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A review of the Late Cenozoic Cancridae (Decapoda) from West Japan, with descriptions one new genus and one new species

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Abstract

The cancrid crabs from the Neogene and Quaternary deposits of West Japan are clarified. *Mizuhocancer* Karasawa, a new monotypic genus is proposed for *Cancer? imamurae* Imaizumi, 1962, previously assigned to *Platepistoma* Rathbun, 1906, by Karasawa (1993). *Glebocarcinus doii* Karasawa and Takahashi, a new species is described from the Early Miocene Igami Formation of southern Honshu. The fossil cancrids known to date from the Late Cenozoic of West Japan consist of 11 species within five genera, *Anatolikos japonicus* (Ortmann, 1893), *A. fujinaensis* (Sakumoto, Karasawa, and Takayasu, 1992), new combination, *A. itoigawai* (Karasawa, 1990), *A. tomowoi* (Karasawa, 1990), new combination, *Glebocarcinus doii* Karasawa and Takahashi, new species, *G. kaedei* Karasawa, 1990, *Metacarcinus izumoensis* Sakumoto, Karasawa, and Takayasu, 1992, *Mizuhocancer imamurae* (Imaizumi, 1962), new combination, *Romaleon gibbosulum* (De Haan, 1833), *R. odosense* (Imaizumi, 1962), and *R. sakamotoi* (Kato, 1996).

Key words: Decapoda, Brachyura, Cancridae, Late Cenozoic, Japan

Introduction

Nations (1975) proposed the subgeneric divisions for *Cancer* Linnaeus, 1758, and Karasawa (1990) adapted his subgeneric divisions to the Japanese fossil species. Subsequently, Schweitzer and Feldmann (2000) gave the subgenera placed under *Cancer* the full generic status. Their classification of Cancridae Latreille, 1802, has been widely accepted by several workers (i.e., Ng et al., 2008; De Grave et al., 2010; Schweitzer et al., 2010; Schram and Ng, 2012). Species of Cancridae of West Japan are rare in the Miocene–Pliocene deposits and relatively common in the Pleistocene. The identifies of species occurred in the Miocene deposits are different within authors (i.e.,

Imaizumi, 1962, 1969; Sakumoto et al., 1992; Karasawa, 1993).

The purpose of this paper is to clarify the taxonomic status of cancrids known as fossils, based upon examination of the hitherto described and figured, and additional specimens, deposited in the Mizunami Fossil Museum (MFM) and Mine City Museum of History and Folklore (MMHF). Consequently, 11 species belonging to five genera, including one new genus and one new species, are recognized as fossils.

Taxonomical Accounts

Family Cancridae Latreille, 1802

Genus *Anatolikos* Schweitzer and Feldmann, 2000

Type species: Cancer japonicus Ortmann, 1893, by original designation.

***Anatolikos japonicus* (Ortmann, 1893)**

(Figs. 1.1a–1.5)

Cancer japonicus Ortmann, 1893, p. 427, pl. 17, fig. 5.

Anatolikos japonicus (Ortmann, 1893); Schweitzer and Feldmann, 2000, p. 228.

Emended diagnosis: Carapace suboval, wider than long, maximum length 70–80 percent maximum carapace width, carapace widest at last anterolateral spine, located about three-quarters the distance posteriorly on carapace. Fronto-orbital width from 31–46

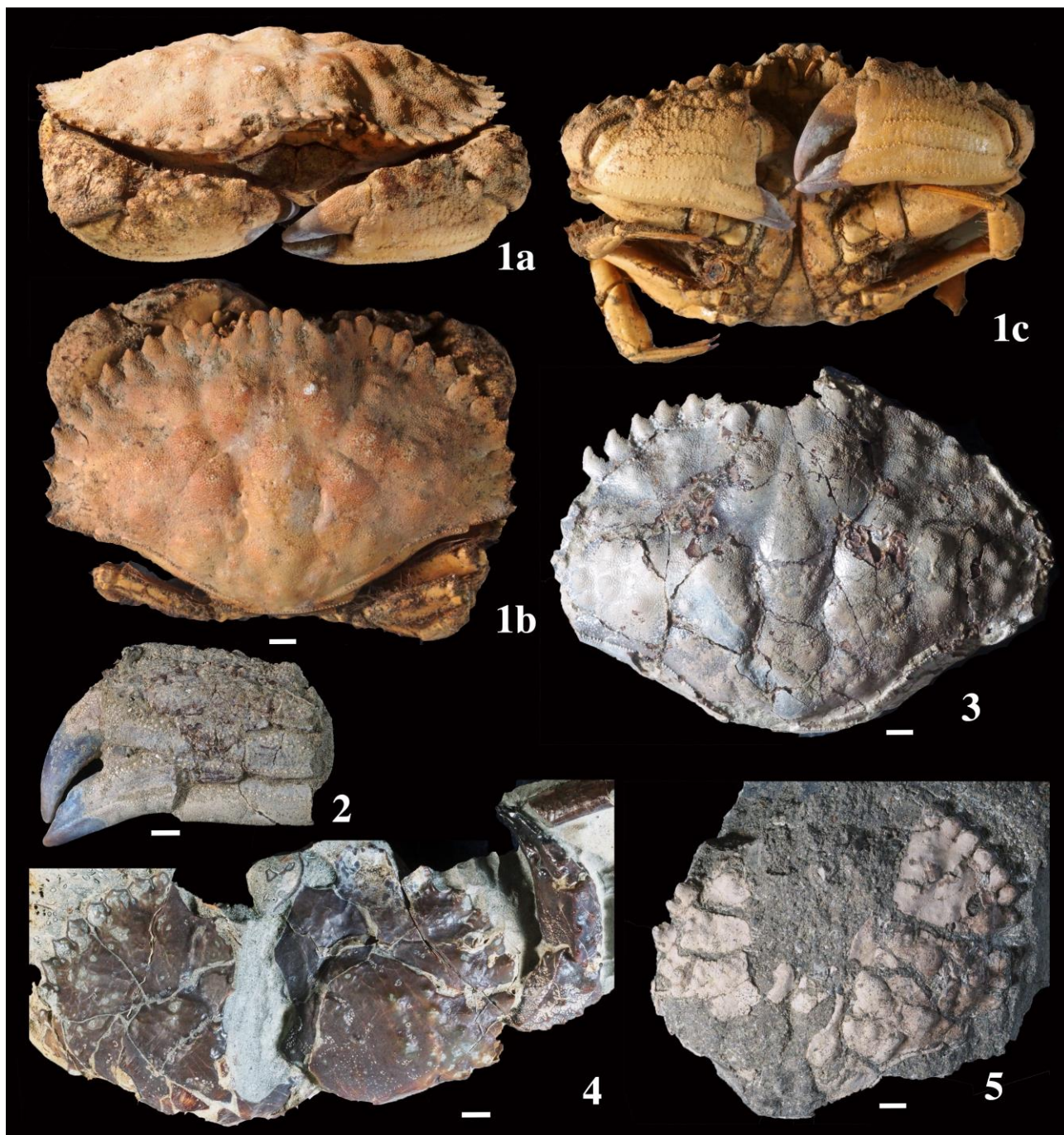


Fig. 1. *Anatolikos japonicus* (Ortmann, 1893). 1a–c, MFM192150, a Recent specimen from Mikawa Bay, 1a, frontal; 1b, dorsal; 1c, ventral view. 2, MFM142122 from the Middle Pleistocene Onma Formation, lateral view of left cheliped. 3, MFM142183 from the Late Pliocene–Early Pleistocene Ananai Formation, dorsal view of carapace. 4, MFM142650 from the Early Pleistocene Dainichi Formation, dorsal view of carapace and chelipeds. 5, MFM142651 from the Late Miocene Iitomi Formation, dorsal view of carapace. Scale bar = 5 mm.

percent maximum carapace width. Front projected beyond orbits, nearly straight, frontal spines lobate, separated by fissures. Orbits with thickened rim. Anterolateral margin convex, most convex posteriorly; with 11 spines, separated by fissures, triangular at tips; outer-orbital spine small, not well developed; second spine singular, sharp; third and fourth, fifth and sixth, seventh and eighth, and ninth and tenth spines paired; eleventh and twelfth spines singular, sharp. Posterolateral margin weakly concave, rimmed, with one spine. Posterior margin nearly straight, rimmed. Regions moderately well-defined, especially axial, protogastric, and metabranchial regions; surface of carapace granular. Manus of cheliped short; lateral surface with three granular ridges and scattered tubercles; upper margin with three short spines; ventral margin keeled. Fixed finger short, medially keeled; large, blunt denticles on occlusal surface. Dactylus short, granular, with small, blunt denticles on occlusal surface (modified from Schweitzer and Feldmann, 2000, p. 228).

Remarks: Ng et al. (2008) and Schram and Ng (2012) questionably regarded three Japanese Miocene species, *Cancer sanbonsugii* Imaizumi, 1962, *C. odosensis* Imaizumi, 1962, and *Cancer? imamurae* Imaizumi, 1962, as a junior subjective synonym of *A. japonicus*. However, these species are moved to other genera as discussed below. Ikeda (1998) thought that *Anatolikos tumifrons* (Yokoya, 1933) was a juvenile form of *A. japonicus* and regarded as a junior subjective synonym of *A. japonicus*, but Schweitzer and Feldmann (2000), Ng et al. (2008), and Schram and Ng (2012) did not mention his work.

Anatolikos japonicus is the extant species recorded from Korea, Japan, and Taiwan (Ko and Lee, 2013; Ng et al., 2017) and has the fossil records from the latest Late Miocene to Pleistocene of Japan: the Late Miocene Iitomi Formation of the Fujikawa Group (herein); the Late Pliocene–Early Pleistocene Ananai Formation of the Tonohama Group (Karasawa and Kinugawa, 2013); the Early Pleistocene Dainichi Formation of the Kakegawa Group (Karasawa, 1993; herein); the Middle Pleistocene Onma Formation (Karasawa, 1993). Although Hu and Tao (2000) reported the present species from the Pleistocene Ryukyu Group in Taiwan, Karasawa and Kinugawa (2013)

moved it to the xanthid *Etisus* H. Milne Edwards, 1834.

Material examined: MFM142651 from the Late Miocene Iitomi Formation of the Fujikawa Group of Osozawa, Minobu-cho, Yamanashi Prefecture; MFM142122 from the Middle Pleistocene Onma Formation of Okuwa, Kanazawa City, Ishikawa Prefecture; MFM142183 from the Late Pliocene–Early Pleistocene Ananai Formation of the Tonohama Group of Tonohama, Aki City, Kochi Prefecture; MFM142650 from the Early Pleistocene Dainichi Formation of the Kakegawa Group of Asuka, Kakegawa City, Shizuoka Prefecture; MFM192150, a Recent specimen from Isshiki, Mikawa Bay, Aichi Prefecture.

