 setae anterior distal end. Distal segment with 1 plumose seta and 4 setae distal end. Outer masticatory process with 7 setae distal end. Each of the middle and inner masticatory processes with 4 setae.

Thoracic legs (Figs 2G–I). All three legs 4-segmented and similar in shape. Length ratio between distal segments 46: 32: 25: 24 in first thoracic leg, 52: 42: 27: 31 in second thoracic leg, and 61: 55: 25: 35 in third thoracic leg. Distal margin of each segment sometimes covered with many short setules. Exoskeletons developed on both margins of each segments. First segment with two setae anterior margin, 1 or 2 plumose seta(e) anterior distal end. Second segment bearing plumose seta on anterior distal end. Fourth segment bearing large terminal claw.

Copulatory organ of male (Fig. 4J): basal capsule rounded. Exoskeleton developed along anterior margin. Subtriangular supporting lobe (distal lobe) developed distal end basal capsule. Ductus ejaculatorius well developed and coiled at one-half from distal end. One linguiform clasping apparatus posterior side of ductus ejaculatorius.

Remarks. Puri (1953a) distinguished *Actinocythereis* from *Trachyleberis* by its three distinct rows of spines on the carapace. The spines of *A. kisarazuensis* do not show such an arrangement,



Explanation of Plate 3.

figs 1–12. Scanning electron photomicrographs of the carapaces of *Hirsutocythere hanaii* Ishizaki, 1981, female (1–6; UMUT RA30566) and male (7–12; UMUT RA30567) from the Tsushima Strait, southwestern Japan: 1, 7, left lateral view; 2, 8, right lateral view; 3, 9, anterior view; 4, 10, dorsal view; 5, 11, ventral view; 6, 12, posterior view. Scale bar 100 μ m.

although two horizontal rows of spines are recognized in the species (Yajima, 1978). However, other morphological characters of *A. kisarazuensis* are closely assigned to the genus *Actinocythereis*, as Hanai *et al.* (1977) mentioned. The present species is similar to *Actinocythereis scutigera* (Brady) figured in Zhao *et al.* (1985; pl. 19, fig. 12), but the node pattern on the dorsal part of the carapace is different. This species differs from *A.?* sp.

E, which was reported from the Recent sediment of the Ulleung Basin, Korea by Cheong *et al.* (1986), in its more protruded caudal process.

Genus *Hirsutocythere* Howe, 1951
Hirsutocythere hanaii Ishizaki, 1981
 (Pl. 3, Fig. 3)

