Online ISSN 2435-0931 Print ISSN 0385-0900
DOI: 10.50897/bmfm.50.1_21

Bulletin of the Mizunami Fossil Museum, vol. 50, no. 1, 21–35, 6 figs., 1 table.

Manuscript accepted on February 11, 2023; online published on March 17, 2023
https://zoobank.org/urn:lsid:zoobank.org:pub:CB4DB95D-7DBE-41B5-B678-BE0BA13847A1

Decapod crustaceans from the Miocene Itsukaichi Basin, western Tokyo, Japan, including a new species of *Trichopeltarion* (Brachyura: Trichopeltariidae)

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Abstract

Seven species of decapod crustaceans were described from the Miocene Itsukaichimachi Group based mainly upon examinations of the museum collection. Decapod fossils are stratigraphically limited to the Kosho and Tateya formations and characterized by the predominance of *Callianopsis titaensis* (Nagao, 1941). Five and two additional species were obtained from these formations, respectively. *Trichopeltarion ryouheii*, Kato n. sp. and *Carcinoplax antiqua* (Ristori, 1889) are the first recognized decapod species common to the adjacent Miocene Chichibu Basin in Saitama Prefecture.

Key words: Decapoda, Itsukaichi, Miocene, new species, *Trichopeltarion*

1. Introduction

The Miocene strata in the Itsukaichi Basin have long been known for the rich occurrences of marine invertebrate fossils (Fujimoto, 1926; Kanno and Arai, 1964; Kanno, 1967; Itsukaichi Basin Research Group, 1981, 1983; Paleontological subgroup of Itsukaichi Basin Research Group, 1985; Kurihara, 1980; Matsukawa et al., 1997). In his comprehensive paleontological study of the Miocene Itsukaichi Basin, Kanno (1967) remarked on abundant occurrence of the chelipeds of *Callianopsis titaensis* (Nagao, 1941) as “*Callianassa* sp.”, and figured a large chela of *Macrocheira* sp.

Details of the decapod fauna of the Itsukaichi Basin, however, had not been revealed up to present. Recently, a decapod fossil collection made by the late Ryouhei Taru was donated to the Natural History Museum and Institute, Chiba. This collection comprises about 110 specimens representing 7 species of decapods including the first records from the basin (CBM-PI 3506–3613). In addition, several well-preserved *C. titaensis* from the Itsukaichi Basin are included in the fossil collection donated to the National Museum of Nature and Science, Tokyo by the late Iwao Hamano, Tokyo (NMNS PA 18641–18648). Most recently, Toru Nagaoka and Masao Ichiki provided a chela identified as *Macrocheira* sp. (CBM-PI 3651) and *C. titaensis* (CBM-PI 3734–3754).

Based upon examinations of these collections as well as the other specimens collected by the authors, we present an overview of the Miocene decapod fauna in the Itsukaichi Basin. All specimens in this study are housed in the Natural History Museum and Institute, Chiba (CBM-PI) and the National Museum of Nature and Science, Tsukuba (NMNS PA).

2. Geological setting

The Miocene Itsukaichi Basin, located approximately 50 km west of central Tokyo, occupies about 5 km north-south and 4 km east-west (Fig. 1). Miocene deposits called the Itsukaichimachi Group (Kanno and Arai, 1964) show an overall transgression-regression cycle (Kanno, 1967; Ito, 1989). Although stratigraphic divisions of the Miocene deposits and correlations of each units, including intercalated thick pyroclastics, vary among authors, there are no significant differences in definitions of the Kosho and Tateya formations from which all the known decapod specimens have been obtained (Fig. 2). The Kosho Formation consists of bedded sandstone in the lower part and alternating beds of sandstone and mudstone in the upper part. The Tateya Formation is predominated by black or dark gray-colored massive mudstone with a locally intercalated thick tuff layer. The uppermost part is dominated by sandstone (Irizuki et al., 1990).

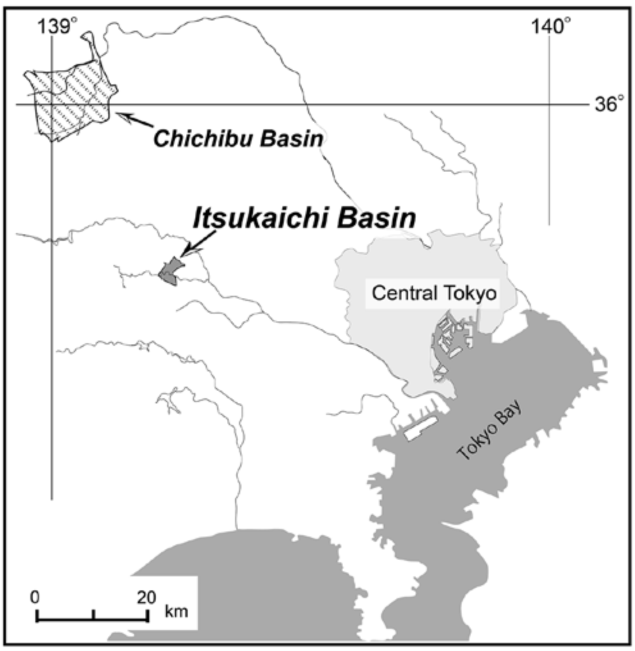

Fig. 1. Index map showing Miocene Itsukaichi and Chichibu basins.

According to Irizuki et al. (1990), geologic age of the Yokozawa Formation is correlated to Zone N8 of planktonic foraminifera of Blow (1969) and Zones CN3–4 of calcareous nannofossils of Okada and Bukry (1980). Uemura et al. (2001) studied the plant fossils obtained from the Sajikami, Kosho and Tateya formations, and concluded the flora to late Early Miocene in age. Therefore, the geologic age of the decapod fossils is assignable to Burdigalian to Langhian.

