

Checklist of ostracods from the Pleistocene Ogushi Formation, Amakusa City, Kumamoto, southwestern Japan

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Abstract

Here we show the checklist of Ostracoda from the Pleistocene Ogushi Formation, Itsuwa Town, Amakusa City, Kumamoto Prefecture, Japan for identifying ostracods from the Quaternary sediments. Twenty-four genera including 39 ostracods species are systematically checked and illustrated. Shallow marine tropical ostracod *Kotoracythere inconspicua* (Brady, 1880) was firstly reported from the Ogushi Formation in this study.

Keywords : Crustacea, Ogushi Formation, Ostracoda, Podocopida, Systematics

Introduction

Ostracods are tiny crustaceans that have long stratigraphical fossil record at least 500 million years (e.g., Williams et al., 2008) and provide good indicator for reconstructing paleoenvironment. Also, because ostracods (especially Podocopa), that we examine here, some of which have been shown to be important indices for reconstructing Cenozoic paleogeography (e.g., Tanaka et al., 2018). The paleoenvironmental analysis using ostracods from the Ogushi Formation was already done by Kawano et al. (2011). According to Kawano et al. (2011), the Ogushi Formation was deposited during the Late Pleistocene (MIS 7), the outcrop of this age is extremely rare in the Kyushu Island, Japan. The occurrence of *Neomonocerotina delicata* from this formation by Kawano et al. (2011) confirmed that the species existed during the Late Pleistocene from Kyushu to Honshu islands, Japan. Present distribution *N. delicata* is from Java Seas to Ryukyu Islands (till Tokara Straight) via the coast of China and northern Vietnam (Irizuki et al., 2009; Tanaka et al., 2009). Although the ostracod assemblages from the Ogushi Formation provide updating of ostracod paleobiogeography during the Late Pleistocene, Kawano et al. (2011) did not illustrate and mention about the species

which occurred from the Ogushi Formation. This article focuses on the systematics and illustration for identifying the ostracods from the Ogushi Formation.

Materials and methods

Unconsolidated light-gray mud with shell fragments was used in this study. The original mud was putted into a bucket and added hot water (around 98 degrees). The samples were washed through a sieve of the opening of 125 μ m and dried in an oven at 80 degrees in the Aitsu Marine Station (AMS) at Kumamoto University. Ostracod specimens picked out under stereoscopic microscope by 21 undergraduate students (see Tanaka and Participants of 2016 base experiment of earth science class in Kumamoto University, 2019), G.T., T. M., R. U. and then digital images of selected specimens were observed and took using a HITACHI TM-1000 scanning electron microscope (SEM) under a low vacuum, and with a non-evaporation coating at AMS.

Systematic Palaeontology

The asterisk mark in front of each species name shows that the species described with appendages by the author(s) or other author(s).

Class Ostracoda Latreille, 1802

Family Bairdiidae Sars, 1865

Genus *Neonesidea* Maddocks, 1969

Neonesidea sp.

Fig. 3.14

Remarks - This fragmented specimen seems to *Neonesidea oligodentata* (Kajiyama, 1913), but it is difficult to identify because of the juvenile stage. Because we could not discover completely adult specimen, we did not identify the specimen. Kajiyama (1913) firstly described this species with antennule, antenna, mandible, maxilla, fifth and sixth limbs, and furca. Appendages including male copulatory organ was described by Okubo (1975a). Smith and Kamiya (2002) described ontogenetic change of shell size, appendages and number of pore canals of this species.

Family Bythocytheridae Sars, 1926

Genus *Bythoceratina* Hornibrook, 1952

Bythoceratina subjaponica Zhou, 1995

Fig. 1.15

Bythoceratina subjaponica Zhou, 1995, p. 80, 81, pl. 4, figs. 5, 6a, 6b.

Remarks - Zhou (1995) described this species from the Recent sediment of Hyuga-nada, Kyushu Island. The specimens consisted of one right valve (holotype) and one left valve (paratype), and recovered from 42 m in depth. Zhou mentioned that this species also occurred from Recent samples from the Tosa Bay, Kumano-nada and off Tanabe. There are no soft parts description.

Family Paradoxostomatidae Brady and Norman, 1889

Genus *Hemicytherura* Fischer, 1855

**Paradoxostoma setoense* Schornikov, 1975

Fig. 3.15

Paradoxostoma setoense Schornikov, 1975, p. 27, 28, fig. 14.

Remarks - This species was described by Schornikov (1975) on the basis of the carapace and appendages (except for thoracopod III) from the rocky intertidal zone near the Seto Marine Biological Laboratory, Seto Inland Sea, Japan. Okubo (1977) mentioned sexual dimorphism of color pattern of the valve between female and male: The carapace of female has dark blue pigments almost of all areas under the carapace, but the male is only pigmented dorso-central areas with dark blue pigment.

Family Cytheruridae G. W. Müller, 1894

Genus *Hemicytherura* Elofson, 1941

**Hemicytherura choeae* Kaseda et Ikeya, 2011

(Tanaka et al., 2011 in reference)

Figs. 2.6, 2.7

Hemicytherura choeae Kaseda et Ikeya, 2011, p. 32-34, figs. 3F, 4E, 12.1a-12.1f, 12.2a - 12.2f.

Remarks - Kaseda and Ikeya, 2011 (in Tanaka et al., 2011) described the carapace and appendages from the rocky shore, Hakona-Irie, coast of southern Noto-jima Island, northeastern Noto Peninsula, central Japan.

**Hemicytherura cuneata* Hanai, 1957

(Hanai, 1957b in reference)

Fig. 2.8

Hemicytherura cuneata Hanai, 1957, p. 24, 25, pl. 2, figs. 2a, 2b, text-figs. 1a, 1b.

Remarks - Hanai (1957b) described this species from the Recent sand collected at a shore behind an Imperial villa, Hayama-cho, Kanagawa Prefecture, Japan (see Ikeya et al., 2003). The materials consist of two complete carapaces (holotype and paratype). All appendages including male copulatory organ of this species were described by Okubo (1980).

**Hemicytherura tricarinata* Hanai, 1957 (Hanai, 1957b in reference)

Figs. 2.9, 2.10, 4.16

Hemicytherura tricarinata Hanai, 1957, p. 25, 26, pl. 2, figs. 3a, 3b.

