

# A NEW SPECIES OF ALPINE FRESHWATER CRAB (BRACHYURA, POTAMIDAE) FROM SIANGYANG NATIONAL FOREST RECREATION AREA, TAIWAN

BY

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## ABSTRACT

A new species of freshwater crab, *Geothelphusa haituan*, is described from the SiangYang National Forest Recreation Area, adjacent to the southeastern part of YuShan National Park in Taiwan. *G. haituan* is a small-sized Alpine species, obtained at an elevation of about 2000 m a.s.l. The species is diagnosed and figured, and compared with allegedly allied species. Detailed features of the male first gonopod are examined using scanning electron microscopy (SEM), and part of the species' COI gene was analysed.

## RÉSUMÉ

Une nouvelle espèce de crabe d'eau douce *Geothelphusa haituan*, provenant du "SiangYang National Forest Recreation Area", proche de la partie sud-est du parc national YuShan à Taiwan, est décrite. *G. haituan* est une petite espèce alpine, récoltée à une altitude d'environ 2000 m. Une diagnose, des figures et une comparaison avec les espèces supposées proches sont données. Les détails des caractéristiques du premier gonopode du mâle ont été examinés au microscope à balayage et une partie du gène COI de l'espèce a été analysé.

## INTRODUCTION

SiangYang National Forest Recreation Area is adjacent to the southeastern part of YuShan National Park (YSNP) in the Central Mountain Range (Yushan ShanMo), of Taiwan (fig. 1, c). It is a typical, subtropical mountainous region,

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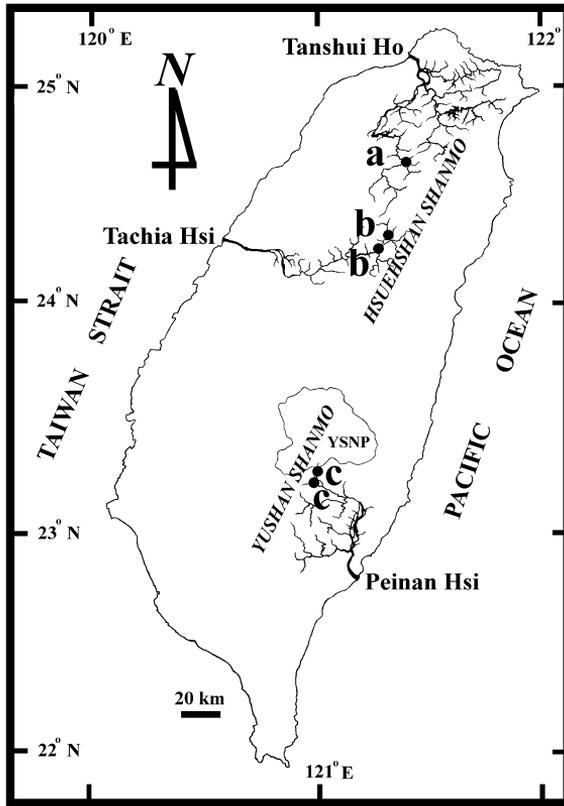


Fig. 1. The locality of: c, *Geothelphusa haituan* sp. nov.; as well as those of: a, *G. takuan* Shy, Ng & Yu, 1994; and, b, *G. monticola* Shy, Ng & Yu, 1994 in Taiwan. YSNP, Yushan National Park.

elevation more than 2000 m a.s.l., and includes the headwater of drainage in eastern Taiwan (Peinan Hsi River) (Kuo et al., 2002). The present new species, *Geothelphusa haituan*, was found in this area (fig. 1, c).

According to survey records, there are two common species of *Geothelphusa* Stimpson, 1858 that are small-sized and Alpine (= living at altitudes above 1500 m) in Taiwan, viz., *Geothelphusa takuan* Shy, Ng & Yu, 1994 and *Geothelphusa monticola* Shy, Ng & Yu, 1994 (cf. Shy et al., 1994). *Geothelphusa haituan* new species belongs to the Alpine potamid fauna as well.

*Geothelphusa haituan* is most similar to *G. takuan* and *G. monticola* from northern and central Taiwan, respectively (fig. 1, a, b). They can, however, easily be separated by morphological characters of the male first gonopods and the molecular composition of a partial sequence (658 bps) of the COI gene of the mtDNA.

With the present new species, there are now 35 species of the genus *Geothelphusa* recorded from Taiwan (Shy et al., 1994; Tan & Liu, 1998; Shy & Yu, 1999; Shy et al., 2000; Ng et al., 2001; Chen et al., 2003, 2005; Shy, 2005).

