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Original Article

Early Middle Miocene ostracods from ‘Kojyakui-sho’, Tomioka City, Gunma Prefecture, central Japan

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Abstract： The taxonomic study of the ostracod assemblages from ‘Kojyakui-sho’, a stratum of the Middle Miocene Obata Formation, Tomioka Group, occurring at the Kabura-gawa River near Tajima, Tomioka City, western Gunma Prefecture, central Japan, were documented herein. The ostracods assemblage indicated that the ‘Kojyakui-sho’ was formed under the bathyal environment. Three new podocopid ostracod species, *Krithe tomiokaensis* sp. nov., *Acanthocythereis oshimaensis* sp. nov, and *Acanthocythereis noriyukikeyai* sp. nov. are described. *Loxoconcha tuberculatus* proposed by Tanaka *et al.*（2012）from the Upper Miocene Maja Formation was junior homonym of *Loxoconcha eichwaldii tuberculata* Livental, 1929 and *Loxoconcha dafarovi tuberculata* Sheydaeva-Kulieva, 1958, and we propose here the new name *Loxoconcha eugenkempfi* sp. nov.（*see* the end of references of this paper）.

Key Words： bathyal ostracod assemblage, Middle Miocene, new species, Obata Formation, *Loxoconcha eugenkempfi* sp. nov.

Introduction

The Miocene deep-sea ostracod assemblages from Japan have only been reported from the Early to Middle Miocene Kadonosawa Formation, northern Japan（Irizuki and Matsubara, 1994）. Recently, one of the authors（G. T.）discovered bathyal ostracod fossil assemblages from the ‘Kojyakui-sho’, a stratum of the Middle Miocene Obata Formation along the river side of Kabura-gawa River（Tanaka *et al*., 2013）. This report is the systematic study of the ostracods discovered in the ‘Kojyakui-sho’.

Materials and Methods

In the field, fossiliferous rock samples were collected for ostracod shells. Each of the dried rock samples（80 g）were disaggregated, using 5 % hydrogen peroxide solution or naphtha and / or sodium sulphate solution for rock maceration（Maiya and Inoue, 1973）, washed through a 235 mesh（63 μm）sieve, and dried again. This procedure was repeated till the whole sediment samples had disaggregated. Ostracod specimens were picked and were identified under a stereoscopic microscope（Nikon SMZ-U）at 70 × magnification. As a result, only one sample（J-02 of Tanaka *et al*., 2013）contained ostracod specimens. As for the details of the description of the sediment and strata in which were found the ostracod assemblage, see Tanaka *et al.*（2013）. The male and female specimens were mounted on stubs, then viewed using HITACHI（Tokyo）Microscope TM-1000 scanning electron microscope under rough vacuum with non-evaporation coating. Nineteen species in 18 genera of ostracods were identified from the sample（J-02 of Tanaka *et al*., 2013）.

Systematic Palaeontology

The morphological terms follow the usage of Scott（1961）and Athersuch *et al.*（1989）. All illustrated specimens are deposited in the Gunma Museum of Natural History（GMNH-PI-number）. The ostracod fossil locality is as follows：Right side of the bank of Kabura-gawa River, Oshima, Tomioka City, Gunma Prefecture, central Japan（36°14.24’ N, 138°51.59’ E）.

PODOCOPIDA Müller, 1894
BAIRDIOCOPINA Grundel, 1967
BAIRDIOIDEA Sars, 1865（1866）
NEONESIDEA Maddocks, 1969

Neonesidea sp.
Plate 1, fig. 1

Neonesidea sp. 1 of Irizuki and Yamada, 2004（in Irizuki *et al*., 2004）.

Material：12 carapaces and 4 valves（see Tanaka *et al*., 2013）.

Remarks. Because of lack of well preserved specimens and enough adult specimens, we do not propose this undescribed species as a new species. The Present species somewhat resembles *Neonesidea oligodentata*（Kajiyama, 1913）from Recent sediment from the Misaki, Kanagawa Prefecture, central Japan, but the present species differs from *N. oligodentata* with acute mid dorsal point and straight upper half of posterior margin. The present species is somewhat similar to *Neonesidea mutsuensis*（Ishizaki, 1971）but differs with it having a more rounded lateral outline

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and convex outline of ventral margin. *Neonesidea* sp. is similar to *Bairdia haikangensis* Guan, 1978 from central China but differs with straight upper half of anterior margin and acute mid dorsal point. *Neonesidea* sp. is resemble to *Bairdia taiwanensis* Hu & Cheng (1977) from the Late Pleistocene Lungkang Formation, Miaori, northwestern Taiwan, but it differs with more straight postero-dorsal outline. This species is similar to *Neonesidea hanaii* Yajima, 1987 from the Pleistocene Tahara Formation, Atsumi Peninsula, central Japan, but it differs with convexed ventral margin. *Neonesidea* sp. is resemble to *Bairdoppilata itoigawai* Yajima, 1992 from the Early Miocene Mizunami Group, central Japan, but it differs from *B. itoigawai* with having lower height of left valve, acute mid-dorsal point and straight upper half of posterior margin. The present species is similar to *Neonesidea posteroacuta* Zhou, 1995 from the Recent sediment off Tanegashima Island but differs with having acute mid-dorsal point and straight upper half of the anterior margin. The present species is similar to *Neonesidea* cf. *elegans* (Brady, 1869) figured by Irizuki *et al*. (1998, 2001) from the Middle Miocene Kobana Formation, central Japan. However, the present species differs from *N.* cf. *elegans* of Irizuki *et al*. (2001) with having acute mid-dorsal point and straight upper half of posterior margin. The present species is resembles to *N*. sp. reported from Recent sediments of Okhotsk Sea by Ozawa and Tsukawaki (2008) but differs with convex outline of ventral margin.

CYPRIDOCOPINA Grundel, 1967
CYPRIDOIDEA Baird, 1845
CANDONIDAE Kaufmann, 1900
PARACYPRIS Sars, 1866

Paracypris sp.
Plate 1, fig. 4

Material: 1 carapace.

Remarks. Because of lack of enough adult specimens, we do not propose this undescribed species as a new species. This species is similar to *Propontocypris attenuata* (Brady, 1868) from the Recent sediment but differs with having more sinuated ventral margin and straight dorsal margin with parallel to the half of posterior area of ventral margin. The present species is somewhat similar to *Pontocypris kanazawensis* Ishizaki, 1963 from the Early to Middle Miocene Sunagozaka Formation, Kanazawa City, central Japan, but differs from it with having more elongated lateral outline and with straight of dorsal margin. The present species is similar to *Propontocypris euryhalina* Zhao, 1984 from the Recent sediment from the coast of the Yellow Sea, but differs with having broadly arched anterior margin and sinuated ventral margin. This species is similar to *Pontocypris* cf. *mytiloides* (Norman, 1862) of Zheng (1987) from Quaternary sediment from the coast of the Fujian, China, but differs with more acute posterior terminal end and broadly rounded anterior margin. The present species is similar to *Paracypris* sp. of Lee & Paik (1992) from the Plio-Pleistocene Sogwipo Formation, Cheju Island, Korea, but differs with having more broadly rounded anterior margin and more sinuated ventral margin.

MACROCYPRIDOIDEA Müller, 1912
MACROCYPRIDIDAE Müller, 1912
MACROCYPRIS Brady, 1867

Macrocypris sp.
Plate 1, fig. 2

Macrocypris sp. of Tanaka and Nomura, 2009

Material: 5 carapaces and 1 valve (see Tanaka *et al*., 2013).

Remarks. Because of lack of well preserved specimens and enough adult specimens, we do not propose this undescribed species as a new species. This species is similar to *Macrocypris pacifica* Hu, 1979 from the Pleistocene limestone from the Hangchun Peninsula, southern Taiwan, but it is differs from *M. pacifica* with more rounded lateral view of carapace outline and broadly arched anterior margin. *Macrocypris* sp. is resemble to *Propontocypris*? sp. A of Ishizaki & Matoba (1985) from the Early Pleistocene Sasaoka Formation, northern Japan, but differs with having more rounded lateral view of the carapace. This species is similar to *Macrocypris decola* (Brady, 1865) figured by Cai & Chen (1987) from the Recent sediment from the South China Sea. However, this species differs from *M. decola* with having straight ventral margin and more rounded lateral outline. This species is similar to *Macrocypris* sp. of Ikeya & Suzuki (1992), but differs with more rounded posterior terminal end and straight ventral margin. The Present species is somewhat resembles *Propontocypris*? sp. of Irizuki & Matsubara (1994) from the Early to Middle Miocene Kadonosawa Formation, northern Japan, but it differs from *P*? sp. with rather straight ventral margin and more rounded posterior terminal end. The present species is somewhat similar to *Macrocypris* sp. of Irizuki (2004) from the Early Pleistocene Masuda Formation, Tanegashima Island, southern Japan, but differs with more rounded lateral view of carapace outline and broadly arched anterior margin. This species is somewhat resemble to *Macrocypris* sp. of Irizuki *et al*. (2006) from the Recent sediment from the Urauhi Bay, Kagoshima Prefecture, southern Japan, but differs with more gently curved dorsal margin and broadly rounded anterior margin.

