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GEOTHELPHUSA MIYAKOENSIS, A NEW SPECIES OF FRESHWATER CRAB (CRUSTACEA: DECAPODA: BRACHYURA: POTAMIDAE) FROM MIYAKO ISLAND, SOUTHERN RYUKYUS, JAPAN

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ABSTRACT. – *Geothelphusa miyakoensis*, new species, from Miyako Island, Southern Ryukyus, Japan, is described. The new species is closest to *G. levicervix* (Rathbun, 1898) (sensu Minei, 1973), but is distinguished by a number of characters of carapace, male abdomen, first gonopod, cheliped, and second ambulatory leg. The new species is also similar to the Taiwanese *G. bicolor* Shy, Ng & Yu, 1994, *G. caesia* Shy, Ng & Yu, 1994, and *G. yangmingshan* Shy, Ng & Yu, 1994, but differs in characters of the carapace, first gonopod, male abdomen, ambulatory legs, and colour. The present work is the first finding of potamid crab from Miyako Island, and brings the total number of *Geothelphusa* species known to 42.

KEY WORDS. – *Geothelphusa miyakoensis*, new species, Potamidae, Miyako Island, Southern Ryukyus, Japan, taxonomy.

INTRODUCTION

The Ryukyu Islands are located between the Japanese Island of Kyushu and Taiwan, and are divided into three groups, Northern Ryukyus, Central Ryukyus, and Southern Ryukyus. The island groups formed at different geologic times, and each island has a unique origin and history. Miyako-Jima [=Island] (24°-25°N., 125°-126°E.) consists mainly of Ryukyu limestone, which suggests that it was submerged during the mid-Pleistocene and excludes the possibility of a historical land connection between Miyako-Jima and other large islands such as Yaeyama and/or the Central Ryukyus (Kizaki & Oshiro, 1977; Ujiié, 1990).

In 1997, one of authors (HF) obtained specimens of a previously undescribed species of potamid crab from Miyako-Jima, though potamid crabs complete their life history in freshwater or on land, and are completely independent of seawater. The paper describes the new species and compares it to other *Geothelphusa* species from the Ryukyus and Taiwan.

MATERIALS AND METHODS

Specimens examined were deposited in the National Science Museum, Tokyo, Japan, (NSMT), the Ryukyu University Museum, Fujukan, Japan (RUMF), the Zoological Laboratory, Kyushu University, Japan, (ZLKU), (Kitakyushu Museum and Institute of Natural History, Kitakyushu City, Japan), and the Zoological Reference Collection (ZRC), Raffles Museum, National University of Singapore.

The terminology and measurements in the present paper follow Ng (1988), Dai (1999), and Shy & Yu (1999). Abbreviations are as follows: CL, carapace length; CW, carapace width; CH, carapace height; FW, front width; EXW, width between external orbital angles; G1, gonopod 1; G2, gonopod 2.

Characters of G1 were measured by using a stereomicroscope (Nikon SMZ-10) with a eyepiece micrometer, and all other characters were measured to the nearest 0.01 mm using digital calipers (Mitsutoyo CD-20C). To reduce the effect of growth on measurements, only large specimens (more than 23 mm CL) were used for ratio. For ratio values, mean value and range of ratio values (inside of brackets) were provided.

Geothelphusa miyakoensis was compared to *G. levicervix* (Rathbun, 1898) (sensu Minei, 1973), *G. bicolor* Shy, Ng & Yu, 1994, *G. caesia* Shy, Ng & Yu, 1994, and *G. yangmingshan* Shy, Ng & Yu 1994. In addition, the taxonomic position of *G. levicervix* (sensu Rathbun, 1898, 1905) and *G. levicervix* (sensu Minei, 1973) was discussed. Specimens examined were as follows: *G. levicervix* (sensu Minei, 1973), Minei (1973: 211, 212, Figs. 6, 9C, D), ZLKU

m. 1094 (2 males, CL 40.49, 42.65 mm, 1 female, CL 34.19 mm, Fusato, Tamagusuku-Son [=Village], Okinawa-Jima, coll. H. Minei, 25 Jun.1972); *G. levicervix* (sensu Rathbun, 1898, 1905), Rathbun (1898: 28, 29, Pl. II Figs. 1-4), Rathbun (1905: 223, 224, Pl. XVIII Fig. 12), Bott (1970: 155, Pl. 58 Figs. 93, 94); *G. bicolor,* Shy et al. (1994: 783, 803-805, Fig. 9), Shy & Yu (1999: 30-32); *G. caesia*, Shy et al. (1994: 783, 789, 790, Fig. 1), Shy & Yu (1999: 33-35); *G. yangmingshan*, Shy et al. (1994: 783, 822, 823, Fig. 19), ZRC 2000. 2245 (1 female, CL 24.37 mm, Yangming-Shan [=mountain], Taipei City, Taiwan, coll. K. Y. Yau, Mar.1989).

