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Original Article

Reclassification of the genus *Hemicytherura* (Crustacea, Ostracoda) from Japan and the surrounding regions

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Abstract： The genus *Hemicytherura* is comparatively small (0.65mm in largest length) Ostracoda even in Podocopa (usually less than 1 mm). This genus appeared in the coastal areas of Japan and the surrounding regions after Miocene, and currently, its members inhabit the intertidal zones of these areas. Here six new species, *i.e., Hemicytherura choeae* n. sp., *H. huangi* n. sp., *H. japonica* n. sp., *H. notoensis* n. sp., *H. okuboi* n. sp., and *H. taiwanensis* n. sp. are described. In addition, we have described four species that were previously reported from these coastal areas, *i.e., H. kajiyamai* Hanai, 1957; *H. cuneata* Hanai, 1957; *H. tricarinata* Hanai, 1957 and *H. houhsengi* Hu & Tao, 2008. Based on the fossa-reticulation unit pattern of the external surface of the carapace and the outline of the carapace, these species can be systematically classified to four groups: (1) *H. kajiyamai* group, (2) *H. cuneata* group, (3) *H. taiwanensis* group, and (4) *H. tricarinata* group. Moreover, each species can be reclassified by adopting the numerical notation of Hoskin (1975). These characters can be also applied to fossil specimens.

Key Words： carapace, Ostracoda, *Hemicytherura*, ornamentation, fossa-reticulation Unit, Japan.

Introduction

The genus *Hemicytherura* is comparatively a small (0.65mm in largest length) ostracod even in Podocopida. The oldest fossil record of this genus was recovered from the Berriasian stratotype (Lower Cretaceous) in Berrias, southern France. Currently, members of the genus are found in shallow seas worldwide, and are especially common in the intertidal zones of areas with flourishing seaweed and sea algae populations. The name "Hemicytherura" was first used for a subgenus of *Cytheropteron* by Elofson (1941), but was then elevated to the generic status by Hornibrook (1952). A living specimen of *Cythere cellulosa* from the Lamlash Bay, Scotland was designated as the type species of *Hemicytherura* by Norman (1865). To date, a total of 110 species, including fossil species, have been reported worldwide (Kempf, 1986, 1995, 2008).

Hanai (1957) was the first to report the genus *Hemicytherura* from the coastal areas of Japan. He examined living specimens that Kajiyama (1913) identified as *Cytheropteron videns* Müller, 1894 (this species was placed in the subgenus *Hemicytherura* by Elofson [1941]), and concluded that Kajiyama's specimens could be distinguished from the Europian *Cytheropteron videns* by surface ornamentation and the outline of the carapace. Hanai renamed the species as *H. kajiyamai* in 1957. In the same study, he described the following two other new species that differed from *H. kajiyamai* with respect to carapace morphology: *H. cuneata* and *H. tricarinata*. These two species were identified from among recent specimens collected from the Miura Peninsula and Kumamoto. Okubo (1980) provided further descriptions of these three species with appendage illustrations using specimens from the Inland Sea of Japan.

The following three species have also been reported from the coastal areas of Japan: (1) *H. clathrata* (Sars, 1866); their living specimens were obtained from the Plio-Pleistocene Tomikawa Formation of Hokkaido (Cronin and Ikeya, 1987). (2) *H. radiata* Hornibrook 1952, which was described based on a Recent specimen found off the Great King Island in northern New Zealand, has also been reported from the East China Sea (Ishizaki, 1981) and from the Pliocene Ananai Formation of Shikoku (Ishizaki, 1983). (3) *H. delicatula* Hornibrook, 1952, which was described based on a Recent specimen from the North Island of New Zealand, has also been reported from some Plio-Pleistocene sediments in Okinawa Island (Nohara, 1987). Some unidentified species have also been reported from Japan (Tabuki, 1986; Ikeya & Itoh, 1991; Ikeya & Suzuki, 1992).

The purpose of the present study was to describe six new species from Japan and the surrounding regions. Furthermore, on the basis of the fossa-reticulation Unit (FRU) pattern of the external surface of carapace, the outline of the carapace, and the

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male copulatory organ, 10 species belong to the genus *Hemicytherura* from the coastal areas of Japan were systematically reclassified. *H. clathrata* (Sars, 1866) was excluded from this study because the FRU pattern could not be specified for this species. *H. radiata* and *H. delicatula* were also excluded because although these species have been previously reported (Ishizaki, 1981, 1983; Nohara, 1987), they could not be found from among materials collected from the Japanese Islands and their surrounding regions.

Materials and Methods

Specimens from the coastal areas of Japan that were used in this study were mainly selected from among the ostracod collection held by Shizuoka University, which consists of ostracods collected by one of the authors (N. I.) since 1969. To compare the Japanese ostracod specimens with that of Taiwan, we went to fieldwork to Taiwan to collecting the Recent ostracod specimens and the fossil topotype specimens described by Dr. Hu Chung-Hung (1976-1986) in 1998 (N. I., Y. K. & G. T.) and 2004 (N. I. & G. T.). In 2004, we visited Taiwan to collect topotype specimens and to research Dr. Hu's type specimens. The collecting research of his topotype specimens was almost successful, however, Dr. Hu Chung-Hung said 'all of the type specimens described by him were washed away by flooding by two typhoons in 1993 & 2001, because he deposited all of the type specimens in the basement of his house (although he described that his type specimens were deposited in several universities and museums of Taiwan in his papers (1978-1986)). Recently, Hu & Tao (2008) published a monograph "Studies on the ostracod fauna of Taiwan and its adjacent seas". In that study, they redescribed many species which named previously as new but different species name after that. They reported eight *Hemicytherura* species including three new species. In this paper, we considered and reclassified these species from Taiwan on the bases of our Recent and fossil specimens.

A total of 324 Recent specimens were collected mainly from intertidal zones and shallow seas, and 139 fossil specimens were collected from Miocene to Holocene sediments in Japan and Taiwan. The details of the sample location of each of the illustrated specimens can be found in the Appendix. All type specimens were registered and deposited in the Gunma Museum of Natural History (GMNH-PI-number). The species were identified by scanning electron microscopy (JSM-5600LV) on the basis of carapace morphology; a transmitted light optical microscope (OLYMPUS BX50F) equipped with a camera lucida was used for drawings the male copulatory organ.

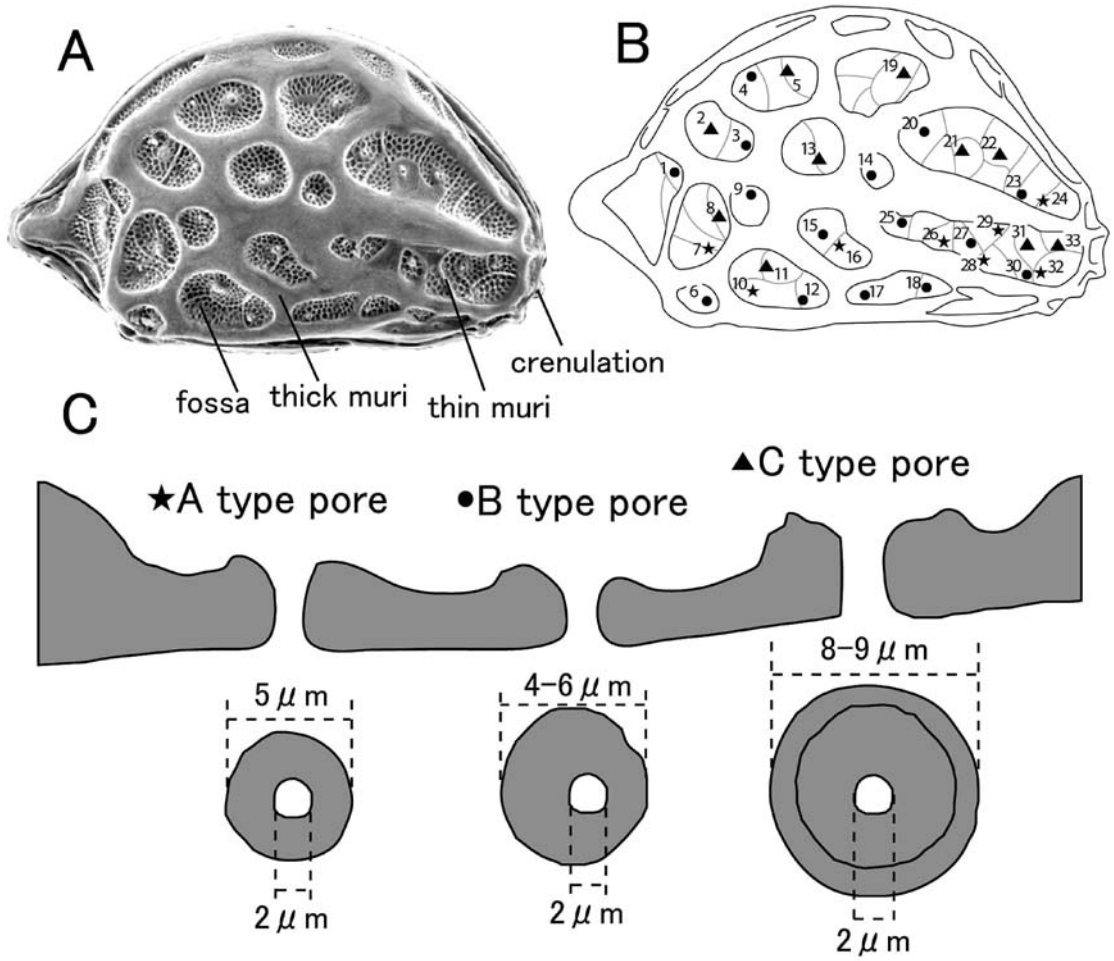

Figure 1. A. The terms used to describe the morphology of *Hemicytherura*. B. The number of pores and their distribution on *Hemicytherura kajiyamai* Hanai, 1957. C. Morphology of the 3 pore types.

Surface Ornamentation of *Hemicytherura*

Surface ornamentation of the genus *Hemicytherura* basically consists of a thick muri and surrounding fossae. The fossae are subdivided into smaller subareas by thin muri (Figure 1A). The shape and arrangement of the fossae and reticulations are extremely stable among individuals within each species. In the present study, we defined a fossa with no reticulations or one reticulation surrounded by thick and/or thin muri as one unit, and we described the distributional pattern of FRU among 10

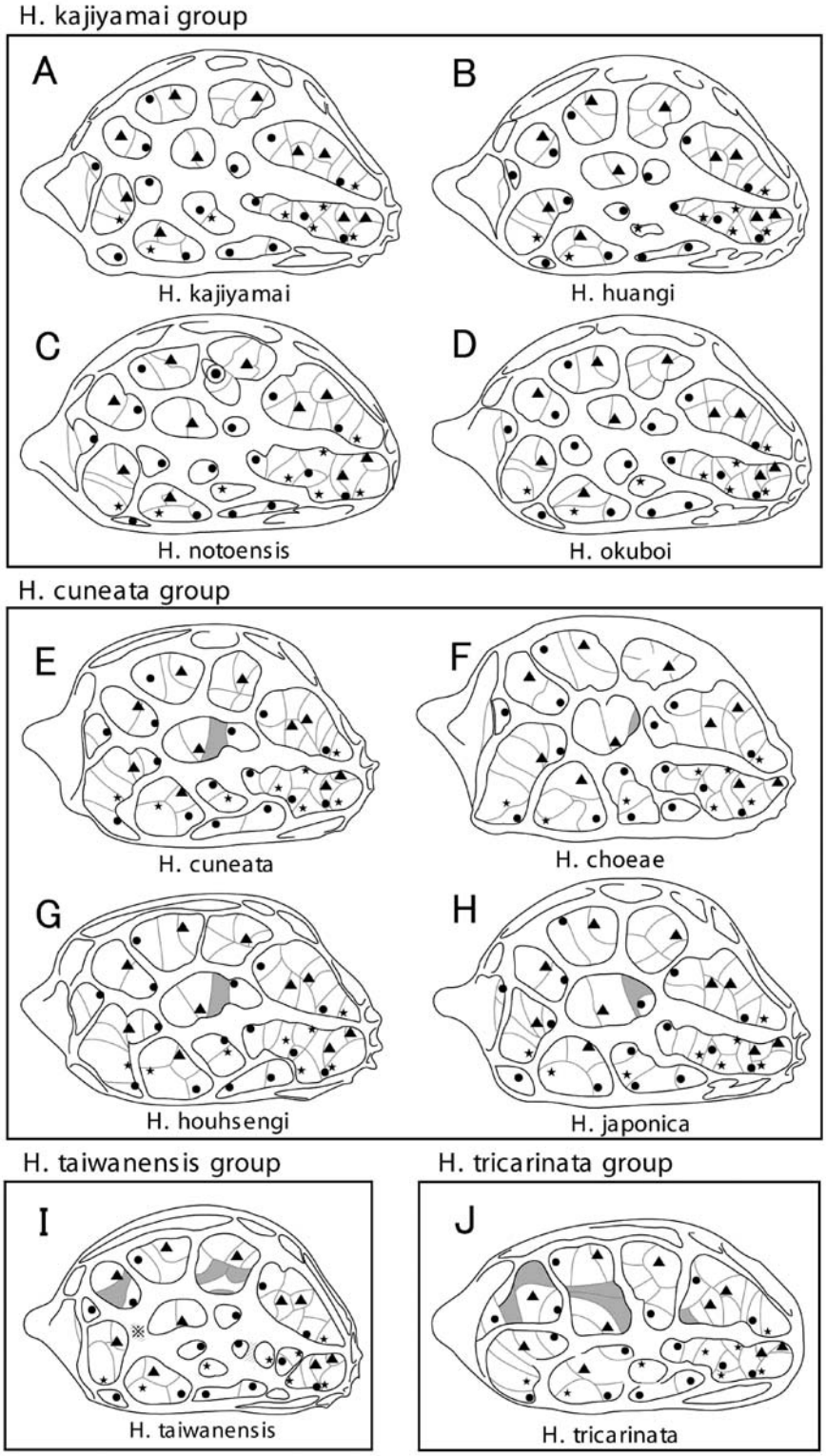

Figure 2. Line drawings of *Hemicytherura* species discussed in this study. Ten species were categorized into four groups on the basis of the distributional pattern of fossa-reticulation unit. Gray-colored areas denote an added area compared with the standard species (*H. kajiyamai*). Each figure also shows the distributional pattern of the three pore types (star = A-type pore; circle = B-type pore; triangle = C-type pore). Double circles indicate an added new pore.

species using FRU of *H. kajiyamai* as a standard for comparison (Figure 1B).

One of the most stable characters found on the ostracod valve is the normal pore canal, which passes from the inner surface to the outer surface through the ostracod carapace and forms a pore system with the bristle. The bristle transmits external stimuli and prompts inner nerve cells (Müller, 1894; Okada, 1982). The form (type), number, and mode of the relative distributional pattern of these pore systems are known as extremely conservative characters during ontogeny (Tsukagoshi, 1990; Sato & Kamiya, 2007). Thus, to determine whether FRU was added or lost systematically, we also considered the relative positions of the normal pore canals. Three pore types (types A, B, and C) found in the 10 *Hemicytherura* species were distinguished (Figure 1C). On the basis of the relative position of each pore and pore type, each possible homological pore was numbered as the same figure (Figure 1B and Figure 2).

The 10 *Hemicytherura* species were divided into the following four groups on the basis of a similar FRU: (1) *H. kajiyamai* group (Figure 2A-D); the FRU pattern was same as that of *H. kajiyamai*. Four species,*i.e., H. kajiyamai, H. huangi,* and *H. notoensis, H. okuboi* were included in this group. (2) *H. cuneata* group (Figure 2E-H); compared with the FRU pattern of *H. kajiyamai*, one FRU was added between the 13th and 14th pores. Four species, *i.e., H. cuneata, H. choeae, H. houhsengi, H. japonica* were included in this species group. (3) *H. taiwanensis* group (Figure 2I); compared with the FRU pattern of *H. kajiyamai*, one FRU was added between the 2nd and 3rd pores and two FRUs were added below the 19th pore, or one FRU disappeared from between the 25th and 26th pores. In this regard, one FRU was worn away with the disappearing 9th pore, and one FRU was added to the fossa including 19th pore in *H. taiwanensis*. (4) *H. tricarinata* group (Figure 2J); a total of 5 FRUs were added around the 2nd, 13th, and 20th pores.