PONTOCYPRIDOIDEA Müller, 1894
PONTOCYPRIDIDAE Müller, 1894
ARGILLOECIA Sars, 1865 (1866)

Argilloecia sp.
Plate 1, fig. 8

Material: 4 carapaces (see Tanaka *et al*., 2013).

Remarks. Because of lack of well preserved specimens and enough adult specimens, we do not propose this undescribed species as a new species. This species is similar to *Argilloecia hanaii* Ishizaki, 1981 from the Recent sediment from the East China Sea, but differs with having protruded caudal process and more rounded lateral outline. This species rather resembles to

Argilloecia lunata Frydl, 1982 from the Holocene sediment from the Boso Peninsula, central Japan, but differs with having more rounded carapace and triangular shaped posterior area. This species rather resembles to *Argilloecia minor* (Müller, 1894) reported by Cai & Chen (1987) from the Recent sediment from the South China Sea, but differs with having protruded caudal process. The present species is similar to *Argilloecia toyamaensis* Ishizaki & Irizuki, 1990 from the Recent sediment from the Toyama Bay, central Japan. However, this undescribed species is distinguished from *A. toyamaensis* with having shorter carapace length and widely arched dorsal margin. This species is similar to *Argilloecia* sp. 2 by Ikeya & Suzuki (1992) from the Recent sediment off Shimane, southwestern Japan, but differs with having broadly arched dorsal margin and straight ventral margin. This species resembles to *Argilloecia cylindrica* Sars, 1866 of Cai (1996) reported from the Holocene core sediment from the Great Wall Bay, Antarctica, but differs with having triangular shaped posterior area and more rounded lateral outline. This species somewhat resembles to *Argilloecia hanaii* Ishizaki, 1981 by Nakao *et al*. (2001), but differs with having tapered caudal process and straight ventral margin. This species resembles to *Argilloecia* cf. *symmetrica* Zhao, 1988 reported by Tanaka (2003) from the Middle Miocene Omori Formarion, southwestern Japan, but differs with having more narrowly arched dorsal margin and prominent caudal process. This species is rather similar to *Argilloecia* sp. reported by Irizuki (2004) from the Lower Pleistocene Masuda Formation, Tanegashima Island, southern Japan, but differs with having more protruded caudal process and straight ventral margin. This species is somewhat similar to *Argilloecia* sp. 1 of Ozawa & Tsukawaki (2008) from the Recent sediment from off Hokkaido, Japan, but differs with having more elongated carapace and more acutely pointed caudal process. This species is rather similar to *Argilloecia* sp. 2 of Ozawa & Tsukawaki (2008) from the Recent sediment from off Hokkaido, Japan, but differs with having less acutely rounded anterior margin and triangular shape of posterior area. This species rather resembles to *Argilloecia* sp. by Ozawa & Domitsu (2010) from the Early Pleistocene Hamada Formation, northern Japan, but differs with having more elongated lateral outline.

PONTOCYPRIS Sars, 1866

Pontocypris kanazawensis Ishizaki, 1963
Plate 2, figs. 1-15

Material: 12 carapaces (see Tanaka *et al*., 2013).

Description. Valve triangular outline in lateral view (Pl. 2, figs. 1, 2, 7, 8). Anterior margin evenly rounded toward ventrally with small curvature; dorsal margin acutely pointed at mid-length, anterior and posterior half of dorsal margin straight; posterior margin truncated and caudated posteroventrally; ventral margin straight sinuated at the front of mid-length. In the ventral view, the line of free edge sinuated at mid-length. No eye tubercle. Carapace surface smooth.

Large sexual dimorphism; in dorsal and ventral views, rounded form (possibly female) is fusiform (Pl. 2, figs. 4, 5) and great width at mid-length, elongated form (possibly male) is polygonal shape (Pl. 2, figs. 10, 11) and not inflated at mid-length; in anterior and posterior views, rounded form rugby ball shape and widest at mid height (Pl. 2, figs. 3, 6), elongated form almond shape and rather straight at mid – height (Pl. 2, figs. 9, 12).

Remarks. The present species was reported by Ishizaki (1963) from the Early to Middle Miocene Sunagozaka Formation, Kanazawa City, central Japan, but he did not show sexual dimorphism. This species is resemble to *Propontocypris* sp. of Yajima (1982) from the Late Pleistocene Kioroshi Formation, Boso Peninsula, central Japan, but differs with having more rounded lateral outline and more straight posterior half of dorsal margin. This species is similar to *Propontocypris subtriangularis* Hu, 1984 reported from the Pleistocene Ssukou Formaton, southern Taiwan, but differs with having triangular outline in lateral view and the position of highest point at mid-length. The present species is somewhat similar to *Propontocypris euryhalina* Zhao, 1984 from the Recent sediment from the coast of the Yellow Sea, but differs with having broadly arched anterior margin and more rounded lateral outline. The present species somewhat resemble to *Propontocypris* sp. 1 of Ikeya & Suzuki (1992), but differs with having more rounded lateral outline and more protruded caudal process. This species is rather resemble to *Propontocypris* sp. 1 of Yamane (1998) from the Recent sediment from the Hiuchi-nada, Seto Inland Sea of Japan, but differs with having more rounded lateral outline. This species is somewhat similar to *Propontocypris* sp. of Kamiya *et al*. (2001) from Recent sediment from the Echizen-matsushima, Ishikawa Prefecture, central Japan, but differs with having more rounded lateral outline and steeply inclined posterior part of dorsal margin. The present species somewhat resembles *Propontocypris* sp. 2 of Irizuki *et al*. (2006) from the Recent sediment from the Urauchi Bay, Kagoshima Prefecture, southern Japan, but differs with having the position of highest point at mid-length and less acuted caudal process.

PROPONTOCYPRIS Sylvester-Bradley, 1947

Propontocypris sp.
Plate 1, fig. 3

Material: 12 carapaces (see Tanaka *et al*., 2013).

Remarks. Because of lack of well preserved specimens and enough adult specimens, we do not propose this undescribed species as a new species. The present species is somewhat similar to *Pontocypris kanazawensis* Ishizaki, 1963 from the Early to Middle Miocene Sunagozaka Formation, Kanazawa City, central Japan, but differs from it with having more elongated lateral outline and with highest point at anterior area of dorsal margin. The present species is similar to *Propontocypris euryhalina* Zhao, 1984 from the Recent sediment from the coast of the Yellow Sea, but differs with having broadly arched anterior margin and more acutely protruded posterior terminal end. This species is similar to *Pontocypris* cf. *mytiloides* (Norman, 1862) of Zheng (1987) from Quaternary sediment from the coast of the Fujian, China, but differs with more acute posterior terminal end and

evenly rounded anterior margin. The present species is similar to *Paracypris* sp. of Lee & Paik (1992) from the Plio-Pleistocene Sogwipo Formation, Cheju Island, Korea, but differs with having more narrowly rounded anterior margin and longer lateral outline.

PODOCOPINA Sars, 1866
CYTHEROCOPINA Baird, 1850
CYTHEROIDEA Baird, 1850
BYTHOCYTHERIDAE Sars, 1866
SCLEROCHILUS Sars, 1866

Sclerochilus? sp.
Plate 1, fig. 6

Material: 2 carapaces (see Tanaka *et al*., 2013).

Remarks. Because of lack of enough adult specimens, we do not propose this undescribed species as a new species. This species is somewhat resemble to *Sclerochilus mukaishimensis* Okubo, 1977 reported from the Recent material from the Seto Inland Sea of Japan, however, it differs from *S. mukaishimensis* with having rather straight ventral margin and elongated lateral outline. This species is somewhat resemble to *Sclerochilus ovatoides* Hu, 1984 reported from the Pleistocene Ssukou Formation, southern Taiwan, but differs with having more elongated lateral outline and protruded caudal process. This species is somewhat similar to *Sclerochilus contortus* (Norman, 1862) of Cronin & Ikeya (1987) reported from the Plio-Pleistocene Setana Formation, Hokkaido, northern Japan, but differs with having evenly rounded anterior margin and protruded caudal process at mid-height. The present species is rather resemble to *Sclerochirus* sp. of Ikeya & Itoh (1991) from the Recent sediment from the Sendai Bay, northern Japan. However the present species differs with having broadly arched anterior margin and shorter caudal process.