TAXONOMY

FAMILY POTAMIDAE ORTMANN, 1896

Genus *Geothelphusa* Stimpson, 1858

***Geothelphusa miyakoensis*, new species**
Japanese name: Miyako-Sawagani
(Figs. 1-3)

Geothelphusa sp. 1 Yoshigou, 1999: 21, 22, Pl. 2 Fig. K.
Geothelphusa sp. Segawa, 2000: 243, Table 1, Figs. 1, 2.

Material examined. – Holotype - male, CL 29.40 mm, RUMF-ZC-00014, Miyako-Jima (type locality), the Southern Ryukyus, Japan, coll. S. Shokita, H. Kamizato, S. Tomari & K. Arakaki, 14 Aug.1997.

Paratypes – 1 male, CL 26.62 mm, NSMT-Cr 14263, 1 female, CL 17.88 mm, NSMT-Cr 14264, locality same with holotype, coll. H. Fujii, 24 Jan.1997; 2 males, CL 24.05 mm, ZRC 2001.2251, 21.13 mm, ZRC 2001.2252, 2 females, CL 21.56, ZRC 2001.2253, 21.75 mm, ZRC 2001.2254, collection data same with holotype; 1 male, CL 23.18 mm, RUMF-ZC-00015, 1 female, CL 24.26 mm, RUMF-ZC- 00016, Miyako-Jima, coll. Y. Hokama, Oct.1997; 1 male, CL 26.61 mm, RUMF-ZC-00017, locality same with RUMF-ZC- 00015, 00016, coll. Y. Hokama, 14 Nov.1997.

Description. – Carapace (Figs. 2a, b).- Carapace smooth, with very fine concave pits, cervical and H-shaped gastric grooves shallow, mesogastric region convex longitudinally; CL 0.81 (0.79-0.83) times as long as CW; frontal margin almost entire, straight in large specimens, but faintly divided into 2 lobes in smaller specimens; anterolateral margin cristate, lined with small granules, region between rudimentary epibranchial tooth and external orbital angle sometimes lined with small granules; posterolateral region slightly rugose; posterolateral margin reaching to posterior carapace margin. CH 0.62 (0.60-0.64) times as long as CL, CW 2.01 (1.91-2.10) times as wide as CH, CL 1.62 (1.57-1.68) times as long as CH; FW 0.41 (0.36-0.46) times as wide as EXW, FW 0.25 (0.22-0.28) times and EXW 0.62 (0.60-0.64) times as wide as CW, respectively; supraorbital

