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**Supplemental description of a rare brackish-water crab,
Moguai pyriforme Naruse, 2005 (Decapoda: Brachyura: Camptandriidae),
with an emphasis on male morphology**

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Abstract: *Moguai pyriforme* Naruse, 2005, is a rare brackish-water crab, occurring in riverbeds of brackish waters as well as subtidal flats near river mouths with pebbly-muddy substratum in the central Ryukyu Islands, southern Japan. This species was originally described based on only 3 female specimens collected from Okinawa-jima and Amami-oshima islands, and therefore male morphology was unknown. Our study provides detailed male morphological features based on 5 specimens from the Amami-oshima Islands, and compares them with the female specimens as well as congeners. The diagnostic features of the genus *Moguai* have been also amended.

Introduction

Moguai pyriforme Naruse, 2005, is a small camptandriid crab living on pebbly-muddy substratum in riverbeds of brackish-waters in southern Japan (Naruse 2005a, 2010). This species was described based on only 3 female specimens collected from Okinawa-jima and Amami-oshima islands, of which one female specimen from Amami-oshima Island was formerly identified by Kishino et al. (2001b) as *M. elongatum* (Rathbun, 1931). Naruse (2005a) distinguished *M. pyriforme* from *M. elongatum* by the characters of their relative frontal width of the carapace, anterolateral carapace margin and third maxillipeds.

Besides the female specimens examined by Kishino et al. (2001b) and Naruse (2005a), we have collected male specimens of *M. pyriforme* in Amami-oshima and Kakeroma-jima islands. The present study describes the male morphology of *M. pyriforme*, comparing them with the female specimens and with allied species of *M. aloutos* and *M. elongatum*. The diagnostic features of the genus *Moguai* Tan & Ng, 1999, are slightly amended.

Materials and method

Specimens were collected by a hand net with a mesh size of 2 mm at Amami-oshima and Kakeroma-jima islands, central Ryukyu Islands, southern Japan, from 2001 to 2003. The examined specimens were preserved in 70–80% ethanol and deposited in the Osaka Museum of National History in Osaka, Japan (OMNH-Ar). The specimens were stained by methylene blue prior to observation under a dissecting microscope at 8–40 times magnification.

To measure carapace length (CL, between frontal to posterior carapace margin), carapace width (CW, widest carapace width at laterally swollen mesobranchial regions near above coxae of second ambulatory legs), breadth between both sides of external orbital teeth (EOTW), frontal width (FW) and posterior width (PW, between posterolateral subtriangular teeth), the dorsal view of the carapace was first photographed with a scale by a digital camera (Pentax: Optio W90), then the above-mentioned characters were calculated by digital images using image analysis software (lenaraf200). The measurement ratios of each carapace portion were compared between both sexes by the statistical test (Mann-Whitney's *U*-test). Carapace sizes are shown as CL × CW in millimeters.

Results

Camptandriidae Stimpson, 1858

***Moguai* Tan & Ng, 1999**

***Moguai pyriforme* Naruse, 2005**

(Figs. 1–4)

Moguai elongatum: Kishino et al. 2001a (p. 129);
Kishino et al. 2001b (p. 21; plate 2-fig. 6);
Kishino 2003 (p. 559).