CYTHEROIDEA Baird, 1850
PARADOXOSTOMATIDAE Brady & Norman, 1889

Gen. et sp. indet
Pl. 1, fig. 7

Material: 1 carapace (see Tanaka *et al*., 2013).

Remarks. Because of lack of enough adult specimens and the information of internal morphology, we do not determine the genus of this undescribed species.

NEOCYTHERIDEIDAE Puri, 1957
COPYTUS Skogsberg, 1939

Copytus sp.
Plate 1, fig. 5

Material: 1 carapace (see Tanaka *et al*., 2013).

Remarks. Because of lack of enough adult specimens, we do not propose this undescribed species as a new species. Hu and Yeh (1978) reported *Cyprdeis yehi* from the Pleistocene Liushuang Formation from Taiwan morphologically belongs to the genus *Copytus*. The present species resembles to *Copytus yehi* (Hu and Yeh, 1978) but differs with having shorter valve length and ventrally curved anterior margin. The present species somewhat resembles *Copytus* sp. by Zheng (1987) reported from the Holocene sediment from the coast of the Fujian, China, but differs with having caudal process at mid-height and ventrally arched anterior margin. This species is similar to *Copytus posterosulcus* Zhao, 1988 (in Wang, P. *et al*., 1988) from the Recent sediment from the East China Sea, however, it is different from *C. posterosulcus* with having ventrally arched anterior margin and shorter lateral length of carapace.

CYTHERIDAE Baird, 1850
SPINILEBERIS Hanai, 1961

Spinileberis sp.
Plate 1, fig. 9

Material: 1 carapace (see Tanaka *et al*., 2013).

Remarks. Because of lack of enough adult specimens, we do not propose this undescribed species as a new species. This species is rather similar to *Spinileberis quadriaculeata* (Brady, 1880) from the Recent sediment from the Seto Inland Sea, southwestern Japan, but differs with having more elongated lateral outline and inflated posterior area. The present species is somewhat similar to *Spinileberis furuyaensis* Ishizaki & Kato, 1976 from the Holocene sediment from the Kakegawa City, Shizuoka Prefecture, central Japan, but differs with having reticulated carapace and elongated lateral outline. This species somewhat resembles *Spinileberis pulchra* Chen, 1982 (in Hou *et al*., 1982) from the Quaternary sediment from the Jiangsu, China, but differs with having more prominent reticulation and elongated lateral outline. *Spinileberis rhomboidalis* Chen, 1982 (in Hou *et al*., 1982) from the Quaternary sediment from the Jiangsu, China, but differs with having elongated lateral outline and straight dorsal margin parallel with ventral margin. This species resembles *Spinileberis* sp. by Wang, Q. *et al*. (1988) reported from the Quaternary sediment from the core material from the Bohai Sea, China, but differs with having more elongated lateral outline and straight dorsal margin parallel with ventral margin. This species is somewhat similar to *Spinileberis* sp. of Huh & Paik (1992) reported from the Miocene Chunbuk Conglomerate, Korea, but differs with having coarser reticulation and triangular shaped posterior margin. This species is similar to *Spinileberis* sp. by Irizuki & Matsubara (1994) reported from the Early to Middle Miocene Kadonosawa Formation, northern Japan, but differs with having more elongated lateral outline and triangular shaped posterior margin. The present species is rather similar to *Spinileberis* sp. by Yamaguchi & Hayashi (2001) from the Late Miocene Kubota Formation, central Japan, but differs with having reticulated carapace and elongated lateral outline. The present species rather resembles *Spinileberis*? sp. by Tanaka *et al*. (2004) re-

ported from the Early to Middle Miocene Sunagozaka Formation, Kanazawa City, Ishikawa Prefecture, central Japan, but differs with having inflated posterior area and without long ridge from central part to mid-height of dorsal margin. The present species is somewhat similar to *Spinileberis endoi* Nakao & Tsukagoshi, 2010 reported from the Recent sediment from the Luzon Island, Philippines, but differs with having evenly rounded anterior margin and without having prominent ridge from anteroventral margin to postero-dorsal area. This species is somewhat similar to *Spinileberis lubrica* Kuroda *et al*., 2011 (in Tanaka *et al*., 2011), but differs with having reticulated ornamentation and elongated lateral outline.

KRITHIDAE Mandelstam, 1958
KRITHE Brady, Crosskey and Robertson, 1874

Krithe tomiokaensis sp. nov.
Plate 3, figs. 1-15

Derivation of name. Tomioka is a city situated southwastern part of Gunma Prefecture from which the type specimens were discovered.

Holotype. GMNH-PI-4211
Allotype. GMNH-PI-4212

Material: 43 carapaces (see Tanaka *et al*., 2013).

Description. Valve cylindrical shape in lateral view (Pl. 3, figs. 1,2,7,8). Anterior margin evenly rounded with small curvature and slightly tapered at mid height; dorsal margin broadly arched and rather undulated in male; posterior margin truncated and caudated ventally at bottom, upper half of posterior margin curved and meet dorsal margin with wide posterior cardinal angle, and lower half of posterior margin acutely curved, making rather prominent caudal process and fused ventral margin; ventral margin straight in female, rather undulated in male. Left valve overlap right valve at dorsal margin and upper half of anterior margin. No eye tubercle. Carapace surface smooth. In dorsal and ventral views, the carapace fusiform-shaped and prominent two pointed caudal processes (Pl. 3, figs. 4,5,11,12). In anterior and posterior views, carapace elliptical-shaped (Pl. 3, figs. 3,6,9,12).

Large sexual dimorphism; in lateral view, male more elongate, upper half of posterior margin more gently curved in male than that of female, dorsal margin widely arched in female, gently undulated in male, slightly acuted mid height of anterior margin in female, straight ventral margin in female, undulated ventral margin in male; in dorsal and ventral views, the valves of female forms are more inflated than male, widest at middle in female, widest at anterior third in male, more prominent protruberance develops in male.

Remarks. The present new species somewhat resembles *Krithe sawanensis* Hanai, 1959 reported from the Pleistocene Sawane Formation from the Sado Island, northwestern Japan, but differs with having more protruded caudal process and evenly rounded anterior margin. This species is similar to *Krithe antiswanensis* Ishizaki, 1966 reported from the Miocene Hatatate Formation (SEM of type specimen; see Tanaka, 2009), northwastern Japan, but differs with having more protruded caudal process and evenly rounded anterior margin. This species is somewhat similar to *Krithe japonica* Ishizaki, 1971 reported from Recent sediment from the Aomori Bay, northern Japan, but differs with having more protruded caudal process and rather tapered anterior margin. This species rather resembles *Krithe* sp. by Ishizaki & Matoba (1985) from the Pleistocene Wakimoto Formation, northern Japan, but differs with having less arched dorsal margin and less protruded caudal process. This species is similar to *Krithe surugensis* Zhou & Ikeya, 1992 reported from the Recent sediment of the Suruga Bay. However, it differs from *K. surugensis* by having more gently inclined posterodorsal margin in male and with straight ventral margin in female. The present species is rather similar to *Krithe* sp. 1 by Ikeya & Suzuki, 1992 from the Recent sediment off the Shimane peninsula, southwestern Japan, but differs with having straight ventral margin and less prominent caudal process. This new species somewhat resembles to *Parakrithe japonica* Zhou, 1995 reported from the Recent sediment from the Hyuga-nada, southern Japan, but differs with having more rounded lateral outline and more gently curved posterodorsal margin. This species rather resembles *Parkrithe subjaponica* Zhou, 1995 reported from the Recent sediment from the Hyuga-nada, southern Japan, but differs with having rather tapered anterior margin and straight ventral marign. This species somewhat resembles *Krithe* sp. 1 by Zhou (1995) reported from the Recent sediment from off the Tanegashima Island, southern Japan, but differs with having gently curved dorsal margin and straight ventral margin. This species somewhat resembles *Krithe* sp. 2 by Zhou (1995) reported from the Recent sediment from the Kumano-nada, southern Japan, but differs with having more elongated lateral outline and not inclined dorsal margin toward anterior. This species is rather similar to *Krithe* cf. *antisawanensis* Ishizaki, 1966 by Tanaka (2003) reported from the Middle Miocene Omori Formation, San-in district, southwestern Japan, but differs with having more gently curved posterodorsal margin and rather undulated dorsal margin. This new species resembles *Krithe* sp. reported by Yamaguchi (2004) from the Oligocene Itanoura Formation, Nagasaki Prefecture, southwestern Japan, but differs with having more protruded caudal process and more slender carapace outline in dorsal view. The present species is somewhat similar to *Krithe hemideclivata* (Ruan,1988 in Ruan & Hao,1988) reported by Irizuki *et al*. (2007) from the Middle Pliocene Kuwae Formation, central Japan, but differs with having triangular shaped posterior area and straight ventral mrgin. This new species is somewhat similar to *Krithe* sp. by Tanaka & Nomura (2009) reported from the Middle Miocene Furue Formaton, Shimane Prefecture, southwestern Japan, but differs with having prominent caudal process and more gently curved posterodorsal margin. This new species is rather similar to *Krithe* sp. by Ozawa & Domitsu (2010) reported from the Early Pleistocene Hamada Formation, northern Japan, but differs with having more rounded lateral outline and gently inclined postero half of dorsal margin.