## MATERIALS AND METHODS

Specimens examined are deposited in Department of Biological Sciences, National Sun Yat-sen University (NSYSU), Kaohsiung, Taiwan. Scanning electron microscopy (SEM) techniques were used to observe the male right first gonopod, as modified from Felgenhauer (1987). The following measurements and abbreviations are used: CW, carapace width; CL, carapace length; G1, male first gonopod (pleopod); G2, male second gonopod; TLG1, total length of G1; SW, width of subterminal segment of G1; TSL, length of terminal segment of G1; TSW, width of terminal segment of G1; SML, length of synovial membrane of G1; and SMW, width of synovial membrane of G1. The direction of the curvature of the tip of the G1 (TD) is defined as follows: “curving outwards”, tip with curvature in direction with angle greater than  $95^\circ$  in ventral view; “curving inwards” tip with curvature in direction with angle smaller than  $85^\circ$ ; and “curved upwards”, tip with curvature in direction with angle  $86^\circ$ - $94^\circ$ . The common molecular methods followed Yu (2002) and the primers designed were f-TTTCTACAAATCATAAAGACATCG and r-TATACTTCAGGATGACCGAAAAATCA. Some measurements and terms for morphology used in this study essentially follow those of Ng (1988), Shy et al. (1994), and Dai (1999).

## TAXONOMIC ACCOUNT

Genus *Geothelphusa* Stimpson, 1858***Geothelphusa haituan* sp. nov.**

(figs. 2, 3)

Material examined. — Holotype: male (18.4 by 13.9 mm), NSYSU F91101901, Haituan, Taidong county, 2000 m a.s.l.,  $23.14^\circ\text{N}$   $120.59^\circ\text{E}$ , coll. W.-J. Chen & Z.-S. Sun, 19 Oct. 2002. — Paratypes: 2 males, 6 females, and 3 juveniles (largest male 18.2 by 14.2 mm, largest female 20.2 by 15.5 mm), NSYSU F911019011, same data as holotype. — Other specimens: 1 male, 2 females, and 3 juveniles (largest male 17.2 by 13.3 mm, largest female 19.7 by 15.1 mm), NSYSU F92030201, Haituan, Taidong county, coll. W.-J. Chen, 2 March 2003; 1 male (15.6 by 11.8 mm), NSYSU F92030202, same locality as NSYSU F91101901, coll. W.-J. Chen, 2 March 2003.

Comparative material. — *Geothelphusa takuan* and *Geothelphusa monticola*: all specimens examined that were reported in Shy et al. (1994).

Description of holotype (male). — Carapace (figs. 2A, 3A) moderately squarish, width and length about 2.2 and 1.7 times depth, respectively; width about 1.3 times length; frontal width about 0.34 times carapace width. Dorsal surface with fine pits, gastric region smooth, posterolateral regions with short striae. Postorbital crista faint, orbital and frontal regions gently depressed, divided into 2 lobes. Anterolateral margin distinctly cristate, lined with small granules, epibranchial

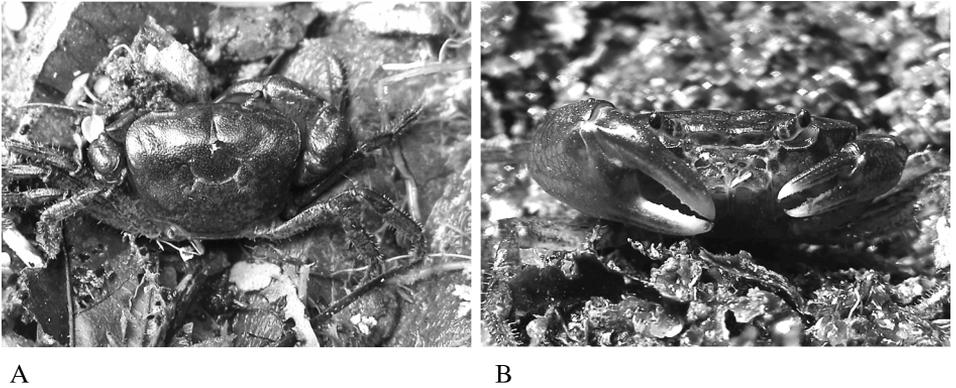


Fig. 2. *Geothelphusa haituan* sp. nov. Holotype male, NTSYS F91101901, 18.4 by 13.9 mm. A, dorsal view; B, frontal view.

tooth absent. Cervical groove faint. H-shaped gastric groove distinct. Posterior epistomial margin sinuous, median lobe not acutely triangular.

Third maxilliped (fig. 3B) with rectangular ischium, width about 0.73 times length, bearing distinct median sulcus; merus subquadrate, with shallow median depression. Exopod reaching to half the length of outer margin of merus, with long flagellum.