***Anatolikos itoigawai* (Karasawa, 1990)**

(Figs. 2.1a–2.3b)

Cancer (Glebocarcinus) itoigawai Karasawa, 1990, p. 7, pl. 1, fig. 10; Karasawa, 1993, p. 50, pl. 10, fig. 3; Karasawa, 1997, p. 45, pl. 11, Fig. 7; Sakumoto, 1997, pl. 1, fig. 4 (non fig. 3).

Cancer (Glebocarcinus) sp. cfr. *C. (G.) itoigawai* Karasawa, 1990, p. 9, pl. 1, figs. 11, 12.

Anatolikos itoigawai (Karasawa); Schweitzer and Feldmann, 2000, p. 299; Schweitzer et al., 2010, p. 101; Karasawa et al., 2011, p. 34, figs. 2.11, 2.14.

Emended diagnosis: Carapace suboval, much wider than long, length about 70 percent maximum carapace width, widest at last anterolateral spine, moderately vaulted transversely and longitudinally. Fronto-orbital width about 45 percent maximum carapace width. Front projected beyond orbits, lobate. Anterolateral margin strongly convex, with nine triangular teeth; second and third, fourth and fifth, sixth and seventh, and eighth and ninth teeth paired; third, fifth, and seventh notches deep. Posterolateral margin weakly concave, narrow, bearing shallow notch anteriorly, fringed with fine, granular rim. Posterior margin nearly straight, fringed with finely granulated rim. Dorsal surface densely covered with fine granules; regions well-defined (modified from Karasawa, 1990, p. 7).

Remarks: Sakumoto (1997, p. 157, pl. 1, figs. 3, 4) figured two specimens of the species from the Early Miocene Korematsu Formation of the Bihoku Group in Shobara City, Hiroshima Prefecture; however, his

illustrated specimens are not conspecific. One of them (Sakumoto, 1997, pl. 1, fig. 3) should be identical with *Romaleon sakamotoi* (Kato, 1996) by the possession of three posterolateral spines of the carapace.

Anatolikos itoigawai has been recorded from the Early–early Middle Miocene Mizunami Group (Karasawa, 1990, 1993, 1997), the Early Miocene Korematsu Formation of the Bihoku Group (Sakumoto, 1997), the Early Miocene Toyota Formation of the Masuda Group (herein), and the Early–early Middle Miocene Shimo Formation (Karasawa et al., 2011).

Material examined: MFM9025 (holotype) from the Early–early Middle Miocene Akeyo Formation of the Mizunami Group of Yamanouchi, Akiyo-cho, Mizunami City, Gifu Prefecture; MFM9372 from the Early–early Middle Miocene Akeyo Formation of the Mizunami Group of Oginoshima, Kamado-cho, Mizunami City, Gifu Prefecture; MFM83313 from the Early Miocene Toyota Formation of the Masuda Group of Okuda, Masuda City, Shimane Prefecture.

***Anatolikos fujinaensis* (Sakumoto, Karasawa, and Takayasu, 1992), new combination**
(Fig. 2.4)

Cancer (Cancer) fujinaensis Sakumoto, Karasawa, and Takayasu, 1992, p. 448, pl. 61, figs. 3a–c; Karasawa, 1993, p. 40, pl. 10, fig. 2; Karasawa, 1997, p. 47, pl. 10, fig. 4.

Cancer fujinaensis Sakumoto, Karasawa, and Takayasu; Schweitzer and Feldmann, 2000, p. 227; Schweitzer et al., 2010, p. 101.

Emended diagnosis: *Anatolikos* with dorsal surface decorated with tubercles and granules and rounded anterolateral teeth (slightly modified from Sakumoto et al., 1992, p. 448).

Remarks: Sakumoto et al. (1992) described the present species as the new species of *Cancer* s.s., based upon an incompletely preserved carapace. Later, Schweitzer and Feldmann (2000) placed it in their restricted genus *Cancer*; however, granulated and tuberculated ornamentations of the dorsal carapace suggest that the species is assigned to *Anatolikos*. The present species is similar to *Anatolikos japonicus* but differs in having dorsal regions densely covered with

irregular-sized tubercles.

Anatolikos fujinaensis has not yet been known from the type locality.

Material examined: MFM83397 (plaster cast of holotype, T. 3132 = SMU-TC-F0259 deposited in the Shimane University Museum) from the Middle Miocene Fujina Formation of the Izumo Group of Ijiri, Shinji-cho, Matsue City, Shimane Prefecture.

***Anatolikos tomowoi* (Karasawa, 1990),
new combination**
(Figs. 2.5–2.7b)

Cancer (Cancer) tomowoi Karasawa, 1990, p. 11, pl. 1, figs. 2a–d, 3a–d, 8, 16a, b; Sakumoto et al., 1992, p. 448, pl. 61, figs. 2a–c; Karasawa, 1993, p. 40, pl. 10, figs. 7a, b; Karasawa, 1997, p. 47, pl. 10, figs. 7a, b.

Cancer tomowoi Karasawa; Schweitzer and Feldmann, 2000, p. 227; Schweitzer et al., 2010, p. 101.

Emended diagnosis: Dorsal margin of dactylus granulated proximally; occlusal surface with four blunt denticles. Fixed finger with five blunt denticles on occlusal surface; lateral surface possessing finely granular, longitudinal ridges medially and ventrally. Lateral and dorsal surfaces of palm rugose transversely and obliquely, granular, covered with six longitudinal ridges; rugosities well sculptured on dorso-lateral and dorsal surfaces; dorsal margin with three distally directed teeth. Carpus densely granular, deeply rugose laterally and dorsally (modified from Karasawa, 1990, p. 11).

Remarks: Karasawa (1990) noted that the species is close to *Cancer* s.s. *productus* Randall, 1840, rather than *Cancer* s.s. *japonicus*. Re-examination of the holotype shows that *C. s.s. tomowoi* is most similar to *Anatolikos japonicus* (Figs. 1.1a and 1.1c) in having the granular, rugose dorsal and lateral surfaces of the cheliped palm. Therefore, the present species is assigned to *Anatolikos*.

Anatolikos tomowoi is represented by the specimens with the chelipeds and thoracic sternum but the carapace has not yet been discovered. Therefore, it is difficult to compare *A. tomowoi* with other Miocene species of *Anatolikos*, *A. itoigawai* and *A. fujinaensis*, both of which the chelipeds have not occurred.

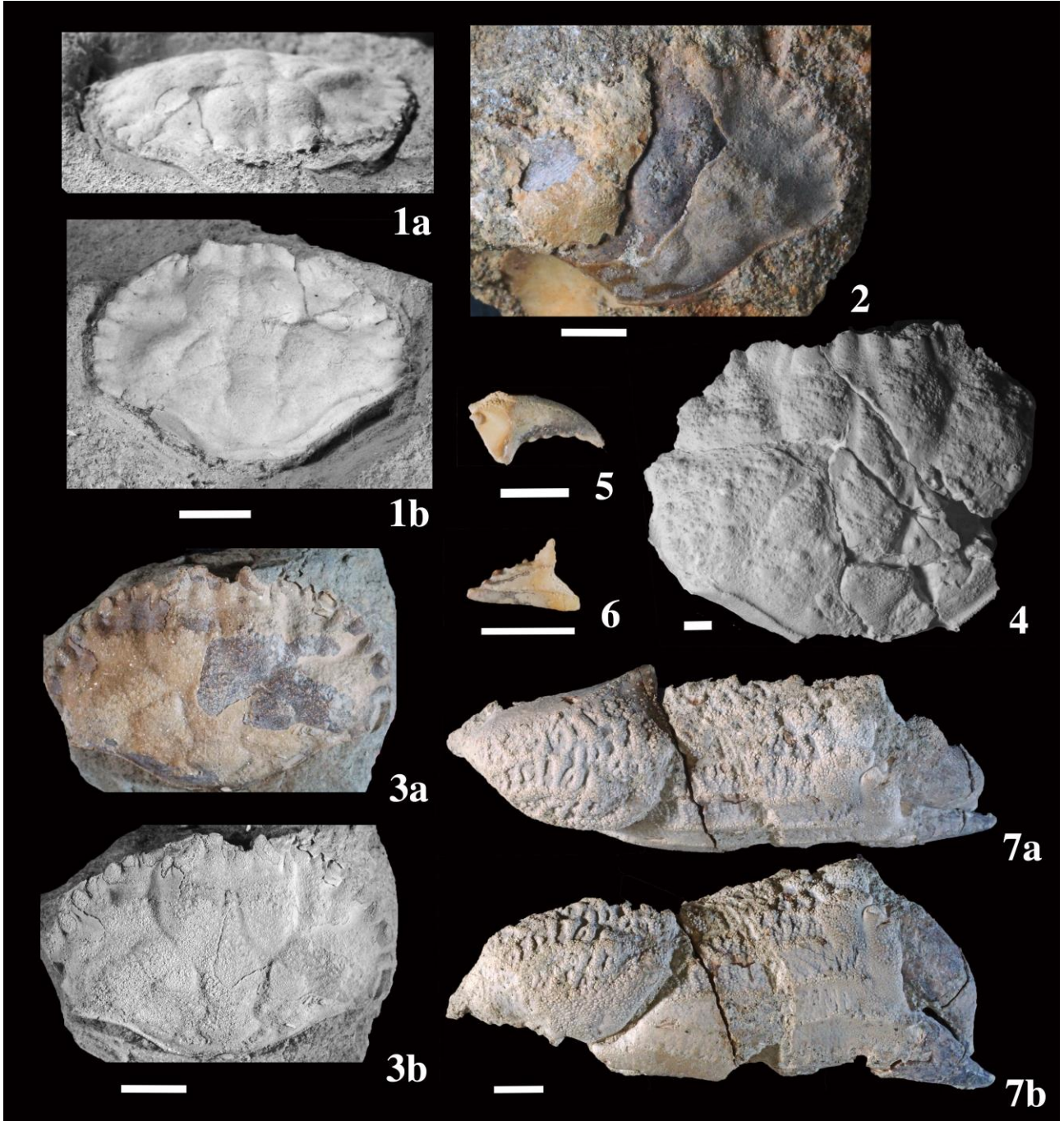


Fig. 2. *1a–3b. Anatolikos itoigawai* (Karasawa, 1990). *1a–b*, MFM9025 (holotype) from the Early–early Middle Miocene Akeyo Formation, carapace, *1a*, frontal; *1b*, dorsal view. *2*, MFM9372 from the Early–early Middle Miocene Akeyo Formation, dorsal view of carapace. *3a–b*, MFM83313 from the Early Miocene Toyota Formation, dorsal view of carapace. *4. Anatolikos fujinaensis* (Sakumoto, Karasawa, and Takayasu, 1992), new combination, MFM83397, plaster cast of holotype (T. 3132) from the Middle Miocene Fujina Formation, dorsal view of carapace. *5–7b. Anatolikos tomowoi* (Karasawa, 1990), new combination, *5*, MFM9023 (paratype) from the Early Miocene Toyama Formation, lateral view of left cheliped fixed finger. *6*, MFM9024 (paratype) from the Early Miocene Toyama Formation, lateral view of right cheliped dactylus. *7a–7b*, MFM9022 (holotype) from the Early Miocene Toyama Formation, *7a*, dorsal view; *7b*, lateral view of right cheliped. Scale bar = 5 mm. *1a*, *1b*, *3b*, and *4* are whitening images coated with ammonium chloride sublimate.