During the present study, *Trichopeltarion ryouheii* n. sp. was obtained also from the Miocene Chichibu Basin, Saitama Prefecture, located about 30 to 40 km NNW from the Itsukaichi Basin (Fig. 1). Eighteen species of decapod crustaceans have been reported from this basin (Kato, 1996). In the Chichibu Basin, the new species occurs in sandy siltstone of the upper part of the Chichibumachi Formation (Yokoze Formation in Kato, 1996). Geologic age of the Chichibumachi Formation is also correlated to Blow (1969)'s Zone N8 of planktonic foraminifera and Okada and Bukry (1980)'s Zones CN3–4 of calcareous nannofossils (Takahashi et al., 1989; Takahashi, 1992; Yagi and Ishigaki, 1993).

3. Decapod fossil localities

Whereas many outcrops are no longer accessible due to revetment of rivers or development construction, decapod fossils were identified from 12 of the 26 fossil localities listed in Kanno and Arai (1964) and Kanno (1967) (Table 1). In addition, examination of donated collections and present field surveys revealed that the decapod fossils had occurred in the following localities in the Itsukaichi Basin, Tokyo Metropolis (Fig. 3, Table 1).

Loc. D1 : Outcrop along the Akigawa River, upstream of the athletic field "Kowada ground", Kowada, Akiruno City.

Loc. D2 : Left bank of the Akigawa River, Kosho, Akiruno City. Very close to the "Kosho East" of Uemura et al. (2001), but slightly upstream.

Loc. D3 : "The cliff of Dairoku-ten" in Totohara, Itsukaichimachi, Akiruno City.

Loc. D4 : Left bank of the Akigawa River, upstream of the Akigawabashi-Bridge, Totohara, Akiruno City.

Loc. D5 : River bed of the Akigawa River, downstream of the Akigawabashi-Bridge, Akiruno City.

Loc. D6 : Right bank of the Akigawa River, Totohara, Akiruno City (opposite bank of D7).

Loc. D7 : Left bank of the Akigawa River near the Kinkoukaku Inn, Tateya, Akiruno City.

Loc. D8 : Rivermouth of the Sannaigawa River near the Itsukaichibashi-Bridge, Sannai, Akiruno City.

	Formation max. thickness (Irizuki et al., 1990)	Environment (Ito, 1989)
Quater-nary	Hanno Formation	
Miocene	Yokozawa Formation 1200 m+	submarine talus slope apron submarine fan
	Tateya Formation 200 m-	basin plane
	Kosho Formatin 700 m-	slope
	Sajikami Formation 400 m-	fan delta allivial fan talus
Basement rocks (Pre-Neogene)		

Fig. 2. Stratigraphy of the Neogene in the Itsukaichi Basin. Compiled after Irizuki et al. (1990) and Ito (1989).

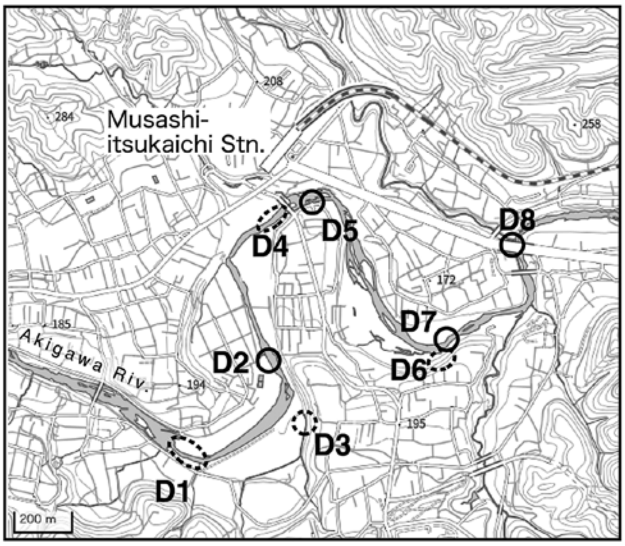

Fig. 3. Newly recognized decapod fossil localities in the Itsukaichi Basin (D1–D8). Dashed circles indicate that the fossil localities disappeared and could not be defined precisely. The topographic base map is modified after GSI maps vector version.

Among them, Locs. D1, D2, D3, D4, D5 and D6 belong to the Kosho Formation. D8 are definitely in the Tateya Formation. However, Loc. D7 is located near the boundary between the two formations, and the donated collection may contain specimens from both formations.

4. Paleoenvironments

Kanno (1967) indicated that the molluscan assemblages in the upper part of the Kosho Formation and the lower part of the Tateya Formation are dominated by the muddy bottom inhabitants of deeper water, and deduced that the basin reached a maximum water depth during the deposition of the Tateya Formation. He also estimated the paleodepth of *Macrocheira* sp. in the Kosho Formation to deeper than 300 m based upon co-occurring molluscan assemblages, habitat of the extant giant spider crab *Macrocheira kaempferi* (Temminck, 1836), and other fossil records of *Macrocheira* in Japan.

In addition, he remarked on the associated occurrence of glendonite (gennoishi), a calcite pseudomorph after ikaite which is usually formed under cold-water environments from the Kosho Formation (e.g. Suess, et al., 1982; Ito, 1998; Selleck et al., 2007). Kanno (1967) pointed out that the Eocene Poronai Formation in Hokkaido, north Japan yields glendonite in association with a similar type of molluscan assemblage inhabiting in the muddy bottoms of the deep sea. Interestingly, the decapod assemblage of the Poronai Formation is dominated by Callianopsidae [*Callianopsis muratai* (Nagao, 1932)] with *Macrocheira* sp. also known (Kato, 2000).

Based upon sedimentary facies analysis, Ito (1989) considered the depositional environment of the Kosho and Tateya formations as submarine slope and basin plain respectively (Fig. 2), and estimated the deepest and calmest depositional environments in the Tateya Formation with a water depth attaining a maximum of 600 m. These conclusions are consistent with the paleoenvironments inferred by paleontological data.