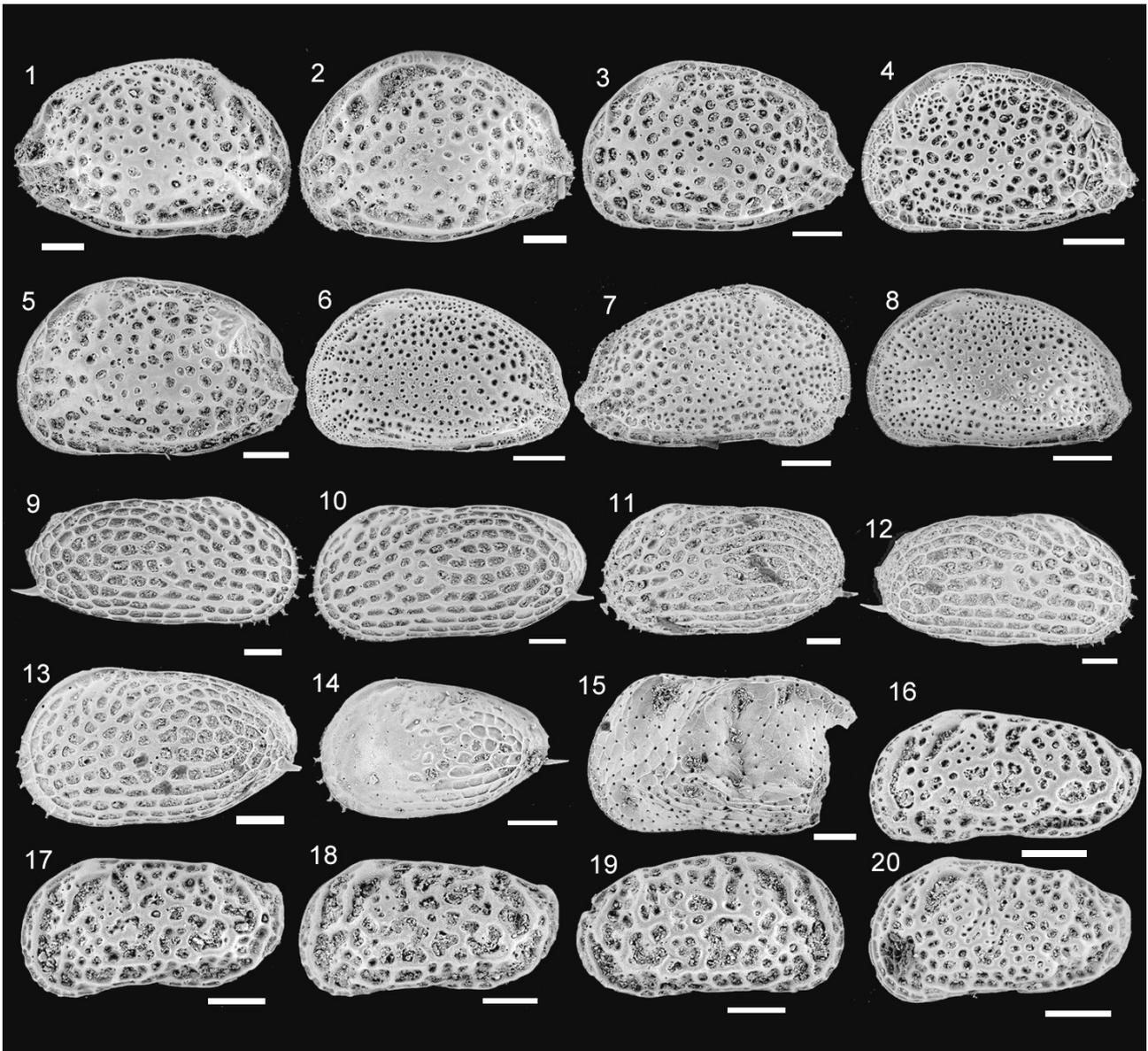


Fig. 1. SEM images of ostracods from the Pleistocene Ogushi Formation, Amakusa, Kyushu, Japan. 1–4. *Aurila cymba* (Brady, 1869). 1. Right lateral view of adult specimen. 2. Left lateral view of adult specimen. 3. Left lateral view of juvenile specimen. 4. Left lateral view of juvenile specimen. 6–8. *Aurila hataii* Ishizaki, 1968. 5. Left lateral view of juvenile specimen. 6. Left lateral view of juvenile specimen. 7. Right lateral view of juvenile specimen. 8. Left lateral view of juvenile specimen. 9–14. *Bicornucythere bisanensis* s.l. (Okubo, 1975), 9. Right lateral view of adult male specimen. 10. Left lateral view of adult male specimen. 11. Left lateral view of adult female specimen. 12. Right lateral view of adult female specimen. 13. Left lateral view of juvenile specimen. 14. Left lateral view of juvenile specimen. 15. Fragmented left lateral view of juvenile specimen. of *Bythoceratina subjaponica* Zhou, 1995 16. *Callistocythere hotaru* Yajima, 1982, left lateral view of adult specimen. 17–20. *Callistocythere hayamensis* Hanai, 1957. 17. Left lateral view of adult male specimen. 18. Left lateral view of adult female specimen. 19. Right lateral view of adult female specimen. 20. Left lateral view of juvenile specimen.