Anatolikos tomowoi has been recorded from the Toyama, Akeyo, and Oidawara Formations of the Early–early Middle Miocene Mizunami Group (Karasawa, 1990) and the Middle Miocene Izumo Group (Sakumoto et al., 1992).

Material examined: MFM9022 (holotype), MFM9023 (paratype), and MFM9024 (paratype) from the Early Miocene Toyama Formation of the Mizunami Group of Higashihora, Yamaoka-cho, Ena City, Gifu Prefecture.

Genus *Glebocarcinus* Nations, 1975

Type Species: *Trichocera oregonensis* Dana, 1852a, by original designation.

***Glebocarcinus kaedei* Karasawa, 1990**

(Figs. 3.1a–3.6b)

Cancer (Glebocarcinus) kaedei Karasawa, 1990, p. 9, pl. 1, figs. 4a–c, 7a, b, 13, 14.

Platepistoma kaedei (Karasawa); Karasawa, 1993, p. 49, pl. 9, 4, 6a, 6b (non fig. 5); Karasawa, 1997, p. 44, pl. 9, figs. 3, 4 (non figs. 2, 5); Schweitzer et al., 2010, p. 102; Karasawa et al., 2015, p. 14, pl. 1, fig. 3.

Not *Platepistoma kaedei* (Karasawa); Sakumoto et al., 1992, p. 446, pl. 60, figs. 3, 4; Karasawa et al., 1999, p. 4, figs. 2-7, 2-15 (= *Mizuhocancer imamuræ* (Imaizumi, 1962), new combination).

Not *Platepistoma kaedei* (Karasawa); Karasawa et al., 2004, p. 2, pl. 1, figs. 1, 3; pl. 2, fig. 1 (= *Glebocarcinus doii* Karasawa and Takahashi, new species).

Emended diagnosis: Carapace suboval, length about 75 percent maximum carapace width, widest at last anterolateral spine, strongly convex longitudinally and transversely. Fronto-orbital width about 55 percent maximum carapace width. Front not produced beyond orbits, with five spines; inner three spines very closely spaced; medial spine small, at lower level than other frontal spines. Anterolateral margin strongly convex, with eight, sharp, anterolaterally directed spines, separated to bases; third and fourth, fifth and sixth, and seventh and eighth spines paired. Posterolateral margin nearly straight, rimmed, with five spines; anterior spine larger than other spines, directed anterolaterally. Posterior margin nearly straight, rimmed. Dorsal regions finely granular, well-defined

by broad grooves. Proto-, meso- and metagastric, and epibranchial regions well inflated. Cardiac region with two swellings arranged transversely. Hepatic and mesobranchial regions with one swelling. Chelipeds short, massive. Both fingers short, black in color, with blunt denticles on occlusal margin; dactylus unarmed dorsally; palm bearing three weak longitudinal carinae on lateral surface and three longitudinal carinae consisting of low tubercles on dorsal surface (modified from Karasawa, 1990, p. 9).

Remarks: Karasawa (1990) originally described *Cancer (Glebocarcinus) kaedei* from the Early Miocene Mizunami Group. Since Sakumoto et al. (1992) has assigned *C. (G.) kaedei* to *Platepistoma* Rathbun, 1906, based upon examination of the specimens collected from the Middle Miocene Izumo Group, the subsequent workers (Karasawa, 1993, 1997; Karasawa et al., 1999; Karasawa et al., 2004; Schweitzer et al., 2010; Karasawa et al., 2015) followed this systematic assignment. However, the species should be re-assigned to *Glebocarcinus* because of lacking the diagnostic characters of *Platepistoma*, such as the dorsal surface of the carapace with well-defined, evenly granulated regions separated by deep prominent grooves (Davie, 1991; Schweitzer and Feldmann, 2000; Schram and Ng, 2012). Moreover, *Platepistoma* has protogastric regions divided into two regions by a longitudinal groove, which lack in *Glebocarcinus*. The identifies of *Cancer (Glebocarcinus) kaedei* have been confused. Re-examination of the specimens deposited in the Mizunami Fossil Museum and Mine City Museum of History and Folklore show that *Glebocarcinus kaedei* is not conspecific and that consists of three species of Cancridae. The type specimens of *Cancer (Glebocarcinus) kaedei* are apparently distinguished from the specimens from the Higashibessho Formation (MFM83204, 83374–83376), Asagaya Formation (MFM83294–83296, 83300), Aoki Formation (MFM83338), and Fujina Formation (MFM83395; plaster cast of T.3128) in having a smooth, well-areolated dorsal surface of the carapace without well-defined tubercles. These specimens should be assigned to *Mizuhocancer imamuræ* (Imaizumi, 1962), new combination, for the presence of tubercular ornamentations of the carapace. Karasawa et al. (2004) reported *Platepistoma kaedei*

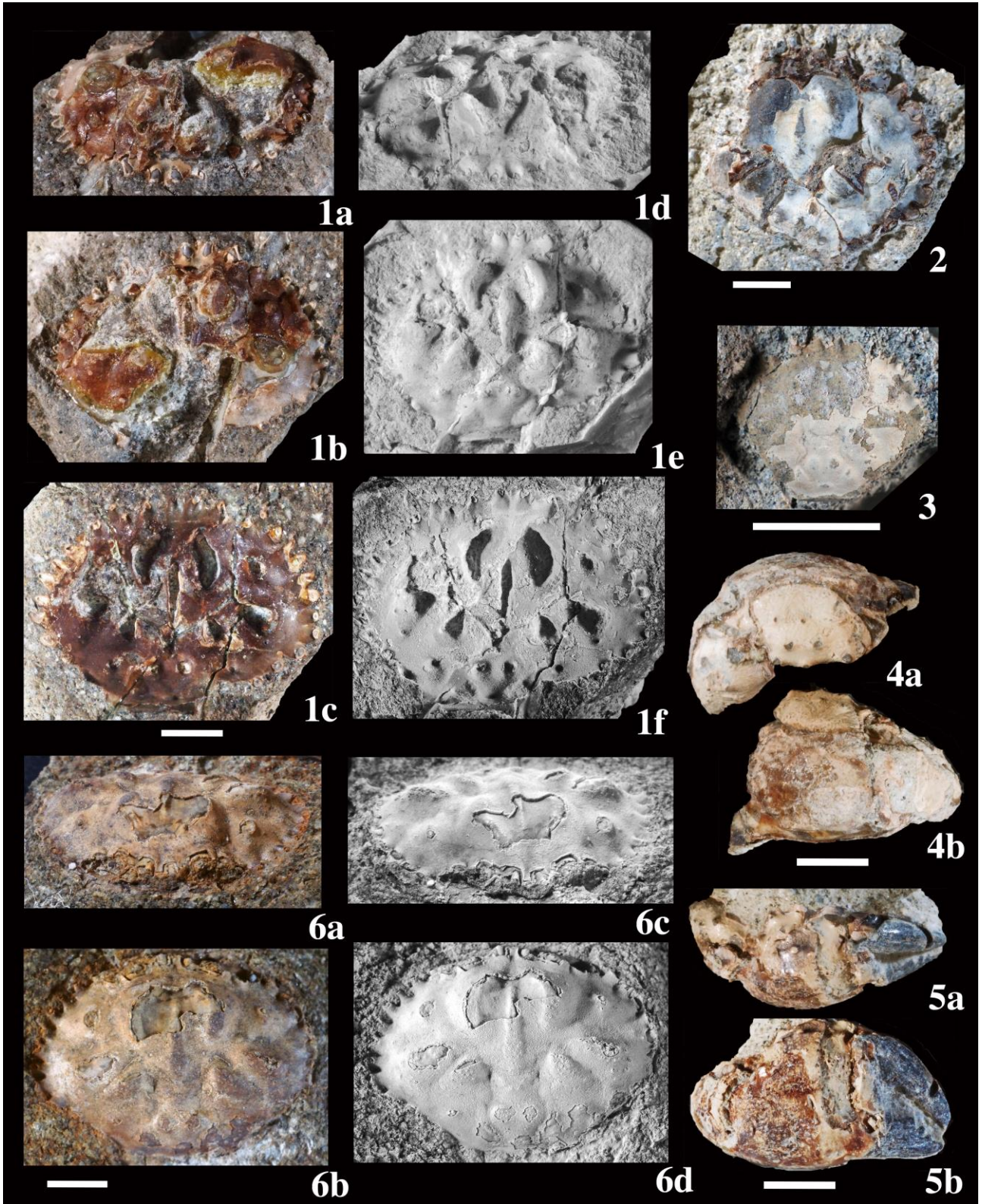


Fig. 3. *Glebocarcinus kaedei* Karasawa, 1990. **1a–b**, MFM9026 (holotype), carapace; **1c–1f**, MFM9027 (paratype), carapace; **2**, MFM9165, carapace; **3**, MFM9164, juvenile carapace; **4a–4b**, MFM9029 (paratype), left cheliped; **5a–5b**, MFM9028 (paratype), right cheliped; all from the Early Miocene Akeyo Formation. **6a–6d**, MFM39166, carapace, from the Early Miocene Oi Formation. Scale bar = 5 mm. **1a**, **4a**, **4c**, frontal view; **1b**, **2**, **3**, **6b**, **6d**, dorsal view; **1c**, **1f**, reversal image of outer mold; **1d**, frontal view of latex cast derived from MFM9027; **1e**, dorsal view of latex cast derived from MFM9027; **4a**, **5a**, dorsal view of cheliped; **4b**, **5b**, lateral view of cheliped. **1d–1f**, **6c**, and **6d** are whitening images coated with ammonium chloride sublimate.

from the Early Miocene Igani Formation of Yamaguchi Prefecture. Re-examination of these specimens represents another species in *Glebocarcinus*, in having the carapace finely tuberculated on the dorsal regions with triangular anterolateral teeth. Consequently, *G. kaedei* has only known from the Early Miocene Mizunami and Ichishi Groups of central Japan.