5. Systematic paleontology

(H. Kato)

Order Decapoda Latreille, 1802

Infraorder Axiidea de Saint Laurent, 1979

Family Callianopsidae Manning and Felder, 1991

Genus *Callianopsis* de Saint Laurent, 1973

Type species: Callianassa goniophthalma Rathbun, 1902, by original designation and monotypy.

Remarks: Hyžný and Schlögl (2011) listed 9 fossil species of the genus *Callianopsis* de Saint Laurent, 1973 including uncertain ones. Among them, Japanese Eocene to Oligocene *C. elongatodigitata* (Nagao, 1941) is considered to be a female cheliped of co-occurring *C. muratai* (Nagao, 1932) and a junior subjective synonym (Schweitzer-Hopkins and Feldmann, 1997; Kato, 2000). Furthermore, *C. kusiroensis* (Nagao, 1941) is known only by one specimen obtained from the same locality with these two forms. *Callianopsis kusiroensis* is considered to be conspecific with *C. muratai* because it shows no clear difference between "*C. elongatodigitata*" except for its slightly short-looking medial surface of the manus.

Existence of a proximal meral spine of the major cheliped as one of the diagnostic characters for the genus *Callianopsis* has been highlighted both in extant (Manning and Felder, 1991; Poore et al., 2019) and fossil species (Pasini et al., 2020). This spine is present in *C. titaensis* (Fig. 4.7). On the other hand, a postrostral dorsal carina of the carapace, which Poore et al. (2019) considered another diagnostic character of this genus, could not be recognized in the present material. However, detailed morphological features of the major cheliped of *C. muratai* and *C. titaensis* are more closely similar to the type species *C. goniophthalma* (Rathbun, 1902) than other living and fossil congeners. Therefore, these two species can be included in the genus *Callianopsis*. Other diagnostic characters, a pair of lateral projections of the pleomere 6, and dorsal plate of uropodal exopod are not preserved in the present material.

***Callianopsis titaensis* (Nagao, 1941)**

(Figs. 4.1–10)

Callianassa titaensis, Nagao, 1941, p. 93–97, pl. 26, figs. 3–7; Karasawa, 1989, p. 8, pl. 1 fig. 10; Mizuno and Takeda, 1993, p. 82, pl. 2, figs. 5, 6.

Callianassa shikamai, Imaizumi, 1957b, p. 81– 83, pl. 14. figs. 1–5.

Callianopsis titaensis, Karasawa and Nakagawa, 1992, p. 10, pl. 2, fig. 5; Karasawa, 1993, p. 36–37, pl. 5, figs. 1, 3, 4; Karasawa, 1997, p. 31–32, pl. 3, figs. 3, 9, 11, pl. 4, fig. 10; Kato, Karasawa and Koizumi, 2016, p. 67–68, Fig. 6.

Material: CBM-PI 450–481, 1813, 1891, 1892, 3250–3299, 3506–3522, 3524–3529, 3531, 3533–3549, 3551–3552, 3554–3560, 3565, 3569, 3571–3590, 3592, 3594, 3599, 3603, 3608, 3610, 3734–3754; NMNS PA 18641–18648.

Description: Carapace with a triangular rostrum; anterolateral angle slightly projected forward; dorsal oval inflated; postrostral carina absent; cardiac prominence present; linea thalassinica well defined.

Pleonal somites partially missing. Somite 1 broadened posteriorly; somite 2 longest with anteriorly narrowing broad pleomere; somite 3 short, somites 4 and 5 shortest. Pleomeres 4 and 5 with median sulcus. Lateral projection of somite 6 missing. Telson and uropods poorly preserved.

Table 1. List of decapod crustaceans in the Miocene Itsukaichi Basin. Locality number 1–26 are based upon Kanno and Arai (1964) and Kanno (1967). Due to insufficient label information, some specimens could not be accurately assigned to fossil localities in Kanno (1967) (i.e. 7–8, 12–13, 16–17, 19–20).

Formation	Kosho Formation												Tateya Formation																					
Locality	1	2	3	4	5	6	D1	D2	D3	D4	D5	D6	D7	D8	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
This study																																		
Callianopsis titaensis (Nagao)			●	●		●			●	●	●		●	●	●		●	●		●			●	●		●	●						●	
Axiidea fam., gen. et sp. indet.							●					●																						
Axiidea? indet.													●																					
Trichopeltarion ryouheii n. sp.										●																								
Macrocheira sp.				●							●		●	●																				
Cheiragonidae? gen. et sp. indet.								●																										
Carcinoplax antiqua (Ristori)									●																									
Kanno (1967)																																		
Callianassa sp. [= *Callianopsis titaensis* (Nagao)]						●									●					●				●	●						●		●	
Macrocheira sp.				●																														