Systematic Paleontology

The following abbreviations are used for the systematic descriptions: CC, complete carapace; RV, right valve; LV, left valve; L, length of valve; H, height of valve; W, width of valve; X, arithmetic mean; OR, observed range; N, number of specimens; M, male; F, female; NNH, the numerical notation of Hoskin (1975); UMUT, the University Museum, University of Tokyo; and NPIM, Palaeontological Museum, Nanjing (Nanjing Institute of Geology and Palaeontology).

Order Podocopida G.W.Müller, 1894
Suborder Podocopa Sars, 1866
Superfamily Cytheracea Baird, 1850
Family Cytheruridae G. W. Müller, 1894
Subfamily Cytherurinae G. W. Müller, 1894
Genus *Hemicytherura* Elofson, 1941

Type species.--*Cythere cellulosa* Norman, 1865

Quality of Carapce.--Strongly calcified. Living specimen shows, dark-brown color.

Size.--Adult carapace approximately 0.27-0.65mm in length and 0.14-0.36mm in height. LV larger than RV in length; reverse in height.

Outline.--In lateral view, LV subrhomboidal, RV subovate. Dorsal margin gently arched. Ventral margin almost flat. Anterior margin obliquely rounded, usually with four or five crenulations in the lower half. Posterior margin with a prominent caudal process. Viewed dorsally, considerably laterally compressed. RV higher than LV, conspicuously overlapping LV along the dorsal margin. However, at the caudal process, LV overlaps RV.

Sexual dimorphism.--Carapace length, height and width is generally larger in the female generally larger than in the male; the L/H ratio is also larger in the female. In lateral view, the curve of the dorsal margin is stronger in the female than in the male.

Ornamentation.--Covered with some remarkable fossae surrounded by thick muri. The surfaces of the fossae are covered with small muri in a fine honeycomb pattern. In some species, a striking longitudinal murus runs almost straight, other species are covered with mesh-like fine muri. Eye-spot is appearent but obscure.

The male Copulatory organ. (Figure 4)--Basal capsule subquadrate when entire with complex appendages in the distal part. The complex appendages include one chitinized distal lobe, one short and not spiral copulatory duct, and one or two lamelliform clasping apparatus.

Remarks. The numerical notation of Hoskin (1975).--One of the various systems of coding and analysis of ornament patterns on ostracods with more complex ornamentation and many fossae. The surface ornamentation of *Hemicytherura* species used in the present study consisted of 12 major fossae in relatively constant positions on the exterior of the valve. The subdivisions of these 12 major fossae are represented by superscripted Roman numerals to the right of the Arabic numerals representing the fossae (Figure 3).

HEMICYTHERURA KAJIYAMAI GROUP

Hemicytherura kajiyamai Hanai, 1957
(Figure 3A; Figure 4A; Figure 5, 1a-c, 2a-c)

Cytheropteron videns G. W. Müller. Kajiyama, 1913, p. 4, 5, pl. 1, figs. 19-25.
Hemicytherura kajiyamai Hanai, 1957, p. 24, pl. 2, figs. 1a-d. Ikeya *et al*., 1985, pl. 5, figs. 12, 13, 16; Ishizaki & Matoba, 1985, pl. 4, fig. 8; Ruan & Hao, 1988; p. 293, pl. 50, fig. 15; Kamiya, 1989, p. 85, fig. 13 (4); Ikeya & Suzuki, 1992, p. 128, pl. 5, fig. 3; Kamiya *et al*., 2001, fig. 13 (5), fig. 17 (7); Nakao *et al*., 2001, fig. 5 (7).
Hemicytherura sp. Tabuki, 1986, p. 95, pl. 17, figs. 7, 8.
Hemicytherura cf. *scaholmensis* Mckenzie. Hu & Tao, 2008, Pl. 119, fig. 15, pl. 213, fig. 18.
Hemicytherura cf. *seaholmensis* McKenzie. Hou & Gou, 2007, pl. 111, fig. 9.
Hemicytherura cf. *H. seaholmenesis* Mckenzie. Ruan & Hao, 1988, p. 292, 293, pl. 50, figs. 9-13.
Hemicytherura sp. 3, Ikeya & Suzuki, 1992. p. 129, pl. 5, fig. 4.
non *Hemicytherura kajiyamai* Hanai. Okubo, 1980, p.8, 9, 14, figs. 1c, 1d, 2e-h, 5; Hu, 1982, text-figs. 3A, 3B, pl. 3, figs. 13, 17; Ruan & Hao, 1988, pl. 50, figs. 14, 16; Ka-

miya, 1988, fig. 5 (9); Kamiya, 1989, p. 79, fig. 4 (9); Hou & Gou, 2007, pl. 111, fig. 8; Tanaka, 2007, fig. 1; Hu & Tao, 2008, pl. 29, figs. 11, 22.

Types.--Holotype, UMUT-CA-2616 (CC: L=0.37mm, H=0.22mm, W=0.18mm); paratypes, UMUT-CA-2617 (CC: L=0.37mm, H=0.22mm, W=0.18mm), 2618.

Type locality.--The shore back of an Imperial villa, Hayama-machi, Kanagawa Prefecture (Recent beach sand), Japan (35°15. 3′ N, 139°34. 8′ E).

Description.--Carapace somewhat small, thick and subovate. In lateral outline, subrhomoboidal (Figure 5-1a, 5-1c, 5-2a, 5-2c): dorsal margin highest at middle and strongly arched in female; anterior margin obliquely rounded with four crenulations in narrowly rounded lower half; in posterior margin, obvious caudal process. Viewed dorsally, widest in mid-point. According to NNH (Figure 3A), lost murus separating Fossae 1^{II} and 5^{II}; central area with four fossae (1^{I}, 1^{II} fused 5^{II}, 2, 8^{III}); Fossa 8 divides into 3 fossae (8^{II}, 8^{III} and 8^{IV}); Fossa 3 and Fossa 12 bear one and two non-reticulated small areas, respectively. Most of

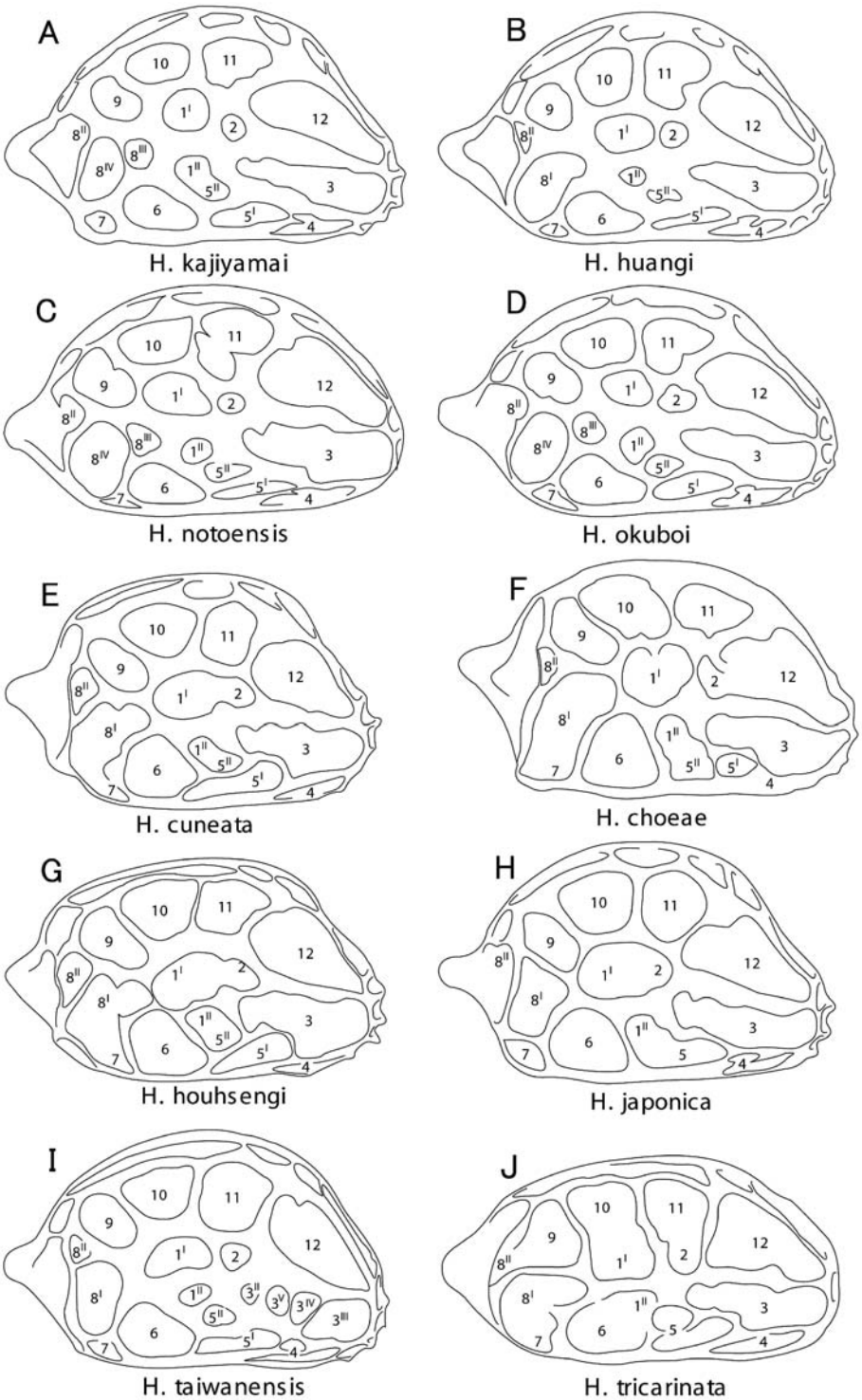

Figure 3. Ornamentation patterns of *Hemicytherura* species using the numerical notation of Hoskin (1975).

surface of fossae covered with fine honeycombed pattern (Figure 5-1a, 5-1c, 5-2a, 5-2c). In male copulatory organ, basal capsule size middle and subround in outline. Distal lobe crescent shape and obtuse tip. Ductus ejaculatorius short and coiled up in basal. Two clasping apparatuses developed: outer one long and slender, inner one short and beak-shaped.

Occurrences.--Recent: Coasts of Northwestern Pacific, with range of south of latitude 44° N. Fossil: Middle Miocene (Mizunami Group) to Holocene formations of Japan, Pliocene formation of Taiwan and Holocene sediments of Hong-Kong.

Remarks.--Kajiyama (1913) reported the left valve of this species as *Cytheropteron videns* Müller, 1894 from Misaki with first and second antenna, mandible, maxilla and male copulatory organ. Although he didn't describe sexual distinction, the valve illustration apparently shows a female specimen. Hanai (1957) redescribed the Kajiyama's *C. videns* as *Hemicytherura kajiyamai* based on only carapace. Okubo (1980) described a *Hemicytherura* species from Inland Sea of Japan based upon the morphology of the soft parts as *H. kajiyamai*. But his specimens differ *H. kajiyamai* from morphologies of both carapace and male copulatory organ. (Okubo's *H. kajiayamai* is redescribed as a new species in this paper, i. e. *H. okuboi* n. sp..) *H.* sp. of

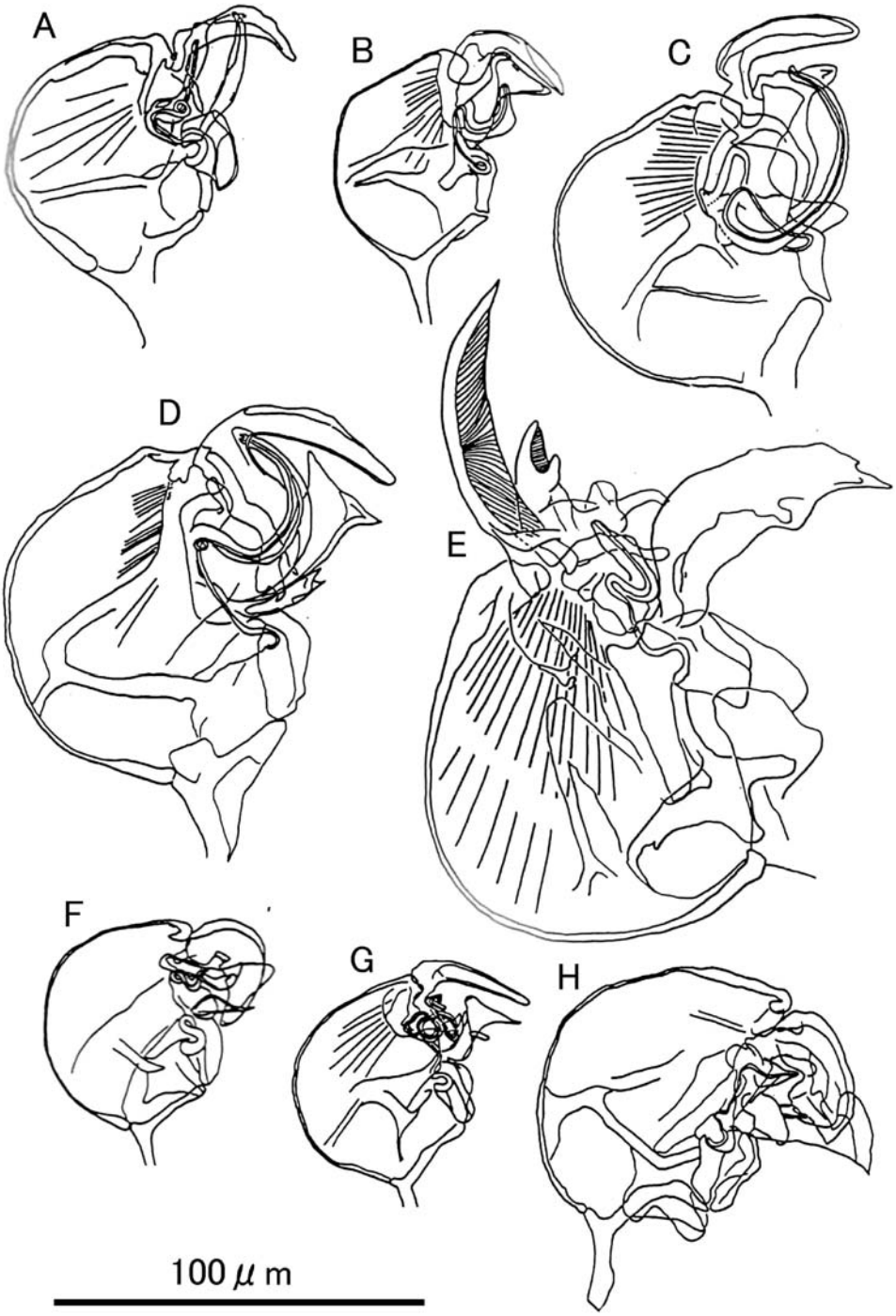

Figure 4. Line drawings of the male left copulatory organs of Recent *Hemicytherura* species. A. *Hemicytherura kajiyamai* Hanai, 1957. B. *H. huangi* n. sp. (GMNH-PI-3169). C. *H. notoensis* n. sp. (GMNH-PI-3172). D. *H. okuboi* n. sp. (GMNH-PI-3175). E. *H. choeae* n. sp. (GMNH-PI-3184). F. *H. japonica* n. sp. (GMNH-PI-3187). G. *H. taiwanensis* n. sp. (GMNH-PI-3190). H. *H. tricarinata* Hanai, 1957.