The remarkable change in the carapace morphology from juveniles to adults within some species of Cancridae has been recognized (Schmitt, 1921; Rathbun, 1930; Sakai, 1939, 1965; Ingle, 1981; Felder et al., 1985; Martin et al., 2018). These works showed that a juvenile form has a narrower and longer carapace than an adult one. Based upon these studies MFM9164 is identical with the juvenile carapace of *G. kaedei*.

Material examined: MFM9026 (holotype), MFM9027–9029 (paratypes), MFM9164, and MFM9165 from the Early Miocene Akeyo Formation of the Mizunami Group of Matsugase, Matsugase-cho, Mizunami City, Gifu Prefecture; MFM39166 from the Early Miocene Oi Formation of the Ichishi Group of Bungo, Misato-cho, Tsu City, Mie Prefecture.

***Glebocarcinus doii* Karasawa and Takahashi,
new species**

(Figs. 4.1–6.12)

Platepistoma kaedei (Karasawa); Karasawa et al., 2004, p. 2, pl. 1, figs. 1, 3; pl. 2, fig. 1.

Diagnosis: Carapace suboval, length about 73 percent maximum carapace width, widest at last anterolateral spine, moderately convex longitudinally and transversely. Fronto-orbital width about 45 percent maximum carapace width. Front slightly produced beyond orbits with five spines; inner three spines very closely spaced; medial spine small, slightly protruded to lobate lateral spines. Anterolateral margin strongly convex, with nine, sharp, triangular spines, separated to bases; second and third, fourth and fifth, sixth and seventh, and eighth and ninth spines paired. Posterolateral margin nearly straight, rimmed, with four short spines. Posterior margin narrow, nearly straight, rimmed. Dorsal regions, inflated, covered with irregular-sized tubercles, well-defined by broad grooves. Gastric, cardiac, and epibranchial regions densely tuberculated. Meta- and urogastric regions with two swellings arranged transversely. Cardiac region with

shallow axial depression. Hepatic regions weakly convex, sparsely tuberculated. Outer sub-region of epibranchial regions covered with short, irregular-sized tubercles and spines directed anterolaterally.

Etymology: The specific name is dedicated to E. Doi (Sanyo-Onoda, Yamaguchi) who is one of our co-researchers working on fossil crabs from Yamaguchi Prefecture, Japan.

Description: *Glebocarcinus* with moderate-sized carapace. Carapace suboval, length about 73 percent maximum carapace width, widest at last anterolateral spine, moderately convex longitudinally and transversely. Fronto-orbital width about 45 percent maximum carapace width. Front sulcate axially, slightly produced beyond orbits, with five spines including inner-orbital spines; inner three spines very closely spaced, medial spine small, slightly protruded to lobate lateral spines with nearly straight anterior margin; inner-orbital spine broadly triangular. Orbits directed forward with two upper orbital fissures. Anterolateral margin strongly convex, with nine, sharp, triangular spines, separated to bases; second and third, fourth and fifth, sixth and seventh, and eighth and ninth spines paired; first to eighth spines directed anterolaterally; last spine directed laterally. Posterolateral margin nearly straight, rimmed, with four short spines diminishing in size posteriorly. Posterior margin narrow, nearly straight, rimmed. Dorsal regions, inflated, covered with irregular-sized tubercles, well-defined by broad grooves. Protogastric and mesogastric regions densely tuberculated. Metagastric and urogastric regions with two swellings arranged transversely. Cardiac region densely tuberculated, with shallow axial depression. Hepatic regions weakly convex, sparsely tuberculated. Epibranchial regions divided into two regions by oblique groove; inner sub-region densely tuberculated; outer sub-region covered with short, irregular-sized tubercles and spines directed anterolaterally. Meso- and metabranchial regions gently convex, sparsely tuberculated. Intestinal region short, narrow, smooth, weakly convex axially.

Chelipeds poorly preserved, short; propodi, carpi, and meri with spines and tubercles dorsally and laterally; dactylus black in color without spines and tubercles dorsally. Pereiopods 2–5 not well-preserved, flattened laterally; dorsal margins of propodi and carpi

weakly dentate; dactyli medially keeled laterally, with pointed tip; propodi, carpi, and meri medially keeled laterally.

Remarks: This new species possesses the carapace characters most like those of *Glebocarcinus kaedei* but differs in having the inflated dorsal regions tuberculated densely and an outer sub-region of the epi-

branchial region ornamented with irregular-sized spines directed anterolaterally. Furthermore, the anterolateral margin of *G. doii* has nine well-developed, triangular spines, whilst that of *G. kaedei* has eight-sharp spines. *Glebocarcinus kaedei* has five well-developed posterolateral spines, which lack in *G. doii*.

Preservation of crabs with in a single rock (MMHF

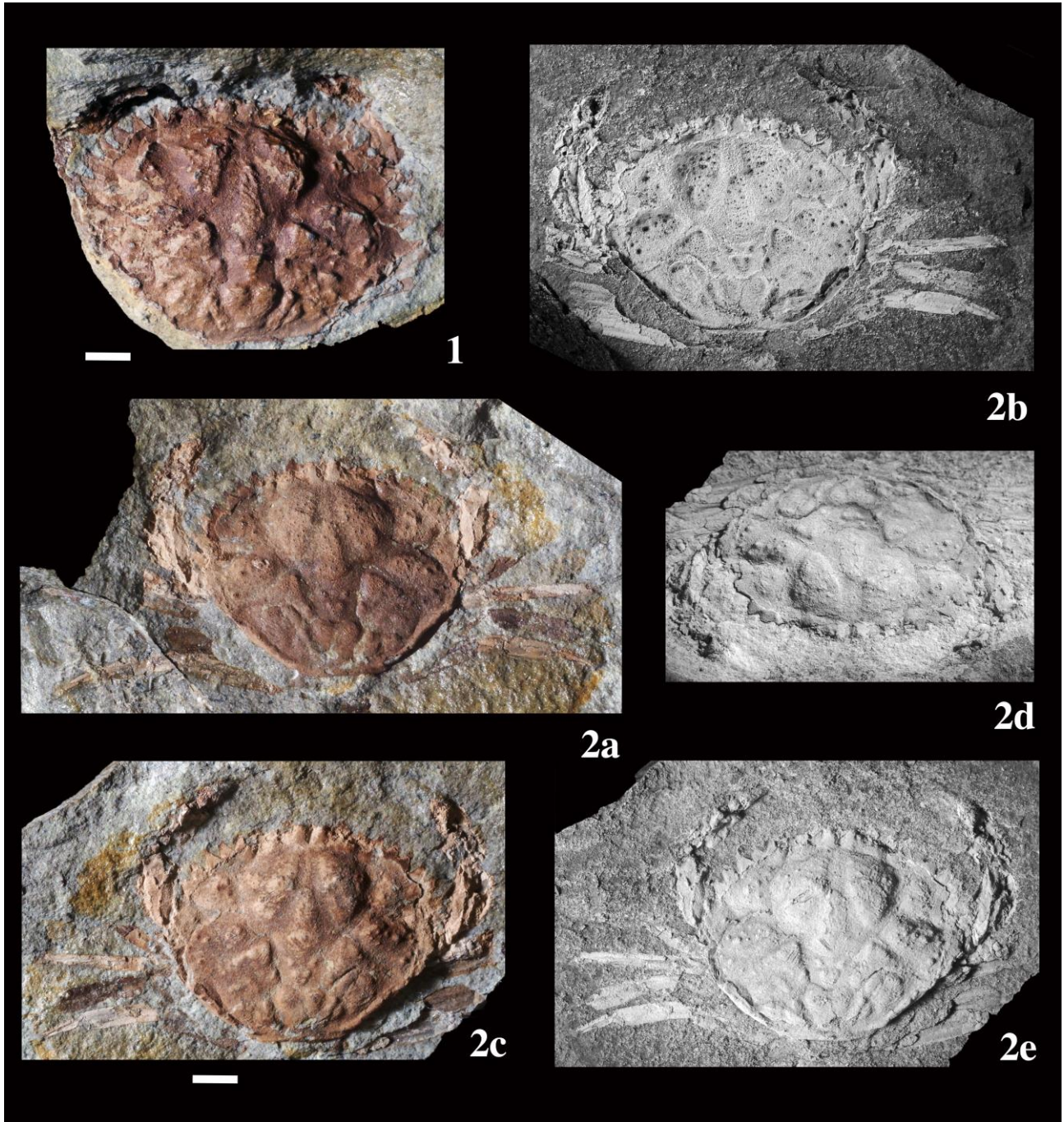


Fig. 4. *Glebocarcinus doii* Karasawa and Takahashi, new species. **1**, MMHF 8-00029 (paratype), dorsal view of carapace; **2a–2e**, MMHF 8-00028 (holotype), **2a**, **2b**, external mold of holotype, dorsal view; **2c**, **2e**, dorsal view of holotype; **2d**, frontal view of holotype; all from the Early Miocene Igani Formation. Scale bar = 5 mm. **2b**, **2d**, and **2e** are whitening images coated with ammonium chloride sublimate.



Fig. 5. *Glebocarcinus doii* Karasawa and Takahashi, new species. **1**, MMHF 8-00030 from the Early Miocene Igani Formation. Scale bar = 5 mm.