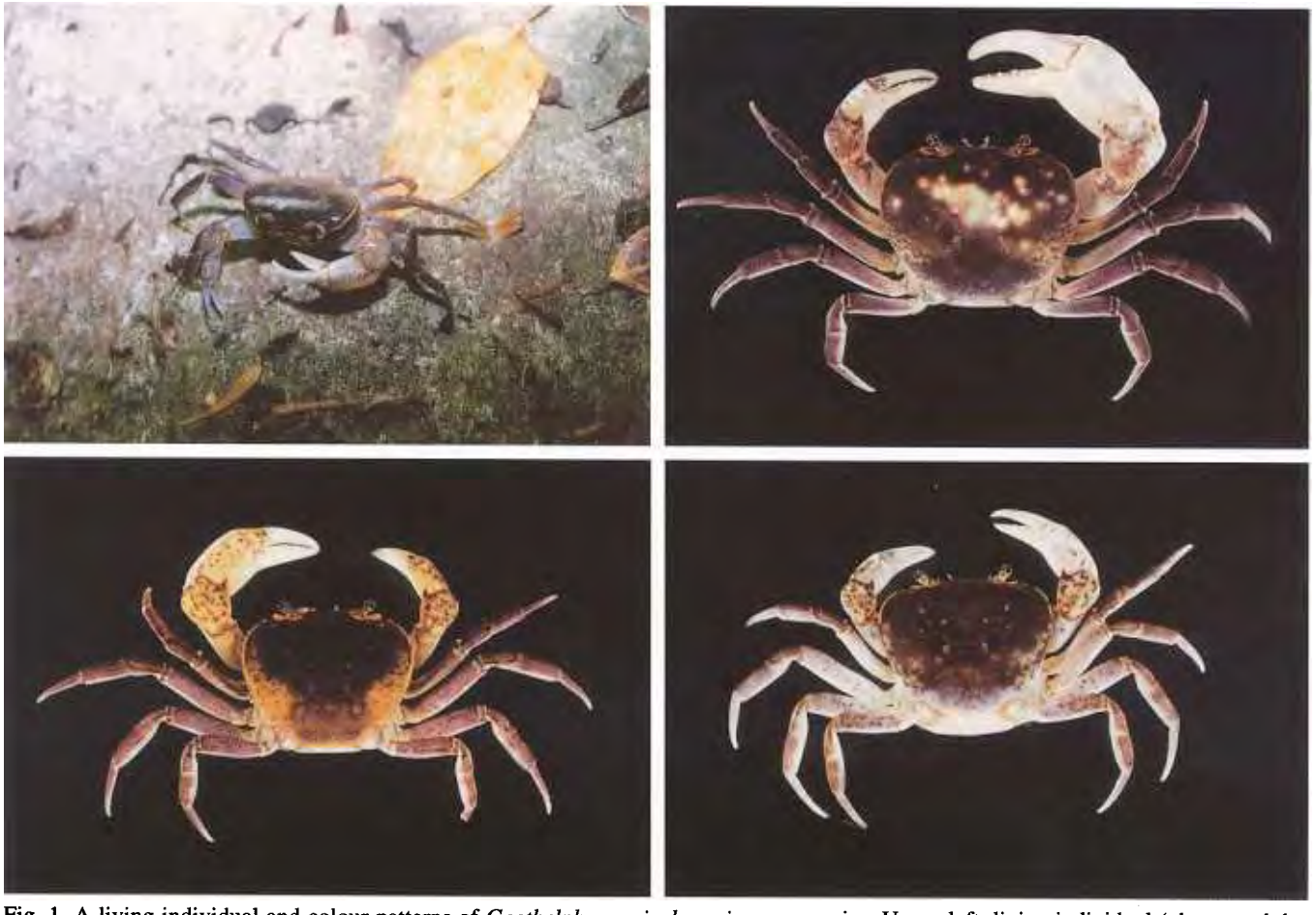

Fig. 1. A living individual and colour patterns of *Geothelphusa miyakoensis*, new species. Upper left, living individual (photograph by Mr. H. Iraha); upper right, male with purplish brown colour; lower left, male with brown background and a white region on the posterolateral margin; lower right, female with purplish brown colour.