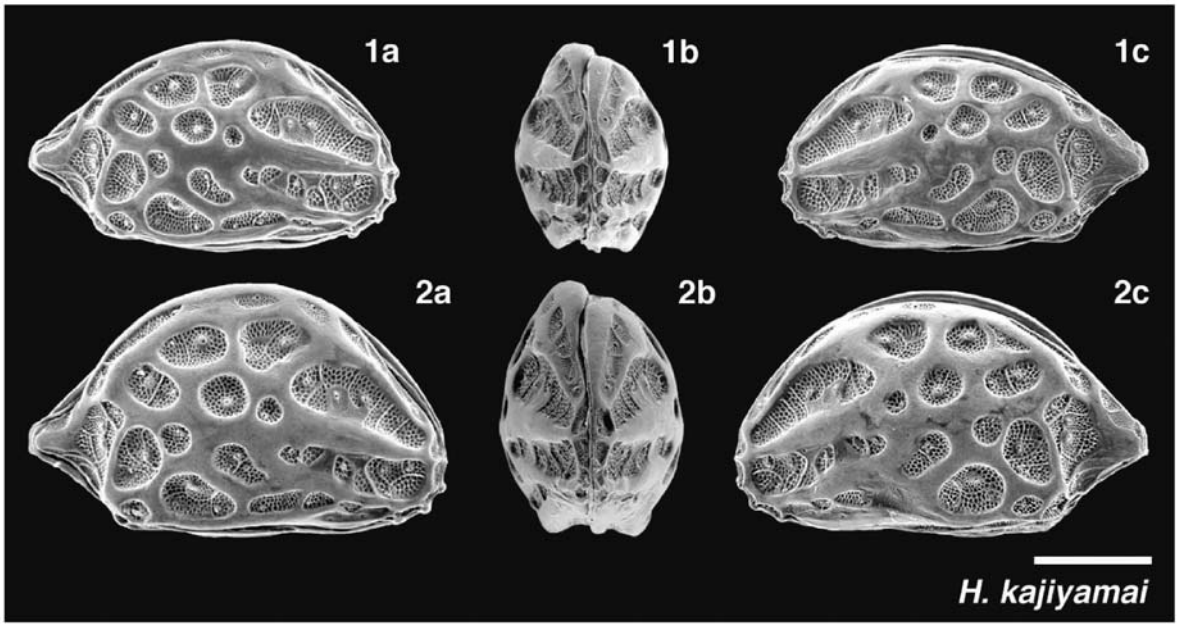

Figure 5. *Hemicytherura kajiyamai* Hanai, 1957 (Loc. 4). 1. Complete male carapace: a, right lateral view; b, anterior view; and c, left lateral view, GMNH-PI-3165. 2. Complete female carapace: a, right lateral view; b, anterior view; and c, left lateral view, GMNH-PI-3166. Scale = 100 μm.

Tabuki (1986) and *H.* sp. 3 of Ikeya & Suzuki (1992) correspond to a juvenile (A-1 stage) of this species. This species is one of the oldest species which occurs in Japan and its adjacent area from Middle Miocene to Recent.

Hemicytherura huangi Kaseda and Ikeya n. sp.
(Figure 3B; Figure 4B; Figure 6, 1a-f, 2a-f; Figure 7)

Hemicytherura kajiyamai Hanai. Hu & Tao, 2008, pl. 201, fig. 8.

Types.--Holotype. Male, CC (Fig. 6: 1a-f), L=0.293mm, GMNH-PI-3167; Paratype. Female, CC (Fig. 6: 2a-f), L=0.328mm, GMNH-PI-3168.

Type locality.--Loc. 1.

Etymology.--In honour of Dr. Tun-Yow Huang who worked in Geological Survey of Taiwan.

Diagnosis.-- Central area of four subcircular fossae (1^{I}, 1^{II}, 5^{II}, 2) distinct, 1^{II} separated 5^{II} by thin murus; postero-ventral Fossa 8 divided into 2 fossae ($8^{I}$and 8^{II}) by thin murus. Ductus ejaculatorius comparatively large and waving at middle.

Description.--Carapace small and thick. In lateral outline, subtriangular (Figure 6-1a, 6-1c, 6-2a, 6-2c): dorsal margin greatest height in middle; anterior margin obliquely rounded with four crenulations in lower half; posterior margin triangularly protruding. In dorsal view, concave at middle of the side, peanut-like shape (Figure 6-1d, 6-2d). Sexual dimorphism conspicuous: in male, carapace size remarkable small and lateral outline long and slender (Figure 6-1); in female, RV conspicuously overhanging along dorsal margin (Figure 6-2b, 6-2c, 6-2d, 6-2e). According to NNH, central area of four subcircular fossae (1^{I}, 1^{II}, 5^{II}, 2) distinct, 1^{II} separated 5^{II} by thin murus; postero-ventral Fossa 8 divided 2 fossae ($8^{I}$and 8^{II}) by a thin murus (Figure 3B). Surface of fossae covered with fine honeycombed pattern (Figure 6-1a, 6-1c, 6-2a, 6-2c).

Description of soft-parts

Antennule (Figure 7a): Five articulated segments (Originally, six articulated, but sixth segment was broken during the preparation of slide). Length ratio between distal segments 32:42:26:34:37. Walls developed, especially well on segments 3-5. Third segment with one simple seta on anterior distal end. Fourth segment with one simple seta on anterior distal end. On distal end, fifth segment with 2 long stout simple setae.

Antenna (Figure 7b): Five articulated segments. Length ratio between distal segments 53:28:30:50:8. Walls developd, especially broad third and fourth segments. Second segment with 3-segmented exopodite and one plumose seta on posterior distal end. Along its anterior margin, third segment bearing three long setules and many short setules. Furthermore, third segment bearing two simple setae along distal margin. Fourth segment with simple seta on middle part of anterior margin, and many short setules along lower half of posterior margin. Furthermore, simple seta on distal end of posterior margin. Fifth segment with stout claw-like seta with serrations along anterior margin on distal end and one stout crenate seta on ledge of posterior margin.

Mandible (Figure 7c): Composed of protopodite and exopodite. Distal part of protopodite with 6 teeth. Length ratio between endopodite segments 15:30:24:8. First segment of endopodite with simple seta on ventral distal end. Second segment of endopodite with stout simple seta on ventral distal end. Third segment of endopodite with two simple setae on ventral distal end. Three unequal simple setae on dorsal distal end. Three stout setae on proximal margin: one plumose long seta and two short simple setae. Fourth segment of endopodite bearing 2 simple setae.

Maxilla (Figure 7d): Palp with 5 simple setae on distal end. Outer masticatory process with 5 setae on distal end. Middle and inner masticatory process with 5 and 4 setae, respectively.

Thoracic legs (Figures 7e-g): First, second and third thoracic legs 4-segmented and similar in shape. Length ratio between dis-

tal segments 67:50:25:32 in first thoracic leg, 66:65:30:37 in second thoracic leg, 70:60:31:35 in third thoracic leg. First segment with plumose seta on anterior margin in first thoracic leg. First segment with one plumose seta on anterior distal end and two long simple setae on posterior margin. Second thoracic leg with simple seta on anterior distal end in first and second segment. Second thoracic leg with short setules on distal half of anterior margin of second and fourth segment. Third thoracic leg with plumose seta on anterior distalend of second segment. Fourth segment bearing large comb-like terminal claw and setules on distal end.

Copulatory organ of male (Figure 4B): Basal capsule size smaller and subrhomboidal in outline. Distal lobe boomerang shape and obtuse at the tip. Copulatory duct comparatively large and waving at middle. Two clasping apparatuses developed: the inner one T-shape, outer one lamelliform with projection.

Dimensions.--The following list are the length and height measurements (in mm) of adult specimens from the type locality.

	L		H		
	X	OR	X	OR	(N)
RV (M)	0.290	0.276-0.303	0.154	0.150-0.159	16
RV (F)	0.320	0.310-0.330	0.187	0.180-0.194	9
LV (M)	0.292	0.277-0.300	0.148	0.141-0.156	16
LV (F)	0.321	0.304-0.332	0.179	0.174-0.189	6

Occurrence.--Recent: known from the type locality and the Penghu Islands of Taiwan. Fossil: unknown.

Remarks.--Surface ornamentation of the carapace of this species closely resemble those of *H. kajiyamai*, *H. okuboi* n.sp., and *H. notoensis* n. sp. However, the present species is distinguished from *H. kajiyamai* by the shape of male copulatory organ and ventro-median fossa of carapace, which Fossa 1^{II} fuses with Fossa 5^{II} in *H. kajiyamai. H. okuboi* differs from this species in the carapace size, the shape of male copulatory organ, and the shape and area of Fossa 8^{II}. The present species is distinct from *H. notoensis* with the shapes of Fossa 1^{I}, Fossa 10 and Fossa 11. The habitat of this species is on the algae in the littoral zone of rocky shore.

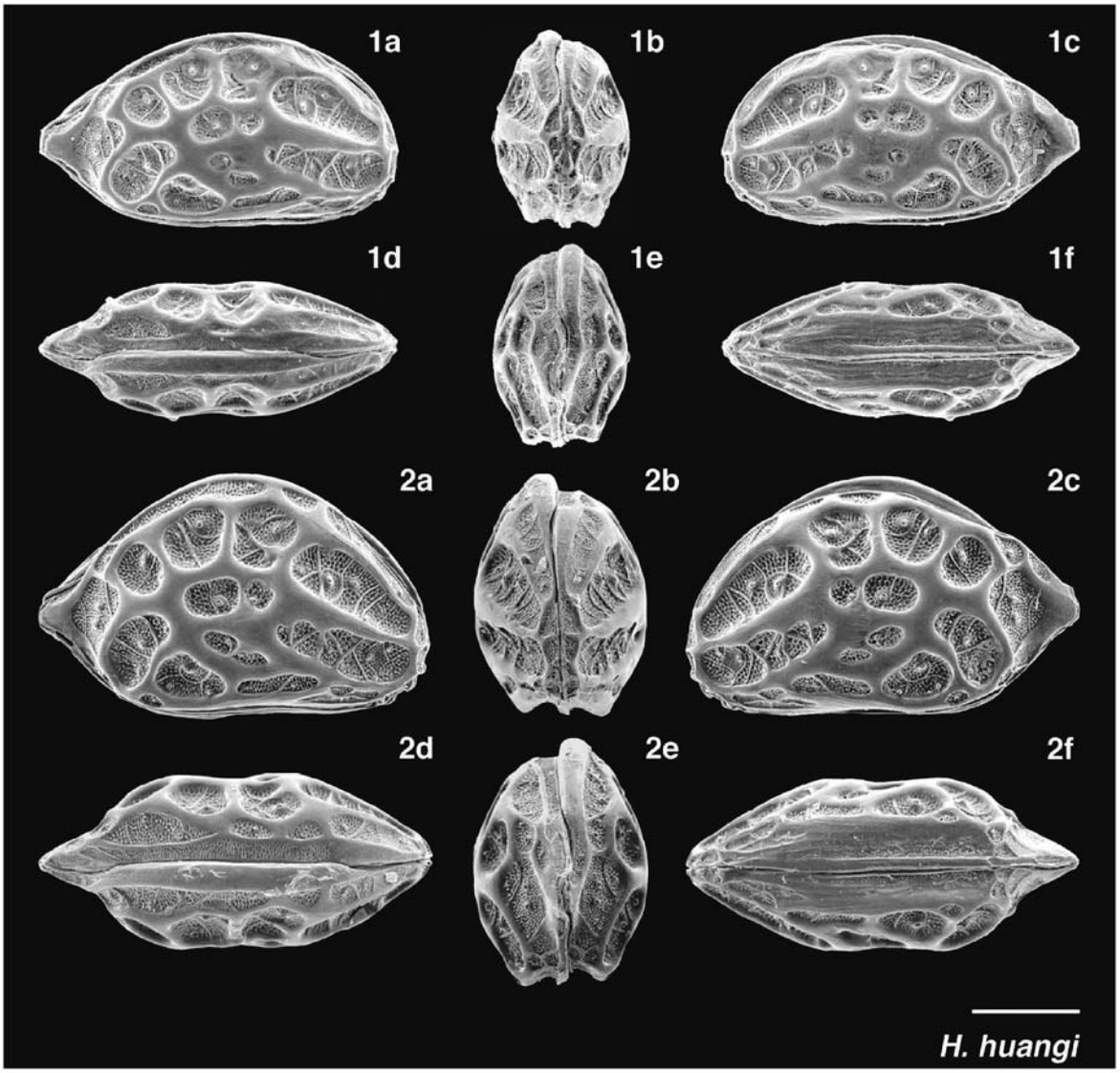

Figure 6. *Hemicytherura huangi* n. sp. (Loc. 1). 1. Complete male carapace: a, right lateral view; b, anterior view; c, left lateral view; d, dorsal view; e, posterior view; and f, ventral view, GMNH-PI-3167. 2. Complete female carapace: a, right lateral view; b, anterior view; c, left lateral view; d, dorsal view; e, posterior view; and f, ventral view, GMNH-PI-3168. Scale = 100 μm.

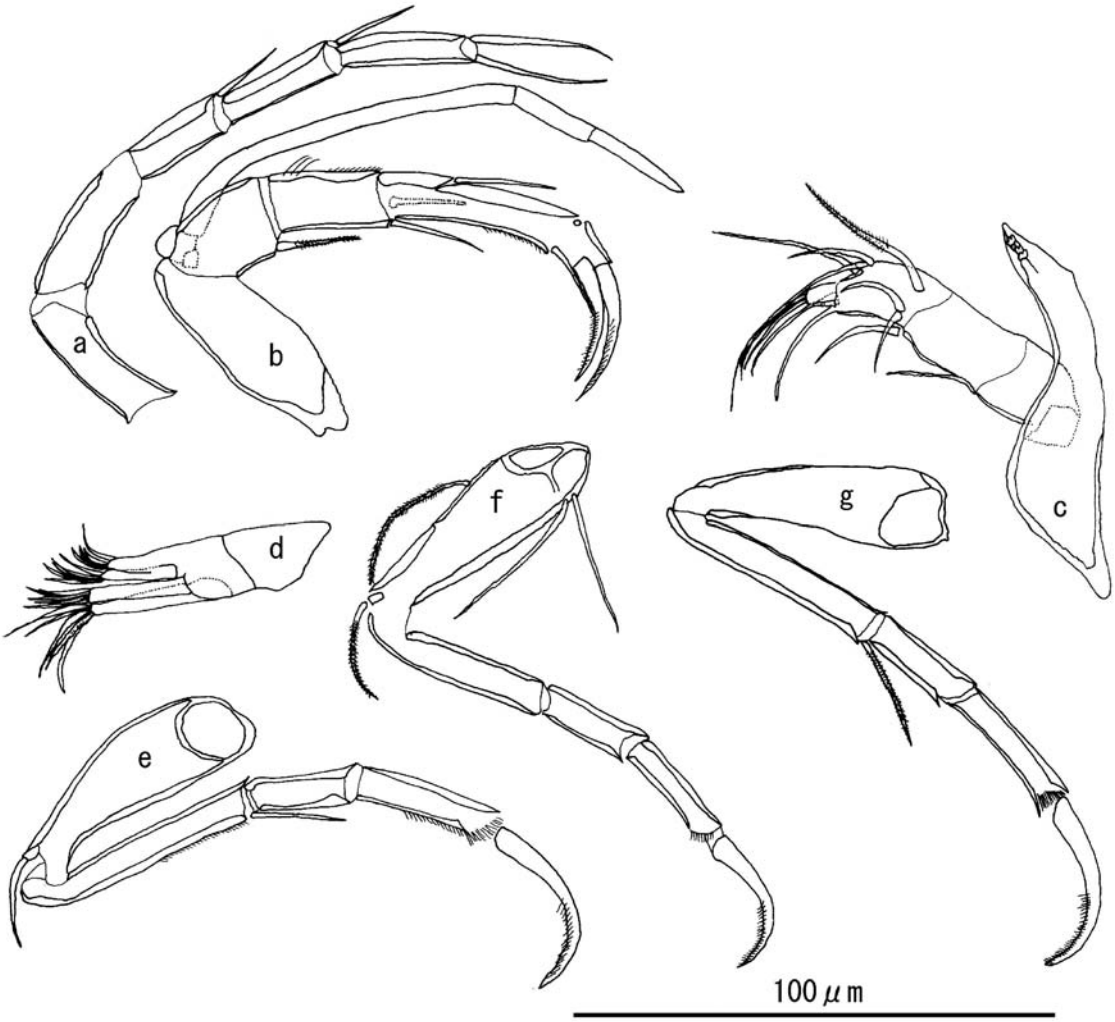

Figure 7. Soft parts of *Hemicytherura huangi* n. sp. (paratype: GMNH-PI-3169). a. antennule, b. antenna, c. mandible, d. maxillula, e. first thoracic leg, f. second thoracic leg, and g. third thoracic leg.