TRACHYLEBERIDIDAE Sylvester-Bradley, 1948
ACANTHOCYTEREIS Howe, 1963

Acanthocythereis oshimaensis sp. nov.
Plate 4, figs. 1-15

Derivation of name. Oshima is a town situated southwastern part of Gunma Prefecture from which type specimens were discovered.

Holotype. GMNH-PI-4228
Allotype. GMNH-PI-4229

Material：10 carapaces（see Tanaka *et al*., 2013）.

Description. Carapace subquadrate in lateral view（Pl. 4, figs. 1,2,7,8）. Denticulated anterior margin rounded anteroventrally with infracurvature；dorsal margin sloping toward posterior；posterior margin narrowly arched than anterior margin with having denticules and spines；ventral margin sinuated, concurved at mid length. Prominent eye tubercle situated at ventral area of anterior cardinal angle. Surface ornamented by clvate/conical spines. Marginal rim developed along anterior and posterior margin. In dorsal and ventral views, the carapace arrowhead-shaped（Pl. 4, figs. 4,5,10,11）. In anterior and posterior views, carapace elliptical-shaped（Pl. 4, figs. 3,6,9,12）. Strong sexual dimorphism：Male more elongated than female.

Remarks. This species is similar to *Acanthocythereis dunelmensis*（Norman, 1865）from the Recent sediment from off coast of the Northumberland and Durham, but differs without having reticulation and prominent spines of posteroventral margin. This new species rather resembles *Acanthocythereis niitsumai* Ishizaki, 1971 from the Recent sediment of the Aomori Bay, northern Japan, but differs with having clavate/conical spines and arched posterior margin. The present species somewhat resembles *Acanthocythereis munechikai* Ishizaki, 1981 from the Recent sediment from the East China Sea, but differs with having smooth marginal rims and arched posterior margin. The new species rather resembles *Acanthocythereis sinensis*（Hu, 1981）from the Pleistocene Hengchun Limestone, southern Taiwan, but differs with having smoother carapace and arched posterior margin. The present new species is somewhat similar to *Acanthocythereis*? sp. by Yajima（1982）from the Late Pleistocene Yabu Formation, central Japan, but differs without having reticulation and spines on the marginal rim along with anterior margin. This species is rather similar to *Acanthocythereis uniformiteris* Hu, 1984 from the Pleistocene Sskou Formation, southern Taiwan, but differs with having clavate/conical spines and smooth marginal rims. This species is somewhat similar to *Acanthocythereis tsurugasakensis*（Tabuki, 1985）from the Plio-Pleistocene strata from the Tsugaru Basin, northern Japan, but differs without having reticulation and spines on the marginal rims. The present species somewhat resembles *Acanthocythereis* sp. by Ishizaki & Matoba（1985）from the Pleistocene Wakimoto Formation, northern Japan, but differs with having calvate/conical spines and smooth marginal rim. This species is similar to *Acanthocythereis*? *mutsuensis* Ishizaki, 1971 by Ishizaki & Matoba（1985）from the Pleistocene Sasaoka Formation, northern Japan, but differs with having more numerous clavate/conical spines and rather straight dorsal margin. This new species is similar to *Acanthocythereis* sp. of Lee & Paik, 1992 from the Plio-Pleistocene Sogwipo Formation, Cheju Island, Korea, but differs with having smooth marginal rims and without having posterovantral spine. This new species is somewhat similar to *Acanthocythereis*? sp. 1 by Ikeya & Suzuki（1992）reported from the Recent sediment off the Shimane Peninsula, southwestern Japan, but differs without having fine spines and more rounded lateral outline. The present species is somewhat similar to *Acanthocythereis* sp. by Huh & Paik（1992）from the Miocene Chunbuk Conglomeratem of the Pohang Basin, Korea, but differs without having reticulation and triangular shaped posterior area. This new species is somewhat similar to *Acanthocythereis* sp. 1 by Zhou（1995）from the Recent sediments off southwestern Japan, but differs without having reticulation and spines on the marginal rims. This new species rather resembles *Acanthocythereis koreana* Huh & Whatley, 1997 from the Miocene Yeonil Group, Korea, but differs without having reticulation and spines on the marginal rim along anterior margin. This new species is somewhat similar to *Acanthocythereis fujinaensis* Tanaka, 2002（in Tanaka *et al*., 2002）from the Middle Miocene Fujina Formation, Shimane Prefecture, southwestern Japan, but differs with having more elongated lateral outline and more acutely curved posterior margin. This species is similar to *Acanthocythereis izumoensis* Tanaka, 2002（in Tanaka *et al*., 2002）from the Middle Miocene Fujina Formation, Shimane Prefecture, southwestern Japan, but differs with having more numerous clavate/conical spines and prominent marginal rim. This species is somewhat similar to *Acanthocythereis japonica* Irizuki & Yamada, 2004（in Irizuki *et al*., 2004）from the Early Miocene Toyama Formation, central Japan, but differs without having posteroventral spine and spines of marginal rim of anterior area. This species is rather similar to *Acanthocythereis quadrata* Irizuki & Yamada, 2004（in Irizuki *et al*., 2004）from the Early Miocene Toyama Formation, central Japan, but differs with having more elongated lateral outline and acutely curved posterior margin. The Present new species somewhat resembles *Acanthocythereis volubilis*（Liu, 1989）by Yamaguchi（2004）reported from the Oligocene Itanoura Formation from the Nagasaki Prefecture, Kyushu Island, Japan, but differs in lacking spines on the marginal rims and arched posterior margin. This species somewhat resembles *Acanthocythereis* sp. figured by Irizuki *et al*.（2007）from the Pliocene Kuwae Formation, northern Japan, but differs with having more elongated lateral outline and without having long spines at ventral margin.

Acanthocythereis noriyukikeyai sp. nov.
Plate 5, figs. 1-15

Derivation of name. Late Professor Noriyuki Ikeya（Shizuoka University）who was great Japanese Ostracodologist.

Holotype. GMNH-PI-4230
Allotype. GMNH-PI-4231

Material：5 carapaces.

Acanthocythereis cf. *quadrata* Irizuki & Yamada, 2004（in Irizuki *et al*., 2004）; Tanaka *et al*., 2013, p.21, fig.5.

Description. Carapace subtrapezoid in lateral view (Pl. 5, figs. 1,2,7,8). Denticulated anterior margin rounded anteroventrally with infracurvature; dorsal margin straight; posterior margin curved posteroventrally and narrowly arched than anterior margin with having denticules and spines; ventral margin rather straight, concurved at mid length. Weak eye tubercle situated at ventral area of anterior cardinal angle. Surface ornamented by clevate/conical spines and reticulation. Marginal rim developed along anterior and posterior margin and with many clevate/ conical spines along with anterior and posterior margins. In dorsal and ventral views, the carapace arrowhead-shaped (Pl. 5, figs. 4,5,10,11). In anterior and posterior views, carapace trapezoidal-shaped (Pl. 5, figs. 3,6,9,12).
Strong sexual dimorphism: Male more elongated than female.