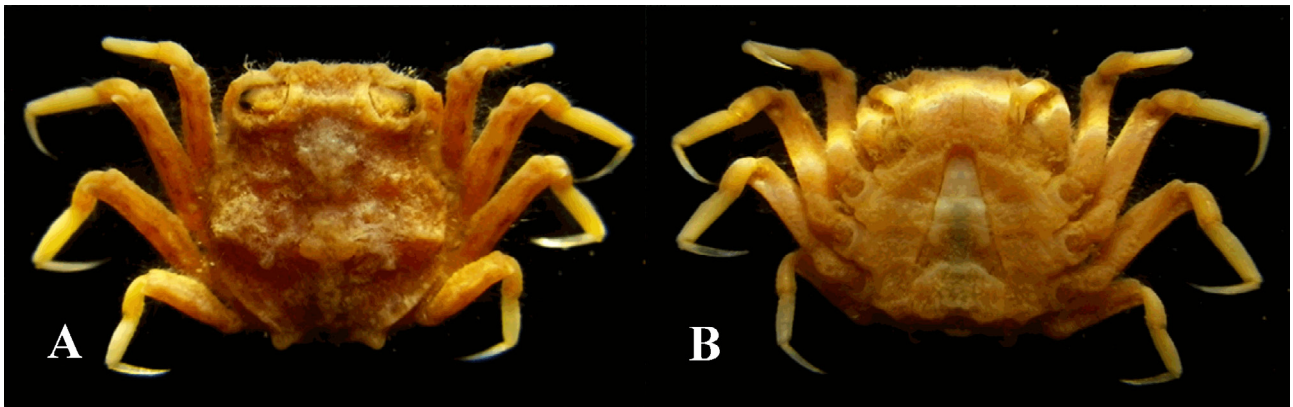


Fig. 1. Male (OMNH-Ar9542; 4.3 × 3.7 mm) of *Moguai pyriforme* Naruse, 2005, from dorsal view (A) and ventral view (B).

図 1. ヨウナシカワスナガニ雄 (OMNH-Ar9542; 4.3 × 3.7 mm) の背面 (A) と腹面 (B).

Table 1. Measurements of carapace of *Moguai pyriforme* Naruse, 2005. Abbreviations as follow: CL, carapace length; CW, carapace width; EOTW, width between external orbital teeth; FW, frontal width; ovig., ovigerous female; PW, width between tip of teeth on posterior margin.

表 1. ヨウナシカワスナガニの甲の各部位の計測値. 各略字は, CL = 甲長, CW = 甲幅, EOTW = 眼窩外歯間幅, FW = 額域幅, ovig. = 抱卵雌, PW = 後縁幅 (両突出部間)を示す.

Specimen No. (OMNH-Ar)	Sex	Carapace length (mm)	Carapace width (mm)	CW/CL ratio	EOTW/CW ratio	FW/EOTW ratio	PW/CW ratio
9539	male	3.6	3.1	0.85	0.79	0.41	0.44
9539	male	3.4	2.8	0.81	0.83	0.38	0.45
9539	male	3.8	3.1	0.82	0.82	0.40	0.45
9540	male	3.8	3.1	0.83	0.80	0.40	0.44
9542	male	4.3	3.7	0.85	0.81	0.41	0.42
9539	female	4.8	4.2	0.87	0.72	0.42	0.51
9539	female	5.6	5.0	0.89	0.67	0.43	0.54
9540	female	6.2	5.5	0.89	0.68	0.40	0.52
9540	female	5.9	5.4	0.92	0.65	0.40	0.48
9541	female	5.5	4.9	0.88	0.67	0.42	0.49
9542	ovig.	6.2	5.7	0.92	0.66	0.37	0.49
9542	ovig.	6.5	5.9	0.91	0.64	0.42	0.48
9542	ovig.	6.0	5.4	0.90	0.62	0.39	0.53

Moguai sp.: Naruse 2005b (p. 207–208).

Moguai pyriforme Naruse, 2005a (original description); Ng et al. 2008 (p. 233: list); Miura 2008 (p. 91: photograph without explanation); Naruse 2010 (p. 8); Naruse 2012a (p. 285: photograph with explanation).

Material examined. Three males, 2 females (OMNH-Ar9539), Konase (28°11'49.1"N 129°16'55.8"E), Amami-oshima Island, coll. A. Nomoto & T. Kishino, 19 Apr. 2001; 1 male, 2 females (OMNH-Ar9540), Nominoura (28°07'03.0"N 129°15'39.8"E), Kakeroma-jima Island, coll. T. Yonezawa, 18 May 2001; 1 female (OMNH-Ar9541), Yanma (28°14'43.4"N 129°24'56.5"E), Amami-oshima Island, coll. T. Kishino, 25 May 2002; 1 male, 3 females

(OMNH-Ar9542), Uchiumi (28°17'33.1"N 129°26'45.9"E), Amami-oshima Island, coll. T. Kishino & T. Yonezawa, 2 May 2003.

Carapace sizes in each individual are shown in Table 1.

Description of male (OMNH-Ar9542).

Carapace pear-shaped (Figs 1A, 2A). CW slightly shorter than CL, about 0.8 times of CL, EOTW as wide as 0.8 times of CW, FW as wide as 0.4 times of EOTW, PW as wide as 0.4 times of CW (Table 1).