Hemicytherura notoensis Kaseda and Ikeya n. sp.
(Figure 3C; Figure 4C; Figure 8, 1a-f, 2a-f; Figure 9)

Types.--Holotype. Male, CC (Figure 8: 1a-f), L=0.336mm, GMNH-PI-3170; Paratype. Female, CC (Figure 8: 2a-f), L=0.393mm, GMNH-PI-3171.

Type locality.--Loc. 10.

Etymology.--Named after the Noto Peninsula, Ishikawa Prefecture, central Japan, the location where the species was found in abundance.

Diagnosis.--In lateral view, anterior margin without fine crenulation. Fine pits occur on inconspicuous muri. Central area of four subcircular fossae (1^{I}, 1^{II}, 5^{II}, 2) distinct; Fossa 8 divides into 3 fossae (8^{II}, 8^{III} and 8^{IV}). One pore canal adds in Fossa 11. Male copulatory duct long and curved.

Description.--Carapace size medium in this genus, somewhat thin and weak calcified. Lateral outline of carapace bean-shaped (Figure 8-1a, 8-1c, 8-2a, 8-2c): dorsal margin gently arched; ventral margin barely concave; anterior margin slightly rounded without fine crenulation; posterior margin with somewhat inconspicuous caudal process. Dorsal outline of carapace spindle shape (Figure 8-1d, 8-2d). Surface ornamentations covered with thin muri and fine honeycombed pattern in weak fossae (Figure 8-1a, 8-1c, 8-2a, 8-2c). Fine pits occur on inconspicuous muri. According to NNH, central area of four subcircular fossae (1^{I}, 1^{II}, 5^{II}, 2) distinct; Fossa 8 divides into 3 fossae (8^{II}, 8^{III} and 8^{IV}). One pore canal adds in Fossa 11.

Description of soft-parts

Antennule (Figure 9a): six articulated segments. Length ratio between distal segments 52:47:34:40:39:15. Walls developed, especially well on segments 3 and 4. Second segment with short simple seta on anterior margin and plumose seta on posterior margin. Short setules on distal area and long setules on lower half of anterior margin. Third segment with setules on posterior margin. Fourth segment with two unequal simple setae on anterior and posterior distal end. On distal end, fifth segment with one short plumose seta and one simple seta. Six segment with 4 simple setae on distal end.

Antenna (Figure 9b): Five articulated segments. Length ratio between distal segments 89:29:37:56:12. Walls developd, especially broad third, fourth and fifth segments. Second segment with 3-segmented exopodite and one stout plumose seta on posterior distal end. A bunch of setules near distal margin. Third

segment bearing one stout plumose seta on posterior proximal end. Furthermore, third segment with two simple setae and one plumose seta on the distal margin. Fourth segment with simple seta on middle part of anterior margin, and many short setules along the lower half of posterior margin. Furthermore, simple seta on distal end of posterior margin. Fifth segment with stout claw-like seta along anterior margin on distal end and one stout claw-like seta on ledge of posterior margin. Two claw-like setae with comb-like setules.

Mandible (Figure 9c) : Composed of protopodite and exopodite. Distal part of protopodite with at least 4 teeth. Length ratio between endopodite segments 27:38:20:10. First segment of endopodite with simple seta on ventral distal end and one simple seta on proximal area. Second segment of endopodite with stout simple seta on ventral distal end. Three setae: one simple seta and two plumose setae on distal margin. Third segment of endopodite with three simple setae on ventral distal end. One simple seta and one plumose seta on middle part of dorsal margin. Fourth segment of endopodite bearing 2 simple setae.

Maxilla (Figure 9d) : Extremely thin branchial plate with 16 setae. Palp 2-segmented. Proximal segment with 3 simple setae on anterior distal end. Palp with 2 simple setae on distal end. Outer masticatory process with 4 setae on distal end. Middle and inner masticatory process with 3 setae, respectively.

Thoracic legs (Figures 9e-g) : First, second and third thoracic legs 4-segmented and similar in shape. Length ratio between distal segments 72:33:24:18 in first thoracic leg, 78:57:31:34 in second thoracic leg, 83:71:29:40 in third thoracic leg. First segment with plumose seta on anterior margin in first thoracic leg. First segment with one plumose seta on anterior distal end and two long simple setae on posterior margin in first and second thoracic leg. Second thoracic leg with two setae (at least one plumose seta) on anterior margin in first segment. Second segment with plumose seta on anterior distal end. Second leg with setules on distal and anterior margin of second segment. Third and fourth thoracic leg with plumose seta on distal end of third

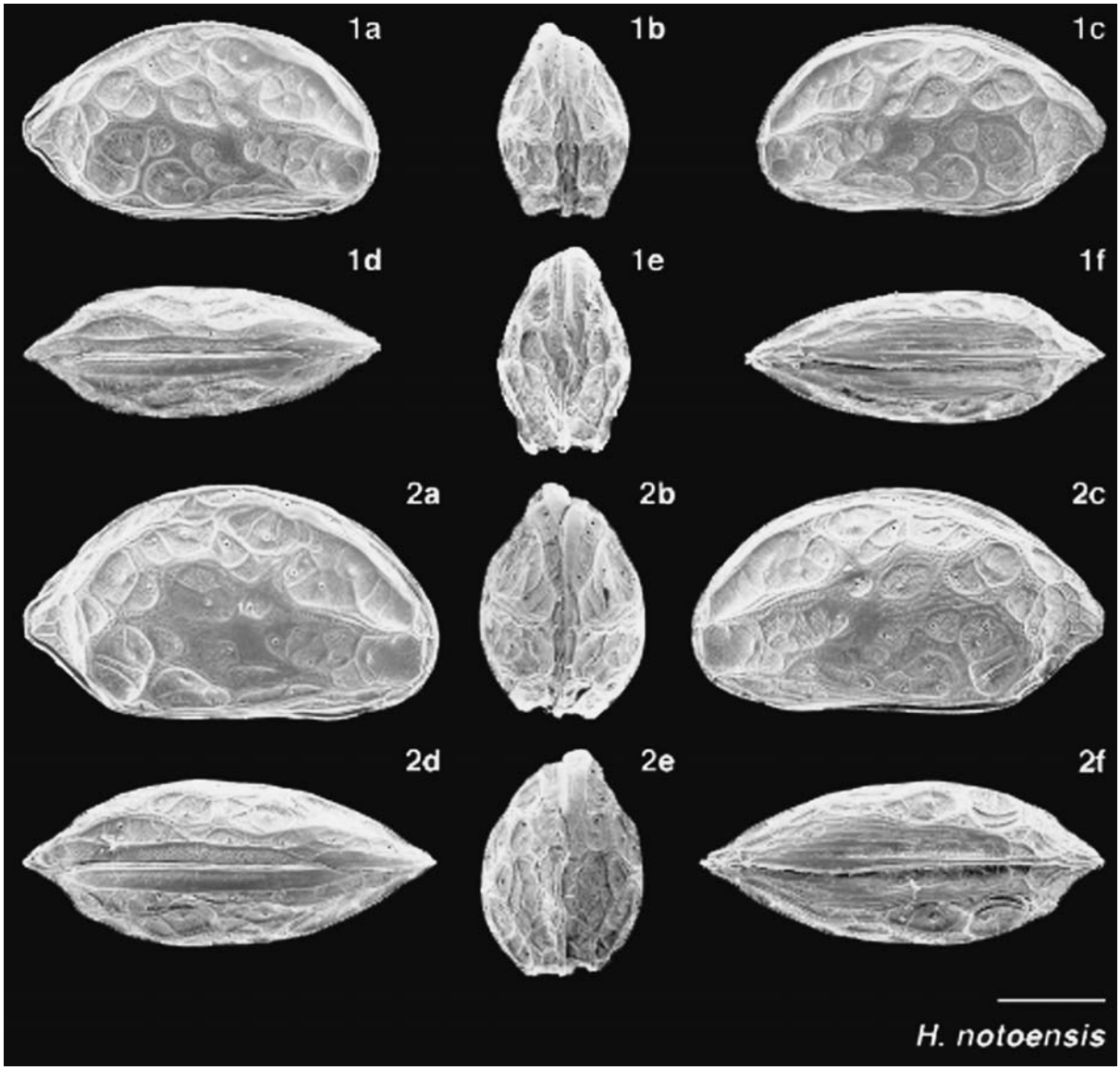

Figure 8. *Hemicytherura notoensis* n. sp. (Loc. 10) . 1. Complete male carapace: a, right lateral view; b, anterior view; c, left lateral view; d, dorsal view; e, posterior view; and f, ventral view, GMNH-PI-3170. 2. Complete female carapace: a, right lateral view; b, anterior view; c, left lateral view; d, dorsal view; e, posterior view; and f, ventral view, GMNH-PI-3171. Scale = 100 μm.

and fourth segment. Fourth segment bearing large terminal claw.

Copulatory organ of male (Figure 4C): Basal capsule size middle and subround in outline. Distal lobe short and obtuse on the tip. Copulatory duct long and curved. Two lamella-formed clasping apparatuses developed: outer one distorted triangular and obtuse on tip, inner one greatly bifurcated.

Dimensions.--Listed below are the length and height measurements (in mm) of adult specimens from the type locality.

	L		H		W		
	X	OR	X	OR	X	OR	N
C (M)	0.331	0.333-0.362	0.187	0.189-0.211	0.142	0.135-0.163	17
C (F)	0.397	0.379-0.424	0.235	0.220-0.254	0.183	0.167-0.197	22

Occurrences.--Recent: coasts of central to western Japan. Fossil: unknown.

Remarks.--This species resembles *H. okuboi* n. sp. in lateral outline, but differs in the inconspicuous fossae of surface ornamentations and the morphology of male copulatory organ. The present species is distinguished from *H. kajiyamai* and *H. huangi* n. sp. by the shape of Fossa 1^{I} and Fossa 11. The habitat is on the algae in the littoral zone of rocky shore.

Hemicytherura okuboi Kaseda and Ikeya n. sp.
(Figure 3D; Figure 4D; Figure 10, 1a-f, 2a-f)

Hemicytherura kajiyamai Hanai. Okubo, 1980, p.8, 9, 14, figs. 1c, 1d, 2e-h, 5; Kamiya, 1988, text-fig. 5 (9); Kamiya, 1989, p. 79, fig. 4 (9); Tanaka, 2007, fig. 1.
Hemicytherura sp.A. Lee, 1990, p. 321, 322, pl. 27, figs. 5, 6.
Hemicytherura sp. 2. Ikeya & Itoh, 1991, p. 116.
Hemicytherura sp. Nakao & Tsukagoshi, 2002, p. 93, figs. 13E, 13F.

Types.--Holotype. Male, CC (Figure 10: 1a-f), L=0.382mm, GMNH-PI-3173; Paratype. Female, CC (Figure 10: 2a-f), L=0.434mm, GMNH-PI-3174.

Type locality.--Loc. 6.

Etymology.--This species was named in honour of Dr. Ichiro Okubo who reported this species as *H. kajiyamai* in Okubo (1980).

Diagnosis.--Central area of four subcircular fossae (1^{I}, 1^{II}, 5^{II}, 2) distinctly separated from surrounding fossae; Fossa 8 divides

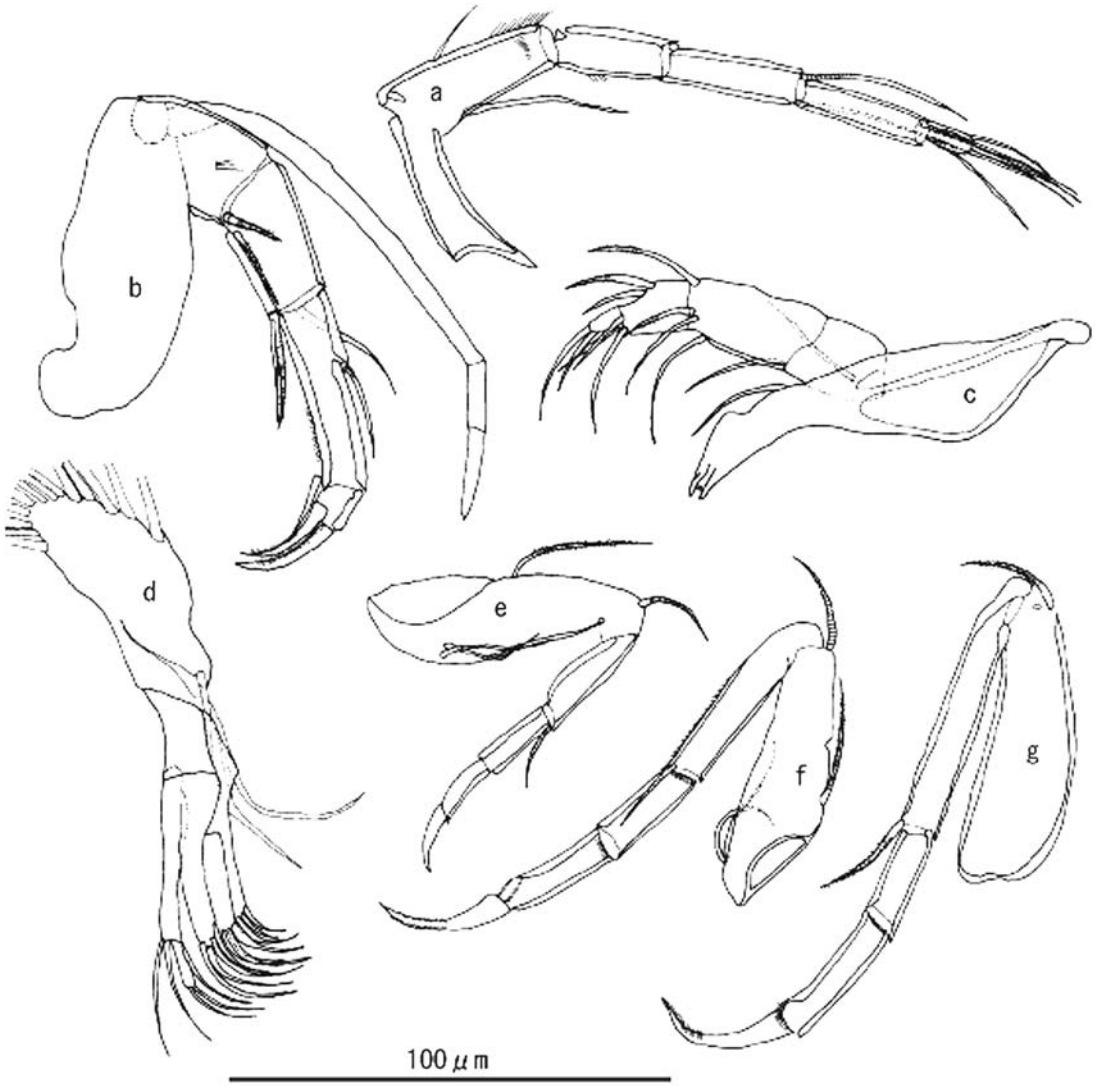

Figure 9. Soft parts of *Hemicytherura notoensis* n. sp. (paratype: GMNH-PI-3172). a. antennule, b. antenna, c. mandible, d. maxillula, e. first thoracic leg, f. second thoracic leg, and g. third thoracic leg.

into 3 fossae (8^{II}, 8^{III} and 8^{IV}); Fossa 9 rarely subdivided by thin murus. Male copulatory duct extremely long and guradually thick toward proximal.