Remarks. This species is similar to *Acanthocythereis dunelmensis* (Norman, 1865) from the Recent sediment from off coast of the Northumberland and Durham, but differs without having prominent reticulation and prominent spines of posteroventral margin. This new species rather resembles *Acanthocythereis mutsuensis* Ishizaki, 1971 from the Recent sediment of the Aomori Bay, northern Japan, but differs with having reticulations and straight dorsal margin. The present species somewhat resembles *Acanthocythereis munechikai* Ishizaki, 1981 from the Recent sediment from the East China Sea, but differs with having strapezoid lateral outline and less developed poseroventral spine. The new species rather resembles *Acanthocythereis sinensis* (Hu, 1981) from the Pleistocene Hengchun Limestone, southern Taiwan, but differs with having trapezoid lateral outline and posteroventrally arched posterior margin. The present new species is somewhat similar to *Acanthocythereis*? sp. by Yajima (1982) from the Late Pleistocene Yabu Formation, central Japan, but differs without having posteroventral calvate spine and prominent central node. This species is rather similar to *Acanthocythereis uniformiteris* Hu, 1984 from the Pleistocene Sskou Formation, southern Taiwan, but differs with having clavate/conical spines and trapezoid lateral outline. This species is somewhat similar to *Acanthocythereis tsurugasakensis* (Tabuki, 1985) from the Plio-Pleistocene strata from the Tsugaru Basin, northern Japan, but differs with having trapezoid lateral outline and straight dorsal margin. The present species somewhat resembles *Acanthocythereis* sp. by Ishizaki & Matoba (1985) from the Pleistocene Wakimoto Formation, northern Japan, but differs with having clavate/conical spines and trapezoidal shape of lateral outline. This species is similar to *Acanthocythereis*? *mutsuensis* Ishizaki, 1971 by Ishizaki & Matoba (1985) from the Pleistocene Sasaoka Formation, northern Japan, but differs with having more numerous calvate/conical spines and straight dorsal margin. This new species is similar to *Acanthocythereis* sp. of Lee & Paik, 1992 from the Plio-Pleistocene Sogwipo Formation, Cheju Island, Korea, but differs with having reticulation and trapezoid lateral outline. This new species is somewhat similar to *Acanthocytheteis*? sp. 1 by Ikeya & Suzuki (1992) reported from the Recent sediment off Shimane Peninsula, southwestern Japan, but differs without having fine spines and with trapezoid lateral outline. The present species is somewhat similar to *Acanthocythereis* sp. by Huh & Paik (1992) from the Miocene Chunbuk Conglomeratem Pohang Basin, Korea, but differs with having trapezoid lateral outline and posteroventrally arched posterior margin. This new species is somewhat similar to *Acanthocythereis* sp. 1 by Zhou (1995) from the Recent sediments off southwestern Japan, but differs with having trapezoid lateral outline and straight dorsal margin. This new species rather resembles *Acanthocythereis koreana* Huh & Whatley, 1997 from the Miocene Yeonil Group, Korea, but differs with having more rounded lateral outline and less prominent eye tubercle. This new species is somewhat similar to *Acanthocythereis fujinaensis* Tanaka, 2002 (in Tanaka *et al*., 2002) from the Middle Miocene Fujina Formation, Shimane Prefecture, southwestern Japan, but differs with having trapezoidal lateral outline and less prominent eye tubercle. This species is similar to *Acanthocythereis izumoensis* Tanaka, 2002 (in Tanaka *et al*., 2002) from the Middle Miocene Fujina Formation, Shimane Prefecture, southwestern Japan, but differs with having numerous calvate/conical spines and reticulations. This species is somewhat similar to *Acanthocythereis japonica* Irizuki & Yamada, 2004 (in Irizuki *et al*., 2004) from the Early Miocene Toyama Formation, central Japan, but differs without having posteroventral spine and strapezoidal lateral outline. This species is similar to *Acanthocythereis quadrata* Irizuki & Yamada, 2004 (in Irizuki *et al*., 2004) from the Early Miocene Toyama Formation, central Japan, but differs with having infracurvated anterior margin and posteroventrally arched posterior margin. The Present new species somewhat resembles *Acanthocythereis volubilis* (Liu, 1989) by Yamaguchi (2004) reported from the Oligocene Itenoura Formation from the Nagasaki Prefecture, Kyushu Island, Japan, but differs with having trapezoid lateral outline and posteroventrally arched posterior margin. This species somewhat resembles *Acanthocythereis* sp. figured by Irizuki *et al*. (2007) from the Pliocene Kuwae Formation, northern Japan, but differs with having trapezoid lateral outline and short marginal spines.

PACAMBOCYTHERE Malz, 1982

Pacambocythere aff. *similis* Malz, 1982
Plate 1, fig. 10.

Material: 12 carapace (see Tanaka *et al*., 2013).

Remarks. Because of lack of well preserved specimens, we do not propose this species as a new species. This species somewhat resembles *Buntonia* sp. by Ishizaki, 1981 from the Recent sediment from the East China Sea, but differs with having more elongated lateral outline and lacking of reticulation at ventral area. The present species somewhat resembles *Pacambocythere reticulata* (Jiang & Wu, 1981) (p. 177 in Gou *et al*., 1981) from the Tertiary sediment from China, but differs with having finer ornamentation and straight posterior margin. This species rather resembles *Pacambocythere buntoniae* Malz, 1982 from the Plio-Pleistocene deposit from Taiwan, but differs with having elongated lateral outline and less developed anterodorsal sulcus. This species somewhat resembles *Buntonia scrota* Ishizaki, 1983 from the Pliocene Ananai Formation, Shikoku Island, southwestern Japan, but differs with having quadrate lateral outline and without ventral margin. The present species is somewhat similar to *Buntonia u-carinata* Ishizaki, 1983 from the Pliocene Ananai Formation, Shikoku Island, southwestern Japan, but differs without

U-shaped carina and with more rounded lateral outline. This species is rather similar to *Ambocythere subovate* Hu, 1984 reported from the Pleistocene Ssukou Formation, southern Taiwan, but differs without having ventral ridge and projection at mid-posterior area. The present species is somewhat similar to *Pacambocythere* sp. 1 of Ikeya & Suzuki (1992) from the Recent sediment off Shimane Peninsula, southwestern Japan, but differs with having reticulated carapace and elongated lateral outline. This species rather resembles *Pacambocythere izuensis* Ikeya and Zhou in Zhou (1995) from the Recent sediment from off Kii Peninsula, southwest Japan, but differs with having reticulation and inflacurveted anterior margin. This species is somewhat similar to *Pacambocythere* sp. of Zhou (1995) from the Tosa Bay, Shikoku Island, southwestern Japan, but differs with having anteroventral ornamentation and straight posterior margin.

Gen. et sp. indet
Pl. 1, fig. 13

Material: 5 carapaces (see Tanaka *et al*., 2013).

Remarks. Because of the information of internal morphology, we do not determine the genus of this undescribed species.

HEMICYTHERIDAE Puri, 1953
CORNUCOQUIMBA Ohmert, 1968

Cornucoquimba saitoi (Ishzaki, 1963)
Plate 1, fig. 11.

Material: 4 carapaces (see Tanaka *et al*., 2013).

Bradleya saitoi Ishizaki, 1963, p. 29, 30, pl. 2, figs. 11, 13– 19.
Hermanites saitoi (Ishizaki). Ishizaki, 1966, p. 159, pl. 18, figs. 7, 8.
Cornucoquimba saitoi (Ishizaki). Hanai *et al*., 1977, p. 47; Irizuki *et al*., 1998, p. 37, fig. 6 (2); Irizuki *et al*., 2001, p. 67, fig. 18 (13); Yamaguchi and Hayashi, 2001, p. 247, fig. 5 (8); Yamada *et al*., 2001, pl. 1, fig. 6; Tanaka *et al*., 2004, p. 60, pl. 1, figs. 14, 15; Tanaka in press Fig. 5.9 (in Tanaka & Hasegawa, in press).
Cornucoquimba sp. 2, Ozawa *et al*., 2008, p. 166, pl. 1, fig. 12.
Non *Cornucoquimba saitoi* (Ishizaki). Irizuki *et al*., 2004, p. 134, pl. pl. 7, figs. 7– 12; Ozawa and Domitsu, 2010, p. 4, fig. 3 (17). Tanaka *et al*., 2013, p. fig.

Remarks. This species differs from *Cornucoquimba tosaensis* (Ishizaki, 1968) reported from the Recent sediments of the Uranouchi Bay, Kochi Prefecture, Shikoku Island, Japan, in its straight dorsal margin, lack of ridge running from postero-dorsal margin to mid-ventral area, and rather unclear central node. The figured specimen as *C. saitoi* in Ozawa and Domitsu (2010) from the Lower Pleistocene Hamada Formation, northeastern Japan is different from the type specimen in its lacks of surface ornamentation, short ventral ridge and broad postero-ventral flat area. The specimens reported from the Lower Miocene Toyama Formation by Irizuki *et al*. (2004) differ from the type specimen in its higher lateral outline and prominent central node.

LAPEROUSECYTHERE Brouwers, 1993

Laperousecythere sp.
Plate 1, fig. 12.

Material: 4 carapace (see Tanaka *et al*., 2013).