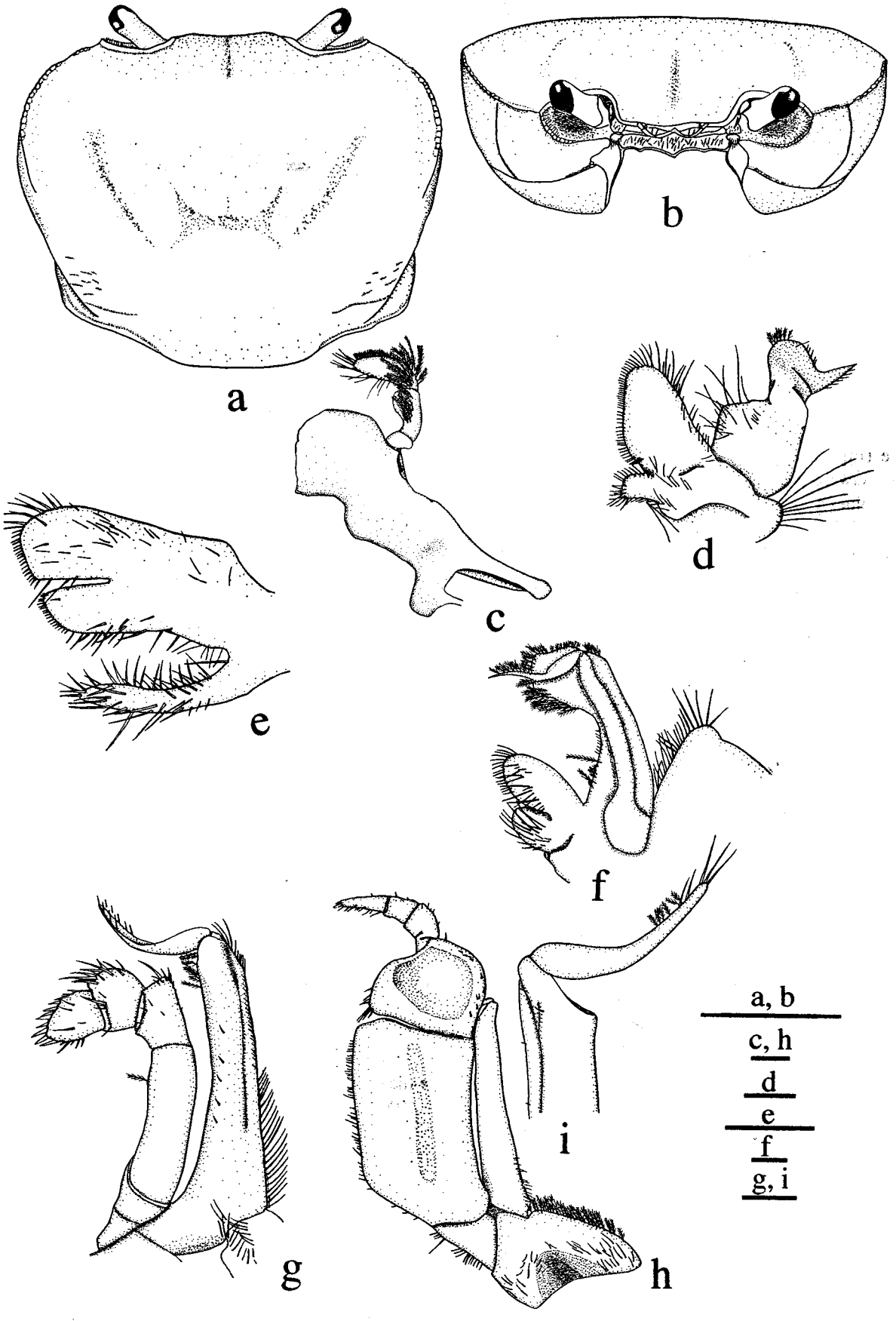

Fig. 2. Carapace and mouthparts of *Geothelphusa miyakoensis*, new species, paratype, male CL 24.05 mm (ZRC 2001.2251). a, carapace dorsal view; b, carapace frontal view; c, mandible; d, maxillule; e, maxilla; f, first maxilliped; g, second maxilliped; h, third maxilliped, i, exopod and flagellum of third maxilliped. Scales: a, b, 10mm; c-h: 1 mm; i, 0.5 mm.

margin straight, outer angle of orbits evaginated, rounded; epistomal median lobe obtusely triangular; outer 2/3 of infraorbital margin lined with small granules; inner portion of groove between subhepatic and infraorbital region lined with small but distinct granules.

Male abdomen. – Sixth abdominal segment length 0.46 (0.39-0.55) times as long as wide, telson length 0.76 (0.72-0.81) times as long as wide, width of sixth segment 1.25 (1.17-1.30) times as long as the width of telson. Distance between tip of male abdomen and anterior margin of thoracic sternite 4, 1.73 (1.55-2.00) times as long as thoracic sternites 1-3.

Eye (Figs. 2a, b). – Cornea slightly wider than eyestalk.

Antenna. – Antenna visible from side of frontal region; when folded back, distal end of antennal flagellum reaching half length of the antennal basis.

Mandible (Fig. 2c). – Inner margin of coxa thin, hard, sometimes saw-edged; palp 3-segmented, ultimate segment with short spines on anterior margin, long naked setae present on posterior margin, inner margin of penultimate segment weakly extended, long plumose setae lining base of ultimate segment to basal 1/3 of penultimate segment.