Description.--Carapace size relatively large in this genus. Subovate lateral outline (Figure 10-1a, 10-1c, 10-2a, 10-2c): Dorsal margin gently arched; ventral margin almost straight; anterior margin obliquely rounded with four crenulations in lower half; posterior margin with caudal process moderately strong and subtriangular. Viewed dorsally, subspindle shape in outline (Figure 10-1d, 10-2d). According to NNH, central area of four subcircular fossae (1^{I}, 1^{II}, 5^{II}, 2) distinctly separated from surrounding fossae; Fossa 8 divides into 3 fossae (8^{II}, 8^{III} and 8^{IV}); Fossa 9 rarely subdivided by thin murus. Surface of fossae covered with remarkable honeycombed pattern (Figure 10-1a, 10-1c, 10-2a, 10-2c). In male copulatory organ, basal capsule size middle and semicircle in outline. Distal lobe elongate and obtuse on tip. Copulatory duct extremely long and gradually thicking toward proximal. Two clasping apparatuses developed: outer one stout and T-shape, both terminals sharp-pointed, inner one short and occurs two projections on the tip.

Description of soft-parts.-See Okubo (1980).

Dimensions.--Listed below are the length and height measurements (in mm) of adult specimens from the type locality.

	L		H		
	X	OR	X	OR	(N)
RV (M)	0.363	0.357-0.383	0.207	0.196-0.215	5
RV (F)	0.404	0.385-0.416	0.248	0.234-0.265	19
LV (M)	0.370	0.360-0.387	0.208	0.200-0.221	10
LV (F)	0.420	0.396-0.439	0.245	0.232-0.258	22

Occurrence.--Recent: coastal area under the influence of warm water Kuroshio Current in Korea and Japan. Fossil: Late Miocene (Itahana Formation collected by G. T.) to Holocene for-

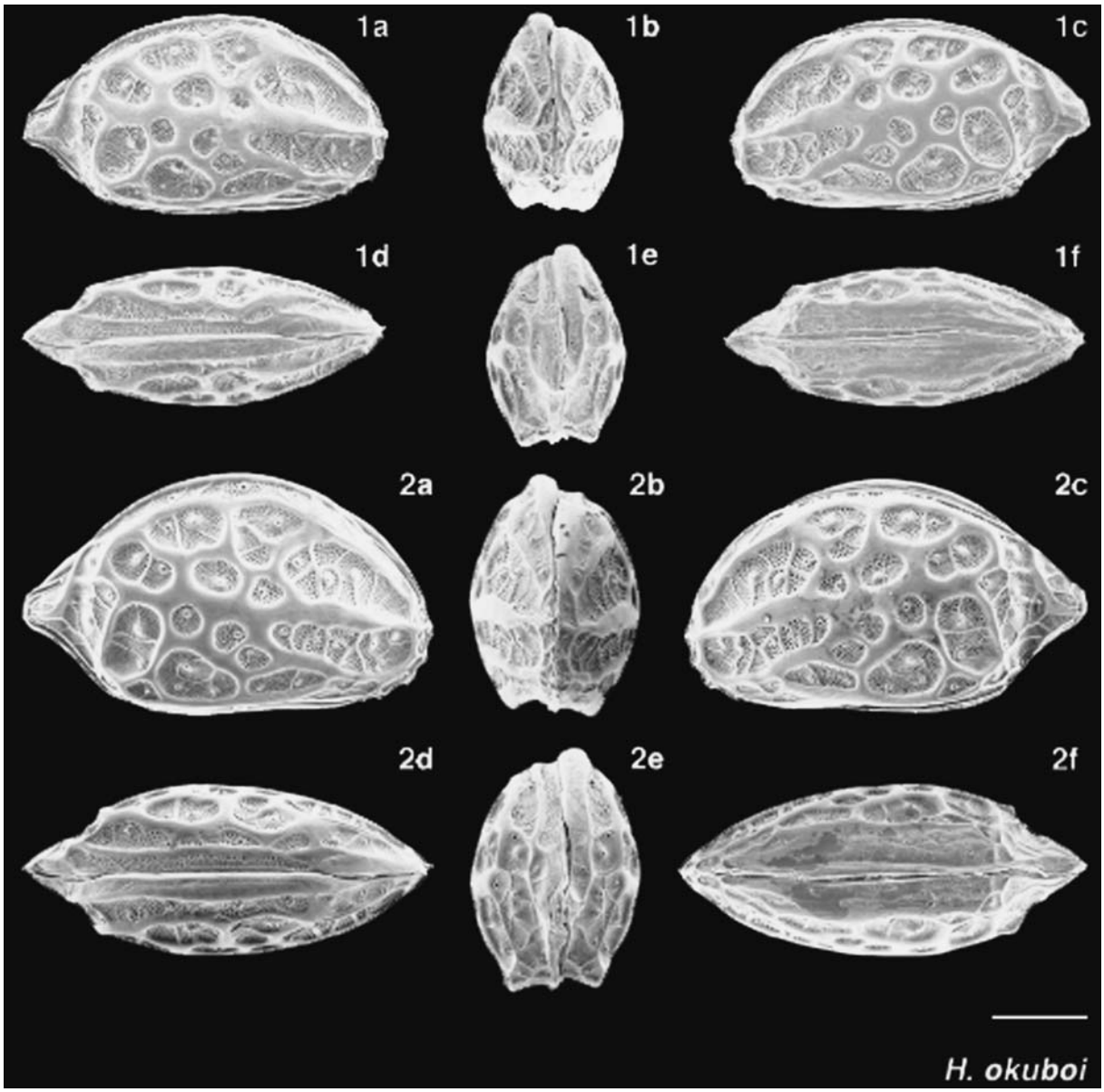

Figure 10. *Hemicytherura okuboi* n. sp. (Loc. 6). 1. Complete male carapace: a, right lateral view; b, anterior view; c, left lateral view; d, dorsal view; e, posterior view; and f, ventral view, GMNH-PI-3173. 2. Complete female carapace: a, right lateral view; b, anterior view; c, left lateral view; d, dorsal view; e, posterior view; and f, ventral view, GMNH-PI-3174. Scale = 100 μm.

mations of Japan and Pleistocene formations of Cheju Island, Korea.

Remarks.--Surface ornamentation is closely similar to *H. kajiyamai*. However this species differ from *H. kajiyamai* by separation between Fossa $1^{I}$and 5^{II}, carapace size and morphologies of the clasping apparatus and the copulatory duct in male copulatory organ. Okubo (1980) and Kamiya (1988, 1989) were misindentified this species with *H. kajiyamai*. The appendages of this species from the Inland Sea of Japan were illustrated as *H. kajiyamai* by Okubo (1980). This species is distinguished from *H. notoensis* n. sp. with the number of pore canals in Fossa 11 (*H. notoensis* n. sp. has two pore canals, however, *H. okuboi* has one pore canal). The present species is different from *H. huangi* n. sp. in the outline of Fossa 1^{I}, 1^{II} and 5^{II}. This species inhabits on seagrass in calm inlet. *H.* sp. 2 of Ikeya & Itoh (1991), which are not shown in the figure in their paper, is identified as the juvenile (A-1 stage) of this species by comparing with the carapace specimens deposited in the Shizuoka University.

HEMICYTHERURA CUNEATA GROUP

Hemicytherura cuneata Hanai, 1957
(Figure 3E; Figure 11, 1-4)

Hemicytherura cuneata Hanai, 1957, p. 24, 25, text-figs. 1a, 1b, pl. 2, figs. 2a, 2b. Okubo, 1980, p. 8, 9, 13, figs. 1a, 1b, 2a-d, 4; Cai, 1982, p. 6, pl. 2, figs. 14, 15; Nohara & Tabuki, 1985, pl. 1, fig. 8; Ishizaki & Matoba, 1985, pl. 4, fig. 7; Ikeya *et al*., 1985, pl. 5, figs. 14, 15; Paik & Lee, 1985, pl. 3, fig, 7; Wang, P. *et al*., 1988, p. 418, pl. 50, fig. 19; Lee, 1990, pl. 27, figs. 1, 2; Yajima & Load, 1990, p. 158, figs. 13, 14; Ikeya & Suzuki, 1992, p.129, pl. 5, fig. 2; Lee & Paik, 1992, pl. 4, fig. 9; Kamiya & Nakagawa, 1993, p. 131, pl. 5, fig. 2; Yamane, 1998, p. 45, pl. 5, fig. 6; Tabuki, 2001, fig. 9 (15); Irizuki *et al*., 2001, fig. 18 (18); Yasuhara & Irizuki, 2001, pl. 5, figs. 10, 13-15; Irizuki, 2004, pl. 2, fig. 10; Hou & Gou, 2007, pl. 111, fig. 3; Hu & Tao, 2008, pl. 38, figs. 8, 14, pl. 218, fig. 9, pl. 225, fig. 10; Tanaka & Nomura, 2009, fig. 3 (27).

Hemicytherura apta Hu. Hu, 1977, text-fig. 6, pl. 26, figs, 8, 9; Hu, 1981, pl. 3, figs. 21, 17, 24; Hu, 1986, pl. 25, figs. 8, 19-21, 23-25, 27.

Hemicytherura cocois Hu & Tao, 2008, p.378-380, pl. 224, figs. 18, 19, text-fig. 225.

Hemicytherura kajiyamai Hanai. Hu & Tao, 2008, pl. 29, figs. 11, 22.

Hemicytherura houhsengi Hu & Tao, 2008, pl. 38, fig. 12.

? *Hemicytherura cuneata* Hanai. Yasuhara & Irizuki, 2001, pl. 5, fig. 12; Irizuki *et al*., 2009, fig. 3 (15).

non *Hemicytherura cuneata* Hanai. Hu, 1981, p. 92, text-figs. 12C, 12D, pl. 3, figs. 7, 10; Gou *et al*., 1981, p. 159, pl. 92, figs. 5, 6, pl. 80, figs. 12-14; Gou *et al*., 1983, p. 48, 49, text-fig. 16, pl. 10, figs. 28-33; Hu, 1984, p. 118, pl. 5, figs. 22, 23; Zheng, 1987, p. 196, pl. 4, fig. 23; Wang, Q. & Zheng, 1987, p. 289, pl. 2, fig, 31; Ruan & Hao, 1988, p. 292, pl. 50, figs. 4-8; Wang, P. *et al*., 1988, p. 102, pl. 1, fig. 17; Yajima, 1988, p. 1076, fig. 18, p. 1078, fig. 7; Yasuhara & Irizuki, 2001, pl. 5, fig. 11; Hou & Gou, 2007, pl.

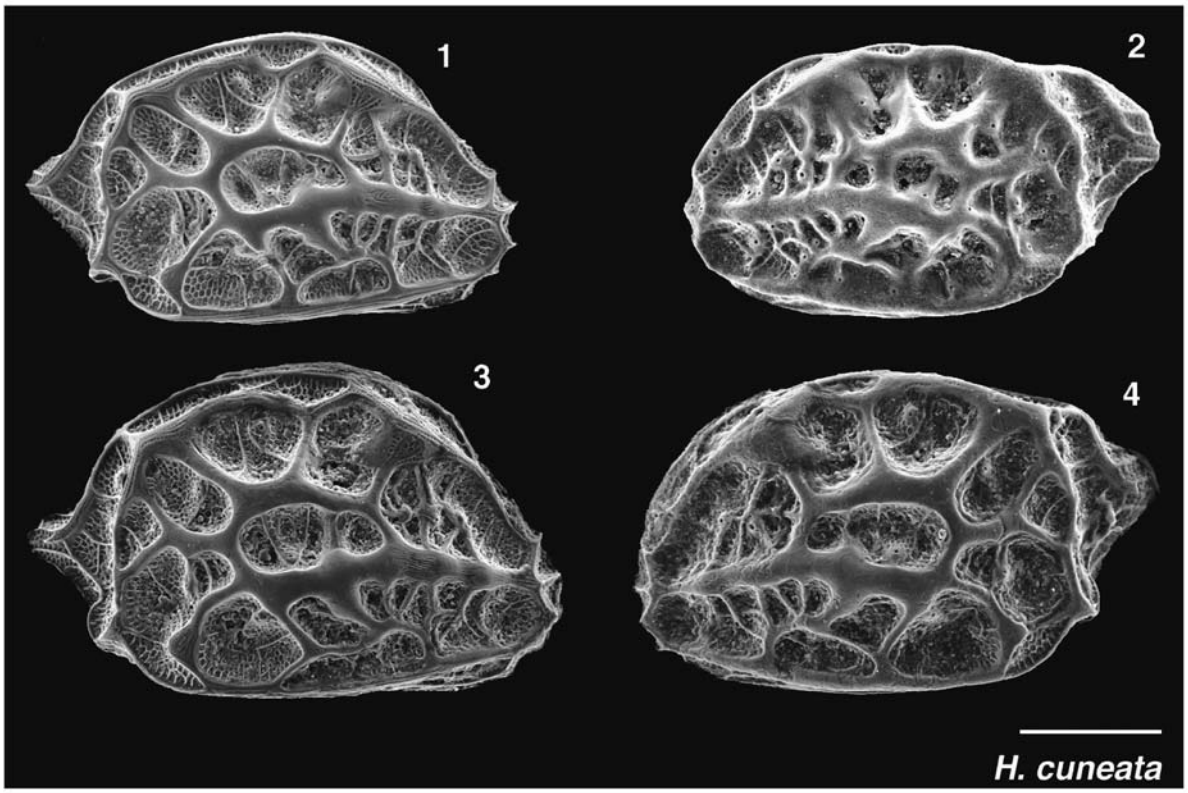

Figure 11. *Hemicytherura cuneata* Hanai, 1957. (Loc. 8). 1. External lateral view of male RV, GMNH-PI-3176. 2. External lateral view of male LV, GMNH-PI-3177. 3. External lateral view of female RV, GMNH-PI-3178. 4. External lateral view of female LV, GMNH-PI-3179. Scale = 100 μm.

111, figs. 1, 2, 4; Hu & Tao, 2008, pl. 57, fig. 2, pl. 70, fig. 18, pl. 165, fig. 17.
Hemicytherura sp. 3. Ikeya & Itoh, 1991, p. 138, fig. 17A.

Types.--Holotype, UMUT-CA-2619 (CC: L=0.37mm, H=0.23mm, W=0.21mm); paratype, UMUT-CA-2620 (CC: L=0.39mm, H=0.24mm, W=0.21mm).

Type locality.--The shore back of an Imperial villa, Hayama-machi, Kanagawa Prefecture (Recent beach sand), Japan (35°15. 3′ N, 139°34. 8′ E).

Description.--Carapace middle in this genus. Lateral outline of RV subtrapezoidal and greatest height just in front of middle (Figure 11-1, 11-3). Dorsal margin of LV sinuated (Figure 11-2, 11-4). In RV, anterior margin obliquely rounded with five crenulatioins in mid to lower area. Surface ornamentation with strong murus surrounding fossae: using NNH, central fossa which compose only Fossa 1^{I} fused 2 distinct, while Fossa 5^{I} and 8^{II} separated from Fossa 5^{II} and 8^{I} respectively. Surface of fossae covered with fine honeycombed pattern.

Description of soft-parts.-See Okubo (1980).

Occurrences.--Recent: coasts of Japanese Islands and China, Penghu Islands and Matsu Island of Taiwan. Fossil: Late Miocene (Kubota Formation) to Holocene formations of Japan and Pliocene to Pleistocene formations of Taiwan.

Remarks.--The appendages of *H. cuneata* from the Inland Sea of Japan were fully illustrated by Okubo (1980). The ornamentation patterns are very similar to those of *H. houhsengi* Hu & Tao, 2008. But *H. cuneata* is distinguished from *H. houhsengi* by high H/L ratio of carapace in female, absence of an obliquely running murus from anteromedian to midventral, murus making angles at posterodorsal and postero-ventral areas and cuneate shape in dorsal view. *H.* sp. 3 of Ikeya & Itoh (1991) correspond to juvenile (A-1 stage) of this species.