Remarks. Because of lack of enough adult specimens, we do not propose this species as a new species. The species is rather similar to *Laperousecythere robusta* (Tabuki, 1986) from the Plio-Pleistocene deposits from the Tsugaru Basin, Aomori Prefecture, northern Japan, but differs with having reticulated carapace and prominent central node. This species rather resembles *Laperousecythere sasaokensis* (Irizuki, 1989) from the Pliocene Sasaoka Formation, Akita Prefecture, northern Japan, but differs with having inclined dorsal outline toward posterior and more finely reticulated carapace. The present species somewhat resembles *Laperousecythere ishizakii* Irizuki & Matsubara, 1995 from the Early Middle Miocene Suenomatsuyama Formation, northeast Japan, but differs with having triangular shaped posterior area and evenly arched anterior margin. This species is somewhat similar to *Laperousecythere* cf. *robsta* (Tabuki, 1985) by Irizuki & Matsubara, 1995 from the Early Middle Miocene Suenomatsuyama Formation, northeast Japan, but differs without having posteroventral spines and long prominent ventral ridge. This species rather resembles *Laperousecythere yahtsensis* Brouwers, 1993 by Irizuki & Matsubara, 1995 from the Early Middle Miocene Suenomatsuyama Formation, northeast Japan, but differs with having more rounded lateral outline and without having posteroventral spines. This species is somewhat similar to *Laperousecythere* sp. Irizuki & Matsubara, 1995 from the Early Middle Miocene Suenomatsuyama Formation, northeast Japan, but differs with having straight dorsal margin and more evenly rounded anterior margin. This species is similar to *Laperousecythere sendaiensis* (Ishizaki, Fujiwara & Irizuki, 1996) from the Upper Miocene Tsunaki Formation, Miyagi Prefecture, northern Japan, but differs with having evenly arched anterior margin and triangular shaped posterior area. This species is somewhat similar to *Laperousecythere* cf. *ishizakii* Irizuki & Matsubara, 1995 by Ozawa (1996) reported from the Plio-Pleistocene Omma Formation, Kanazawa City, Ishikawa Prefecture, southwest Japan, but differs without having prominent dorsal ridge and posteroventral spines. The present species somewhat resembles *Laperousecythere* sp. 1 by Ozawa (1996) from the Plio-Pleistocene Omma Formation, Kanazawa City, Ishikawa Prefecture, southwestern Japan, but differs with having more elongated lateral outline and upwardly protruded caudal process. The species is rather similar to *Laperousecythere* aff. *robusta* (Tabuki, 1986) figured by Irizuki *et al*. (1998) from the Middle Miocene Kobana Formation, Tochigi Prefecture, central Japan, but differs with having downwardly swinged anterior margin and more inclined dorsal margin toward posterior. The present species rather resembles *Laperousecythere* sp. by Irizuki *et al*. (1998, 2001) from the Middle Miocene Kobana Formation, Tochigi Prefecture, central Japan, but differs with having more elongated lateral outline and more inclined dorsal margin toward posterior. This species is rather similar to *Laperousecythere ikeyai* Tanaka, 2002 (in Tanaka *et al*., 2002) from the Middle Mio-

cene Fujina Formation, Shimane Prefecture, southwestern Japan, but differs with having more evenly rounded anterior margin and more feeble reticulated carapace. This species rather resembles *Laperousecythere cronini* Irizuki & Yamada, 2004 (in Irizuki *et al*., 2004) from the Early Miocene Toyama Formation, Nagano Prefecture, central Japan, but differs with having triangular-shaped posterior area and more broadly arched anterior margin. The present species is somewhat similar to *Laperousecythere* cf. *cronini* Irizuki & Yamada, 2004 (in Irizuki *et al*., 2004) by Irizuki *et al*. (2007) from the Pliocene Sasaoka Formation, northern Japan, but differs with having evenly rounded anterior margin and more elongated lateral outline. This species rather resembles *Laperousecythere* cf. *ishizakii* Irizuki & Matsubara, 1996 by Ozawa (2007, 2010) from the Early Pleistocene Omma Formation, Ishikawa Prefecture, southwestern Japan, but differs with having more evenly arched anterior margin and reticulated anterior area. This species is somewhat similar to *Laperousecythere* sp. A by Ozawa (2007, 2010) from the Early Pleistocene Omma Formation, Ishikawa Prefecture, southwest Japan, but differs with having reticulated carapace and evenly rounded anterior margin. The present species is somewhat similar to *Laperousecythere* sp. B by Ozawa (2007, 2010) from the Early Pleistocene Omma Formation, Ishikawa Prefecture, southwest Japan, but differs with having more elongated lateral outline and more evenly rounded anterior margin. The present species rather resembles *Laperousecythere* sp. C by Ozawa (2007, 2010) from the Early Pleistocene Omma Formation, Ishikawa Prefecture, southwest Japan, but differs with having reticulated carapace and straight dorsal margin. This species somewhat resembles *Laperousecythere* sp. D by Ozawa & Kamiya (2005) and Ozawa (2007, 2010) reported from the Plio-Pleistocene Omma Formation, Kanazawa City, Ishikawa Prefecture, southwest Japan, but differs with having more elongated carapace and triangular shaped posterior area. This species is rather similar to *Laperousecythere* sp. by Ozawa and Tsukawaki (2008) reported from the Recent sediment from off Hokkaido, Japan, but differs with having finely reticulated carapace and rather triangular shaped posterior area. This species is somewhat similar to *Laperousecythere* sp. by Ozawa *et al*. (2008) from the Pliocene Ogikubo Formtion, Nagano Prefecture, central Japan, but differs with having more reticulated carapace and prominent central node. This species rather resembles *Laperousecythere* sp. 3 reported by Ozawa & Domitsu (2010) from the Early Pleistocene Hamada Formation, northern Japan, but differs with having reticulated carapace and straight ventral margin.

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Taxonomic note

Professor Eugen Karl Kempf (Frechen, Germany) has kindly drawn my attention to the fact that *Loxoconcha tuberculatus* proposed by Tanaka *et al.* (2012) was junior homonyms of *Loxoconcha eichwaldii tuberculata* Livental, 1929 and *Loxoconcha dafarovi tuberculata* Sheydaeva-Kulieva, 1958. One of author (G. T.) express much thanks to Prof. Kempf for calling my attention to this problem, and we propose here the new names *Loxoconcha eugenkempfi* sp. nov. in his honor.

日本国群馬県富岡市の中部中新統「古蛇崩い礁」から産出した介形虫群

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要旨： 群馬県富岡市南西部田島付近の鏑川右岸に分布する中部中新統小幡層の‘古蛇崩い礁’の泥質堆積物から18属19種の介形虫化石群を報告した．これらの介形虫化石群は‘古蛇崩い礁’が深海環境下で形成されたことを示唆する．3新種，クリセ トミオカエンシス，アカンソシセレイス オオシマエンシス，およびアカンソシセレイス ノリユキケヤアイを記載する．田中ほか(2012)によって久米島の上部中新統真謝層より記載されたロクソコンカ テュバーキュラタスはロクソコンカ エイヒワーディー テュバーキュラタス および ロクソコンカ デファロビー テュバーキュラタスのジュニアホモニムであることが判明したので，ここにロクソコンカ オイゲンケンプアイとして再記載した．

キーワード： 深海性介形虫化石群, 中部中新統, 新種, 小幡層, ロクソコンカ オイゲンケンプアイ

Explanation of Plates

Plate 1. Ostracod species from the Middle Miocene Obata Formation of 'Kojyakui-sho' from the Oshima, Tomioka City, Gunma Prefecture, central Japan. 1, *Neonesidea* sp. (GMNH-PI-4213) ; 2, *Macrocypris* sp. (GMNH-PI-4216) ; 3, *Propontocypris* sp. (GMNH-PI-4218) ; 4, *Paracypris* sp. (GMNH-PI-4215) ; 5. *Copytus* sp. (GMNH-PI-4220) ; 6, *Sclerochilus*? sp. (GMNH-PI-4214) ; 7, Paradoxostomatidae gen. et sp. indet (GMNH-PI-4219) ; 8, *Argilloecia* sp. (GMNH-PI-4070) ; 9, *Spinileberis* sp. (GMNH-PI-4221) ; 10, *Pacambocythere* aff. *similis* Malz, 1982 (GMNH-PI-4222) ; 11, *Cornucoquimba saitoi* (Ishzaki, 1963) (GMNH-PI-4224) ; 12, *Laperousecythere* sp. (GMNH-PI-4225) ; 13, Trachyleberididae gen. et sp. indet (GMNH-PI-4223).

Plate 2. *Pontocypris kanazawensis* Ishizaki, 1963 f from the Middle Miocene Obata Formation of 'Kojyakui-sho' from the Oshima, Tomioka City, Gunma Prefecture, central Japan. 1-6, 13, 14 : carapace of possible female, (GMNH-PI-4226) ; 1, left lateral view ; 2, right lateral view ; 3, anterior view ; 4, dorsal view ; 5, ventral view ; 6, posterior view ; 13, enlargement of anteroventral area of ventral view ; 14, enlargement of anteroventral area of anterior view. 7-12, 15 : valves of possible male, (GMNH-PI-4227) ; 7, left lateral view ; 8, right lateral view ; 9, anterior view ; 10, dorsal view ; 11, ventral view ; 12, posterior view ; 15, penlargement of posterodorsal area of posterior view.