Maxillule (Fig. 2d). – Inner margin of coxa and basis fringed with short setae; endopod of maxillule bent inwards, covering mandible.

Maxilla (Fig. 2e). – Coxa armed with long, fine spines; inner margin of basis fringed with short spines.

First maxilliped (Fig. 2f). – Coxa and basis with long, fine spines; endopod and exopod of distal margin fringed with plumose setae.

Second maxilliped (Fig. 2g). – Distal margin of dactylus with short but strong spines; anterior part of propodus with long spines; outer-proximal margin of exopod fringed with fine simple setae.

Third maxilliped (Figs. 2h, i). – Distal inner and outer angles of merus concave; exopod long, reaching to proximal 1/3 of merus of endopod, distinct flagellum on exopod.

Cheliped (Figs. 3a, b). – Chelipeds smooth, asymmetrical in males, major chela with large palm, fingers forming large gape; symmetrical in females. Fingers of large male chelae with lined fine pits on outer surface; with rounded tooth along inner margin; forming gap when closed; palm length 1.08 (1.00-1.22) times as long as broad, 0.88 (0.80-0.96) times as long as dactylus. Carpus smooth, with acute spine on antero-inner angle, very low granules lining dorso-inner margin. Outer surface of merus rugose, with tiny setae; ventroouter margin lined with rounded granules.

Second ambulatory leg (Fig. 3c). – Merus narrow, length 3.71 (3.45-4.21) times as long as width; ventrodistal portion of propodus with a few spines, propodus length 2.71 (2.57-2.98) times as long as wide; dactylus with 2 dorsal and 2 ventral spine rows, length 1.17 (1.16-1.18) times as long as propodus.

G1 (Figs. 3d, e). – G1 slender, distal half curving outwards, slightly swollen along inner margin near distal part of synovial membrane, total length 2.91 (2.61-3.19) times as long as wide; terminal segment curving outwards, with scattered spines on distal half, length 1.74 (1.38-1.96) times as long as wide; synovial membrane length 3.42 (3.11-3.91) times as long as wide.

G2 (Fig. 3f). – G2 slender, flagellum slightly curving outwards, total length of G2 5.80 (5.33-6.35) times as long as flagellum.

Colour (Fig. 1). – Specimens of *G. miyakoensis* can be roughly separated into two groups on the basis of their colour patterns: one that is purplish brown, and the other that is brown with a white region on the posterolateral margins.

Habitat. – *Geothelphusa miyakoensis* was caught in small springs and its downstream. Those springs are gushing from between limestones, and about 30 cm depth with mud flat. Many burrows were observed at the banks of downstream, and 1 or 2 individuals of *G. miyakoensis* were seen from some burrows.

Feeding habits. – *Geothelphusa miyakoensis* is omnivorous, and was observed to eat land snails and detritus in the field.

Distribution. – *Geothelphusa miyakoensis* is currently known only from the three small springs of Miyako-Jima, Southern Ryukyus, Japan, and the only potamid species reported from Miyako-Jima.

Etymology. – *Geothelphusa miyakoensis* is named for Miyako-Jima, where it is endemic.

Remarks. - *Geothelphusa miyakoensis* is most closely related to *G. levicervix* (Rathbun, 1898) (sensu Minei, 1973). *Geothelphusa levicervix* (sensu Minei, 1973) reaches large body sizes up to CW 49.8 mm compared to CW 36.94 mm in *G. miyakoensis*. Moreover *G. levicervix* (sensu Minei, 1973) can be distinguished from *G. miyakoensis* by the shape of the G1 [slightly curving outward in *G. levicervix* (ZLKU m. 1094) vs. distinctly curving outward in *G. miyakoensis*], the length/width ratio of the synovial membrane of the G1 [4.00 vs. 3.42 (3.11-3.91)], the CH/CL ratio [0.65-0.67 vs. 0.62(0.60-0.64)], the EXW/CW ratio [0.54-0.57 vs. 0.62(0.60-0.64)], and the length/width ratio of the palm of the male major cheliped [0.7 vs. 1.08 (1.00-1.22)].