8-00030) is unusual. Over 80 individuals of the juveniles with approximately 5 mm in the width of the carapace occurred in high density within the same plane

(about 7×9.5 cm). These carapaces were randomly arranged in the same layer and were often associated with articulated and disarticulated chelipeds and other

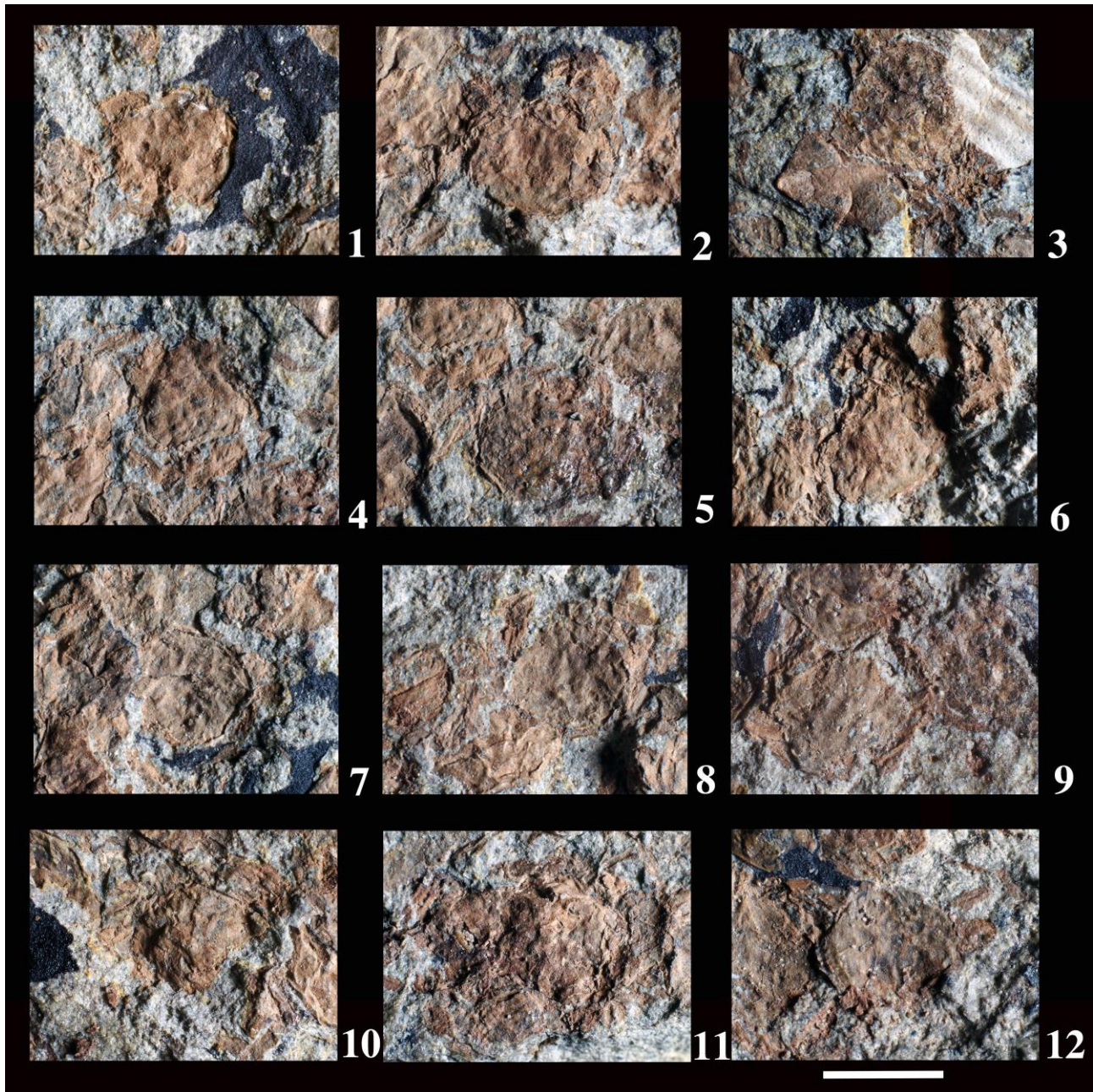


Fig. 6. *Glebocarcinus doii* Karasawa and Takahashi, new species. 1–12, close-up image of MMHF 8-00030 from the Early Miocene Igami Formation. Scale bar = 5 mm.

pereiopods. The crabs have been preserved, associated with fragments of woods and an echinoid, *Brissopsis?* sp.; therefore, Karasawa et al. (2004) thought that the crab-rich layer had been accidentally formed by turbidity currents. The preservation of *G. doii* is similar to *Mizunotengus makiguchimai* Karasawa and Ando in Karasawa et al., 2017, a mudopsid anomuran from the Early Miocene Morozaki Group, central Japan (Karasawa et al., 2017).

Material examined: MMHF 8-00028 (holotype),

MMHF 8-00029 (paratype), and MMHF 8-00030 from the Early Miocene Igami Formation of Igami, Yuya, Nagato City, Yamaguchi Prefecture.

Genus *Metacarcinus* A. Milne-Edwards, 1862

Type species: *Cancer magister* Dana, 1852b, by original designation.

Metacarcinus izumoensis

Sakumoto, Karasawa, and Takayasu, 1992

(Figs. 7.1–7.3)

Cancer (Metacarcinus) izumoensis Sakumoto, Karasawa, and Takayasu, 1992, p. 447, pl. 60, fig. 5, pl. 61, fig. 1; Karasawa, 1993, p. 51, pl. 10, fig. 4; Karasawa, 1997, p. 46, pl. 10, figs. 2, 3.

Metacarcinus izumoensis Sakumoto, Karasawa, and Takayasu; Schweizer and Feldmann, 2000, p. 236; Schweitzer et al., 2010, p. 102; Ando and Kawano, 2014, p. 96, figs. 2A–C.

Emended diagnosis: Mesogastric region bearing medial ridge with two nodes; anterolateral margin with forwardly directed, broadly triangular teeth (slightly modified from Sakumoto et al., 1992, p. 447).

Remarks: The present species has only occurred in the Middle Miocene Fujina Formation of the Izumo Group (Sakumoto et al., 1992; Ando and Kawano, 2014).

Material examined: MFM83396 (plaster cast of holotype, T. 3130 = SMU-TC-F0257 deposited in the Shimane University Museum) from the Middle Miocene Fujina Formation of the Izumo Group of Ijiri,

Shinji-cho, Matsue City, Shimane Prefecture; MFM83399 (plaster cast of paratype, T. 3131 = SMU-TC-F0258 deposited in the Shimane University Museum) from the Middle Miocene Fujina Formation of the Izumo Group of Ijiri, Shinji-cho, Matsue City, Shimane Prefecture; MFM83398 (latex cast of DGSU T.3602 deposited in the Department of Geoscience, Interdisciplinary Faculty of Science and Engineering, Shimane University) of the Middle Miocene Fujina Formation of the Izumo Group of about 350 m south-west of river mouth of Oda-gawa, Taki-cho, Izumo City, Shimane Prefecture.

Genus *Mizuhocancer* Karasawa, new genus

Type species: *Cancer? imamurae* Imaizumi, 1962, by original designation and monotypy. Masculine gender.

Etymology: The generic name is derived from “Mizuho”, an ancient name of Nippon, and *Cancer*, the type genus of Cancridae.

Diagnosis: Small to moderate-sized Cancridae. Carapace



Fig. 7. *Metacarcinus izumoensis* Sakumoto, Karasawa, and Takayasu, 1992. 1, MFM83396, plaster cast of holotype, dorsal view of carapace; 2, MFM83399, plaster cast of paratype, dorsal view of carapace; 3, MFM83398, latex cast of DGSU T.3602, dorsal view of carapace; all from the Middle Miocene Fujina Formation. Scale bar = 5 mm.

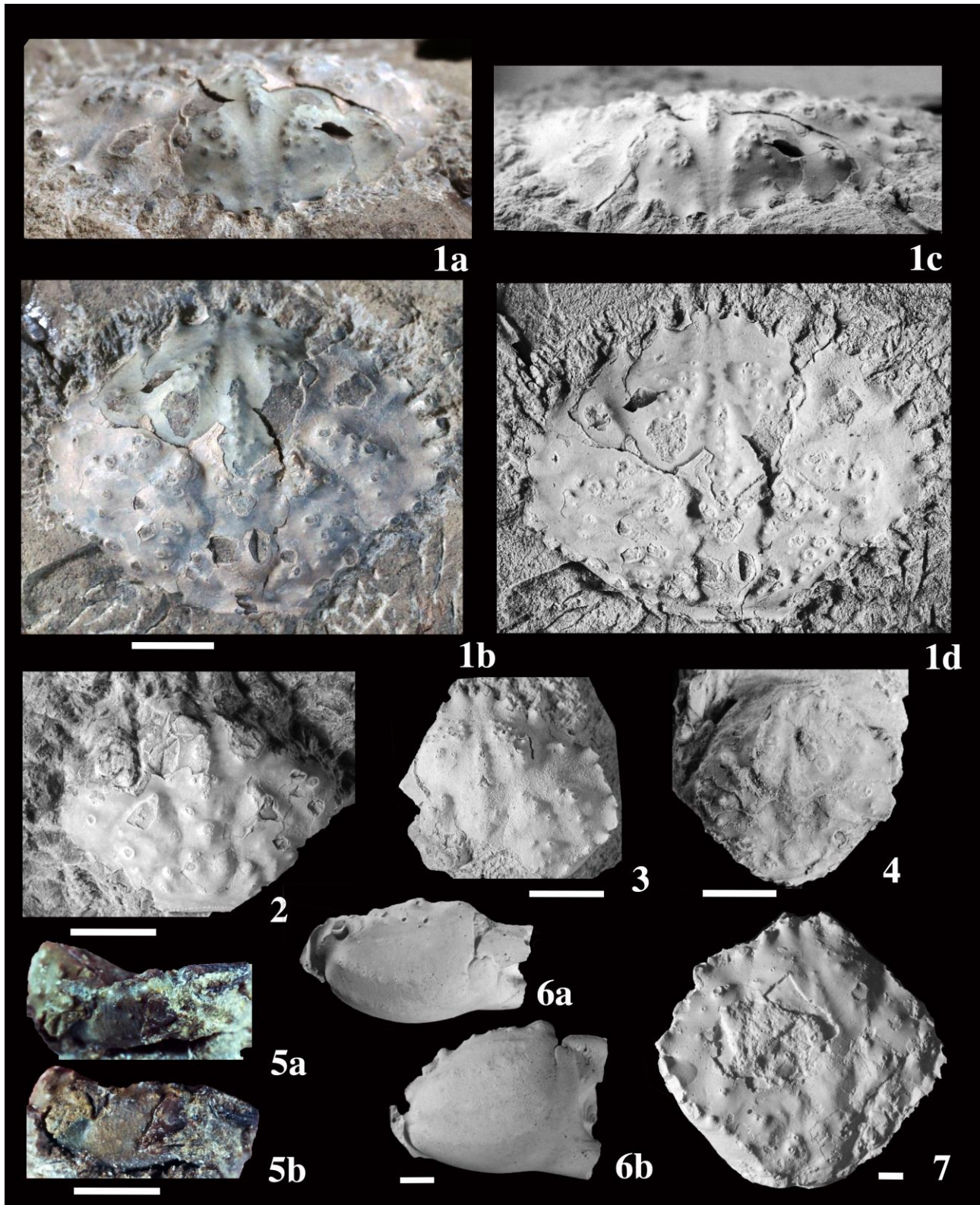


Fig. 8. *Mizuhocancer imamurae* (Imaizumi, 1962), new combination. **1a–d**, MFM83204, carapace; **2**, MFM83376, carapace; **3**, MFM83375, carapace; **4–5b**, MFM83374; **4**, juvenile carapace; **5a–5b**, right; all from the Early–earliest Middle Miocene Higashibessho Formation. **6a–6b**, **7**, MFM83395, plaster cast of T.3128 from the Middle Miocene Fujina Formation, **6a–6b**, right cheliped; **7**, carapace. Scale bar = 5 mm. **1a** and **1c**, frontal view; **1b**, **1d**, **2–5a**, **6a**, and **7**, dorsal view; **5b** and **6b**, lateral view. **1c–4**, **6a**, **6b**, and **7** are whitening images coated with ammonium chloride sublimate.