Abdomen of male and female with 7 distinct body segments (including telson); in male, length of telson (fig. 3C) 0.9 times width, longer than 6th somite. Distance between tip of male abdomen and anterior margin of thoracic sternite 4 about 1.45 times length of sternites 1-3. Thoracic sternites with scattered single setae, margins with longer setae; suture between sternites 1-3 and 4 and near median part of sternite 4 with transverse and oblique rows of long setae, respectively.

Chelipeds unequal, major chela (fig. 3D) with outer surface of palm smooth, upper margin length more than 0.6 times length of dactylus, height 0.6 times length of chela; length of dactylus 0.7 times that of chela; fingers with about 10 and 13 cutting teeth on cutting margins of dactylus and pollex, respectively. Dactylus slender, deflexed, forming an obliquely triangular gape when fingers closed. Distal part of outer face of pollex with 2 rows of fine pits. Carpus (fig. 3E) of major chela with a strong inner spine, with 2 or 3 fine setae on upper surface and a subequal one below it. Outer surface of carpus with fine striae and pits. Inner margin of merus with a longitudinal row of low tubercles slightly displaced to outer face, with scattered fine setae.

Ambulatory legs (fig. 3F, G) slender, merus narrow, with simple setae; second leg longest, last leg shortest. Second ambulatory leg about 2.1 times carapace length. Length to width ratios of second ambulatory propodus and dactylus 0.35 and 0.28, respectively, propodus 0.8 times dactylus. Each of longitudinal margins of dactylus and propodus with a row of 6-11 and 4 spines, respectively.