Dorsal surface of carapace uneven, densely covered with small depressions, with sparse patches of dark short setae and granules (Figs. 1A, 2A). Carapace regions well demarcated, gastric, cardiac and intestinal regions well developed, both sides of hepatic and epibranchial margins weakly divergent

anteriorly, mesobranchial region laterally swollen, representing widest part of carapace. Entire carapace margin lined by small granules.

Front sloping anteroventrally, frontal margin granulated, bilobed with U-shaped median notch (Fig. 2A); one pair of transversely granulated epigastric cristae present. Supraorbital region swelling, margin granulated, sparsely lined with long setae.

Anterolateral margin of carapace without

distinct teeth excepting external orbital teeth (Figs. 1A, 2A). External orbital teeth large, subacutely pointed, directed anterolaterally. Anterolateral margin slightly concave, gradually and convexly continuing to posterolateral margin. Posterior margin almost straight, with subtriangular protrusions on both sides of lateral angles.

Lateral margins of subhepatic region lined with granules (pointed by arrow in Fig. 2A), parallel, margin anteriorly representing border between

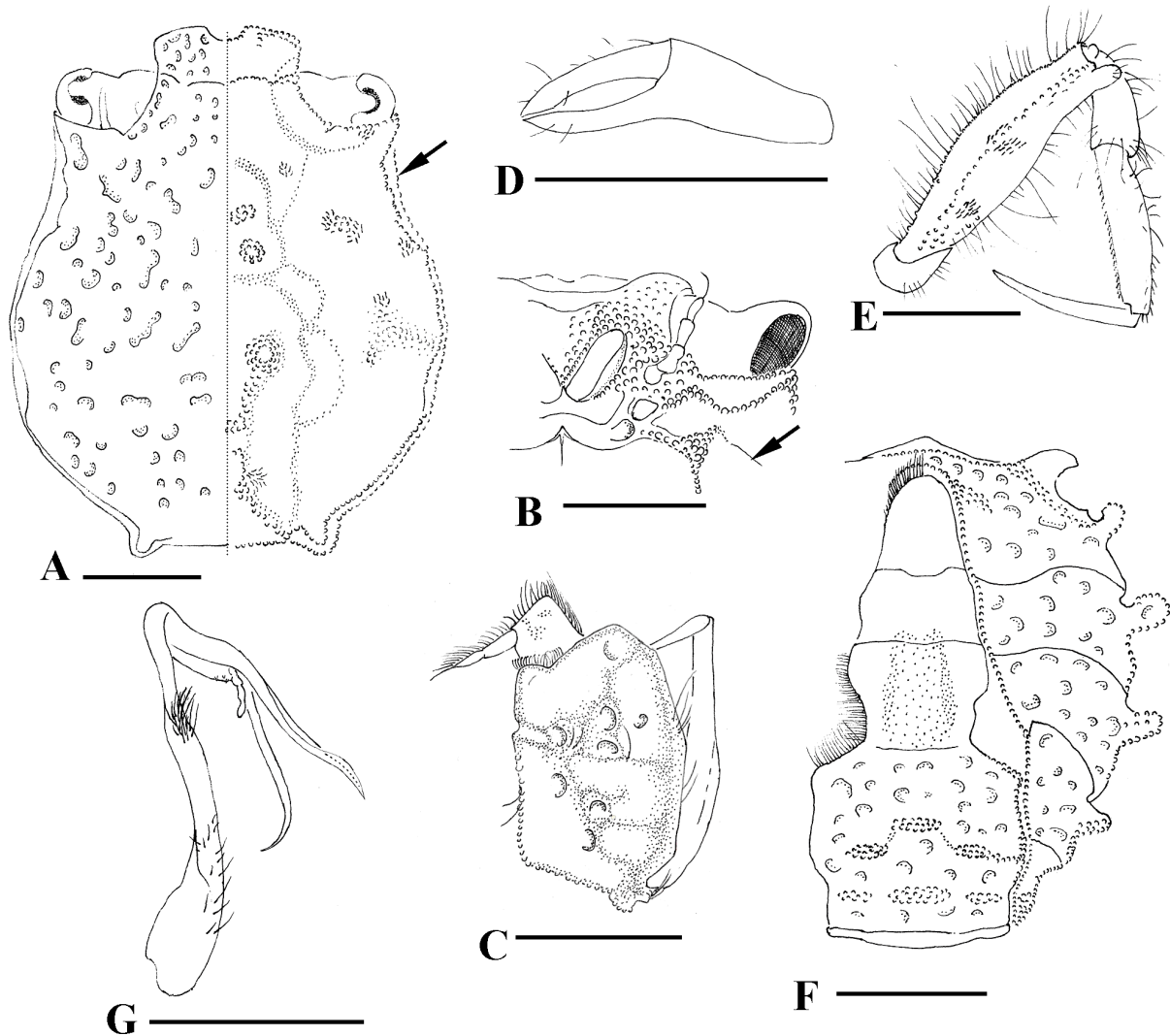


Fig. 2. Male (OMNH-Ar9542; 4.3 × 3.7 mm) of *Moguai pyriforme* Naruse, 2005. A: carapace, dorsal view (marginal setae and surface depressions drawn in left side; surface setae, granules and demarcated carapace regions drawn in right side; lateral carapace margin pointed by arrow corresponding to anterior angle of buccal cavity). B: frontal view of left side of cephalothorax (line with arrow continuing from the lateral carapace margin pointed by arrow in Fig. 2A). C: left third maxilliped. D: left chela (outer view). E: right third ambulatory leg. F: abdomen (marginal setae drawn in left side; marginal granules drawn in right side) and left side of thoracic sternum. G: left first gonopod (ventral view). Scales = 1 mm.

Fig. 2. ヨウナシカワスナガニ雄 (OMNH-Ar9542; 4.3 × 3.7 mm). A: 甲面 (左側では周縁の毛と表面の小さな窪みが、右側では表面の毛と顆粒および隆起した甲域が描かれている。矢印で示した縁は口郭前角へと連続)。B: 頭胸部前面 (矢印が示す線は甲の外周へと連続)。C: 左第三顎脚。D: 左鉗部 (外面)。E: 右第3歩脚。F: 腹節 (左側では周縁の毛が、右側では周縁の顆粒が描かれている) と左胸部。G: 左第1交節肢。スケールは全て1 mmを示す。