transversely ovate, much wider than long, length about 75 percent maximum carapace width, widest at last anterolateral spine, moderately convex transversely and longitudinally. Fronto-orbital width about 35 percent maximum carapace width. Front produced beyond orbits, with five frontal spines; inner three spines very closely spaced; medial spine slightly protruded to triangular lateral spines. Orbit directed forward. Anterolateral margin strongly convex with nine spines; spines sharp, well separated to bases; second and third, fourth and fifth, sixth and seventh, and eighth and ninth spines paired. Posterolateral margin nearly straight granular, rimmed, with five spines. Posterior margin nearly straight, granular, rimmed. Regions well defined, inflated, covered with irregular-sized tubercles. Anterior mesogastric region densely tuberculated; posterior mesogastric region with two large tubercles arranged transversely. Metagastric region with large tubercle centrally. Protogastric regions densely tuberculated anteriorly. Cardiac region with two swellings arranged transversely. Hepatic regions with large tubercle anteriorly. Epibranchial regions divided into two densely tuberculated regions by oblique groove. Mesogastric and metagastric regions sparsely tuberculated. Propodus of chelipeds short; lateral surface with three longitudinal rows of short spines; dorsolateral and dorsal margins tubercular ridges.

Remarks: Imaizumi (1962) questionably assigned *C.? imamurae*, the type species of the present new genus, to *Cancer*. Although Karasawa (1990) suggested that *C.? imamurae* might be ascribed to his *Cancer (Romaleon)*, Karasawa (1993) moved it to *Platepistoma*. This systematic assignment was accepted by Schweitzer and Feldmann (2000) and Schweitzer et al. (2010). Re-examination of the type and additional specimens of *C.? imamurae* suggests that the species is accommodated with its own genus. Indeed, *Platepistoma* has the carapace densely decorated with tubercles, the dorsal regions well-defined by deep grooves, the protogastric regions divided into two sub-regions by an axial groove, and the hepatic regions united with the epibranchial regions. *Mizuhocancer* lacks these characters.

Although members of the subfamily Cancrinae spines. *Mizuhocancer* is similar to *Glebocarcinus* but

differs in having the carapace ornamented with irregular-sized tubercles on the inflated regions, the anterolateral margin armed with sharp, triangular spines, and the posterolateral margin with five irregular-sized spines. *Mizuhocancer* might resemble the lobocarcininae *Tasadia* Müller in Janssen and Müller, 1984, from the Middle Miocene of Europe, but the carapace in *Tasadia* has the dorsal ornamentation of densely arranged tubercles and anterolateral spines decorated with granules and accessory spines.

***Mizuhocancer imamurae* (Imaizumi, 1962),**

new combination

(Figs. 8.1a–9.5b)

Cancer? imamurae Imaizumi, 1962, p. 239, pl. 40, figs. 18, 19; Imaizumi, 1969, p. N-7, figs. 3a–d.

Cancer cfr. *odosensis* Imaizumi; Imaizumi, 1969, p. N-7, figs. 1–2e.

Trachycarcinus huziokai Imaizumi; Imaizumi, 1969, p. N-7, figs. 4, 5.

Platepistoma imamurae (Imaizumi); Karasawa, 1993, p. 49; Karasawa, 1997, p. 45; Schweitzer et al., 2010, p. 102.

Platepistoma kaedei (Karasawa); Sakumoto et al., 1992, p. 446, pl. 60, figs. 3, 4; Karasawa, 1993, p. 49, pl. 9, fig. 5 (non figs. 4, 6a, b); Karasawa, 1997, p. 44, pl. 9, figs. 2, 5 (non figs. 3a–4); Karasawa et al., 1999, p. 4, figs. 2.7, 2.15.

Diagnosis: see the genus.

Revised description: Small to moderate-sized cancrinid. Carapace transversely ovate, much wider than long, length about 75 percent maximum carapace width, widest at last anterolateral spine, moderately convex transversely and longitudinally. Fronto-orbital width about 35 percent maximum carapace width. Front produced beyond orbits, with five frontal spines including inner-orbital spines; inner three spines very closely spaced, medial spine small, slightly protruded to triangular lateral spines; inner-orbital spine sharp, triangular. Orbit directed forward; upper orbital margin concave with two fissures laterally. Anterolateral margin strongly convex with nine spines; spines sharp, well separated to bases; second and third, fourth and fifth, sixth and seventh, and eighth and ninth spines paired; first spine directed forward second to eighth spines directed anterolaterally; last spine directed

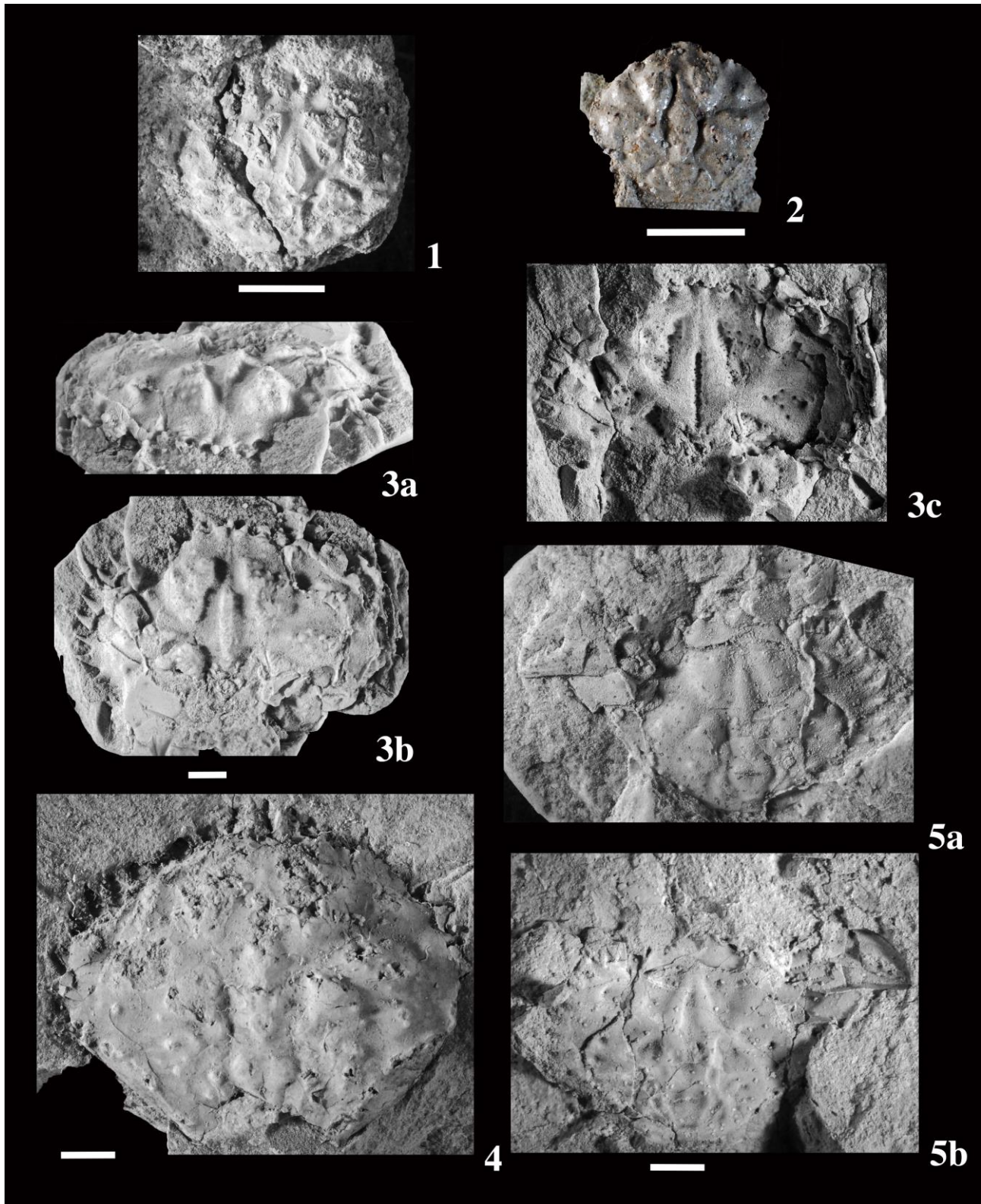


Fig. 9. *Mizuhocancer imamurae* (Imaizumi, 1962), new combination. **1**, MFM83338 from the Middle Miocene Aoki Formation, juvenile carapace?; **2**, MFM83296, juvenile carapace; **3a–3b**, latex cast derived from MFM83295; **3c**, MFM83295, external mold of carapace; **4**, MFM83300, internal mold of carapace; **5a**, latex cast derived from MFM83294; **5b**, MFM83294, carapace and cheliped; all from the early Middle Miocene Asagaya Formation. Scale bar = 5 mm. 3a, frontal view; 1, 2, 3b, 4, and 5a, dorsal view. Images excluding fig. 2 are whitening images coated with ammonium chloride sublimate.

outward. Posterolateral margin nearly straight, granular, rimmed, with five spines decreasing in size posteriorly. Posterior margin shorter than fronto-orbital margin, nearly straight, granular, rimmed. Regions well defined by broad grooves, inflated, covered with irregular-sized tubercles. Anterior mesogastric region densely tuberculated; posterior mesogastric region with two large tubercles arranged transversely. Metagastric region with large tubercle centrally. Protopagastric regions densely tuberculated anteriorly. Cardiac region with two swellings arranged transversely. Hepatic regions with large tubercle anteriorly. Epibranchial regions divided into two densely tuberculated regions by oblique groove. Mesogastric and metagastric regions sparsely tuberculated. Intestinal region short, narrow, flattened. Propodus of cheliped short; lateral surface with three longitudinal rows of short spines; dorso-lateral and dorsal margins tubercular ridges; both fingers blunt denticles on occlusal margins.