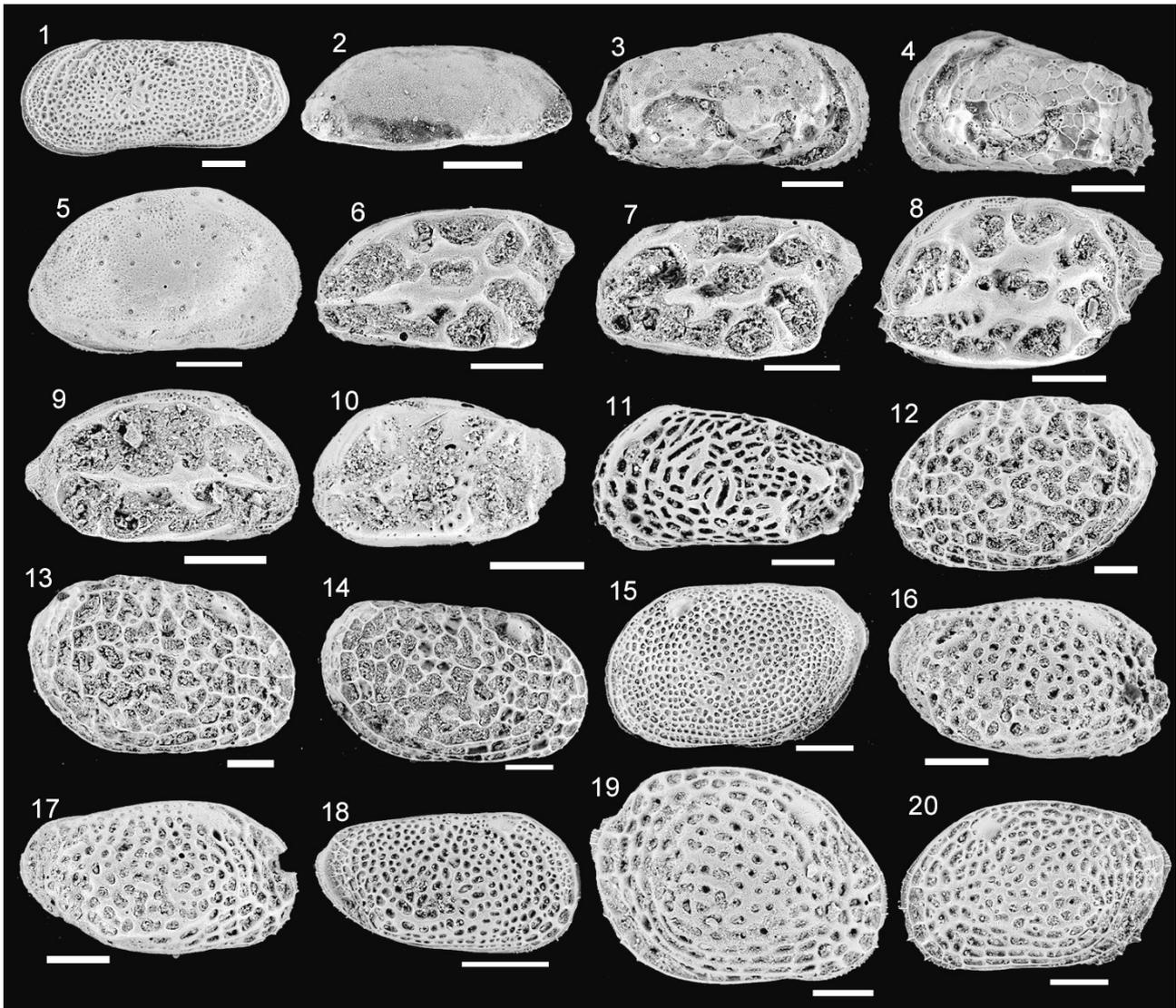


Fig. 2. SEM images of ostracods from the Pleistocene Ogushi Formation, Amakusa, Kyushu, Japan. 1. *Cytheromorpha acupunctata* (Brady, 1880), left lateral view of adult male specimen. 2. *Cobanocythere* sp., right lateral view of adult specimen. 3, 4. *Coquimba ishizakii* Yajima, 1978. 3. Right lateral view of adult specimen. 4. Left lateral view of juvenile specimen. 5. *Cythere nishinipponica* Okubo, 1976, right lateral view of juvenile specimen. 6, 7. *Hemicytherura choeae* Kaseda et Ikeya, 2011 in Tanaka *et al.* (2011). 6. Left lateral view of adult specimen. 7. Left lateral view of adult specimen. 8. *Hemicytherura cuneata* Hanai, 1957, left lateral view of adult female specimen. 9, 10. *Hemicytherura tricarinata* Hanai, 1957. 9. Right lateral view of adult specimen. 10. Left lateral view of juvenile specimen. 11. *Kotoracythere inconspicua* (Brady, 1880), left lateral view of adult specimen. 12–15. *Loxoconcha tosaensis* Ishizaki, 1968. 12. Left lateral view of adult female specimen. 13. Right lateral view of adult female specimen. 14. Right lateral view of adult male specimen. 15. lateral view of juvenile specimen. 16–18. *Loxoconcha harimensis* Okubo, 1980. 16. Right lateral view of adult female specimen. 17. Right lateral view of adult male specimen. 18. Right lateral view of juvenile specimen. 19, 20. *Loxoconcha japonica* Ishizaki, 1968. 19. Right lateral view of adult female specimen. 20. Left lateral view of juvenile specimen. All scale bars are 100 μ m.