Minei's (1973) specimens of *G. levicervix* have a number of differences with Rathbun's (1898, 1905) description of holotype. Those are, CL/CW ratio [0.77 in Rathbun (1898, 1905) vs. 0.79-0.82 in Minei's specimen (ZLKU m. 1094)], presence of epibranchial tooth (distinct vs. rudiment), presence of a deep transverse and triangular depression

behind the orbit (vs. absent), EXW/CW ratio (0.51 vs. 0.54-0.57), FW/EXW ratio (0.44 vs. 0.41-0.43), superior margin of orbits sinuous (vs. straight), prominent acute outer angle of the orbit (vs. not prominent), and the presence of an irregular longitudinal depression on the anterior half of the carpus of the male major chelliped (vs. absent). Bott (1970) also described the holotype of *G. levicervix*, and provided photographs of the dorsal view and the G1. Judging from Bott's (1970) photograph, G1 of holotype is wider and bending stronger than Minei's (1973) *G. levicervix*. The types will need to be re-examined before it can be ascertained if all the specimens are conspecific. This study, in any case, is beyond the scope of the present paper, and none of the difference between Minei's and Rathbun's specimens of *G. levicervix*, however, affect our comparisons with *G. miyakoensis*.

Recently, 28 species of *Geothelphusa* have been described from Taiwan (Shy et al., 1994; Tan & Liu, 1998; Shy, Chen & Chen, 2000). Of those, *G. miyakoensis* is most similar to *G. bicolor* Shy, Ng & Yu, 1994, *G. caesia* Shy, Ng & Yu, 1994, and *G. yangmingshan* Shy, Ng & Yu, 1994. However *G. miyakoensis* is distinguished from *G. bicolor* by the shape of the external orbital angle (sharp in *G. bicolor* vs. rounded in *G. miyakoensis*), the shape of the G1 (straight or slightly curving inwards vs. distinctly curving outwards), the length/width ratio of the synovial membrane of G1 [4.2 vs. 3.42 (3.11-3.91)], the armature of the G1 terminal segment (spines on distal 1/6 vs. scattered spines on 1/2), the length/width ratio of the G1 terminal segment [2.9 vs. 1.74 (1.38-1.96)], the total length of G2 [8.8 times as long as flagellum vs. 5.80 (5.33-6.35)], and the carapace colour (deep brown in the frontal region and yellowish brown in posterior region