suborbital and pterygostomial regions, connected to anterolateral angle of buccal cavity (Fig. 2B: arrow). Infraorbital margin lined by granules, without setae (Fig. 2B), inner infraorbital margin bulged (inner orbital tooth), forming round tip, proximal part of eye stalk not hidden by inner orbital tooth; suborbital ridge conspicuous, forming large, granular “cup” with infraorbital margin; inner part of suborbital ridge forming subtriangular convexity. Proepistome medially excavated together with antenuller fossae. Lateral margin of buccal cavity lined with granules, border between anteromesial corner of pterygostomial region and anterolateral angle of buccal cavity granulated, bulged anteroventrally.

Both antennules and antennae small, short (Fig. 2B). Eyestalks prominent, extending slightly beyond tip of external orbital angle (Fig. 2B).

Third maxillipeds subrectangular (Fig. 2C), without median hiatus between inner margins when closed; entire margin of ischium and merus rimmed; ischium and merus distinctly fused, without fissure, but articulating part at inner margins of ischium and merus discernible, inner length of ischium longer than that of merus, width subequal in both ischium and merus; proximolateral angle of ischium protruded. Carpus triangular, upper margin with dense setae. Dactylus as long as propodus. Exopod slender, length subequal to combined length of lateral margins of merus and ischium, width about 1/4 times of ischium width, with flagellum.

Chelipeds equal in size (Fig. 1B); weak, length shorter than ambulatory legs; chelipedal length subequal to combined length from dactylus to carpus of third ambulatory leg. Chela slender, with

smooth surface; cutting margins of fingers smooth, without tooth or crenulations (Fig. 2D), sparsely setose, distal parts engaged without hiatus.

Second and third ambulatory legs largest, subequal in size, fourth legs smallest (Figs. 1A, B). Dactylus of third ambulatory leg smooth, elongate, sharply pointed (Fig. 2E), length as long as propodus. Anterior margin of propodus and carpus sparsely lined with long setae, those of posterior margin with short setae; surface of propodus and carpus smooth without setae or granule; combined propodus and carpus lengths subequal to that of merus. Cross section of dactylus to propodus oblong, that of merus rhomboidal. Anterior and posterior margins of merus lined with long setae and granules, upper surface on median portion with one longitudinal granular line, with patches of dark short setae; distal end of posterior margin of merus protruded.

Overall of thoracic sternum densely covered with small depression (Fig. 2F) as carapace surface; third to eighth thoracic sternites lined with granules along articulating parts with third maxilliped and pereopods as well as margin of sterno-abdominal cavity.