Remarks: Like as *Glebocarcinus* spp., *Mizuhocancer imamuræ* has the notice change in the carapace morphology from juveniles to adults. The juveniles have a narrow, hexagonal carapace with the dorsal regions defined by deep grooves. Imaizumi (1969, p. N-7, figs. 4, 5) reported *Trachycarcinus huziokai* Imaizumi, 1951 (now, *Tricopeltarion huziokai*) from the early Middle Miocene Asagaya Formation of Ishikawa Prefecture. Based upon examination of his illustrations the specimens are identified with the juveniles of the present species because the characters of the carapace fit those of the juvenile type of *M. imamuræ*.

Mizuhocancer imamuræ has been known from the Early–earliest Middle Miocene Higashibessho Formation of the Yatsuo Group (Imaizumi, 1962; Karasawa, 1993), the early Middle Miocene Asagaya Formation (Imaizumi, 1969; Karasawa, 1993), the Middle Miocene Aoki Formation (Karasawa et al., 1999), and the Middle Miocene Fujina Formation of the Izumo Group (Sakumoto et al., 1992).

Material examined: MFM83204, 83374, 83375, and 83376 from the Early–earliest Middle Miocene Higashibessho Formation of the Yatsuo Group of Murasugi, Yatsuo-cho, Toyama Prefecture; MFM 83294, 83295, 83296, and 83300 from the early Middle Miocene Asagaya Formation of Bessho-cho,

Kanazawa City, Ishikawa Prefecture; MFM83338 from the Middle Miocene Aoki Formation of Oguchizawa, Toyoshina-cho, Azumino City, Nagano Prefecture; MFM83395 (plaster cast of T.3128 = SMU-TC-F0263 deposited in the Shimane University Museum) from the Middle Miocene Fujina Formation of the Izumo Group of Tawa, Matsue City, Shimane Prefecture.

Genus *Romaleon* Gistel, 1848

Type species: *Corystes (Trichocera) gibbosula* De Haan, 1833, by monotypy. Replacement name for *Corystes (Trichocera)* De Haan, 1833, non *Trichocera* Meigen, 1803 [Diptera] (= *Trichocarcinus* Miers, 1879, a replacement name for *Trichocera* De Haan, 1833).

***Romaleon gibbosulum* (De Haan, 1833)**

(Figs. 10.1a–10.8b)

Corystes (Trichocera) gibbosula De Haan, 1833, p. 16, pl. 2, fig. 4, pl. 13, fig. 3.

Trichocera gibbosula (De Haan); Stimpson, 1907, p. 87.

Trichocarcinus gibbosulus (De Haan); Miers, 1879, p. 34.

Trichocarcinus affinis Miers, 1879, p. 35.

Cancer gibbosulus (De Haan); Balss, 1922, p. 94.

Romaleon gibbosulus (De Haan); Schweitzer and Feldmann, 2000, p. 249.

Romaleon gibbosulum (De Haan); Ng et al., 2008, p. 53.

Cancer (Glebocarcinus) amphioetus Rathbun; Karasawa, 1993, p. 50, pl. 9, figs. 2, 3; Karasawa, 1997, p. 45, pl. 11, fig. 2.

Emended diagnosis: Carapace transversely ovate, much wider than long, length 70–75 percent maximum carapace width, widest at last anterolateral spine, moderately convex transversely and longitudinally. Fronto-orbital width 30–35 percent maximum carapace width. Front produced beyond orbits with five frontal spines; inner three spines very closely spaced; medial spine beyond lateral ones. Orbit directed forward. Anterolateral margin strongly convex with nine spines; spines sharp, well separated to bases. Posterolateral margin weakly concave, rimmed, with one anterior spine. Posterior margin slightly convex, rimmed. Regions weakly defined, covered with minute granules. Propodus of chelipeds elongate; lateral and dorsal surfaces with seven granular keels; dorsal keel with

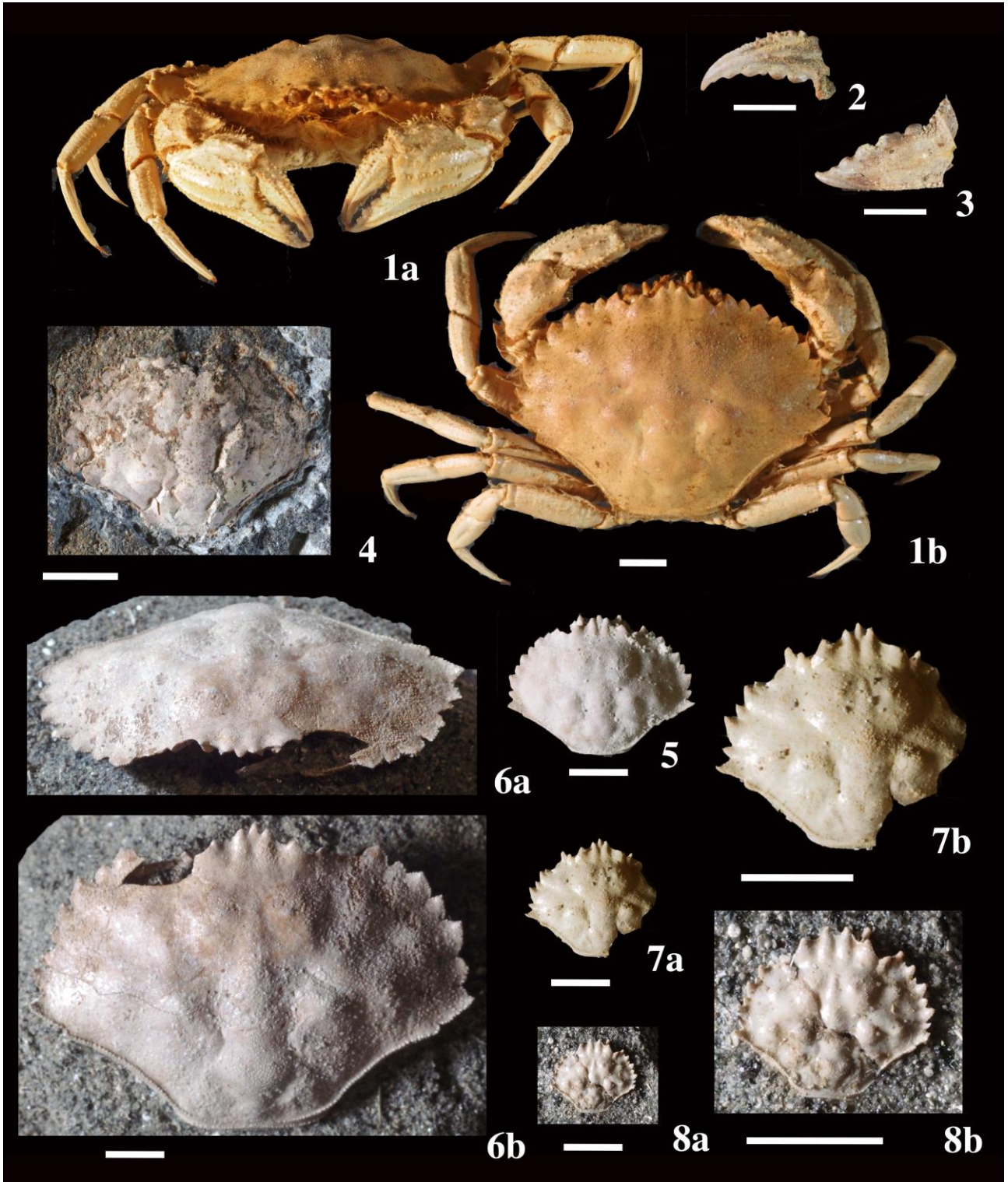


Fig. 10. *Romaleon gibbosulum* (De Haan, 1833). **1a–1b**, MFM192151, a Recent specimen from Mikawa Bay, 1a, frontal; 1b, dorsal view. **2**, MFM142154 from the Early Pleistocene Dainichi Formation, lateral view of left cheliped dactylus. **3**, MFM142153 from the Early Pleistocene Dainichi Formation, lateral view of left cheliped fixed finger. **4**, MFM142652 from the Early Pliocene Okubo Formation, dorsal view of carapace. **5**, MFM152591 from the Middle Pleistocene Atsumi Group, dorsal view of carapace. **6a–6b**, MFM142592-1 from the Middle Pleistocene Atsumi Group, 6a, frontal; 6b, dorsal view of carapace. **7a–7b**, MFM142592-2 from the Middle Pleistocene Atsumi Group, 7a, dorsal view of juvenile carapace; 7b, close-up image. **8a–8b**, MFM142592-3 from the Middle Pleistocene Atsumi Group, 8a, dorsal view of juvenile carapace; 8b, close-up image. Scale bar = 5 mm.

numerous sharp, distally directed spines. Fixed finger with two granular keels, occlusal surface with large, blunt denticles. Dorsal surface of dactylus with three keels consisting of distally directed spines or granules; occlusal surface with large, blunt denticles (modified from Schweitzer and Feldmann, 2000, p. 249, and Ko and Lee, 2013, p. 14).

Remarks: The extant *Romaleon gibbosulum* is known from China, Japan, and Korea (Ko and Lee, 2013). The fossil records of the species are reported from the Early Pliocene Okubo Formation (herein), the Middle Pleistocene Atsumi Group (Karasawa et al., 2014), and Shimosa Group (Kato and Karasawa, 1998).

Sakai (1939, p. 437, text-fig. 22a) figured the outline of the juvenile carapace. Sakai (1965, p. 105) noted within remarks of *Cancer gibbosulus* that “In the younger specimen (PL. 48, fig. 2), the antero-lateral teeth are sharp and alternatively different in size; in the fullgrown, however, they are in size, having a tendency to be confluent with each other”. The specimens from the Middle Pleistocene Atsumi Group show the ontogenetical change of the carapace.

Within the juveniles (MFM142592-2 and 142592-3) the carapace is slightly wider than long with well-defined dorsal regions and the anterolateral margin has nine irregular-sized teeth arranged with four small teeth alternately five large ones. Within the adults or large-sized specimens (MFM142590 and 142592-1) the carapace is much wider than long, the dorsal regions are moderately defined, and the anterolateral margin bears nine triangular teeth which are almost equal in size.

Karasawa (1993) reported fingers of chelipeds of *Cancer (Glebocarcinus) amphioetus* Rathbun, 1898, from the Early Pleistocene Dainichi Formation of the Kakegawa Group. These specimens are identical with those of *R. gibbosulum* in having granular well-defined keels on the dorsal surface of the dactylus and the lateral surface of the fixed finger.