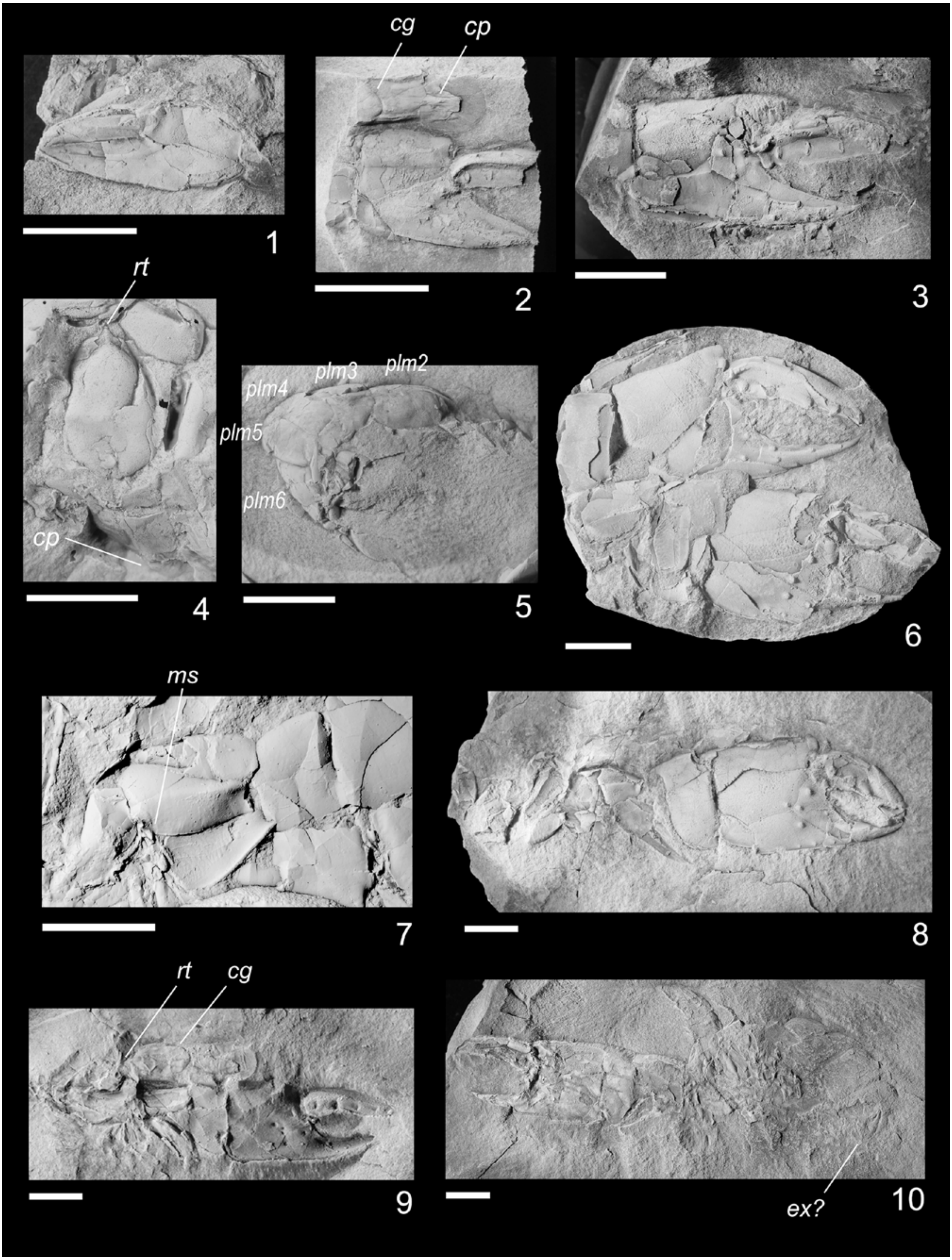

Fig. 4. ***Callianopsis titaensis*** **(Nagao, 1941). 1,** medial view of female right major chela. CBM-PI 3259. **2,** lateral and dorsal views of female right major chela and posterior part of the carapace. CBM-PI 459. **3,** lateral view of female right major chela. CBM-PI 3253. **4,** dorsal view of carapace. Silicone cast. CBM-PI 3603. **5,** Second–6th pleonal somites. Silicone cast. CBM-PI 3588. **6,** lateral view of male right major chelae. CBM-PI 1813. **7,** lateral view of male right major cheliped (silicone cast). CBM-PI 468. **8,** male first chelipeds. CBM-PI 3611. **9,** outer mold of male first chelipeds and carapace. CBM-PI 3510. **10,** male left major cheliped and pleonal somites. NMNS PA 18645. cg: cervical groove, cp: cardiac prominence, ex: uropodal exopod, ms: meral spine, plm: pleomere, rt: rostrum. Scale bars equal 1 cm.