Abdomen longitudinally subtriangular, with conspicuous constriction at the side of fourth and fifth abdominal somites (Fig. 2F); lateral side of constricted somites with row of long setae. First abdominal somite short, with transversely granulated crista on anterior region, middle to posterior region not visible, concealed under posterior margin of carapace, movable from second somite, almost as wide as distance between posterolateral protuberances of carapace. Second to fifth somites completely fused, with two transverse,

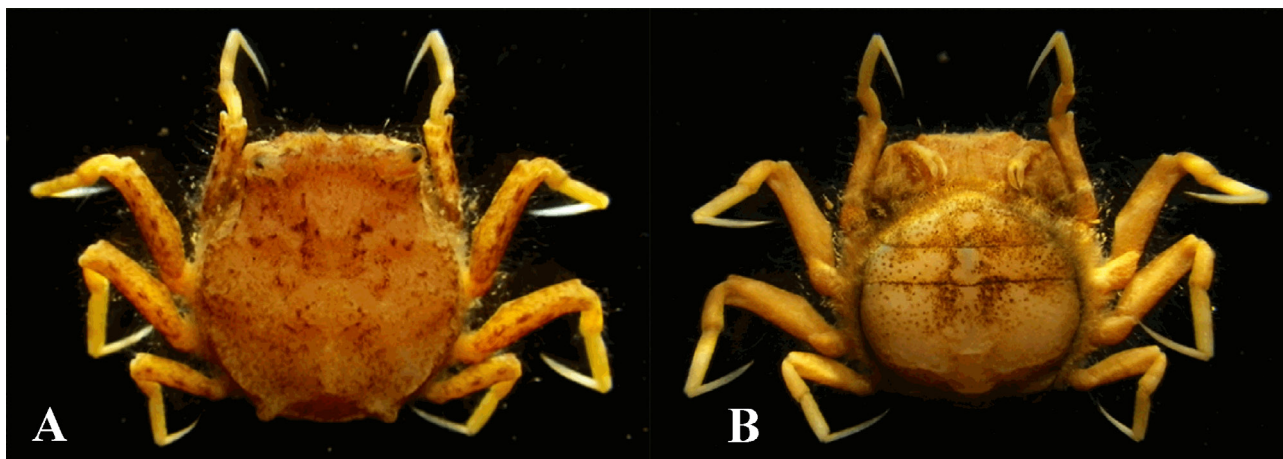


Fig. 3. Female (OMNH-Ar9542; 6.2 × 5.7 mm) of *Moguai pyriforme* Naruse, 2005, from dorsal view (A) and ventral view (B).

図 3. ヨウナシカワスナガニ雌 (OMNH-Ar9542; 6.2 × 5.7 mm) の背面 (A) と腹面 (B)。

granulated broken ridges on posterior region of fused somites and one transverse ridge on anterior region of fused somites. Sixth somite trapezoidal, freely articulated from fifth somite and telson. Telson tapering, tip rounded, around with row of long setae.

First gonopod (pleopod) slender, strongly bent dorsalward at proximal three-fifths. Basal part stoutest, proximal three-fifths slightly sinuous; distal part (distal to bending part) divided to two processes over the distal two-thirds, with one small

projection at base of bifurcate processes; mesial process (in dorsal side) with curved apex, longer than blade-like lateral process; tip of both processes naked.

Condition of females and sexual differences.

Carapace length and width in all females were longer and wider than those in males (Table 1). The outlines of the carapace of females (Fig. 4A) were similar to males (Fig. 2A), but proportional features showed more distinct sexual differences. The CW/CL ratios of the females were significantly