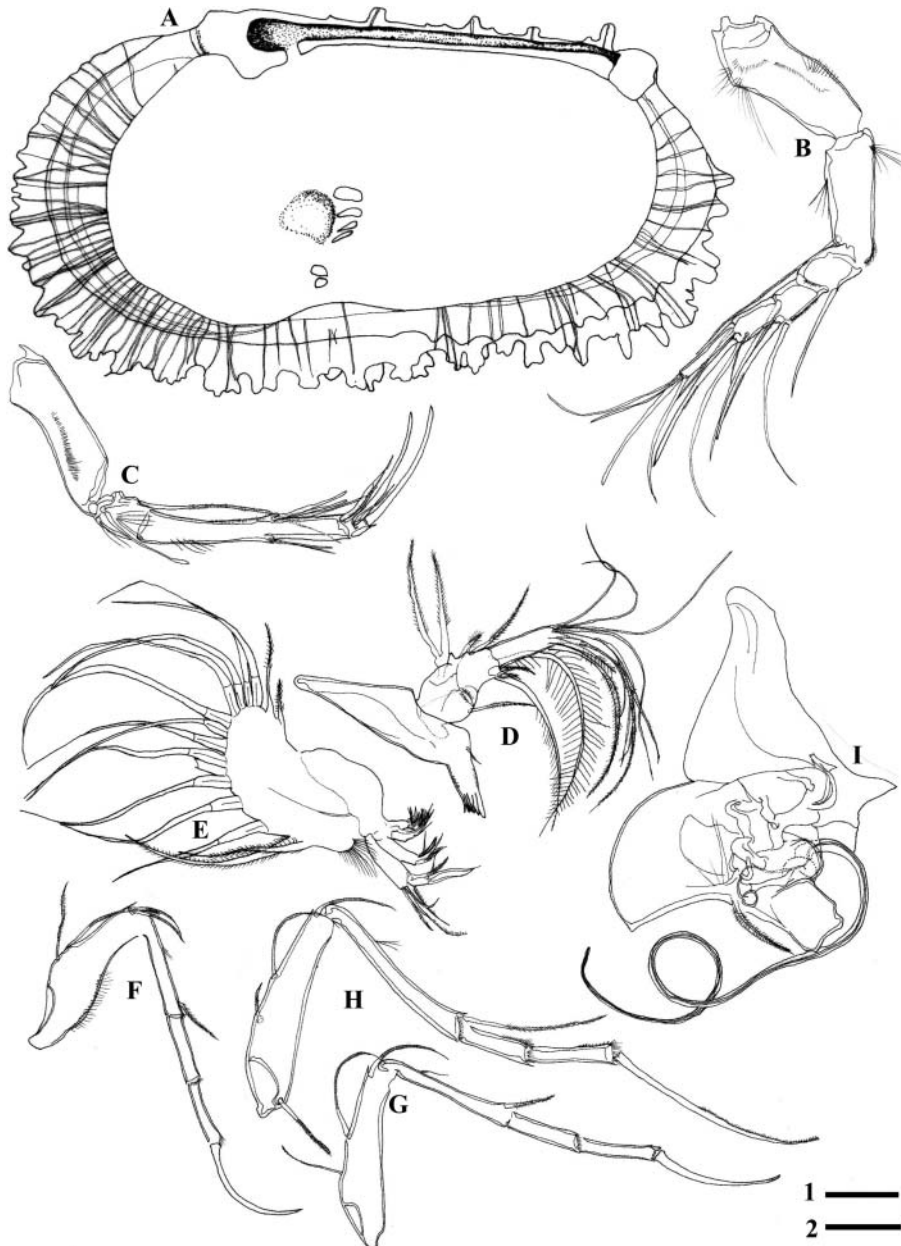


Fig. 3. The valve and the male soft parts of *Hirsutocythere hanaii* Ishizaki, 1981: **A**, male right valve (UMUT RA30568); **B–J**, soft parts of the male (UMUT RA30569) – **B**, antennule, **C**, antenna, **D**, mandible, **E**, maxillula; **F**, first thoracic leg; **G**, second thoracic leg; **H**, third thoracic leg; **I**, copulatory organ. Scale 1, 100 µm for A; scale 2, 100 µm for B–J.

1981 *Hirsutocythere? hanaii* Ishizaki: 46, 47, pl. 9, figs 4a, b, 5a, b, 6a, b, 7; pl. 15, fig. 6.
 1985 *Hirsutocythere? hanaii* Ishizaki; Wang & Zhao: pl. 7, fig. 12.
 1988 *Hirsutocythere? hanaii* Ishizaki; Wang *et al.*: 247, 248, pl. 18, figs 10–13.
 1988 *Hirsutocythere hanaii* Ishizaki; Paik & Lee: pl. 2, fig. 17.
 1988 *Hirsutocythere? nozokiensis* Ishizaki; Yajima: pl. 2, fig. 16.
 1988 *Hirsutocythere? hanaii* Ishizaki; Ruan & Hao: 360, 361, pl. 66, figs 12 & 13.
 1989 *Hirsutocythere? hanaii* Ishizaki; Liu: 158, 159, pl. 171, figs 7 & 11.

1992 *Hirsutocythere? hanaii* Ishizaki; Ikeya & Suzuki: pl. 5, fig. 5.
 1992 *Hirsutocythere hanaii* Ishizaki; Lee & Paik: pl. 4, fig. 7.
 1996 *Hirsutocythere? hanaii* Ishizaki; Kamiya *et al.*: pl. 4, figs 9 & 10.
 1996 *Hirsutocythere? hanaii* Ishizaki; Ozawa: pl. 5, fig. 6.
 1998 *Hirsutocythere? hanaii* Ishizaki; Irizuki *et al.*: fig. 6 (7).
 2001 *Hirsutocythere? hanaii* Ishizaki; Irizuki *et al.*: fig. 7 (15).
 2001 *Hirsutocythere? hanaii* Ishizaki; Nakao *et al.*: fig. 11 (13).
 2007 *Hirsutocythere? hanaii* Ishizaki; Hou & Gou: 456, pl. 179, figs 17–21; pl. 182, figs 13 & 14.
 2008 *Hirsutocythere? hanaii* Ishizaki; Tanaka: fig. 2r.

Description. Valve sub-quadrate in lateral view (Pl. 3, figs 1, 2, 7, 8). Anterior and posterior margins evenly rounded with conical spines, spines especially large and long ventrally; dorsal margin straight, sloping toward posterior with several long conical spines; ventral margin convex. Male slightly elongated in lateral view; female carapace slightly inflated laterally in anterior, dorsal and posterior views. Prominent long conical spine ventro-lateral side male right valve. Eye tubercle absent. Surface ornamented by many prickly spines, some clustered. Lateral outline fusiform-shaped in dorsal and ventral views, anterior end more pointed than posterior (Pl. 3, figs 4, 5, 10, 11). Carapace subovate in anterior and posterior views, broadest near mid-height (Pl. 3, figs 3, 6, 9, 12). Marginal pore canals straight and/or curved numbering 49 anterior, 20 ventral and 17 posterior (Fig. 3A). Duplicature developed. Hinge holamphidont: right valve anterior element with stepped tooth; antero-medial element a large elongate socket, posteromedian element a long socket; posterior element a round tooth. Four elliptical adductor scars in vertical row. Two elliptical mandibular scars. Deep anteromedian depression anterior of adductor scars.