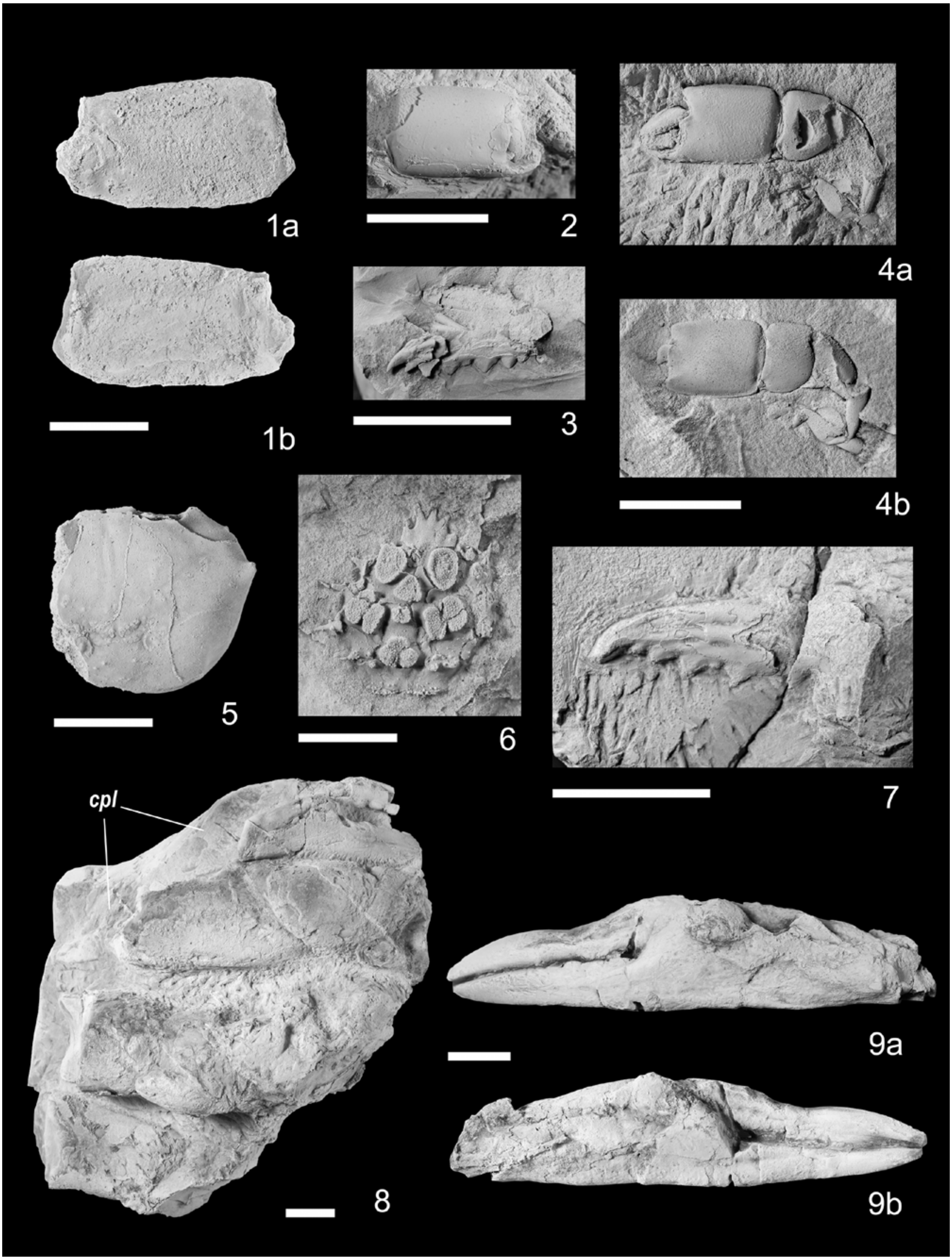

Fig. 5. 1. Axiidea? fam., gen. et sp. indet., *1a*, lateral; *1b*, medial views of left palm. CBM-PI 3613. **2, 4. Axiidea fam., gen. et sp. indet.** 2, lateral view of right chela. CBM-PI 3597. 4, lateral view of left cheliped. *4a*, part; *4b*, silicone cast of the counterpart. CBM-PI 3598. **3, 7. Cheiragonidae? gen. et sp. indet.** 3, lateral view of dactylus of left cheliped. CBM-PI 2943. 7, medial view of dactylus of right cheliped. CBM-PI 3612. **5. *Carcinoplax antiqua* (Ristori, 1889).** carapace. CBM-PI 3601. **6. *Trichopeltarion ryouheii* n. sp.** silicone cast of carapace produced from holotype. CBM-PI 3602. **8, 9. *Macrocheira* sp.** 8, ventral views of right cheliped, P2 and P3. CBM-PI 3600. *9a*, lateral; *9b*, medial views of left cheliped. CBM-PI 3651. cpl: cheliped. Scale bars equal 1 cm.

First pereiopod chelate, strongly heterochelous; distinct sexual dimorphisms in manus and dactylus of larger cheliped. Ischium of major cheliped subcylindrical, distally broadened. Merus quadrilateral, longer than wide, strongly inflated lateral surface with a longitudinal keel around median midline; a minute conical spine existing in ventroproximal corner; few minute spines bearing on ventral margin. Carpus quadrilateral, much wider than long, dorsoproximal corner projecting toward articulation with merus; proximal margin slightly convex; small indentation existing at distoventral corner. Manus with transversely convex lateral surface; six tubercles clustered just behind base of fixed finger; ventroproximal corner slightly convex. Medial surface gently convex in upper two thirds; depression along ventral margin extending to fixed finger; ventral margin rimmed, distal margin sinuous. Lateral and medial surfaces of manus and fixed finger with evenly spaced setal pits on lower margin. Minor chela of first pereiopod slender, dactylus and fixed finger elongated about twice as long as manus; distinct gape between dactylus and fixed finger, occlusal margins of fingers forming sharp rims.

Male major chela: manus proportionally longer than females. Fixed finger slender, thick, rounded triangular in cross section; tip gently curved upward; a small conical spine distally projected near dactylus articulation; a strong longitudinal keel extending on lateral surface and three tubercles with setal pits on it. Occlusal margin with a blunt tooth slightly posterior to longitudinal midpoint, which varying from an indistinct conical swelling to a trapezoidal prominent tooth. Medial surface of fixed finger longitudinally depressed between upper and lower margins. Dactylus stout with a strong longitudinal ridge on upper part of lateral surface which proximally composed of closely spaced tubercles; usually two and four large socket-shaped tubercles aligned above and below ridge; occlusal margin sinuous; upper surface of dactylus with two longitudinal ridges; medial surface depressed except for a medial longitudinal ridge and slightly swelling upper margin.

Female major chela: fixed finger broad, triangular in lateral view, flattened rhomboidal in cross section; tip very slightly curved upward; a sharp longitudinal ridge in lateral surface; occlusal margin with a triangular tooth on basal part near dactylus articulation followed by minute serrated margin at base. Medial surface of fixed finger with a longitudinal ridge on slightly above midline. Dactylus being relatively shorter and straighter; occlusal margin with minute serration proximally.

Remarks: Conspicuous dimorphism in the major cheliped of the first pereiopods are recognized both in extant and fossil species of the genus (Schweitzer-Hopkins and Feldmann, 1997; Kato, 2000; East, 2006; Hyžný and Schlögl, 2011; Kato et al., 2016). In the present specimens, dimorphism in the dactylus and fixed fingers of the major cheliped are quite consistent with the type species *C. goniophthalma* and most useful in distinguishing them.

Measurements (mm): CBM-PI 468, major palm length 32.2, height 18.6; CBM-PI 3259, major palm length 18.7, height 7.8; CBM-PI 3510, major palm length 28.5, height 15.3; CBM-PI 3611, major palm length 34.3, height 20.8, carpus length 9.8, height 18.6; NMNS PA 18645, major palm length 30.4, height 17.0.