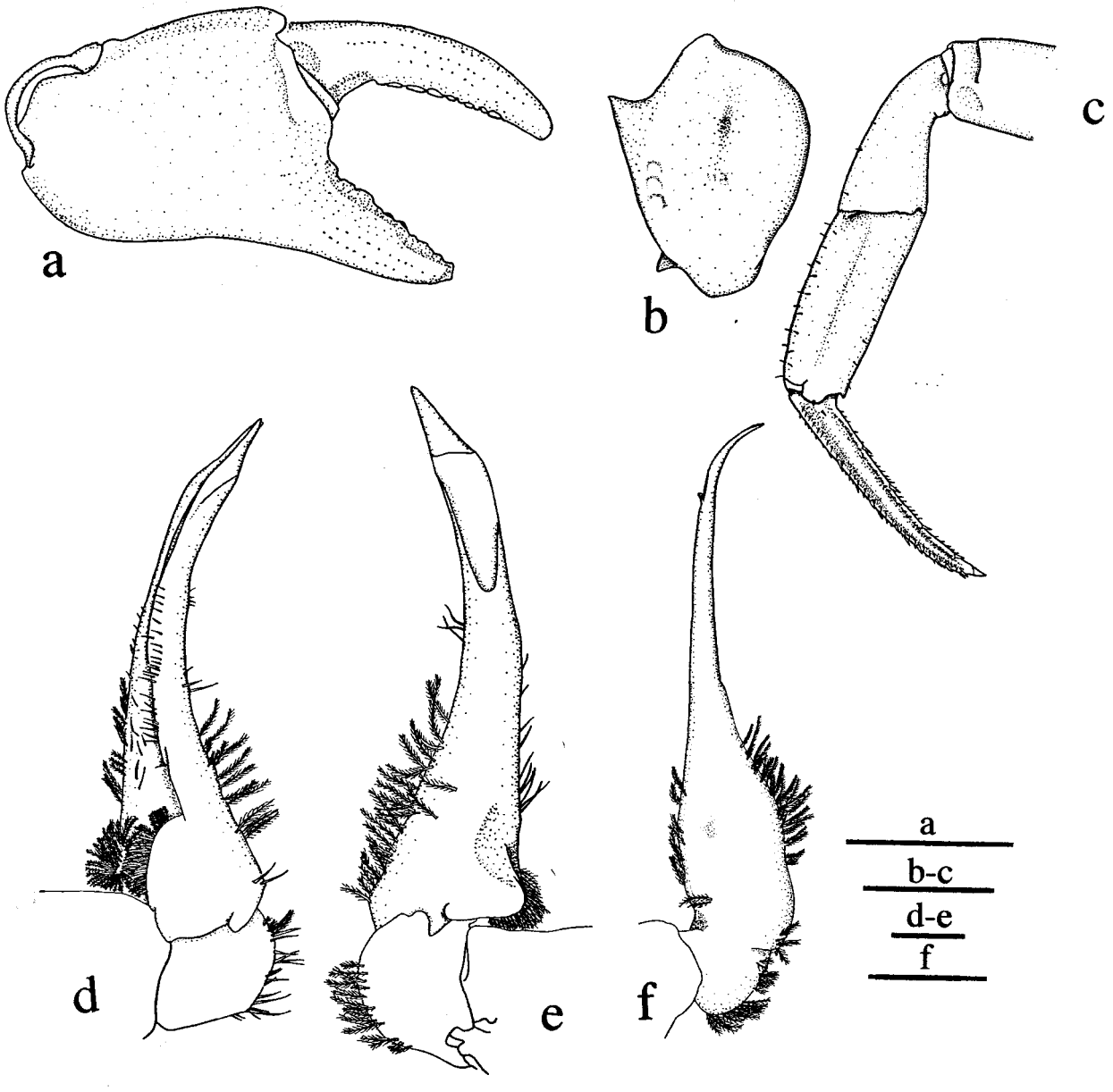

Fig. 3. Appendages of *Geothelphusa miyakoensis*, new species, male large chela; b, carpus of male large chela; c, second ambulatory leg; d, G1 ventral view; e, G1 dorsal view; f, G2 ventral view. [c, paratype, male CL 23.18 mm (RUMF-ZC-00015); all others, paratype, male CL 24.05 mm (ZRC 2001.2251)]. Scales: a, 10 mm; b, c, 5 mm; d-f, 1 mm.

vs. purplish brown, or brown with a white region on the posterolateral margins).

Differences between *G. miyakoensis* and *G. caesia* include cristae on the anterolateral margin (faint and smooth in *G. caesia* vs. distinct in *G. miyakoensis*), the distance between the tip of the male abdomen and the anterior margin of thoracic sternite 4 [0.53 times as long as thoracic sternites 1-3 vs. 1.73 (1.55-2.00)], the length/width ratio of the G1 terminal segment [2.2 vs. 1.74 (1.38-1.96)], the distribution of the spines on the G1 terminal segment (scattered on distal 1/6 vs. distal 1/2), the length/width ratio of the G1 synovial membrane [5.3 vs. 3.42 (3.11-3.91)], and colour (bluish in the anterior half of the carapace, and yellowish in the posterior half of carapace and yellowish ambulatory legs vs. purplish brown, or brown with a white region on the posterolateral margins).

Geothelphusa yangmingshan differs from *G. miyakoensis* in the armature of the crista of the anterolateral margin (without granules, or if present, very low granules in *G. yangmingshan* vs. with distinct granules in *G. miyakoensis*), the shape of the external orbital angle (acutely triangle vs. rounded), and the length/width ratio of the G1 terminal segment [3.1 vs. 1.74 (1.38-1.96)].

Freshwater crabs of the genus *Geothelphusa* are distributed to Taiwan (31 species), the Ryukyu Islands (9 species), and main islands of Japan (2 species, totally 10 species in Japan). The present work brings the number of species in this genus to 42.

Because of their life history and habitat, potamid crabs are considered by some authors to be good indicators of biogeography (Ng, 1988; Ng & Rodríguez, 1995). From Miyako-Jima, where it has been assumed to be once submerged and never been connected to other lands after submergence, the potamid crab, *G. miyakoensis*, was discovered for the first time. This finding may make it necessary to reconsider paleogeographical hypotheses of Miyako-Jima such as mid-Pleistocene submergence and the lack of connections after mid-Pleistocene.

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