Antennule (Fig. 3B): six articulated segments. Length ratio between distal segments 23: 16: 6: 5: 6: 9. Exoskeletons developed, especially in segments 2–5. First segment with three clusters of setules outer lateral side and row of long setules posterior proximal margin. Second segment with plumose seta posterior distal end, long setules near proximal end anterior and posterior margins; small bunch of short setules anterior distal end. Third segment with seta anterior distal end and row of small bunches of short setules distal end. Fourth segment with long seta and stout seta with comb-like structure anterior distal end, numerous short setules on anterior margin, long seta centre. Fifth segment with 4 setae: 2 long setae, 1 stout seta with comb-like structure, and 1 short seta ledge anterior distal end. Sixth segment with 3 long setae and 1 short seta distal end.

Antenna (Fig. 3C): Four articulated segments. Length ratio between distal segments 58: 19: 72: 6. Exoskeletons developed, especially in broad third and fourth segments. First segment with a row of numerous setules outer lateral side. Second segment with short 2-segmented (actually 3 segments, but first and second fused) exopodite, a long setule at the base of the exopodite, two long setules on anterior proximal end, and 6 long setules outer lateral side, long plumose seta posterior distal end. Third segment with a pair of setae anterior margin, 1 relatively long seta and 2 stout setae distal end, numerous short setules middle, and a pair of unequal setae (outer seta longer and stouter with comb-like structure) on distal end. Fourth segment with stout claw-like seta along anterior margin distal end and 2 setae (claw-like stout seta and relatively fine seta) ledge posterior margin.

Mandible (Fig. 3D): five segmented. Length ratio between 2 protopodite segments and 3 endopodite segments 41: 9: 8: 11: 12. Basal segment (coxa, first segment of protopodite) with 6 teeth, and 1 seta anterior distal margin. Second segment of protopodite (basis) with exopodite consisting of three setae, and 2 plumose setae posterior distal margin. First segment of endopodite with 2 long feather-like setae and two plumose setae ventral distal end, a plumose seta dorsal distal end. Second segment of endopodite with a pair of unequal plumose setae on posterior distal margin, and 7 long fine setae on anterior distal

end. Third segment of endopodite bearing 1 simple seta and 2 plumose setae.

Maxillula (Figs 3E): extremely thin branchial plate (exopodite) with 16 plumose setae and many long setules ledge anterior distal margin (Fig. 3E). Basal podomere bearing palp and 3 masticatory processes (Fig. 3E). Palp 2-segmented. Proximal segment with 3 setae anterior distal end. Distal segment with 1 stout plumose seta, 3 simple setae and 1 stout comb-like seta distal end. Outer masticatory process with 6 setae distal end. Each of the middle and inner masticatory processes with 4 setae.

Thoracic legs (Figs 3F–H): all 3 legs 4-segmented and similar in shape. Length ratio between distal segments 56: 36: 22: 23 in first thoracic leg, 32: 23: 12: 14 in second thoracic leg, 32: 30: 13: 15 in third thoracic leg. Distal margin of each segment sometimes covered with many short setules. Exoskeletons developed on both margins of each segments. First segment with two plumose setae anterior margin, and 1 or 2 plumose seta(e) anterior distal end. Second segment with plumose seta anterior distal end. Fourth segment bearing large terminal claw.

Copulatory organ of male (Fig. 3I): basal capsule semilunar. Exoskeleton developed along anterior margin. Subtriangular supporting lobe (distal lobe) developed on distal end of basal capsule. Long ductus ejaculatorius with single coil. One large quadrangular clasping apparatus posterior side of ductus ejaculatorius.

Remarks. This species has been unreliably included in the genus *Hirsutocythere* by many authors since Ishizaki (1981) described it. The present species differs from the genotype species *Hirsutocythere hornotina* Howe, 1951, in its narrow marginal infold area (possibly equal to the vestibule of Scott, 1961). However, the width of the vestibule of a trachyleberidid Ostracoda *Alocopocythere kendgensis* shows wide variation even in the same species (e.g., Carbonel & Hoibian, 1988, fig. 7), although the cause of the variation of the vestibule has not yet been clarified. Moreover, the shell outline and its surface ornamentation with long prickly spines are closely similar to *H. hornotina*. The Japanese genus also resembles the genus *Echinocythereis* Puri (1953b), but differs with its prickly spines and has no concentric arrangement pattern of the spines. *Carinocythereis* (Ruggieri, 1956) is clearly distinguished from the Japanese genus, with its prominent four longitudinal ridges developed from anterior to posterior of the shell surface. This species resembles *Hirsutocythere? akatsukiborensis* Yajima, 1992 in carapace outline, but the pattern of surface ornamentation of the carapace is clearly distinct from that of *H. akatsukiborensis*. This species differs from *Hirsutocythere? nozokiensis* (Ishizaki, 1963) in its arrangement of the prickly spines of anteromedian area. The fossil specimens figured by Irizuki *et al.* (1998, 2001) and Nakao *et al.* (2001) as *Hirsutocythere? hanaii* have slightly different shell outlines from Recent ones.

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