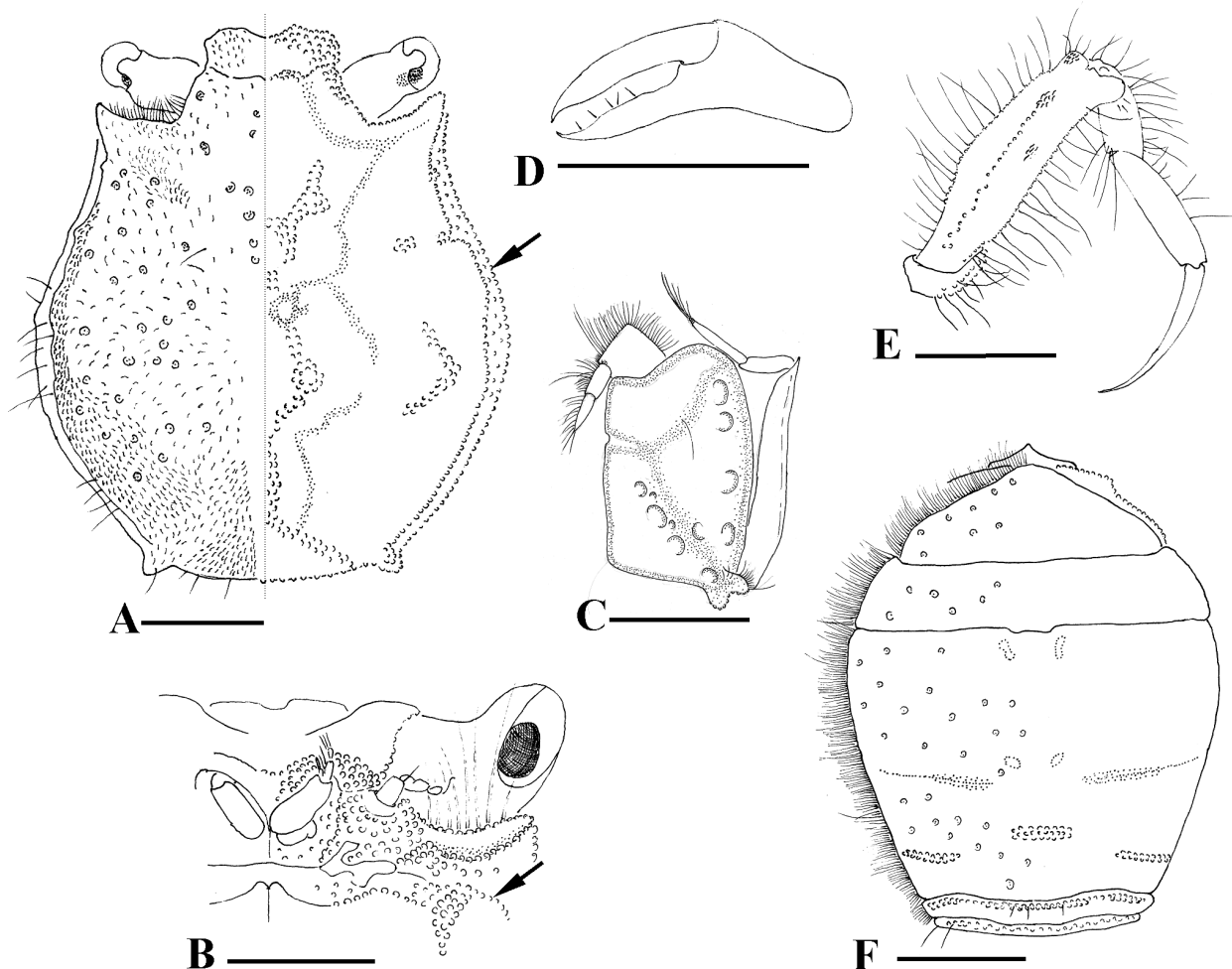


Fig. 4. Female (OMNH-Ar9539; 4.8 × 4.2 mm) of *Moguai pyriforme* Naruse, 2005. A: carapace in dorsal view (setae and depressions drawn in left side; granules and demarcated carapace regions drawn in right side; the lateral carapace margin pointed by arrow corresponding to anterior angle of buccal cavity). B: frontal view of left side of cephalothorax (the line with arrow continuing from the lateral carapace margin pointed by arrow in Fig. 4A), C: left third maxilliped. D: left chela (outer view). E: right third ambulatory leg. F: abdomen (marginal setae and depression drawn in left side). Scales = 1 mm.

Fig. 4. ヨウナシカワスナガニ雌 (OMNH-Ar9539; 4.8 × 4.2 mm). A: 甲面 (左側では周縁と表面の毛および表面の小さな窪みが、右側では周縁と表面の顆粒および隆起した甲域が描かれている。矢印で示した縁は口郭前角へと連続)。B: 頭胸部前面 (矢印が示す線は甲の外周へと連続)。C: 左外顎脚。D: 左鉗部 (外面)。E: 右第3歩脚。F: 腹節 (左側では周縁の毛と表面の小さな窪みが描かれている)。スケールは全て1 mmを示す。

greater than those in males (Mann-Whitney's U test: $U = 40$, $P = 0.003$), i.e. females have laterally more swollen carapace than males. The EOTW/CW ratios were significantly smaller in females than in males ($U = 40$, $P = 0.003$), i.e. females have less produced anterolateral teeth than males. The PW/CW ratios were greater in females than in males ($U = 40$, $P = 0.003$), i.e. width between posterolateral protuberances of carapace was larger in females than in males. However, the FW/EOTW ratios in females were not different from those in males ($U = 23$, $P = 0.66$).