Occurrence: Kosho Formation (3, 4, 6, D3, D4, D5); Tateya Formation (7–8, 9, 10, 12–13, 15, 16–17, 18, 19–20, 23, 25, D7, D8).

Axiidea fam., gen. et sp. indet.

(Figs. 5.2; 5.4a, b)

Material: CBM-PI 3597 (right chela), 3598 (left cheliped).

Description: Ischium of first cheliped cylindrical, elongate, broadened distally; ventral margin with three or more minute spines. Merus as long as ischium; lateral surface strongly inflated with a longitudinal carina slightly above median midline; ventral margin poorly preserved. Carpus quadrilateral; 1.4 times wider than long; ventroproximal corner rounded; distal margin concave, sinuous in ventrodistal corner. Palm quadrilateral, 1.25 times longer than wide, approximately twice length of carpus; lateral surface transversely convex strongly with few numbers of minute setal pits scattered; ventral margin fringed; distal margin with v-shaped shallow furrow beyond base of fixed finger, and a small notch on dactylus articulation. Fixed finger about 25 percent of total palm length, strongly curved medially, apically directed upward; no remarkable teeth on occlusal margin except for an anteriorly directed triangular tooth at basal part. Dactylus about 40 percent of palm length; occlusal margin sinuous with a proximal three quarters being broadly flattened and remaining distal quarter being conical with a tip strongly curved downward.

Remarks: A left cheliped and a right chela are in the donated collection. Both chelae are strongly thickened and seem to be of the major cheliped. The ventral margin of merus is not well preserved to reveal the ornamentation, but there is no evidence of meral spines on either the inner cast and outer mold. Although the general morphology of cheliped resembles several genera of Eucalliacidae Manning and Felder, 1991, the possibilities of other families cannot be ruled out. Therefore, further identification requires additional specimens retaining well preserved chelipeds and other diagnostically important portions.

Measurements (mm): CBM-PI 3597, pam length 11.7, height 7.2; CBM-PI 3598, palm height 6.5, carpus length 4.3, carpus height 5.8.

Occurrence: Kosho Formation (D1, D6).

Axiidea? fam., gen. et sp. indet.

(Figs. 5.1a, b)

Material: CBM-PI 3613 (manus of cheliped without finger).

Description: Manus about 1.7 times longer than wide; narrowing distally. Dorsal and ventral margins forming sharp rims. Lateral surface gently swollen except for slightly depressed basal part of fixed finger where few granules scattered. Although the upper part of the medial surface is convex dorsoventrally, the lower half is remarkably concave in distal two thirds. Therefore, medial surface showing sinuous in ventral view.

Remarks: The single specimen of the left manus resembles that of Axiidea in having an elongate quadrilateral, distally narrowing outline with dorsal and ventral margins rimmed, and the sparse granules on the lateral surface near the basal part of the fixed finger. These features clearly distinguish this specimen from *Callianopsis titaensis* and the above described Axiidea gen. et ep. indet. The slender, distally narrowing manus with few granules on the lateral surface resembles that of the Ctenochelidae Manning and Felder, 1991. However, precise identification is difficult due to the poor state of preservation.

Measurement (mm): CBM-PI 3613, palm height 13.6+.

Occurrence: Tateya Formation (D7).

Infraorder Brachyura Latreille, 1802

Section Eubrachyura de Saint Laurent, 1980

Superfamily Majoidea Samouelle, 1819

Family Macrocheiridae Dana, 1851

Genus *Macrocheira* De Haan, 1839

***Macrocheira* sp.**

(Figs. 5.8; 5.9a, b).

Material: CBM-PI 3600 (right cheliped and meri to coxae of P2 and P3), CBM-PI 3651 (left chela).

Description: Right cheliped merus smaller than that of P2 and P3; distal part of merus, carpus, and most of palm missing. Dactylus and fixed finger with longitudinal groove on lateral surface. Occlusal margins bearing blunt molar-shaped teeth. Meri of P2 and P3 densely covered with conical, centrally pored tubercles.

Left chela slender, lateral and medial surface covered with pored minute tubercles. Dactylus nearly half length of palm, very weakly curved downward. Fixed finger almost straight. Dactylus and fixed finger gently curved medially; tip spatulated; longitudinal grooves on lateral and medial surfaces; relatively larger pits within longitudinal grooves of fixed finger.

Remarks: Kanno (1967) firstly figured a large right chela of *Macrocheira* sp. from the Kosho Formation. Material in the present study includes additional specimens of pereiopods and chela. Although extant monotypic species *Macrocheira kaempferi* (Temminck, 1836) is endemic to Japan and Taiwan, the fossil records of the genus are better known from the northeast Pacific coast than the northwest Pacific. Five species are known from the Eocene to Miocene of the Pacific North America (Rathbun, 1926; Schweitzer and Feldmann, 1999; Nyborg et al., 2016). All these species were described based on the carapace. On the other hand, two fossil species have been described from the Miocene of Japan: *Macrocheira yabei* (Imaizumi, 1957a) from the Yonekawa Formation, Nagano Prefecture and *M.*

ginzanensis Imaizumi, 1965 from the Ginzan and Itahana fromations, Yamagata and Gunma prefectures (Kato, 2001). These Japanese species are known only from juvenile specimens and limb fragments. Subsequently, Karasawa and Ohara (2012) described large chelae of *Macrocheira* from the Miocene Kumano Group as *Macrocheira* sp. aff. *M. kaempferi*. They noted that fingers of *M. ginzanensis* are indistinguishable from those of *M. kaempferi*, and that *M. yabei* is described based on a juvenile specimen only and therefore cannot be compared to their specimen. Nyborg et al. (2016) and Guinot et al. (2022) concurred them and assigned these Japanese Miocene representatives to *M*. sp. aff. *kaempferi*. Indeed, there are no dorsal carapaces in the fossil material from Japan that allow the species identification. The densely tuberculate surface of the palm and molariform teeth on the occlusal margin of the Itsukaichi specimen resemble the living *M. kaempferi* and is in accordance with the redescription by Guinot et al. (2022). However, the chelae of the Itsukaichi specimens exhibit a proportionally shorter manus compared to the fingers in both smaller specimens (present study) and larger chela (Kanno, 1967).