Material examined: MFM192151, a Recent specimen from Isshiki, Mikawa Bay, Aichi Prefecture; MFM142153 and 142154 MFM142122 from the Early Pleistocene Dainichi Formation of the Kakegawa Group of Hongohigashi, Kakegawa City, Shizuoka Prefecture; MFM142652 from the Okubo Formation of Miasa, Omachi City, Nagao Prefecture (herein); MFM152591, 142592-1–142592-3 from the

Middle Pleistocene Atsumi Group of Takamatsu, Tahara City, Aichi Prefecture.

***Romaleon odosense* (Imaizumi, 1962)**

(Figs. 11.1a–11.2b)

Cancer odosensis Imaizumi, 1962, p. 239, pl. 40, figs. 18, 19.

Anisospinos odosensis (Imaizumi); Schweitzer and Feldmann, 2000, p. 230; Schweitzer et al., 2010, p. 101; Karasawa et al., 2011, p. 34, fig. 2.13.

Cancer (Romaleon) odosensis Imaizumi; Karasawa, 1990, p. 6; Kato and Hikida, 2002, p. 48.

Cancer (Romaleon) sanbonsugii Imaizumi; Karasawa, 1993, p. 50, pl. 10, fig. 6; Karasawa, 1997, p. 46, pl. 10, fig. 8.

Emended diagnosis: Carapace transversely ovate, much wider than long, length 72–78 percent maximum carapace width, widest at last anterolateral spine, moderately convex transversely and longitudinally. Fronto-orbital width 40–42 percent maximum carapace width. Front slightly produced beyond orbits with five frontal spines; inner three spines very closely spaced; medial spine slightly protruded to lateral ones. Anterolateral margin strongly convex with nine spines; spines sharp, triangular, well separated to bases. Posterolateral margin weakly concave, granular, rimmed, without spine. Posterior margin nearly straight, granular, rimmed. Regions moderately defined, covered with minute granules; protogastric, mesogastric, epi-branchial, and mesobranchial regions with one low swelling; cardiac regions with two low swellings arranged transversely (modified from Imaizumi, 1962, p. 239).

Remarks: *Cancer odosensis* was originally described from the Early Miocene Odo Formation of Aomori Prefecture, Northeast Honshu (Imaizumi, 1962). Schweitzer and Feldmann (2000) assigned it to *Anisospinos* Schweitzer and Feldmann, 2000. Furthermore, Schweitzer and Feldmann (2000) suggested that *Cancer (Romaleon) sanbonsugii* Imaizumi, 1962, illustrated by Karasawa (1993), was re-identified with *Anisospinos odosensis*. Kato and Hikida (2002) retained the taxonomic status of *Cancer (Romaleon) odosensis* by lacking the anterolateral teeth distinctly *Anisospinos odosensis*. Kato and Hikida (2002)

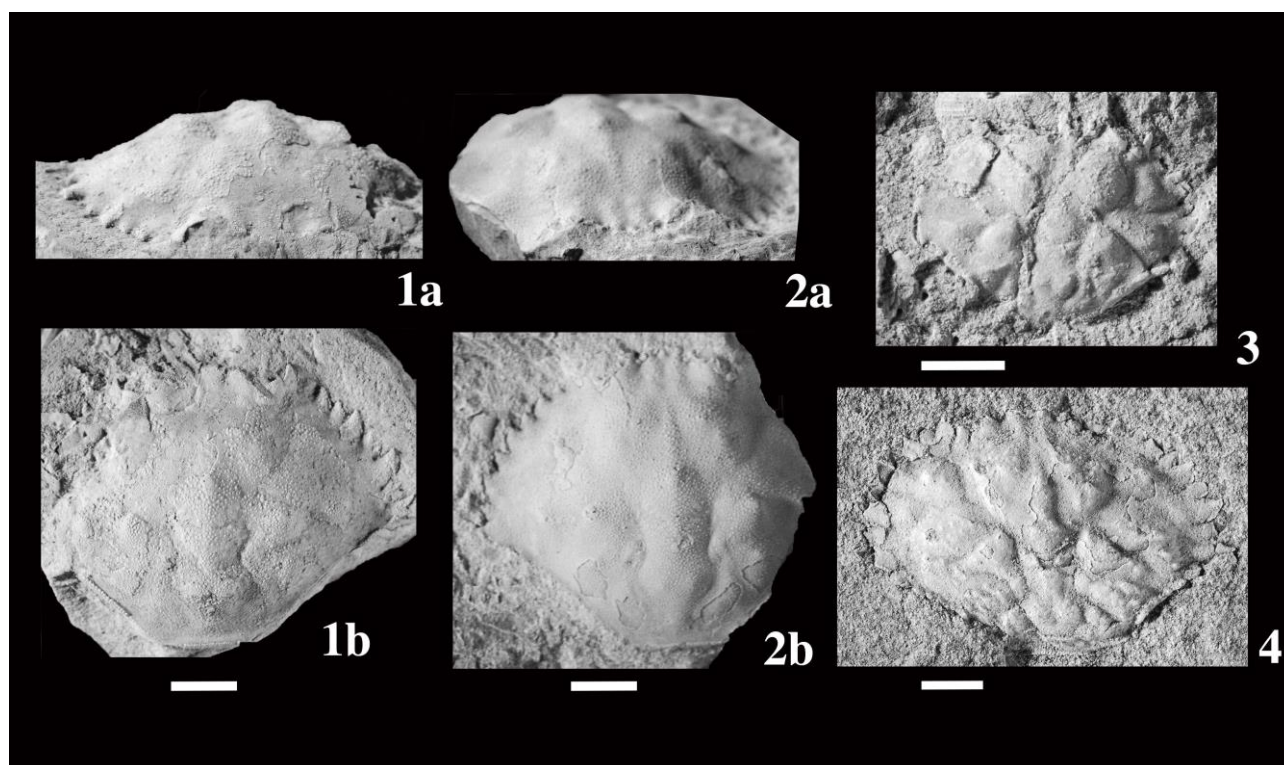


Fig. 11. 1a–2b. *Romaleon odosense* (Imaizumi, 1962). 1a–1b, MFM83202 from the Early–earliest Middle Miocene Higashibessho Formation, 1a, frontal view; 1b, dorsal view of carapace. 2a–2b, MFM83393 from the Early–earliest Middle Miocene Higashibessho Formation, 2a, frontal view; 2b, dorsal view of carapace. 3–4. *Romaleon sakamotoi* (Kato, 1996). 3, MFM83191 from the Middle Miocene Osaki Formation, dorsal view of carapace. 4, MFM83356 from the Middle Miocene Nagura Formation, dorsal view of carapace. Scale bar = 5 mm. All images are whitening images coated with ammonium chloride sublimate.

retained the taxonomic status of *Cancer* (*Romaleon*) *odosensis* by lacking the anterolateral teeth distinctly arranged in pairs, separated by deep clefts, diagnostic characters of *Anisospinos*. We concur with this taxonomic status.

Romaleon odosense has been known from the Early Miocene Odo Formation (Imaizumi, 1962), and the Early–early Middle Miocene Shimo and Higashibessho Formations (Karasawa, 1993, 1997; Karasawa et al., 2011).

Material examined: MFM83202 and 83393 from the Early–earliest Middle Miocene Higashibessho Formation of the Yatsuo Group of Murasugi, Yatsuocho, Toyama Prefecture.

***Romaleon sakamotoi* (Kato, 1996)**

(Figs. 11.3, 11.4)

Cancer sakumotoi Kato, 1996, p. 510, figs. 5–5–9b.

Cancer (*Romaleon*) *sanbonsugii* Imaizumi; Karasawa,

1993, p. 50, pl. 10, fig. 6; Karasawa and Kishimoto, 1996, p. 42, fig. 6; Karasawa, 1997, p. 46, pl. 10, fig. 8.

Cancer sp. cfr. *C. sanbonsugii* Imaizumi; Karasawa and Inoue, 1992, p. 82, pl. 2, fig. 3.

Cancer (*Glebocarcinus*) *itoigawai* Karasawa; Sakumoto, 1997, pl. 1, figs. 3 (non fig. 4).

Romaleon sakamotoi (Kato); Schweitzer and Feldmann, 2000, p. 243; Schweitzer et al., 2010, p. 103.

Emended diagnosis: Carapace with variable sized granules on restricted dorsal regions. Anterolateral teeth with pointed tips, separated from each other by closed fissures. Posterolateral margin with three or four blunt spines. Propodus with a ridge armed with three subconical teeth on dorsal margin and four longitudinal granulated ridges on lateral surface (modified from Kato, 1996, p. 510).

Remarks: Kato (1996) described *Cancer sakumotoi*

Kato, 1996, from the Middle Miocene Nagura Formation in the Chichibu basin. Later, Schweitzer and Feldmann (2000) assigned *C. sakamotoi* to *Romaleon*. The species is most similar to *Romaleon sanbonsugii* (Imaizumi, 1962) from the Middle Miocene Matsukawa Formation of Fukushima Prefecture, but differs in having the dorsal carapace granulated densely and the cheliped more granulated and carinated than that of *R. sanbonsugii* (Kato, 1996). Moreover, *R. sakamotoi* is characterized in having the posterolateral margin with three or four blunt spines (Kato, 1996), which lack in *R. sanbonsugii*.

The identifies of *R. sakamotoi* and *R. sanbonsugii* have been confused. Karasawa and Inoue (1992) described *Cancer* sp. cfr. *C. sanbonsugii* from the Middle Miocene Osaki Formation of the Kakinada Group. Karasawa and Kishimoto (1996) reported *C. (R.) sanbonsugii* from the Early–early Middle Miocene Yoshino Formation of the Katsuta Group. Both are assigned to *R. sakamotoi* for the presence of short posterolateral spines.

Although Ng et al. (2008) and Ng and Schram (2012) questionably synonymised *Romaleon sanbonsugii* with *Anatolikos japonicus*, *R. sanbonsugii* is readily distinguished from *A. japonicus* in the presence of nine anterolateral spines and the absence of any posterolateral spine.

The present species has been recorded from the Early–early Middle Miocene (Katsuta Group, Karasawa and Kishimoto, 1996; Bihoku Group, Sakamoto, 1997) to the Middle Miocene (Kakinada Group, Karasawa and Inoue, 1992; Chichibumachi Group, Kato, 1996).

Material examined: MFM83191 from the Middle Miocene Osaki Formation of the Kakinada Group of Kakinada, Minamitanabe-cho, Kagoshima Prefecture. MFM83356 from the Middle Miocene Nagura Formation of the Chichibumachi Group of Yobake, Ogano-cho, Saitama Prefecture.

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