Female carapace regions (Figs. 3A, 4A) were less demarcated than that of described male (Figs. 1A, 2A). Depressions of the dorsal surface of the carapace were smaller and fewer in females than in the male. Females are also different from the male in more entirely scattered short soft setae on the dorsal surface of the carapace, with much denser setation around posterolateral and posterior margin (Fig. 4A), whereas the male only have patchy short dark setae (Fig. 2A). In addition, females had clearly denser long setae along supraorbital and infraorbital margins (vs. supraorbital margin with sparsely long setae and infraorbital margin without setae in the male). However, these sexual differences of the carapace and orbital features were indistinguishable in small individuals except that small males have more developed carapace regions than females.

Other morphological characters of suborbital region, antennules, antennae, third maxilliped, ambulatory legs and chelae (Fig. 4) were almost same in males and females (Fig. 2). Detailed abdominal features in female were also identical with those in the original description by Naruse (2005a).

Habitat. *Moguai pyriforme* was collected from pebbly-muddy bottom of shallow puddles (water depth: < 1 m at low tide) on tidal flats, located at the outer edges of river mouths. However, Naruse (2005a) collected this species from the same substratum on riverbeds. These observations suggest that *M. pyriforme* appears to prefer pebbly-muddy substratum under water, neighboring river mouths. *Ilyograpsus nodulosus* Sakai, 1983, as well as *Apograpsus paantu* (Naruse & Kishino, 2006) were also collected from the same habitat (Present study; Naruse 2012b).

Japanese name for the genus *Moguai*. The first recorded species of this genus from Japan was *Moguai elongatum* (reported as *Camptandrium elongatum*: Kounaga-kawasuna-gani in Japanese name) (Takeda & Iwasaki 1983). Hence, we

propose the standard Japanese name for the genus as “Kounaga-kawasuna-gani-zoku”.

Discussion

The genus *Moguai* was established by Tan & Ng (1999) for *Camptandrium elongatum* Rathbun, 1931, and a new species, *M. aloutos* Tan & Ng, 1999 (type species). Subsequently, Naruse (2005a) described *M. pyriforme* Naruse, 2005.

Moguai aloutos has been recorded from Singapore (type locality), Malaysia and Indonesia (Tan & Ng 1999). *Moguai elongatum* was collected from Iriomote-jima Island (Takeda & Iwasaki 1983: reported as *Camptandrium elongatum*), from Ishigaki-jima Island (Naruse 2005a) in the southern Ryukyu Islands, as well as from China (Fukien: type locality; Hainan), Hong-Kong (Tan & Ng 1999) and Taiwan (Hsueh & Ng 2008). *Moguai pyriforme* has been recorded only from Okinawa-jima and Amami-oshima islands (Naruse 2005a), indicating the species is endemic to the central Ryukyu Islands.

These three *Moguai* species have small body sizes less than 7 mm CL, and resemble each other in their appearance, which may be a reason why only one species of *M. elongatum* had been known during the past approximately 70 years until *M. aloutos* was described in 1999. However, these three species can be distinguished from each other by characters of frontal width, anterolateral carapace margin, posterolateral protrusions of the carapace, inner orbital tooth, and third maxilliped (Tan & Ng 1999; Naruse 2005a; present study) as follows, **1**): ratio of FW to EOTW 0.37–0.43 (Table 1) in *M. pyriforme* (vs. 0.5 in other 2 species: Tan & Ng 1999: fig. 3A, B, D; Naruse 2005a: fig. 1b; Hsueh & Ng 2008: fig. 1A); **2**): anterolateral margin of carapace without distinct tooth except for external orbital tooth in *M. pyriforme* (Figs. 2A, 4A; Naruse 2005a: fig. 2a) (vs. with small but distinct teeth in other 2 species: Tan & Ng 1999: fig. 3A, B; Naruse 2005a: fig. 1b); **3**): posterolateral protrusions of carapace pronounced in *M. pyriforme* (Figs. 1A, 2A, 3A, 4A; Naruse 2005a: fig. 2a) and *M. aloutos* (Tan & Ng 1999: fig. 3A, B) (vs. not pronounced in *M. elongatum*: Tan & Ng 1999: fig. 3D; Naruse 2005a: fig. 1b; Hsueh & Ng 2008: fig. 1A); **4**): inner orbital tooth not developed, base of eye stalk not hidden by tooth in *M. pyriforme* (Figs. 2B, 4B; Naruse 2005a: fig. 2b) and *M. elongatum* (Tan & Ng 1999: fig. 3C) (vs. inner orbital tooth developed with acute tip, base of eye stalk covered by the tooth in *M. aloutos*: Tan & Ng 1999: figs. 3E,