Plate 3. *Krithe tomiokaensis* sp. nov. from the Middle Miocene Obata Formation of 'Kojyakui-sho' from the Oshima, Tomioka City, Gunma Prefecture, central Japan. 1-6 : carapace of possible female, (holotype : GMNH-PI-4211) ; 1, left lateral view ; 2, right lateral view ; 3, anterior view ; 4, dorsal view ; 5, ventral view ; 6, posterior view. 7-15 : valves of possible male, (allotype : GMNH-PI-4212) ; 7, left lateral view ; 8, right lateral view ; 9, anterior view ; 10, dorsal view ; 11, ventral view ; 12, posterior view ; 13, enlargement of anterodorsal area of dorsal view ; 14, enlargement of posterodorsal area of dorsal view ; 15, right posterior terminate of dorsal view.

Plate 4. *Acanthocythereis oshimaensis* sp. nov. from the Middle Miocene Obata Formation of 'Kojyakui-sho' from the Oshima, Tomioka City, Gunma Prefecture, central Japan. 1-6 : carapace of female, (holotype : GMNH-PI-4228) ; 1, left lateral view ; 2, right lateral view ; 3, anterior view ; 4, dorsal view ; 5, ventral view ; 6, posterior view. 7-15 : valves of male, (allotype : GMNH-PI-4229) ; 7, left lateral view ; 8, right lateral view ; 9, anterior view ; 10, dorsal view ; 11, ventral view ; 12, posterior view ; 13, enlargement of midventral area of ventral view ; 14, enlargement of right eye tubercle of lateral view ; 15, normal pore canal.

Plate 5. *Acanthocythereis noriyukikeyai* sp. nov. from the Middle Miocene Obata Formation of 'Kojyakui-sho' from the Oshima, Tomioka City, Gunma Prefecture, central Japan. 1-6, 14 : carapace of female, (holotype : GMNH-PI-4230) ; 1, left lateral view ; 2, right lateral view ; 3, anterior view ; 4, dorsal view ; 5, ventral view ; 6, posterior view ; 14, enlargement of anterior from ventral view ; 7-13, 15 : valves of male, (allotype : GMNH-PI-4231) ; 7, left lateral view ; 8, right lateral view ; 9, anterior view ; 10, dorsal view ; 11, ventral view ; 12, posterior view ; 13, enlargement of normal pore canal and reticulation ; 15, crystal structure observed on the surface of carapace.