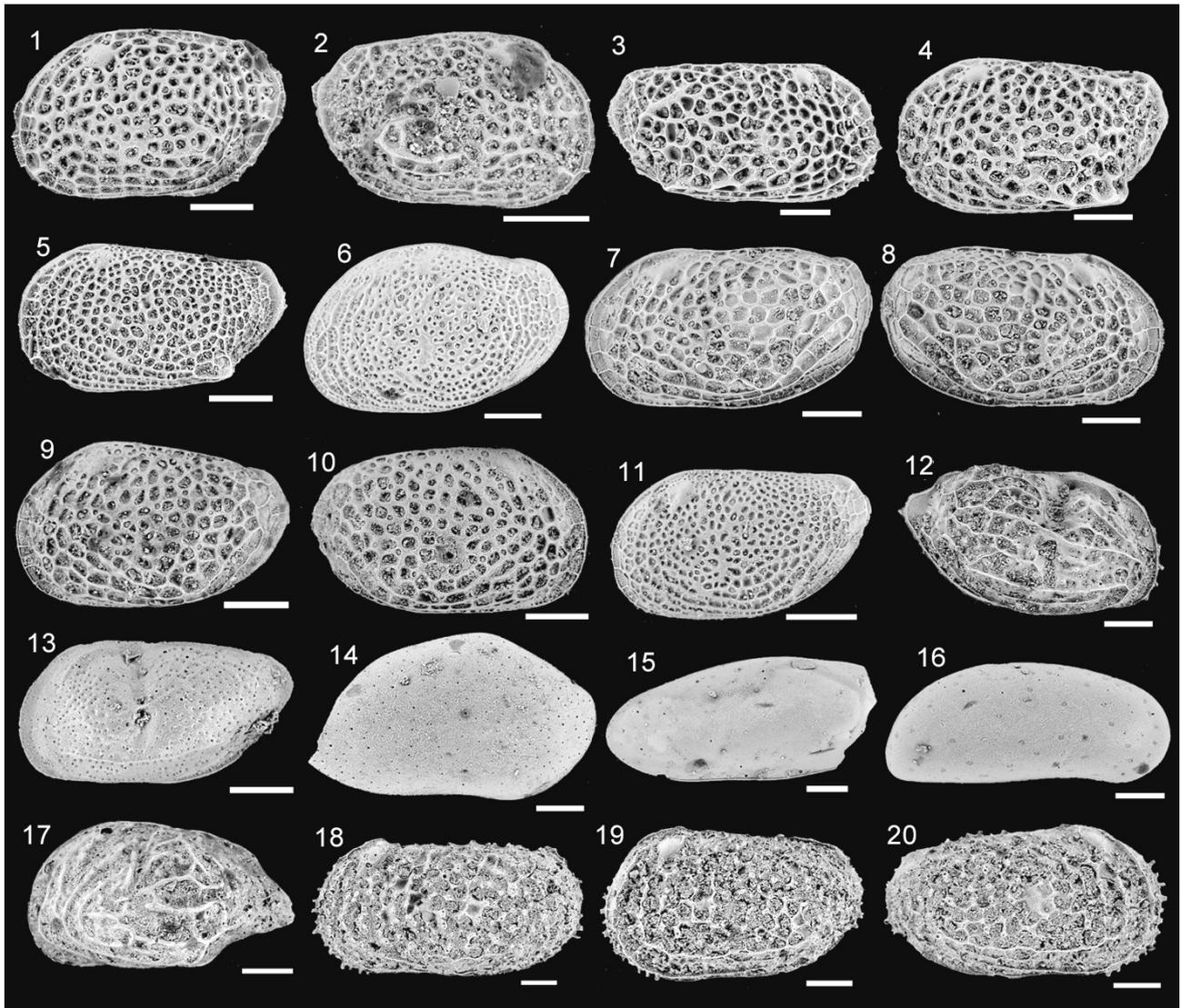


Fig. 3. SEM images of ostracods from the Pleistocene Ogushi Formation, Amakusa, Kyushu, Japan. 1, 2. *Loxoconcha japonica* Ishizaki, 1968. 1. Left lateral view of juvenile specimen with ventral alate ridge. 2. Right lateral view of juvenile specimen. 3–5. *Loxoconcha kitanipponica* Ishizaki, 1971. 3. Right lateral view of adult male specimen. 4. Left lateral view of adult female specimen. 5. Left lateral view of juvenile specimen. 6. *Loxoconcha pulchra* Ishizaki, 1968, left lateral view of juvenile specimen. 7–11. *Loxoconcha uranouchiensis* Ishizaki, 1968. 7. Left lateral view of adult male specimen. 8. Right lateral view of adult male specimen. 9. Left lateral view of adult female specimen. 10. Right lateral view of adult female specimen. 11. Left lateral view of juvenile specimen. 12, 13. *Neomonoceratina delicata* Ishizaki et Kato, 1976. 12. Right lateral view of adult specimen. 13. Left lateral view of juvenile specimen. 14. *Neonesidea* sp., right lateral view of juvenile specimen. 15. *Paradoxostoma setoense* Schornikov, 1975, fragmented valve, left lateral view of juvenile specimen. 16. *Parakrithella pseudadonta* (Hanai, 1959), right lateral view of adult male specimen. 17. *Perissocytheridea inabai* Okubo, 1983, left lateral view of juvenile specimen. 18–20. *Pistocythereis bradyformis* (Ishizaki, 1968). 18. Left lateral view of adult male specimen. 19. Left lateral view of juvenile specimen. 20. Right lateral view of juvenile specimen. All scale bars are 100 μ m.