Hemicytherura choeae Kaseda and Ikeya n. sp.
(Figure 3F; Figure 4E; Figure 12, 1a-f, 2a-f)

Hemicytherura yeosuensis Choe, 1985 MS. Cheong *et al*., 1986, p. 49, pl. 3, fig. 5.
Hemicytherura cuneata Hanai. Yasuhara & Irizuki, 2001, pl. 5, fig. 11.
Hemicytherura sp. Irizuki, 2004, pl. 2, fig. 9.
Hemicytherura sp. Kamiya et al., 2001, fig. 18 (6).
Hemicytherura sp. Paik & Lee, 1985, pl. 3, fig, 8.
Hemicytherura sp. B Lee, 1990, pl. 27, figs, 5, 6.

Types.--Holotype. Male, CC (Figure 12, 1a-f), L=0.477mm, GMNH-PI-3182; Paratype. Female, CC (Figure 12, 2a-f), L=0.512mm, GMNH-PI-3183.

Type locality.--Loc. 9.

Etymology.--This species is named in honor of Dr. Choe who reported this species from the south coast of Korea in her doctral thesis (manuscript).

Diagnosis.--Anterodorsal Fossa 2 fuses with Fossa 12; posteroventral Fossa 8 divided two parts (8^{I} and 8^{II}), Fossa 8^{I} fused with Fossa 7. Large central Fossa 1^{I} distinct by thick muri. Middorsal Fossa 10 deep and sulcus-like depression in left valve. Copulatory duct of male short and swelling on the middle.

Description.--Carapace large in this genus, thick and strongly calcified. Subrhomboidal in lateral view (Figure 12-1a, 12-1c, 12-2a, 12-2c): dorsal margin of RV slightly arched and LV calmly descend from anterior to posterior; anterior margin obliquely and widely rounded with four crenulations; posterior end bearing strong subdorsal caudal process; posteroventral area strongly angular. In dorsal view, maximum width at about three-fifth of length from anterior end (Figure 12-1d, 12-2d). Surface of fossae covered with very fine honeycombed pattern and partly occur smooth area. Surface ornamentation characterized by very coarsely excavated fossae. According to NNH, anterodorsal Fossa 2 fuses with Fossa 12; posteroventral Fossa 8 divided two parts (8^{I} and 8^{II}), Fossa 8^{I} fused with Fossa 7. Large central Fossa 1^{I} distinct by thick muri. Middorsal Fossa 10 deep and sulcus-like depression in left valve (Figure 12-1c, 12-2c).

Description of soft-parts

Antennule (Figure 13a): Six articulated segments. Length ratio between distal segments 74:55:43:54:55:18. Walls developed, especially well on segments 3-5. Second segment with long simple seta on posterior margin and with setules on anterior lower half and distal margin. Third segment with one plumose seta on anterior distal end and setules on anterior margin. Fourth segment with two unequal simple setae on anterior distal end and setules on distal margin. Fifth segment with one long simple seta and setules on distal margin. On distal end, sixth segment with four long simple setae.

Antenna (Figure 13b): Five articulated segments. Length ratio between distal segments 80:45:41:77:13. Walls developd, especially broad fourth and fifth segments. Second segment with 3-segmented exopodite and one plumose seta and simple seta on posterior distal end. Fourth segment with plumose seta on middle part of anterior margin, and many short setules along lower half of posterior margin. Furthermore, simple seta on proximal margin and plumose seta on posterior distal end. A bunch of setules on distal margin. Fifth segment with stout claw-like seta with serrations along anterior margin on distal end and one stout crenate seta on ledge of posterior margin. One short simple seta between anterior and posterior claw-like seta.

Mandible (Figure 13c): Composed of protopodite and exopodite. Distal part of protopodite with 6 teeth. Length ratio between endopodite segments 20:45:25:9. First segment of endopodite with long simple seta on distal margin. Second segment of endopodite with one simple seta on anterior distal margin. Third segment of endopodite with one simple seta on ventral distal end. Two unequal simple setae and one plumose seta on dorsal distal end. Three stout plumose setae on proximal margin. Fourth segment of endopodite bearing 3 simple setae.

Maxilla (Figure 13d): Extremely thin branchial plate with 16 setae. Palp 2-segmented. Proximal segment with 3 simple setae on anterior distal end. Palp with 2 simple setae on distal end. Outer masticatory process with 4 setae on distal end. Middle and inner masticatory process with 4 setae, respectively.

Thoracic legs (Figures 13e-g): First, second and third thoracic legs 4-segmented and similar in shape. Length ratio between distal segments 100:53:33:41 in first thoracic leg, 113:73:40:46 in second thoracic leg, 116:103:37:60 in third thoracic leg. First segment with long plumose seta and long simple

seta on anterior margin in first and second thoracic leg, respectively. First segment with two simple setae on anterior distal end, one simple seta on anterior distal end and one simple seta on posterior margin in first thoracic leg. Second thoracic leg with simple seta on anterior distal end in first and second segment. Second thoracic leg with long simple seta on distal half of anterior margin. Furthermore, second thoracic leg with one plumose seta and one simple seta on posterior proximal end. Third thoracic leg with plumose seta on anterior distal end of first and second segment. Third segment with setules on lower half of anterior margin in second and third thoracic leg. Fourth segment bearing large comb-like terminal claw and setules on distal end.

Copulatory organ of male (Figure 4E): Basal capsule size extremely large and subovate in outline. Evenly arcuate distal lobe especially long and sharpe on tip. Copulatory duct short and swelling on middle. Two clasping apparatuses developed: inner one holly leaf-like shape and lamelliform, outer one short, triangular and occur spiniform projection on middle.

Dimensions.--Listed below are the length and height measurements (in mm) of adult specimens from the type locality.

	L		H		W		
	X	OR	X	OR	X	OR	(N)
C (M)	0.469	0.458-0.477	0.252	0.249-0.255	0.233	0.230-0.235	2
C (F)	0.510	0.492-0.520	0.281	0.278-0.285	0.257	0.251-0.263	3

Occurrences.--Recent: Coastal area under the influence of warm Kuroshio Current and Tsushima Current. Coasts of southern Korean Peninsula and western Japan. Fossil: Plio-Pleistocene formations in Cheju Island, Korea, Lower Pleistocene Masuda Formation, southern Japan, and Holocene sediments

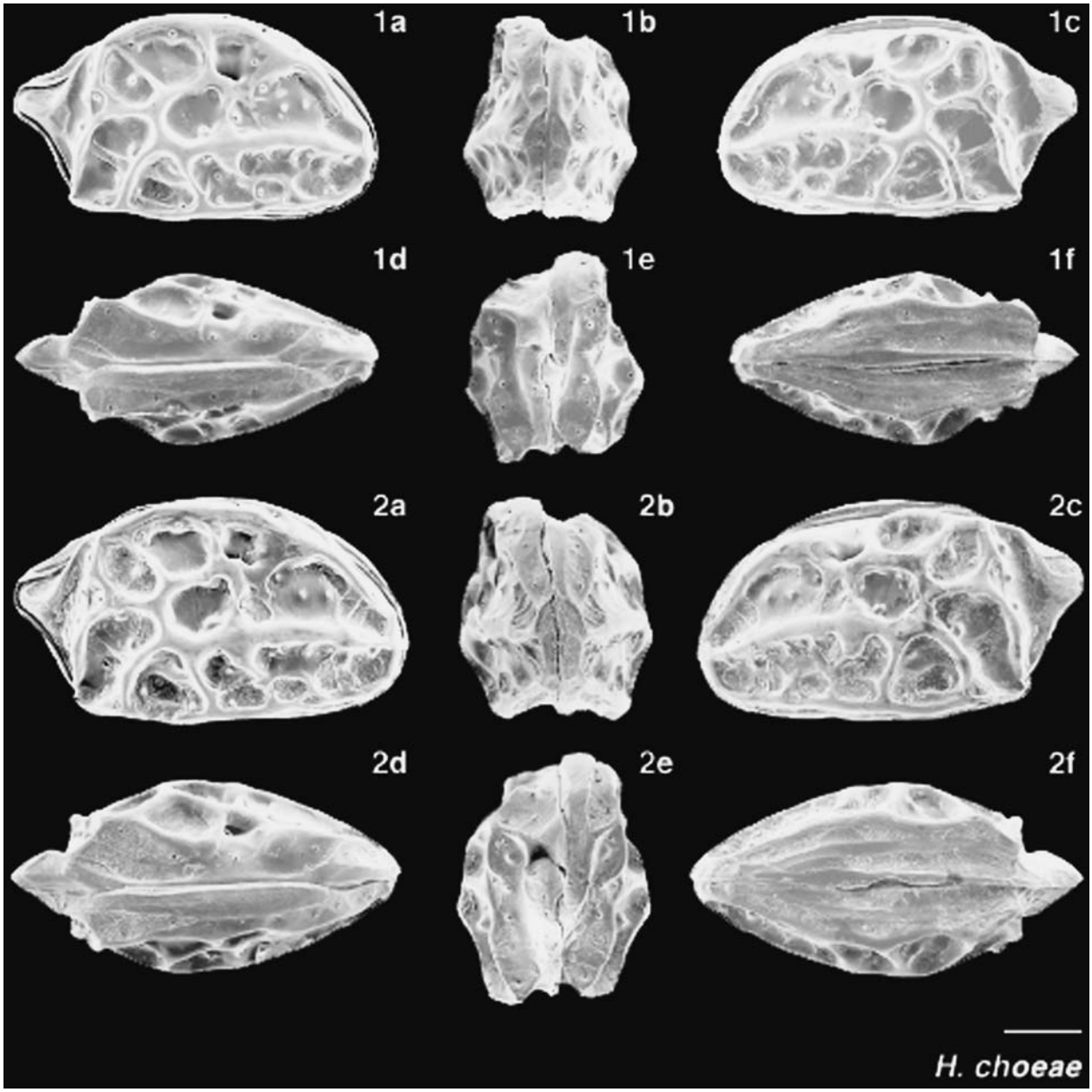

Figure 12. *Hemicytherura choeae* n. sp. (Loc. 9). 1. Complete male carapace: a, right lateral view; b, anterior view; c, left lateral view; d, dorsal view; e, posterior view; and f, ventral view, GMNH-PI-3182. 2. Complete female carapace: a, right lateral view; b, anterior view; c, left lateral view; d, dorsal view; e, posterior view; and f, ventral view, GMNH-PI-3183. Scale = 100 μm.

from Ulleung Basin in the Sea of Japan.

Remarks.--Choe (1985 MS) described one *H.* species from the south coast of Korea as a new species '*H. yeosuensis*'. We recognized her specimen as a new species. This species is distinguished from *H. cuneata* and *H. houhsengi*, *H. japonica* n. sp. by Fossa 2 fuses with Fossa 12.

Hemicytherura houhsengi Hu & Tao, 2008
(Figure 3G; Figure 14, 1a-c, 2a-c)

Figure 13. Soft parts of *Hemicytherura choeae* n. sp. (paratype: GMNH-PI-3187). a. antennule, b. antenna, c. mandible, d. maxillula, e. first thoracic leg, f. second thoracic leg, and g. third thoracic leg.

Hemicytherura houhsengi Hu & Tao, 2008, p. 376, 377, pl. 8, figs. 9, 17-19, pl. 29, figs. 8, 14, 18, 21, pl. 38, fig. 2, 10, pl. 70, figs. 9, 12, 19.

Hemicytherura anapta Hu, 1986, p. 166, pl. 25, figs. 4, 9, 10, 13-18, 22, 26, 28-30.

Hemicytherura cuneata Hanai. Institution of Geological Science of Hubei Province and other institutions ed., 1978, p. 252, 253, pl. 67, figs. 11, 12, text-fig. 46; Hu, 1981, p. 92, text-figs. 12C, 12D, pl. 3, figs. 7, 10; Gou *et al*., 1981, p. 159, pl. 92, figs. 5, 6, pl. 80, figs. 12-14; Gou *et al*., 1983, p. 48, 49, text-fig. 16, pl. 10, figs. 28-33; Hu, 1984, p. 118, pl. 5, figs. 22, 23; Zheng, 1987, p. 196, pl. 4, fig. 23; Wang & Zheng, 1987, p. 289, pl. 2, fig. 31; Ruan & Hao, 1988, p. 292, pl. 50, figs. 4-8; Wang *et al*., 1988, p. 102, pl. 1, fig. 17; Yajima, 1988, p. 1076, fig. 18, p. 1078, fig. 7; Irizuki *et al*., 2006, fig. 7 (9); Hu & Tao, 2008, pl. 57, fig. 2, pl. 70, fig. 18, pl. 165, fig. 17.

Hemicytherura apta Hu. Hu, 1977, pl. 26, figs. 1, 3-7, 10, 11, 14, 17.

Hemicytherura cuneata malaysiana Mostafawi, 1992, p. 154, pl. 6, figs. 118, 119.

non *Hemicytherura houhsengi* Hu & Tao, 2008, pl. 30, fig. 18, pl. 38, fig. 12, pl. 38, fig. 12.

Types.--Holotype, NPIM-038786.

Type locality.--the Upper Miocene Kweichulin Formation, about 2.5km W of Caoling City, central Taiwan (23°59. 0′N, 120°54. 0′E).

Description.--Carapace size medium in this genus, thick and strongly calcified. Lateral outline subrhomblid: dorsal margin slightly arched; four obscure crenurations along anterior margin; posteroventral margin smoothly curved. In dorsal and ventral view, subfusiform, widest at mid-point. A characteristic murus obliquely running from anteromedian to midventral. Several thick muri occur at central and posteroventral area. According to NNH, central Fossa 1^{I} fused with Fossa 2; Fossa 5^{I} and Fossa 5^{II} separated by thick murus. Surface of fossae occur somewhat conspicuous thin muri and covered with small honeycombed pattern.

Occurrence.--Recent: coasts of Northwestern Pacific, with range of south of latitude 38° N. Fossil: Miocene (Kweichulin Formation) to Pleistocene formations of Japan and Pleistocene formation of Taiwan.