Plate 1

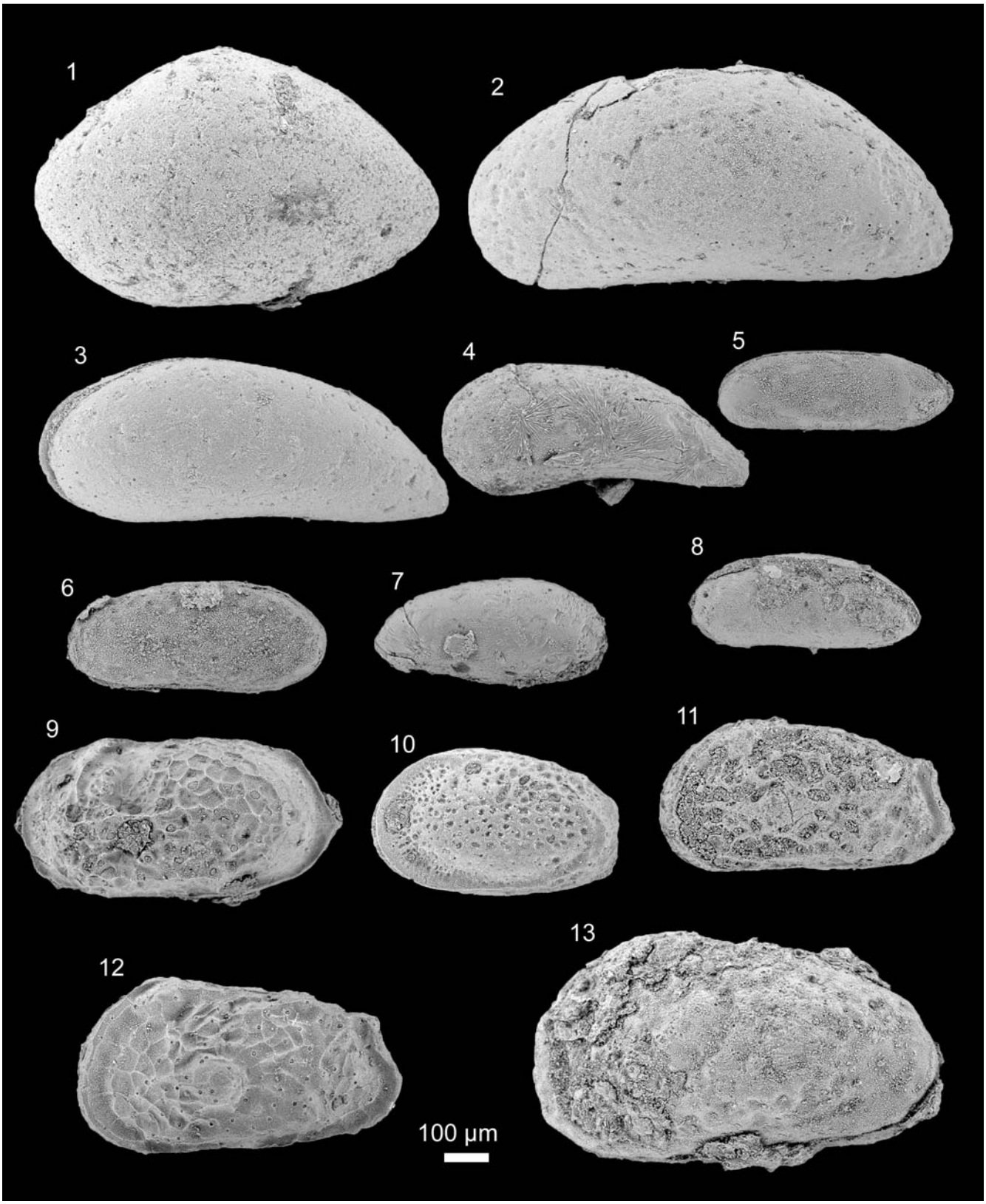

Plate 2

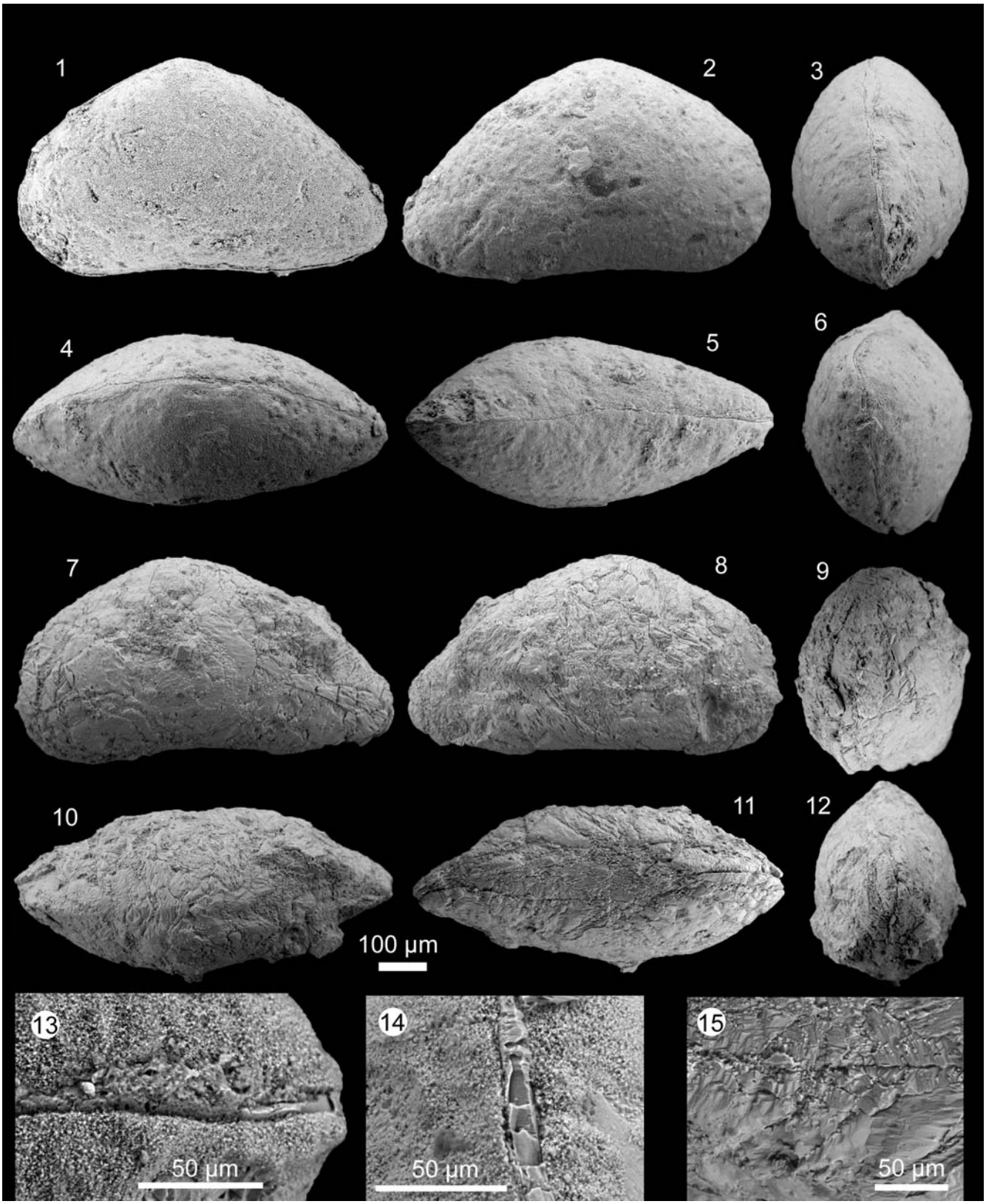

Plate 3

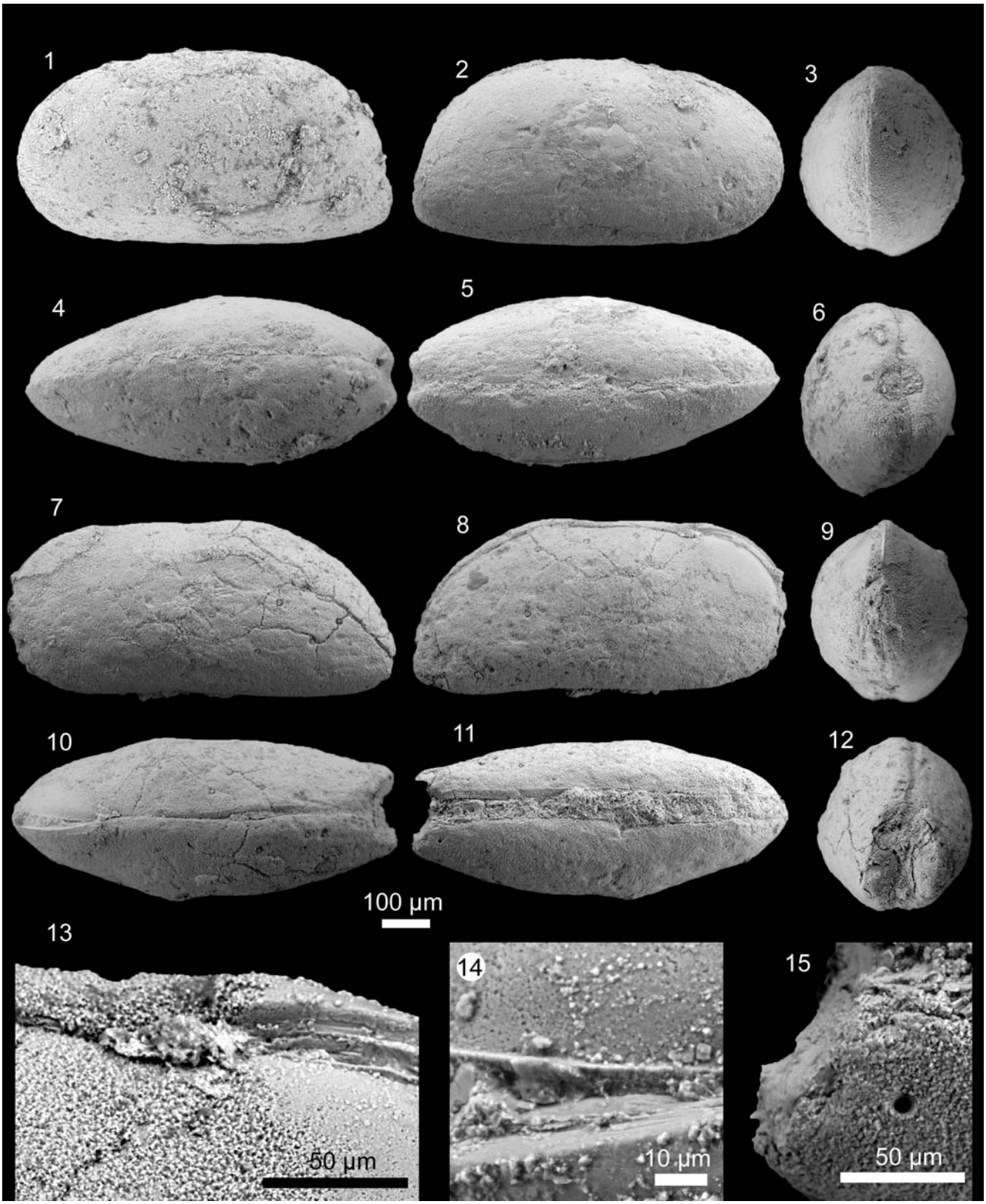

Plate 4

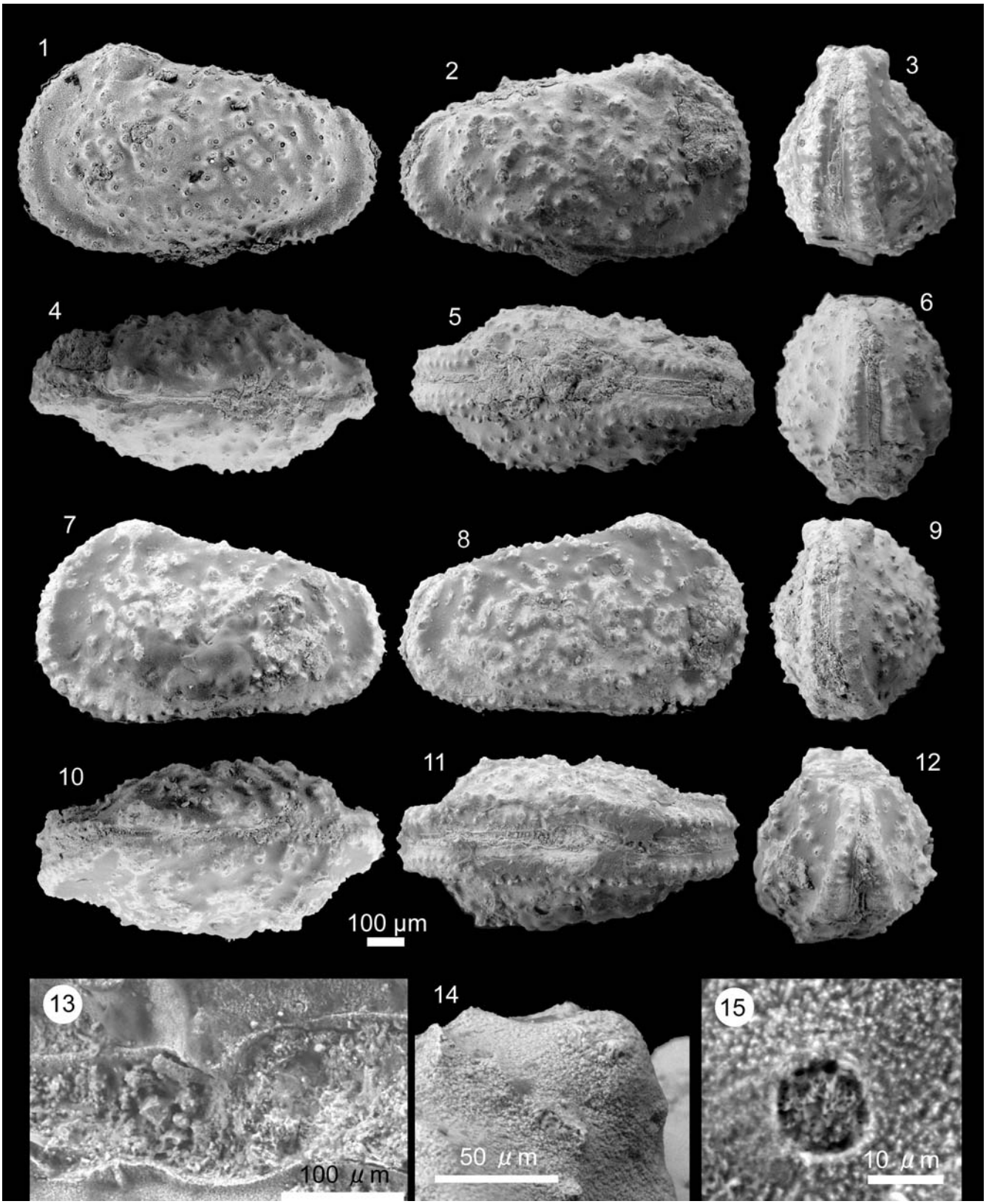

Plate 5