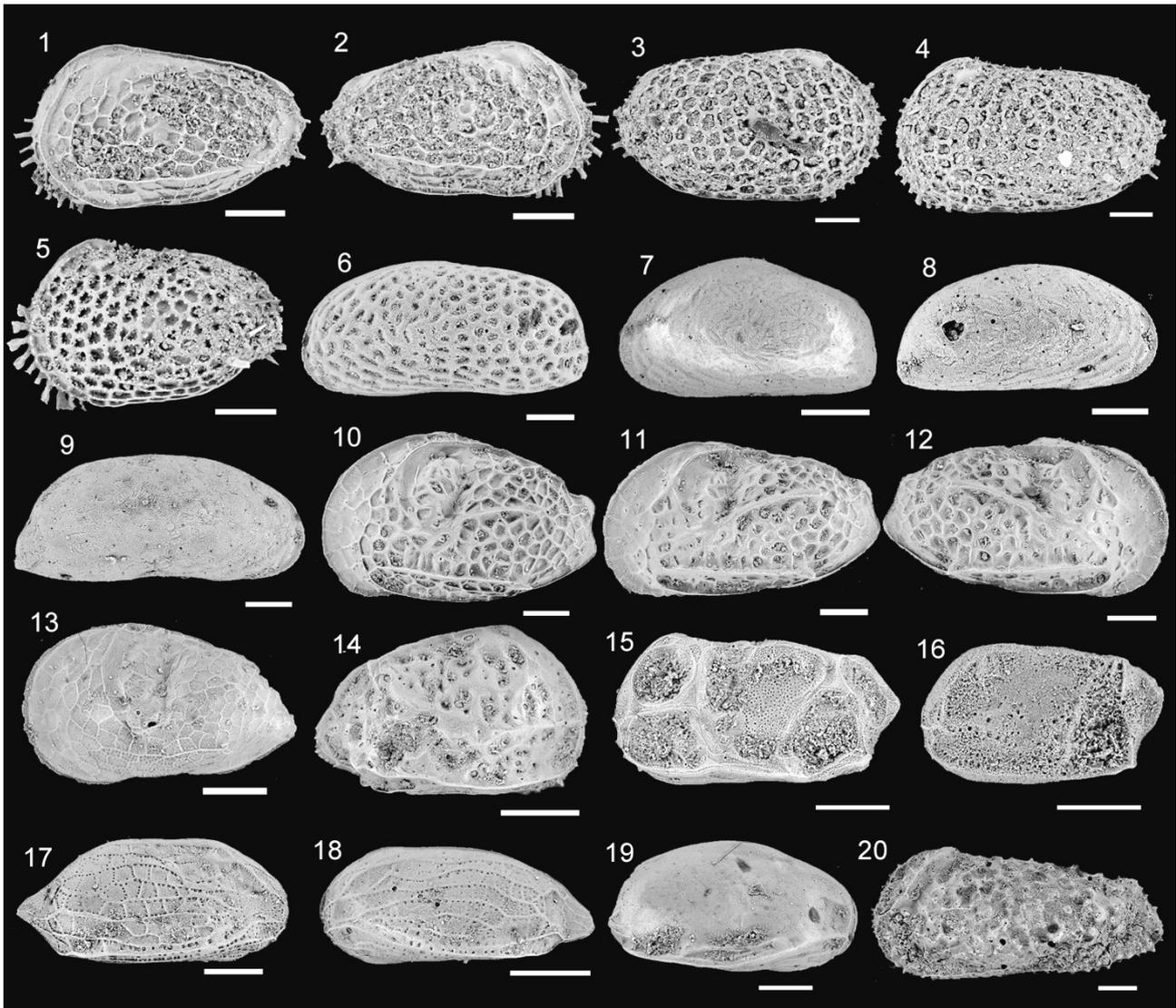


Fig. 4. SEM images of ostracods from the Pleistocene Ogushi Formation, Amakusa, Kyushu, Japan. 1, 2. *Pistocythereis bradyformis* (Ishizaki, 1968). 1. Left lateral view of juvenile specimen. 2. Right lateral view of juvenile specimen. 3–5. *Pistocythereis bradyi* (Ishizaki, 1968). 3. Right lateral view of adult female specimen. 4. Left lateral view of adult male specimen. 5. Left lateral view of juvenile specimen. 6, 7. *Pontocythere kashiwarensis* (Hanai, 1959). 6. Left lateral view of adult specimen. 7. Left lateral view of juvenile specimen. 8. *Pontocythere miurensis* (Hanai, 1959), right lateral view of juvenile specimen. 9. *Pontocythere subjaponica* (Hanai, 1959), right lateral view of adult female specimen. 10–13. *Spinileberis quadriaculeata* (Brady, 1880). 10. Left lateral view of adult female specimen. 11. Left lateral view of adult male specimen. 12. Right lateral view of adult male specimen. 13. Left lateral view of juvenile specimen. 14. *Schizocythere kishinouyei* (Kajiyama, 1913), right lateral view of juvenile specimen. 15. *Semicytherura kazahana* Yamada *et al.*, 2005, left lateral view of adult male specimen. 16. *Hemicytherura tricarinata* Hanai, 1957, left lateral view of juvenile specimen. 17, 18. *Semicytherura miurensis* (Hanai, 1957). 17. Right lateral view of adult male specimen. 18. Left lateral view of juvenile specimen. 19. *Semicytherura* sp., right lateral view of adult specimen. 20. *Trachyleberis niitsumai* Ishizaki, 1971, left lateral view of adult male specimen. All scale bars are 100 μ m.

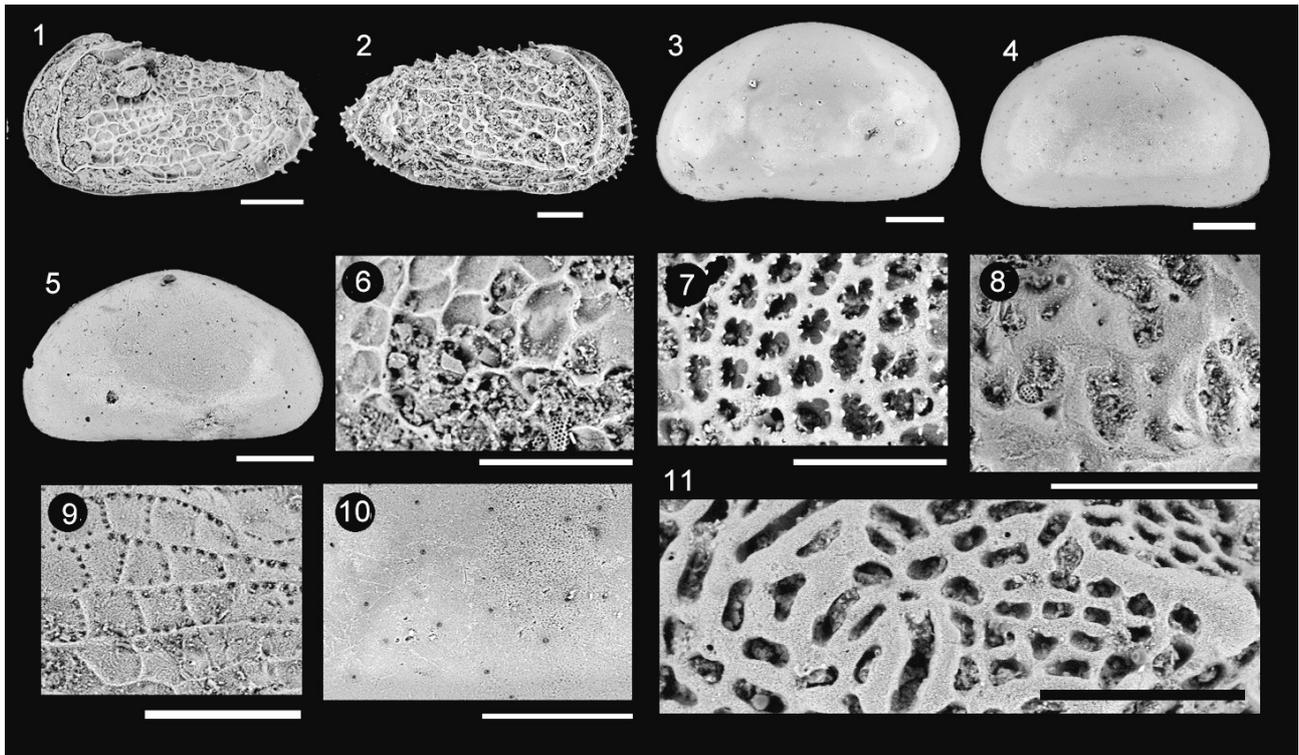


Fig. 5. SEM images of ostracods from the Pleistocene Ogushi Formation, Amakusa, Kyushu, Japan. 1, 2. *Trachyleberis niitsumai* Ishizaki, 1971. 1. Left lateral view of juvenile specimen. 2. Right lateral view of adult female specimen. 3–5. *Xestoleberis hanaii* Ishizaki, 1968. 3. Left lateral view of juvenile specimen. 4. Right lateral view of juvenile specimen. 5. Right lateral view of juvenile specimen. 6. *Pistocythereis bradyformis* (Ishizaki, 1968), enlargement of mid-anterior area of fig. 4.1. 7. *Pistocythereis bradyi* (Ishizaki, 1968), enlargement of mid-anterior area of 4.5. 8. *Schizocythere kishinouyei* (Kajiyama, 1913), enlargement of central area of fig. 4.14. 9. *Semicytherura miurensis* (Hanai, 1957), enlargement of mid-posterior area of fig. 4.17. 10. *Xestoleberis hanaii* Ishizaki, 1968, enlargement of central area of fig. 5.4. 11. *Kotoracythere inconspicua* (Brady, 1880), enlargement of central area of fig. 2.11.