Measurements (mm): CBM PI-3651, pam length 77.9, height 19.7.

Occurrence: Kosho Formation (4, D5); Tateya Formation (D7, D8).

Superfamily Trichopeltarioidea Tavares and Cleva, 2010
Family Trichopeltariidae Tavares and Cleva, 2010

Genus *Trichopeltarion* A. Milne-Edwards, 1880

Type species: *Trichopeltarion nobile* A. Milne-Edwards, 1880, by monotypy.

***Trichopeltarion ryouheii*, n. sp.**

(Figs. 5.6; 6.1, 2)

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[New Japanese name: Ryouhei-tunokurigani]

Etymology: The species name is dedicated to the late Ryouhei Taru. He not only collected the decapod specimens used in this study including the holotype, but he also made many contributions to the geology and paleontology of the Itsukaichi and Tama areas through his many outreach activities.

Material: Holotype: CBM-PI 3602 (outer mold of carapace), from the Kosho Formation. Paratypes: CBM-PI 3674 (outer mold of carapace), CBM-PI 3675 (elevated dorsal regions remaining in counterpart). Paratypes were from the Chichibumachi Formation, Saitama Prefecture.

Diagnosis: Carapace subpentagonal. Medial rostral spine projecting further forward than slightly diverging lateral ones. Elevated dorsal regions basally constricted, being a platy surface covered with coalescent fine tubercles.

Description: Carapace rounded pentagonal. Dorsal surface slightly convex, deeply sculptured. Regions demarcated by deep and broad grooves; forming an elevated platy surface covered with coalescent fine tubercles. Each region constricted at base, forming stump-like appearance. Grooves between regions showing smooth surface except for sparsely scattered granules in posterior part of carapace.

Rostrum consisting of three triangular spines of which medial one being slightly projected more forward than laterals; lateral spines diverging anteriorly. Inner supraorbital and exorbital spines broad triangular; medial supraorbital spine poorly preserved. Hepatic spine with broad base. First and second epibranchial spines acute, barbed on basal part, projecting laterally. First metabranchial spine on posterolateral margin acute, laterally projected with basal barbs. Second metabranchial spine on dorsal surface being blunt triangular protuberance.

Protogastric regions broadly oval, distinctly elevated. Mesogastric region rounded triangular in outline. Metagastric region narrow but distinct. Meso- and metagastric regions fused in larger specimens. Hepatic region narrow but distinct. Cardiac region sub-trapezoidal, consisting of a pair of swellings. Intestinal region indistinct, not elevated. Epibranchial region broadest, divided into two parts by anterior and posterior notches.

Remarks: The genus *Trichopeltarion* includes 9 extinct and 24 extant species (Schweitzer et al., 2010; Tavares and Cleva, 2010; Naruse and Hashimoto, 2014). The cauliflower-like characteristic morphology of dorsal regions easily distinguishes *T.*

ryouheii n. sp. from most fossil and living congeners. Of the 9 fossil species, *T. ryouheii* n. sp. is slightly similar to *T. inflatus* (Kato, 1996) from the Chichibumachi Formation in having the flattened, densely tuberculate dorsal regions. However, those of *T. ryouheii* n. sp. exhibit characteristic platy surfaces covered with finer and denser tubercles. Furthermore, the anterior diverging lateral rostral spines of *T. ryouheii* n. sp. make it easy to distinguish from *T. inflatus*, and another Japanese Miocene congener *T. huziokai* (Imaizumi, 1951).

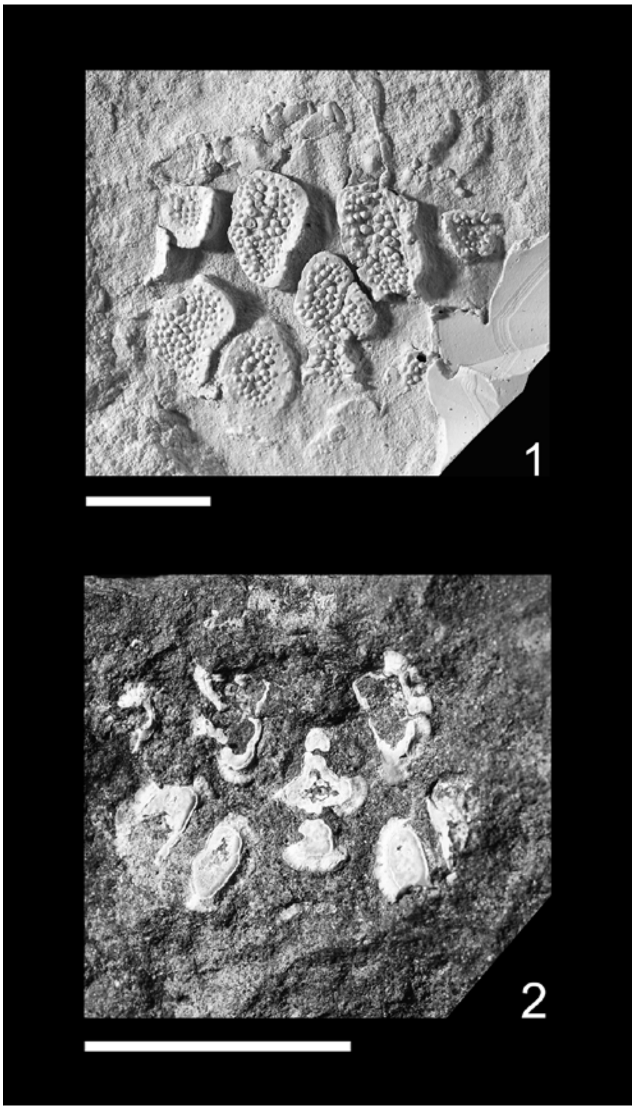

Fig. 6. ***Trichopeltarion ryouheii*, n. sp.** from the Miocene Chichibumachi Formation, Saitama Prefecture. **1,** paratype. dorsal surface of the carapace (silicone cast). CBM-PI 3674. **2,** elevated dorsal regions remaining in the counterpart. CBM-PI 3675. Scale bars equal 1 cm.