4A); 5): ischium and merus of third maxilliped fused in *M. pyriforme* (Figs. 2B, 4B; Naruse 2005a: fig. 2c) (vs. segmented in other 2 species: Tan & Ng 1999: fig. 4B, E).

These morphological characters of *Moguai pyriforme* do not vary between sexes. Furthermore, the male abdomen and first gonopod in *M. pyriforme* were characteristic enough to distinguish the species from congeners. The second to fifth somites of male abdomen were clearly fused in *M. pyriforme* (Fig. 2F), whereas in the other two species, the suture was discernible between second and third somites and third to fifth somites appear fused (Tan & Ng 1999: texts in p. 197, 204, 206, fig. 4C, D). Apex of the mesial, longer process of the distal parts of first gonopod were simply curved and smooth on the surface (Fig. 2G), whereas this part in the other two species was doubly curved and spinulose (Serène & Umari 1972: figs. 128, 129; Tan & Ng 1999: text in p. 204, fig. 4F).

According to Tan & Ng (1999), the most closely related genus of *Moguai* Tan & Ng, 1999, is *Camptandrium* Stimpson, 1858. These two genera can be distinguished by the following features, 1): carapace longer than width in *Moguai* (vs. wider than long in *Camptandrium*), 2): cup shape in suborbital region present (vs. absent), 3): both forked distal processes of first gonopod without forked tip (vs. one of forked distal process with forked tip), 4): ischium and merus of third maxilliped separated (vs. fused), 5): chelae, small, slender in both sexes (vs. chelae inflated in male), 6): second to fifth somites of male abdomen fused, but between second and third somites with suture (vs. second to fifth somites completely fused), 7): posterior angle of carapace with subtriangular protrusion (vs. without protrusion) (Tan & Ng 1999).

Most of these characteristics are in accordance with those of *M. pyriforme*, which supports the placement of the species in the genus *Moguai*. Naruse (2005a), however, indicated that the generic definition of *Moguai* needed to be slightly amended to accommodate the characters of *M. pyriforme*, because the ischium and merus of third maxilliped were fused. In addition, our observation of male specimens has found that abdominal second to third somites were completely fused, which is different from other congeners. Therefore, the characters of third maxilliped and male abdomen should be excluded from diagnostic characters for the genus *Moguai*.

Another morphological feature that is common to all the three species of the genus is that females

appear to attain larger body size than males (Serène & Umari 1972; Tan & Ng 1999; Naruse 2005a; Hsueh & Ng 2008; present study), which is a different condition from the closely related genera *Camptandrium* Stimpson, 1858, and *Takedellus* Tan & Ng, 1999, that have male body sizes larger than or similar to those of females (Takeda 1972; Tan & Ng 1999). The sexual dimorphism in body sizes (males smaller than females) can also be added to the diagnostic features of *Moguai* species.

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汽水性稀少カニ類ヨウナシカワスナガニ (ムツハリアケガニ科) の記載補遺—とくに雄の形態について

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要旨. ヨウナシカワスナガニは琉球列島中部の泥干潟に出現する汽水性の稀種である。この種は沖縄島と奄美大島から得られた雌3個体に基づいて、2005年に新種記載された。本報告では、奄美諸島から得られたヨウナシカワスナガニ雄5個体を基に、これまで知られていなかった雄の詳細な形態を雌と比較しながら記載し、さらに同属他種の形態情報とも比較した。その結果から、本種が属するコウナガカワスナガニ属の標徴形質を再定義した。

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