Remarks - The type materials (holotype, carapace; paratype, carapace) were recovered from the Recent beach sand from about 1km NE of Akase Station, Uto Peninsula, Kumamoto Prefecture, Kyushu Island (Hanai, 1957b). Okubo (1980) described female appendages and male copulatory organ from the intertidal zones of the Seto Inland Sea. Our figured specimens (Pl. 2, fig. 15; Pl. 6, fig. 3) are juvenile the species. Kamiya (1988a) figured the life habitat of the species as sandy bottom under *Zostera* bed in Aburatsubo Cove, central Japan.

Genus *Semicytherura* Wagner, 1957

****Semicytherura kazahana* Yamada et al., 2005**

Fig. 4.15

Semicytherura kazahana Yamada et al., 2005, p. 251-255, figs. 2C, 6, 7.

Remarks - Yamada et al. (2005) described this species from the intertidal zone of Aburatsubo Bay, Kanagawa Prefecture, central Japan. They also described appendages including male copulatory organ and number of pore canals of the species.

***Semicytherura miurensis* (Hanai, 1957) (Hanai, 1957b in reference)**

Figs. 4.17, 4.18, 5.9

Cytherura miurensis Hanai, 1957, p. 18, 19, pl. 2, figs. 4a, 4b, text-figs. 4a, 4b.

Remarks - Hanai (1957b) described this species from the Recent beach sand from shore behind an Imperial villa, Hayama-machi, Kanagawa Prefecture, Japan.

***Semicytherura* sp.**

Fig. 4.19

Remarks - The figured specimen is an undescribed species of the genus *Semicytherura*.

Family Loxoconchidae Sars, 1926

Genus *Loxoconcha* Sars, 1865

****Loxoconcha harimensis* Okubo, 1980**

Figs. 2.16-2.18

Loxoconcha harimensis Okubo, 1980, p. 422-424, figs. 16, 19g-19l.

Remarks - This species was described by Okubo (1980) from the sample of the rocky shores of intertidal zone, Aioi, Hyogo Prefecture, the Seto Inland Sea, Japan. Okubo (1980) illustrated transmitted valves of male and all appendages including male copulatory organ although he did not show SEM image of this species. Kamiya (1988a) figured the life habitat of this species (he figured as *L. sp.*) as sandy bottom under *Zostera* bed in Aburatsubo Cove, central Japan.

****Loxoconcha japonica* Ishizaki, 1968**

Figs. 2.19, 2.20, 3.1, 3.2

Loxoconcha japonica Ishizaki, 1968, p. 28, 29, pl. 2, fig. 1, pl. 6, figs. 10-12.

Remarks - The appendages including male copulatory organ were described by Okubo (1980) from the rocky shore of intertidal zone, near Mukaishima Marine Biological Station, Hiroshima University, Hiroshima Prefecture, Seto Inland Sea, Japan. The life cycle and microhabitat (typical phytal habitat) of this species has explored by Kamiya (1988a, 1988b, 1988c, 1989a, 1989b) in detail. The biogeographical distribution of *L. japonica* and its morphological variation were discussed by Tanaka and Ikeya (2002).

***Loxoconcha kitanipponica* Ishizaki, 1971**

Figs. 3.3-3.5

Loxoconcha kitanipponica Ishizaki, 1971, p. 87, pl. 5, fig. 4, pl. 6, figs. 11, 12, pl. 7, fig. 10.

Remarks - Ishizaki (1971) described this species from the Recent sandy mud collected from Aomori Bay, northern Honshu Island, Japan (21 m in water depth).

****Loxoconcha pulchra* Ishizaki, 1968**

Fig. 3.6

Loxoconcha pulchra Ishizaki, 1968, p. 31, pl. 1, fig. 16, pl. 7, figs. 19, 20.

Remarks - This species was described by Ishizaki (1968) from Uranouchi Bay, Kochi Prefecture, Shikoku Island, Japan. Appendages including male copulatory organ were described by Nakao and Tsukagoshi (2002) from sandy

bottoms of the Obitsu River estuary, Boso Peninsula, central Japan.

***Loxoconcha tosaensis* Ishizaki, 1968**

Figs. 2.12-2.15

Loxoconcha tosaensis Ishizaki, 1968, p. 31, 32, pl. 2, fig. 3, pl. 7, figs. 6-9.

Remarks - *Loxoconcha tosaensis* was described from the Uranouchi Bay by Ishizaki (1968) on the basis of empty valves. On the basis of valve shape and ornamentation, *Loxoconcha tosaensis* is probably a junior synonym of *Loxoconcha bispinosa* Kajiyama, 1913. However, Kajiyama (1913) did not designate type specimen and also were not deposited his type specimens. We use *L. tosaensis* as justifiable taxonomic name. Soft parts are only described antennule and male copulatory organ by Kajiyama (1913). Kamiya (1988a) figured the life habitat of this species (he figured as *L. bispinosa*) as sandy bottom under *Zostera* bed in Aburatsubo Cove, central Japan.

****Loxoconcha uranouchiensis* Ishizaki, 1968**

Figs. 3.7-3.11

Loxoconcha uranouchiensis Ishizaki, 1968, p. 32, pl. 7, figs. 2, 3.

Remarks - Appendages including male copulatory organ were described by Okubo (1980) from sandy bank under *Zostera* from the Seto Inland Sea. The life cycle and microhabitat (typical sandy bottom of *Zostera* bed) of this species has explored by Kamiya (1988a, 1988b, 1988c, 1989a, 1989b) in detail. Recently, Le et al. (2016) described *L. yoshidai* from sandy beach at Bise, Motobu Peninsula, Okinawa Island, Japan. *L. uranouchiensis* differs from *L. yoshidai* by having widely arched postero-ventral margin, more inflated lateral outline and no distinct muri diverging from the mid-anterior area to posteriorly.