Among the extant species, *T. ryouheii* n. sp. resembles *T. corallinum* (Faxon, 1893) in that each elevated region is separated by deep broad grooves, covered with flattened, similar-sized tubercles. In addition to the broad triangular rostral and supraorbital spines, however, *T. ryouheii* n. sp. is easily distinguished from *T. corallinum* by the characteristic dorsal regions that are basally constricted, covered with finer and denser tubercles.

The holotype specimen of *T. ryouheii* n. sp. is preserved within a muddy fine sandstone containing sparse granule- to very coarse-sized sand grain different from other decapod specimens.

Measurements (mm): CBM-PI 3602, carapace length excluding rostrum 19.1, carapace width excluding epibranchial spines 16.6+.

Type locality: Left side bank of Akigawa River, upstream of Akigawabashi-Bridge, Itsukaichimachi, Akiruno City, Tokyo Metropolis.

Occurrence: Holotype: Kosho Formation (D4: type locality). Paratypes: Chichibumachi Formation (River bank of the Arakawa River at Kuna, about 900 m upstream from the Tomoegawabashi-Bridge, Chichibu City, Saitama Prefecture, Yz-4 in Kato, 1996).

Superfamily Cheiragonoidea Ortmann, 1893

Family Cheiragonidae Ortmann, 1893

Cheiragonidae? gen. et sp. indet.

(Figs. 5.3, 7)

Material: CBM-PI 2943, 3612 (left and right dactylus).

Description: Dactylus of left cheliped with broad longitudinal grooves on lateral surface and clusters of setal pits within; acute conical spines aligned on upper surface of proximal part; inclined, slightly curved distally. Occlusal margin bears distally inclined conical distal tooth, following triangular blade-shaped larger teeth, and molar-shaped smaller proximal tooth.

Dactylus of right cheliped gently curved downward and slightly curved inward except for strongly arcuate proximal articulation. Medial surface with two longitudinal grooves. Occlusal margin bearing distally inclined distalmost and neighboring teeth with gently downturned conical tip, followed by two triangular blade-shaped teeth, a small molar-shaped tooth, and three triangular teeth of which distal one is largest of all teeth. Most proximal tooth small, close to propodal articulation.

Remarks: The present dactylus resembles those of the cheiragonid species in the morphologies of lateral and medial surfaces, occlusal margin as well as the acute spines in the dorsoproximal part. Especially, distally inclined occlusal teeth followed by triangular blade-shaped teeth, broad longitudinal groove of the lateral surface with clusters of setal pits, and rows of distally curved acute spines on upper proximal surface are resembles those of the extant *Erimacrus isenbeckii* (Brandt, 1848). However, the largest molar-shaped tooth usually in the proximal part of dactylus are not observed.

Measurements (mm): CBM-PI 2943, dactylus length 10.3+; CBM-PI 3612, dactylus length 14.5+.

Occurrence: Kosho Formation (D2).

Superfamily Goneplacoidea MacLeay, 1838
Family Goneplacidae MacLeay, 1838
Subfamily Goneplacinae MacLeay, 1838
Genus *Carcinoplax* H. Milne Edwards, 1852

***Carcinoplax antiqua* (Ristori, 1889)**
(Fig. 5.5)

Curtonotus antiqus Ristori, 1889, p. 4.

Carcinoplox antiqua (Ristori) Glaessner, 1933, p.17, pl. 4, fig. 3; Imaizumi, 1961, p.164, text-fig. 4, pls. 12–17; Karasawa, 1990, p. 23–24, pl. 7, figs. 1–8 (including synonyms therein); Karasawa, 1993, p. 70, pl. 18, figs. 1, 7, 8; Sakumoto et al., 1992, p. 451, pl. 62, figs. 3a, b, pl. 63, figs. la, b; Kato, 1996, p. 516, Figs. 7-4–8.

Carcinoplax senecta Imaizumi, 1961, p. 172, pl. 18, figs. 1–3.

Material: CBM-PI 3601 (Carapace),

Remarks: The donated collection includes a carapace of *Carcinoplax antiqua*. This carapace is filled with fine sandstone which is apparently coarser than the matrix of other decapod fossils in the Itsukaichi Basin. This is the first record of the species from the Itsukaichi Basin.

Measurement (mm): CBM-PI 3601, carapace length 18.5+.

Occurrence: Kosho Formation (D3).

6. Acknowledgements

We would like to express our deepest gratitude to the late Ryouhei Taru, who collected the majority of the decapod specimens examined in this study. We are also grateful to Toru Nagaoka, Masayuki Ichiki, and the late Iwao Hamano for providing important specimens. We wish to express our thanks to Toshiaki Osada, Yoshiaki Ishida, Hisao Adachi, Tomoki Aotani, and members of the Itsukaichi Geo Society for giving valuable information, and Hideo Nagato and Wataru Mukaimine for their efforts in organizing and preparing the donated collections. We are grateful to C. E. Schweitzer (Kent State University, U.S.A.) and M. Hyžný (Comenius University, Slovakia) for their careful reviewing and helpful comments.

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Appendix

Trichopeltarion ryouheii, Kato in Kato et al., new species LSID: urn:lsid:zoobank.org:act:427A88CC-0CC7-4F71-9878-379F415AB517

新称:リョウヘイツノクリガニ