Remarks.--Hu (1977, 1981) reported *H. apta* and *H. cuneata* from the Pleistocene Toukoshan Formation of Miaoli area, northwest Taiwan and the Pliocene Maanshan Mudstone of Hengchun Peninsula, southern Taiwan, respectively. Hu (1986) redescribed these *Hemicytherura* specimens as *H. anapta* n. sp. based on the new specimens (from the Pleistocene Tungshiao Formation, near Miaoli City, northwestern Taiwan). In 2004, we (N. I. & G. T.) visited Taiwan to collect topotype specimens and to research Hu's type specimens. The collecting research of his topotype specimens is almost successful, and we found topotype specimens of *H. anapta*. However, Dr. Hu Chung-Hung said 'all of the type specimens described by him were washed away by flooding by two typhoons in 1993 & 2001 because he deposited all of his type specimens in the basement of his house (although he described that his type specimens were deposited in several university and museums of Taiwan in his papers (1978-1986)). Recently, Hu & Tao (2008) described a new species *H. houhsengi* from the Miocene to Pleistocene formations of Taiwan. This new species is exactly the same as *H. anapta* described by Hu (1986). The pattern of the ornamentation of this species is very similar to that of *H. cuneata* Hanai, 1957, but the *H. houhsengi* is distinguished by striking murus running obliquely from anteromedian to mid-ventral. Furthermore, the outline in dorsal view is subfusiform in *H. houhsengi* against cuneate-form in *H. cuneata*. The present species differs from *H. choeae* n. sp. in fused Fossa 1^{I} and Fossa 2. *H. houhsengi* is dis-

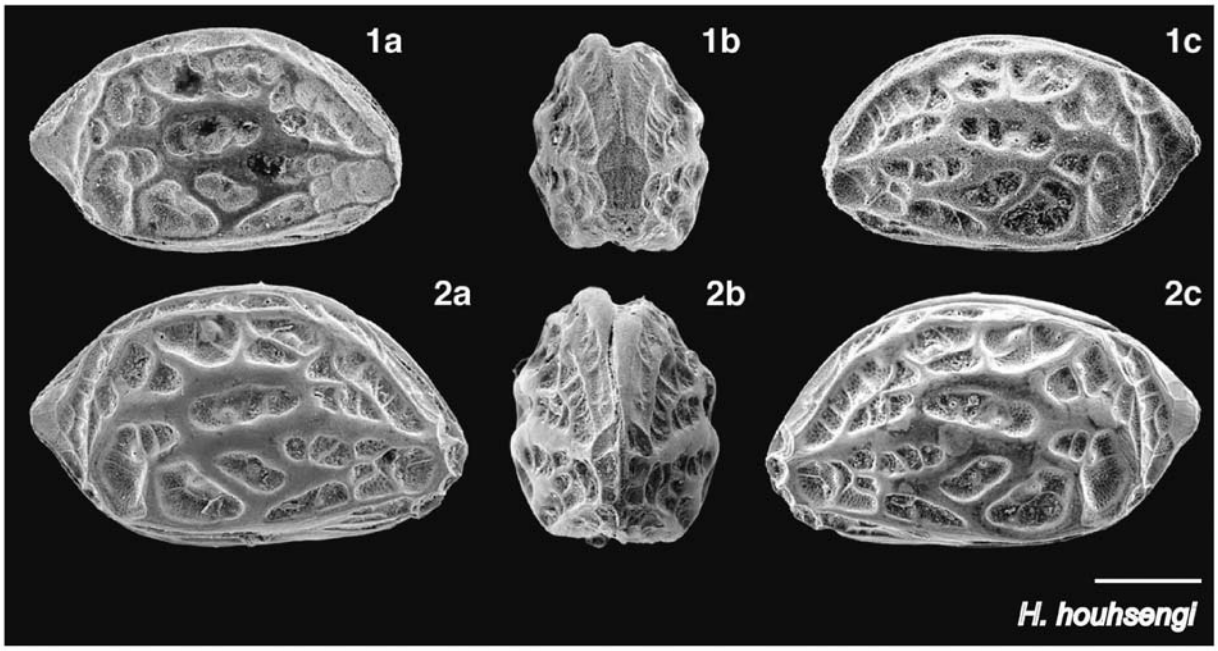

Figure 14. *Hemicytherura houhsengi* Hu & Tao, 2008. (Loc. 3). 1. Complete male carapace: a, right lateral view; b, anterior view; and c, left lateral view, GMNH-PI-3180. 2. Complete female carapace: a, right lateral view; b, anterior view; and c, left lateral view, GMNH-PI-3181. Scale = 100 μm.

tinguished from *H. japonica* in subdivided Fossa 5 (Fossa 5^{I} and Fossa 5^{II}). This species has one of the oldest fossil records in Japan and its adjacent area.

Hemicytherura japonica Kaseda and Ikeya n. sp.
(Figure 3H; Figure 4F; Figure 15, 1a-f, 2a-f)

Hemicytherura eretaoi Hu & Tao, 2008, pl. 119, fig. 13.
Hemicytherura kajiyamai Hanai. Ruan & Hao, 1988, pl. 50, figs. 14, 16; Hou & Gou, 2007, pl. 111, fig. 8.

Types.--Holotype. Male, CC (Figure 15, 1a-f), L=0.318mm, GMNH-PI-3185; Paratype. Female, CC (Figure 15, 2a-f), L=0.363mm, GMNH-PI-3186.

Type locality.--Loc. 5.

Etymology.--This species is named after the distribution around Japan.

Diagnosis.--Roundly central fossa which compose Fossa 1^{I} and Fossa 2 distinct from surrounding fossae; Fossa 8 separated small Fossa 8^{I} and Fossa 8^{II}. Male copulatory duct short and smaller.

Description.-Carapace size medium, thick and strongly calcified. In lateral view, subovate in outline: dorsal margin strongly arched; ventral margin almost straight; highest at middle, anterior margin somewhat round with five conspicuous crenulations in mid to lower half; posterior margin with remarkable caudal process. Viewed dorsally, cuneate shape in outline. On carapace surface, eight straight conspicuous muri radiating from a central round fossa. According to NNH, roundly central fossa composed with Fossa 1^{I} and Fossa 2; Fossa 8 separated with Fossa 8^{I} and Fossa 8^{II}. Fossae surface covered with conspicuous fine honeycombed pattern.

Description of soft-parts (*Only male copulatory organ*)

Copulatory organ of male (Figure 4F): Size of basal capsule relative small and subround in outline. Comma-shaped distal

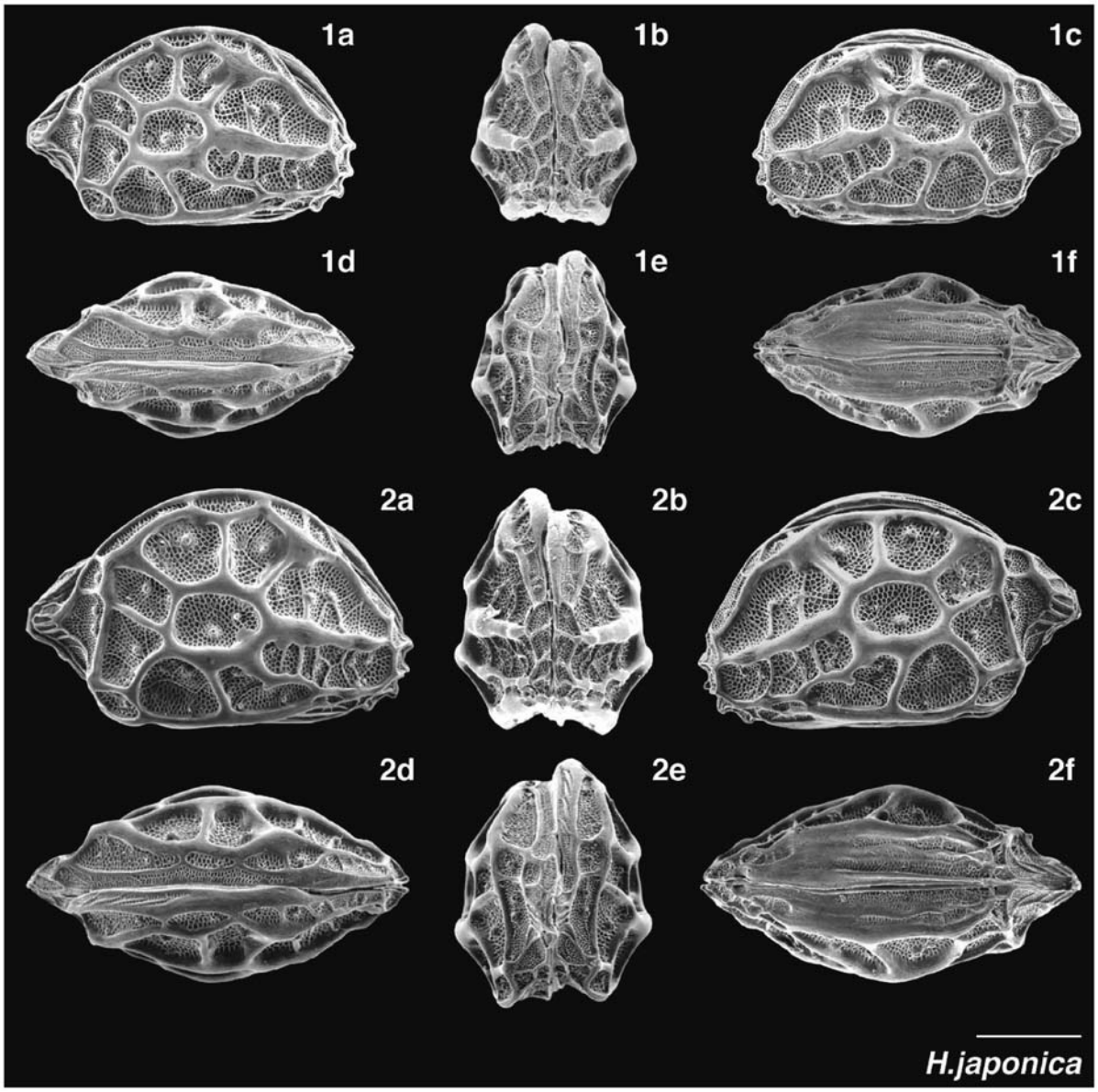

Figure 15. *Hemicytherura japonica* n. sp. (Loc. 5). 1. Complete male carapace: a, right lateral view; b, anterior view; c, left lateral view; d, dorsal view; e, posterior view; and f, ventral view, GMNH-PI-3185. 2. Complete female carapace: a, right lateral view; b, anterior view; c, left lateral view; d, dorsal view; e, posterior view; and f, ventral view, GMNH-PI-3186. Scale = 100 μm.

lobe remarkable broad and obtuse on tip. Copulatory duct short and smaller. Two clasping apparatuses developed; outer one rather larger and triangular, inner one small and acutely sharp on the tip.

Dimensions.--Listed below are the length and height measurements (in mm) of adult specimens from the type locality.

	L		H		
	X	OR	X	OR	(N)
RV (M)	0.323	0.310-0.328	0.219	0.218-0.220	3
RV (F)	0.363	0.340-0.386	0.241	0.233-0.253	21
LV (M)	0.327	0.313-0.329	0.208	0.207-0.209	2
LV (F)	0.369	0.358-0.384	0.230	0.218-0.236	21

Occurrence.--Recent: coasts of the Sea of Japan, with range of latitude 30° to 44°. Fossil: Late Pleistocene Ssukou Formation, southern Taiwan; Holocene sediment of Okinawa trough.

Remarks.--This species are similar to *Kangarina kunchiatiena*, which reported by Hu (1984) from the Ssukou Formations in Taiwan (although Hu, 1984's type specimen was lost as above mentioned). But *H. japonica* n. sp. differs from *K. kunchiatiena* in arched dorsal margin, caudal process which situated middle on posterior margin and valve size. Some specimens of *H. kajiyamai* showed by Ruan & Hao (1988) are identified with this new species by ornamentation and valve outline. This Recent species has been found from only coasts of Japan. *H. japonica* n. sp. is distinguished from the other species of HEMICYTHERYRA CUNEATA GROUP (*H. cuneata* Hanai, *H. choeae* n. sp., and *H. houhsengi*) with not subdivided Fossa 5.

HEMICYTHERURA TAIWANENSIS GROUP

Hemicytherura taiwanensis Kaseda and Tanaka n. sp.
(Figure 3I; Figure 4G; Figure 16, 1a-f, 2a-f)

Hemicytherura hartmanni Yassini & Jones. Yassini & Jones, 1995, p. 376, figs. 522, 575, 576.

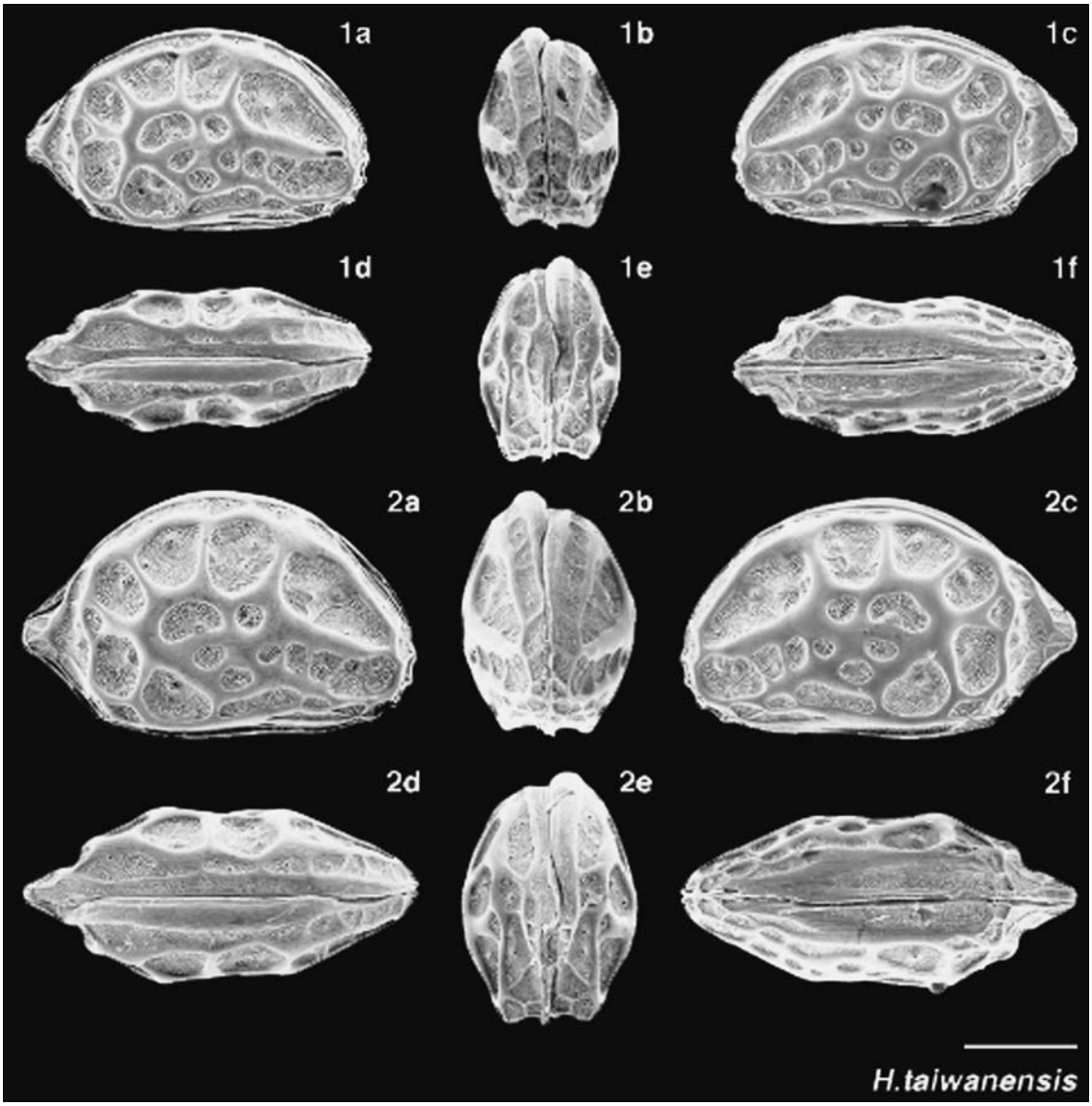

Figure 16. *Hemicytherura taiwanensis* n. sp. (Loc. 2). 1. Complete male carapace: a, right lateral view; b, anterior view; c, left lateral view; d, dorsal view; e, posterior view; and f, ventral view, GMNH-PI-3188. 2. Complete female carapace: a, right lateral view; b, anterior view; c, left lateral view; d, dorsal view; e, posterior view; and f, ventral view, GMNH-PI-3189. Scale = 100 μm.

Types.--Holotype. Male, CC (Figure 14, 1a-f), L=0.312mm, GMNH-PI-3188; Paratype. Female, CC (Figure 14, 2a-f), L=0.345mm, GMNH-PI-3189.

Type locality.--Loc. 2.

Etymology.--This species is named after its distribution of Taiwan.

Diagnosis.-- Central group of five subcircular fossae (Fossa 1^{I}, Fossa 1^{II}, Fossa 2, Fossa 3^{II}, Fossa 5^{II}). Fossa 1^{I} shape subreniform; anteroventral Fossa 3 subdivides four parts (Fossa 3^{II}, Fossa 3^{III}, Fossa 3^{IV}, and Fossa 3^{V}) by some thin muri; some fossae in dorsal area nearly trapezoid; posteroventral Fossa 8 separates Fossae 8^{I} and Fossa 8^{II}. Lacking one pore in Fossa 8. Male copulatory duct complicatedly interwinded at base.