Genus ***Cytheromorpha* Hirschmann, 1909**

****Cytheromorpha acupunctata* (Brady, 1880)**

Fig. 2.1

Cythere acupunctata Brady, 1880, p. 68, pl. 14, figs. 1a-1h.

Remarks - The specimen was described by (Brady, 1880)

from the muddy bottom sediment in the Seto Inland Sea, Japan at a depth of 27.5 m. The appendages including male copulatory organ were described by Okubo (1978) from the sand-mud sediment in subtidal and intertidal zone from the Seto Inland Sea, Japan.

Family Leptocytheridae Hanai, 1957 (Hanai, 1957a in reference)

Genus ***Callistocythere* Ruggieri, 1953**

***Callistocythere hayamensis* Hanai, 1957 (Hanai, 1957a in reference)**

Figs. 1.17-1.20

Callistocythere hayamensis Hanai, 1957, p. 455, 456, pl. 7, figs. 2a-2d.

Remarks - Hanai (1957a) described this species from the Recent beach sand from shore behind an Imperial villa, Hayama-machi, Kanagawa Prefecture, Japan.

***Callistocythere hotaru* Yajima, 1982**

Fig. 1.16

Callistocythere hotaru Yajima, 1982, p. 190, 191, pl. 11, figs. 5, 6, text-figs. 14-1, 14-2.

Remarks - This species was described by Yajima (1982) from the Early Pleistocene Kiyokawa Formation (MIS7.4 to 7.3), near Yokota railway station, Hirakawa-machi, Chiba Prefecture, central Japan.

Family Pectocytheridae Hanai, 1957 (Hanai, 1957a in reference)

Genus ***Kotoracythere* Ishizaki, 1966**

****Kotoracythere inconspicua* (Brady, 1880)**

Figs. 2.11, 5.11

Cythere inconspicua Brady, 1880, p. 70, 71, pl. 13, figs. 1a-1d.

Remarks - This species was described by Brady (1880) from sand material from Torres Straits (284 m in water depth). Complete appendages including female copulatory organ were described by Wouters (2003) from the intertidal zone of the Cape Verde Islands, Atlantic Ocean. The polymorphism, biogeography and fossil record of this species

were discussed by Witte and Van Harten (1991).

Family Cobanocytheridae Schornikov, 1975

Genus *Cobanocythere* Hartmann, 1959

Cobanocythere sp.

Fig. 2.2

Remarks - This family consisted only interstitial species based on a molecular phylogenetic analysis using 18S rDNA (Higashi, 2010).

Family Xestoleberididae Sars, 1928

Genus *Xestoleberis* Sars, 1865

Xestoleberis hanaii Ishizaki, 1968

Figs. 5.3-5.5, 5.10

Xestoleberis hanaii Ishizaki, 1968: p. 41, 42, pl. 9, figs. 1, 2.

Remarks - The short life-cycle (about one month to reach adult) of this species was noted by Ikeya and Kato (2000). The male copulatory organs of the species were figured by Sato and Kamiya (2007), and two morphological types (L-type and I-type) were reported around Japan.

Family Krithidae Mandelstam, 1958 (in Bubikjan, 1958)

Genus *Parakrithella* Hanai, 1961 (in Benson et al., 1961)

Parakrithella pseudadonta (Hanai, 1959)

Fig. 3.16

Neocyprideis pseudadonta hanai, 1959: p. 300, pl. 17, figs. 5-9, text-figs. 2a, 2b.

Remarks - The appendages with male copulatory organ were described by Okubo (1976b). Tanaka (2016) compared the appendages of this species between female and male, he also mentioned this species living from 0 m to 17.5 m in water depth.

Family Cytheridae Baird, 1850

Genus *Cythere* O. F. Müller, 1785

**Cythere nishinipponica* Okubo, 1976 (Okubo, 1976a in reference)

Fig. 2.5

Cythere nishinipponica Okubo, 1976: p. 113-117, figs. 1-3.

Remarks - This species was described by Okubo (1976a) from various intertidal zone from the Seto Inland Sea, Japan. Okubo (1976a) also figured and described appendages.

Genus *Spinileberis* Hanai, 1961 (Hanai, 1961b in reference)

**Spinileberis quadriaculeata* (Brady, 1880)

Figs. 4.10-4.13

Cythere quadriaculeata Brady, 1880: p. 86, 87, pl. 22, figs. 2a-d, pl. 25, figs. 4a-d.

Remarks - This species was described by Brady (1880) from the Seto Inland Sea, Japan at a depth of 27.5 m. The description of full appendages was by Okubo (1978) from sand-mud shores in subtidal and intertidal zones of Seto Inland Sea, Japan.

Family Schizocytheridae Howe, 1961 (in Benson et al., 1961)

Genus *Schizocythere* Triebel, 1950

**Schizocythere kishinouyei* (Kajiyama, 1913)

Figs. 4.14, 5.8

Cythere kishinouyei Kajiyama, 1913: p. 11, figs. 61-63.

Remarks - Kajiyama (1913) described this species from Misaki, Kanagawa Prefecture, Japan on the basis of three appendages and male copulatory organ. However, Kajiyama (1913) did not designate type specimen and also were not deposited his type specimens. Hanai (1970) described all appendages including male copulatory organ from medium sand from beach in front of the Imperial Villa, Kanagawa Prefecture, Japan.

Genus *Neomonoceratina* Kingma, 1948

Neomonoceratina delicata Ishizaki et Kato, 1976

Figs. 3.12, 3.13

Neomonoceratina delicata Ishizaki et Kato, 1976: p. 136-138, pl. 3, figs. 7-10, pl. 4, figs. 1-3, text-fig. 8.

Remarks - Ishizaki and Kato (1976) described this species from the Late Pleistocene (MIS 5) Furuya Mud from Shizuoka Prefecture, central Japan. The (paleo-) biogeographical distribution of the species was mentioned by Irizuki et al. (2009). The occurrences of this species from the Ogushi Formation is the most southern fossil record during

the Late Pleistocene (MIS 7) (Kawano et al., 2011). Present distribution of this species from Java Seas to Ryukyu Islands (till Tokara Strait) via the coast of China and northern Vietnam (Irizuki et al., 2009; Tanaka et al., 2009).

Family Cytherideidae Sars, 1925

Genus *Perissocytheridea* Stephenson, 1938

Perissocytheridea inabai Okubo, 1983

Fig. 3.17

Perissocytheridea inabai Okubo, 1983: p. 410.

Remarks - Okubo (1983) described this species as new species based on his previously published literature (Okubo, 1979). Okubo (1979) reported this species from mud sediment dredged at a depth of 15 m from the Seto Inland Sea, Japan.

Family Cushmanideidae Puri, 1974 (in Hartmann and Puri, 1974)

Genus *Bicornucythere* Schornikov and Shajtarov, 1979

Pontocythere kashiwarensis (Hanai, 1959)

Figs. 4.6, 4.7

Cushmanidea kashiwarensis Hanai, 1959: p. 297, pl. 17, figs. 1-4.

Remarks - Hanai (1959) described this species from a sand sediment from the shore of Kashiwara, about 200 m southeast of Dozanto, Yamaga, Ashiya Town, Fukuoka Prefecture, Japan.

Pontocythere miurensis (Hanai, 1959)

Fig. 4.8

Cushmanidea miurensis Hanai, 1959: p. 299, pl. 16, figs. 7-10, text-figs. 1a, 1b.

Remarks - This species was described by Hanai (1959) from beach sand from the shore in front of the Imperial Villa at Hayama, Kanagawa Prefecture, Japan.

**Pontocythere subjaponica* (Hanai, 1959)

Fig. 4.9

Cushmanidea subjaponica Hanai, 1959: p. 298, 299, pl. 16, figs. 4-6.

Remarks - Hanai (1959) described this species from beach

sand from the shore in front of the Imperial Villa at Hayama, Kanagawa Prefecture, Japan. Okubo (1977) described appendages with male copulatory organ of this species from muddy sand under *Zostera* beds from the Seto Inland Sea, Japan.

Family Trachyleberididae Sylvester-Bradley, 1948

Genus *Trachyleberis* Brady, 1898

Trachyleberis niitsumai Ishizaki, 1971

Figs. 4.20, 5.1, 5.2

Trachyleberis niitsumai Ishizaki, 1971: p. 93, pl. 5, fig. 3, pl. 6, fig. 10, pl. 7, fig. 9.

Remarks - Ishizaki (1971) reported this species from Aomori Bay, northern Honshu Island, Japan. The biogeography and type species were mentioned by Brandão et al. (2013).

Genus *Bicornucythere* Schornikov and Shajtarov, 1979

**Bicornucythere bisanensis* s.l. (Okubo, 1975) (Okubo,

1975b in reference)

Figs. 1.9-1.14

Leguminocythereis bisanensis Okubo, 1975: p. 26-30, figs. 2, 3.

Remarks - This species was described by Okubo (1975) from mud sediment 20 m off the coast of Shibukawa, Tamano City, Okayama Prefecture, the Seto Inland Sea, Japan. He also described appendages including male copulatory organ. According to Abe (1988), there are four morpho-types (A, M, P, G type) around Far East. Our figured specimen would be classified A type of Abe (1988).

Genus *Pistocythereis* Gou, 1983 (in Gou et al., 1983)

Pistocythereis bradyformis (Ishizaki, 1968)

Figs. 3.18-3.20, 4.1, 4.2, 5.6

Echinocythereis bradyformis Ishizaki, 1968: p. 40, pl. 8, fig. 4.

Remarks - This species was described by Ishizaki (1968) from the Uranouchi Bay, Shikoku Island, Japan, on the basis of left valve. Okubo (1979) re-described this species as male of *E. bradyi* (Ishizaki, 1968) from subtidal zone of muddy shores from the Seto Inland Sea, Japan. Okubo (1979) regarded *E. bradyformis* (Ishizaki, 1968) as male of *E. bradyi*. However, on the basis of presence of ridges running from

anterior area to postero-ventral area in *E. bradyformis*, the male and female designated by Okubo (1979) is different species. Although Okubo (1979) described appendages of *E. bradyi*, we cannot identify his figured appendages are *Pistocythereis bradyi* or *P. bradyformis*.

***Pistocythereis bradyi* (Ishizaki, 1968)**

Figs. 4.3-4.5, 5.7

Echinocythereis bradyi Ishizaki, 1968: p. 40, pl. 9, fig. 17.

Remarks - This species was described by Ishizaki (1968) from the Uranouchi Bay, Shikoku Island, Japan, on the basis of left valve. Okubo (1979) re-described this species as female of *E. bradyi* (Ishizaki, 1968) from subtidal zone of muddy shores from the Seto Inland Sea, Japan. See remarks of *Pistocythereis bradyformis* about a problem of description of appendages.

Family Hemicytheridae Puri, 1953

Genus *Aurila* Pokorný, 1955

****Aurila cymba* (Brady, 1869)**

Figs. 1.1-1.4

Cythere cymba Brady, 1869: p. 157, pl. 16, figs. 1-4.

Remarks - Whatley and Zhao (1987) assigned lectotype specimen from Brady's original material. Okubo (1980) described this species as *Aurila subconvexa* (Kajiyama, 1913) with the appendages including male copulatory organ from sandy and rocky shores from the Seto Inland Sea, Japan. The type of *A. subconvexa* was not designated by Kajiyama (1913).

****Aurila hataii* Ishizaki, 1968**

Figs. 1.5-1.8

Aurila hataii Ishizaki, 1968: p. 20, 21, pl. 1, figs. 5, 6, pl. 4, figs. 5, 6.

Remarks - This species was described by Ishizaki (1968) from Uranouchi Bay, Shikoku Island, Japan. The appendages including male copulatory organ were described by Okubo (1980) from the intertidal zones of rocky shore, Seto Inland Sea, Japan.

***Coquimba ishizakii* Yajima, 1978**

Figs. 2.3, 2.4

Coquimba ishizakii Yajima, 1978: p. 397, 398, pl. 49, figs. 4a-4c, text-fig. 7, figs. 3a, 3b.

Remarks - This species was described by Yajima (1978) from the Late Pleistocene Yabu Formation, Sengen Shrine, Kisarazu City, Boso Peninsula, central Japan.

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