Description.--Carapace size small. In lateral outline, subtrapezoid: Dorsal margin gently arched; anterior margin obliquely rounded with four crenulations in lower half; posterior margin with triangular and inconpicuous caudal process. Sexual dimorphism strong: in female, extremely highest at middle; in male, ventral and dorsal margin nearly parallel in right valve. Viewed dorsally, nearly parallel in side of both valves. Using NNH, Central group of five subcircular fossae (Fossa 1^{I}, Fossa 1^{II}, Fossa 2, Fossa 3^{II}, Fossa 5^{II}), of which all but Fossa 3^{II} somewhat separated from surrounding fossae. Fossa 1^{I} shape subreniform; anteroventral Fossa 3 subdivided four parts (Fossa 3^{II}, Fossa 3^{III}, Fossa 3^{IV}, and Fossa 3^{V}) by some thin muri; some fossae in dorsal area nearly trapezoid; posteroventral Fossa 8 separated Fossa 8^{I} and Fossa 8^{II}. Surface of fossae covered with fine delicate honeycombed pattern. Lacking one pore in Fossa 8, in comparison with that of most species in this genus. In male copulatory organ, basal capsule size considerably small and subrhomboidal in outline.

Description of soft-parts

Antennule (Figure 17a): Six articulated segments. Length ratio between distal segments 54:39:30:38:41:11. Walls developed, especially well on segments 3-5. Second segment with simple seta on middle of dorsal margin. Third, Fourth and Fifth segment with one simple seta on anterior distal end, respectively. On distal end, sixth segment with 4 simple setae.

Antenna (Figure 17b): Five articulated segments. Length ratio between distal segments 57:36:32:55:13. Walls developd, especially broad third and fourth segments. Second segment with 3-segmented exopodite and one plumose seta on posterior distal end. Third segment bearing a simple seta on distal end. Fourth segment with simple seta on middle part of posterior margin, simple seta on proximal and distal end of posterior margin, respectively, simple seta on proximal margin. Fifth segment with stout claw-like seta with serrations along anterior margin on distal end and one stout crenate seta on ledge of posterior margin.

Mandible (Figure 17c): Composed of protopodite and exopodite (however, exopodite was not preserved). Distal part of protopodite with 7 teeth.

Maxilla (Figure 17d): Palp with 3 simple setae on distal end. Outer masticatory process with 5 setae on distal end. Middle and inner masticatory process with 3 and 2 setae, respectively.

Thoracic legs (Figures 17e-g): First, second and third thoracic legs 4-segmented (but second segment was only preserved 2 segments) and similar in shape. Length ratio between distal segments 68:32:24:23 in first thoracic leg, 71:50 in second thoracic leg, 80:71:30:39 in third thoracic leg. First segment with simple seta near posterior proximal end. First segment with simple near middle part of anterior margin in first thoracic leg. First segment with stout simple seta on anterior distal end in second thoracic leg, with one plumose seta on anterior distal end in third thoracic leg, a long simple seta and a stout plumose seta on anterior margin in second thoracic leg. Second segment with one simple seta on anterior distal end. Fourth segment bearing large terminal claw.

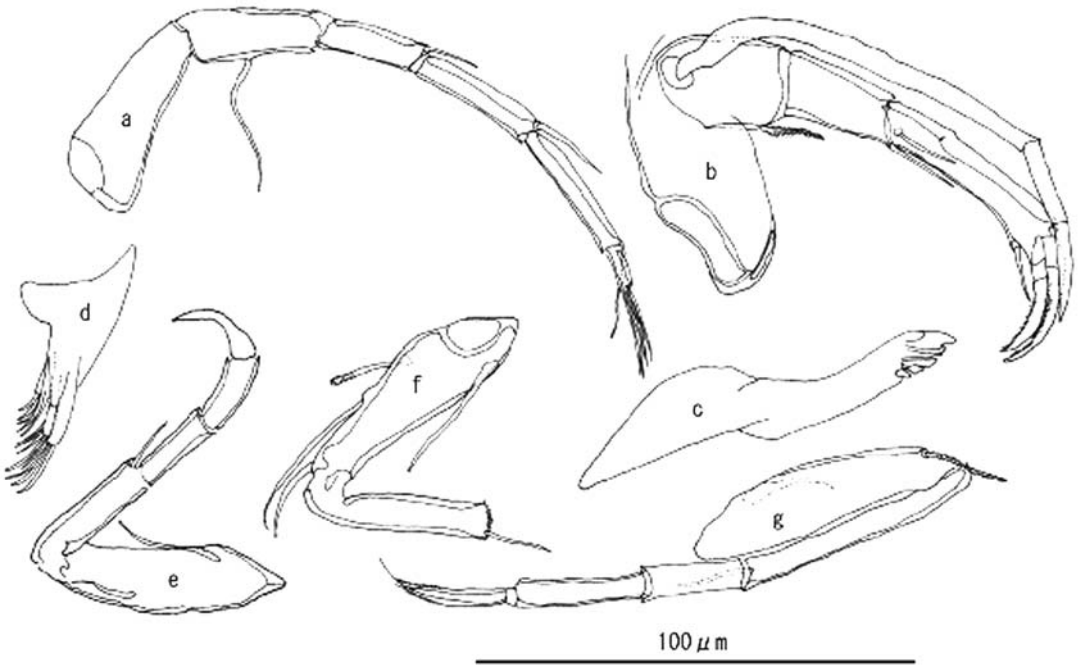

Figure 17. Soft parts of *Hemicytherura taiwanensis* n. sp. (paratype: GMNH-PI-3190). a. antennule, b. antenna, c. mandible, d. maxillula, e. first thoracic leg, f. second thoracic leg, and g. third thoracic leg.

Copulatory organ of male (Figure 4G): Basal capsule size smaller and subrhomboidal in outline. Distal lobe nearly straight and obtuse at tip. Copulatory duct complicatedly interwinded at base. Two clasping apparatuses developed: outer one small, spiniform on tip and bearing projection at middle; inner one lamellaform and obscure T-shape, anterior end acute and posterior end round.

Dimensions.--Listed below are the length and height measurements (in mm) of adult specimens from the type locality.

	L		H		W		
	X	OR	X	OR	X	OR	(N)
C (M)	0.305	0.289-0.316	0.180	0.173-0.191	0.142	0.132-0.153	15
C (F)	0.333	0.323-0.348	0.212	0.201-0.225	0.166	0.150-0.174	26

Occurrences.--Recent: coasts of southern Taiwan and northern Australia. Fossil: unknown.

Remarks.--Yassini & Jones (1995)'s described *H. hartmanni* from Windang Island, East Australia with some pictures as a new species. But their paratype specimen belongs to *H. taiwanensis* in the morphology of carapace.

HEMICYTHERURA TRICARINATA GROUP

Hemicytherura tricarinata Hanai, 1957
(Figure 3J; Figure 4H; Figure 18, 1a-c, 2a-c)

Hemicytherura tricarinata Hanai, 1957, p. 25, 26, pl. 2, figs. 3a, 3b. Ishizaki, 1968, p. 20, pl. 4, fig. 13; Okubo, 1980, p. 8, 9, 17, figs. 1e, 1f, 2i-l, 6; Hou *et al*., 1982, p. 176, 177, 372, pl. 74, fig. 18; Ikeya et al., 1985, p.9, pl. 5, figs. 17-19; Horne & Okubo, 1988, text-figs. 1a, 1b, pl. 1, figs. 1a-3b, pl.2 figs. 1a-3b; Kamiya, 1988, fig. 5 (10); Kamiya, 1989, p. 79, fig. 4 (10); Yajima & Load, 1990, pl. 5, fig. 8; Ikeya & Itoh, 1991, p. 116; Yamane, 1998, pl, 5, fig. 7; Irizuki & Hosoyama, 2000, fig. 3 (14); Kamiya et al., 2001, fig. 17 (8); Yasuhara & Irizuki, 2001, pl. 5, fig. 16; Nakao & Tsukagoshi, 2002, p. 93, fig. 13G, 13H; Hou & Gou, 2007, pl. 111, fig. 7.

non *Hemicytherura tricarinata* Hanai. Cai, 1982, p. 6, pl. 2, figs. 18, 19

Types.--Holotype, UMUT-CA-2621 (CC: L=0.39mm, H=0.22mm, W=0.18mm); Paratype, UMUT-CA-2622 (CC: L=0.37mm, H=0.21mm, W=0.18mm).

Type locality.--The shore about 1 km NE of Akase railroad station, Akase, Uto City, Kumamoto Prefecture (Recent beach sand), Japan. (32°45. 7′ N, 130°46. 2′ E).

Description.--Carapace size medium and subrectangular in lateral outline: ventral and dorsal margin nearly parallel, greatest height at one fourth of length from anterior end in LV; anterior margin obliquely round without fine crenulation; posterior margin with inconspicuous caudal process. Viewed dorsaly, subrhomboidal in female, spindle-shaped with wave-like outline from middle to posterior end in male. In surface ornamentation, striking longitudinal murus runs nearly straight. Using NNH, Fossa 1^{I} and Fossa 10, Fossa 2 and Fossa 11, and Fossa 7 and Fossa 8^{I} fused, respectively; Fossa 1 subdivided two parts (Fossa ^{1}Iand Fossa 1^{II}) by striking longitudinal murus. Openings of pore-systems comparatively small. In male copulatory organ, basal capsule size middle and semicircle in outline. Arcuate distal lobe broad and flame-like shape. Copulatory duct extremly short and triangular on the tip. Two clasping apparatuses developed: inner one smaller, outer one hammer-shape; anterior end acute and posterior end round.

Description of soft-parts-See Horne and Okubo (1988).

Occurrence.--Recent: coast under the influence of warm Kuroshio Current in Japan. Fossil: Pliocene to Holocene formations of southwestern Honsyu, Kyusyu and Okinawa Islands.

Remarks.--Detail illustrations of appendages of this species from Inland Sea of Japan were shown by Okubo (1980). As

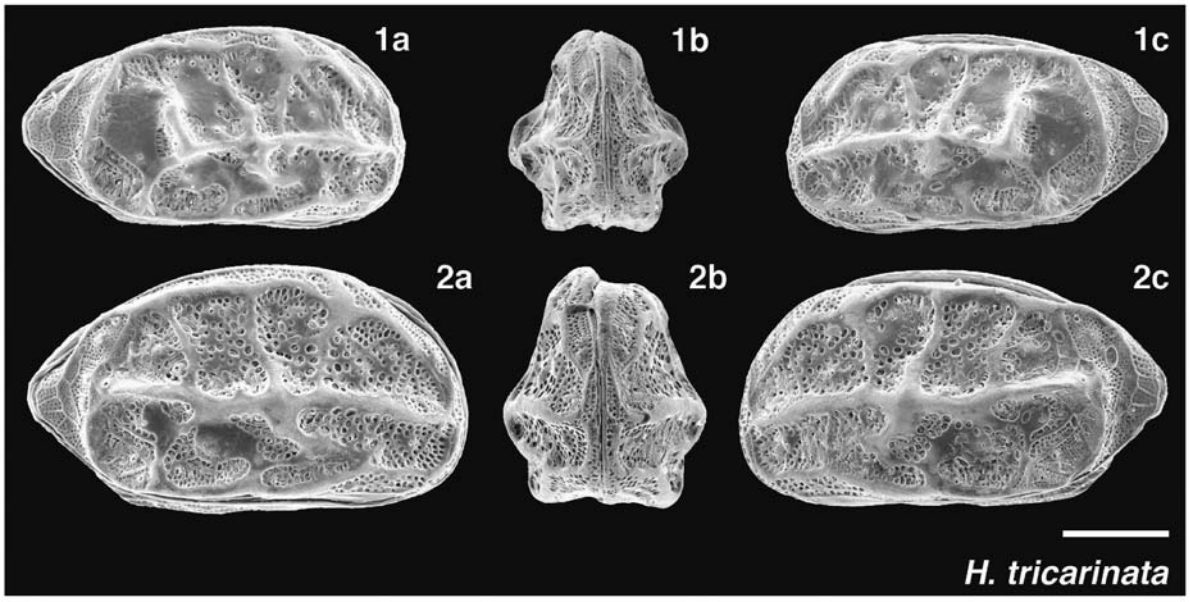

Figure 18. *Hemicytherura tricarinata* Hanai, 1957. (Loc. 7). 1. Complete male carapace: a, right lateral view; b, anterior view; and c, left lateral view, GMNH-PI-3191. 2. Complete female carapace: a, right lateral view; b, anterior view; and c, left lateral view, GMNH-PI-3192. Scale = 100 μm.

noted by Hanai (1957), this species closely resembles *Hemicytherura quadrazea* Hornibrook, 1952 from Recent New Zealand, which is mainly distinguished by having characteristic wave-like feature in ventral outline and four crenulations in anterior lower half. This species inhabits on sand bottom of seagrass bed (Kamiya 1988, 1989).

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Appendix

Loc. 1. Recent: Rocky shore, Fangshans, coast of Southern Taiwan. (21°54. 9′ N, 120°49. 8′ E), (Algae, lottoral zone, Mar. 28, 1998).

Loc. 2. Recent: Rocky shore, 2km NW of Oluanpi, the southern tip of Taiwan (22°14. 8′ N, 120°38. 4′ E), (Algae, littoral zone, Mar. 27, 1998).

Loc. 3. Fossil: An exposure along prefectural highway (Route 153), Shanhai, the west of Hengchun, Pingtung Prefecture South Taiwan. (Hengchun limestone, fine sand, late Pleistocene), (21°59. 2' N, 120°42. 2' E).

Loc. 4. Recent: Rocky shore, koijigahama, the western tip of Atsumi Peninsula, central Japan. (34°34. 3' N, 137°01. 3' E), (Algae, littoral zone, Sep. 6, 1998).

Loc. 5. Recent: Rocky shore, mouth of Abratsubo Cove, Southwestern Miura Peninsula, central Japan. (35°09. 2' N, 139°37. 4' E), (Algae, littoral zone, July 25, 1998).

Loc. 6. Recent: inner part of Abratsubo Cove, Southwestern Miura Peninsula, central Japan. (35°09. 4' N, 139°37. 5E), (Zostera, sublittoral zone, July 25, 1998).

Loc. 7. Recent: Near shore bottom, inner part of Aburatsubo Cove, Southwestern Miura Peninsula, central Japan. (35°09. 6' N, 139°37. 4' E), (fine sand, sublittoral zone, Aug. 8, 1991).

Loc. 8. Recent: Rocky shore, 2km E of Nojima-zaki cape, southern tip of Boso Peninsula, central Japan. (34°56. 0' N, 139°44. 2' E), (Alage, littoral zone, Mar. 19, 1984).

Loc. 9 Recent: Rocky shore, Hakona-Irie, coast of Southern Noto-jima Island, Northeastern Noto Peninsula, central Japan. (37°08. 2′ N, 136°58. 3′ E), (Algae, littoral zone, Jun. 9, 1999).

Loc. 10. Recent: Rocky shore, Hane, 25 km Southwest of Suzu-misaki cape, Northeastern Noto Peninsula, central Japan. (37°17. 8' N, 137°10. 5' E), (Algae, littoral zone, Oct. 5, 1997).

Loc. 11. Recent: Near shore of Tomosiri, the south coast of Nemuro Peninsula, eastern Hokkaido. (43°18. 8' N, 145°40. 8' E), (Sand, sublittoral zone, Aug. 7, 1983).

日本およびその周辺地域におけるヘミシセルーラ属（甲殻類，介形虫）の再分類

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要旨：日本周辺地域から報告されたヘミシセルーラ属について，殻形態と軟体部に基づく，再分類をおこなった．特に殻形態ではFossa / Reticulation ユニット（FRU）を用いて再分類をおこなった．その結果，FRUが適用できない*Hemicytherura clathrata*を除いて，大きく４つのグループ:（1）*H. kajiyamai,*（2）*H. cuneata*,（3）*H. taiwanensis*,（4）*H. tricarinata*に分けられることを明らかにした．6新種：*H. choeae* n. sp., *H. huangi* n. sp., *H. japonica* n. sp., *H. notoensis* n. sp., *H. okuboi* n. sp. and *H. taiwanensis* n. sp.を記載した．