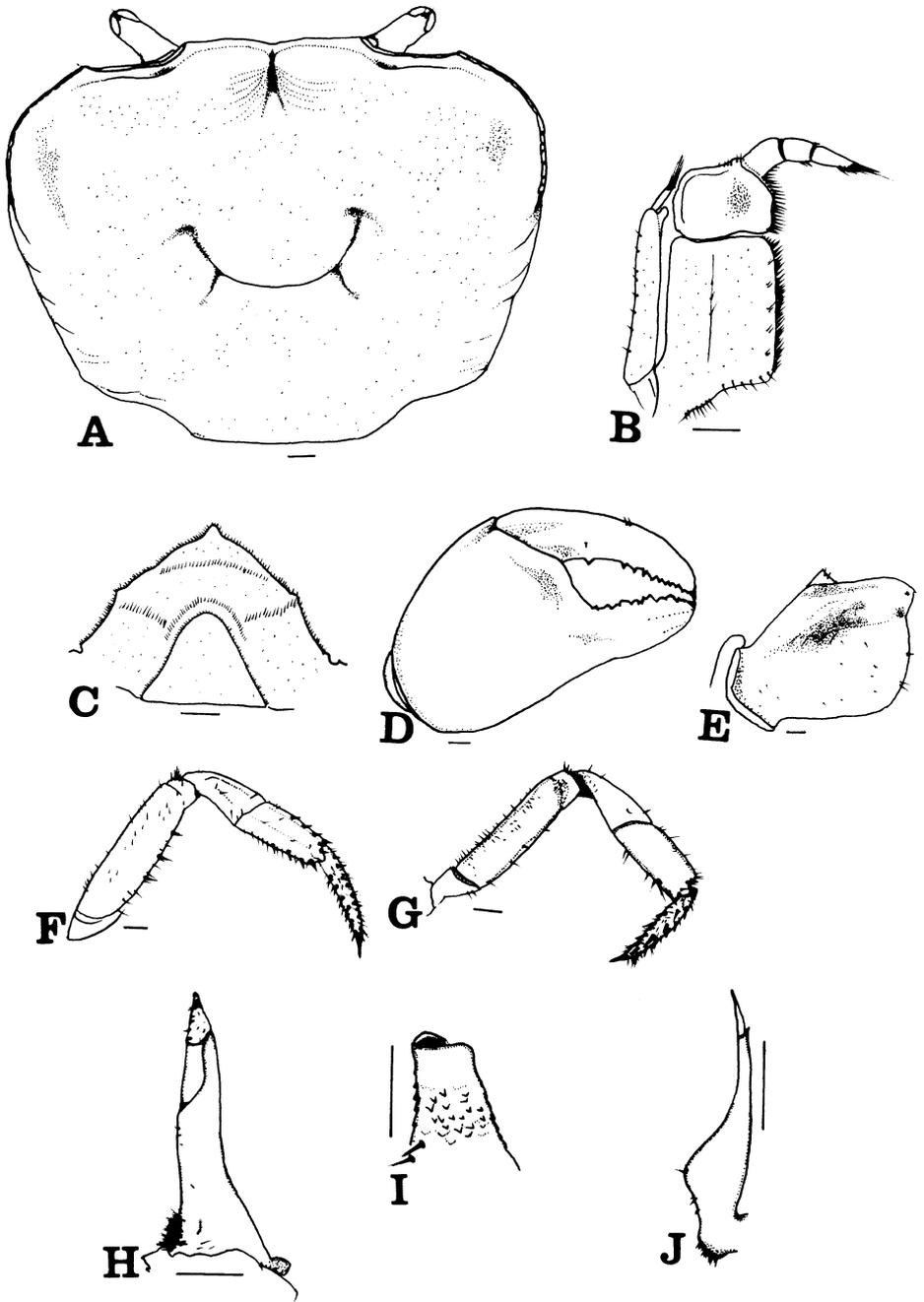


Fig. 3. *Geothelphusa haituan* sp. nov. Holotype male, NTSYS F91101901, 18.4 by 13.9 mm. A, carapace; B, right third maxilliped; C, anterior part of thoracic sternite; D, E, carpus of right cheliped in dorsal view; F, G, right second and last ambulatory legs in dorsal view; H, I, right G1 dorsal view and tip of terminal segment; J, right G2 dorsal view. Scales = 1.0 mm, except in b = 0.5 mm.

G1 (fig. 3H) subterminal segment straight; outer proximal margin with a protuberance and inner proximal margin dilated, both proximal margins with plumose setae, especially on inner proximal margin. Terminal segment of G1 straight, slightly curved outwards, 4-5 rings of distal scales are distributed, and subterminal segment has, sparsely, small spines. Total length of G1 is 5.7 times that of terminal segment, 2.6 times width of subterminal segment width. Terminal segment of G1 with length 2.1 times its width.

G2 (fig. 3J) with median part of outer margin of basal segment strongly dilated; distal segment straight, flat, directed forwards, with length 0.15 of total length of G2.

Coloration. — In life, carapace and upper surface of ambulatory legs dark brown, but posterior half of carapace slightly dark purple, with dark brown spots. Dorsal part of outer and inner surfaces of cheliped light purple.

Habitat. — High altitude habitats (approximately 2000 m a.s.l.). The species inhabits shallow burrows near crevices of shale, usually near springs. The surrounding flora includes lichens, mosses, and sedges.

Distribution. — Eastern Taiwan, SiangYang National Forest Recreation Area.

Etymology. — The species is named after its type locality and the name is used as a noun in apposition.

Remarks. — This species is similar to *G. takuan* Shy, Ng & Yu, 1994 and *G. monticola* Shy, Ng & Yu, 1994, from northern and central Taiwan, respectively (fig. 1, a, b). They can be distinguished in the following aspects. (1) The morphological characters of G1 with SEM (table I): in *G. haituan*, the total length of the G1 is 5.7 times the length of the terminal segment, as opposed to 6.1 and 4.5 times in *G. takuan* and *G. monticola*, respectively; in *G. haituan*, the length of the G1 synovial

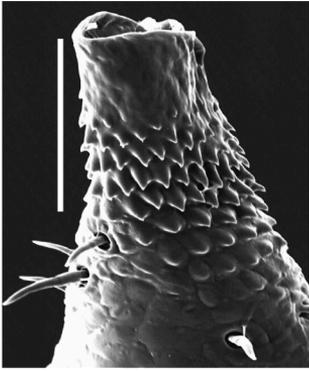
TABLE I

The G1 ratios of *Geothelphusa haituan* sp. nov., *G. monticola* Shy, Ng & Yu, 1994, and *G. takuan* Shy, Ng & Yu, 1994 were checked by SEM; G2 by dissecting microscope. G1, first gonopod; G2, second gonopod; CW, carapace width; CL, carapace length; TLG1, total length of G1; TLG2, total length of G2; SW, subterminal segment width; TSL, terminal segment length; TSW, terminal segment width; SML, synovial membrane length; SMW, synovial membrane width; FAL, distal segment length of G2. All terms follow Shy et al. (1994)

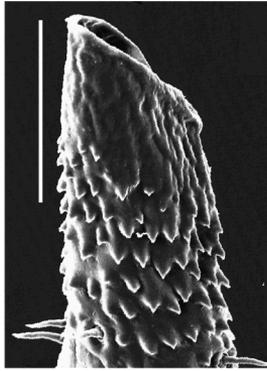
Characteristics	<i>G. haituan</i>	<i>G. takuan</i>	<i>G. monticola</i>
CW × CL	18.4 × 13.9	17.4 × 13.0	18.3 × 14.1
G1 TLG1/SW	2.6	2.4	2.2
G1 TLG1/TSL	5.7	6.1	4.5
G1 TSL/TSW	2.1	2.2	3.4
G1 SML/SMW	2.6	2.9	2.8
G2 FAL/TLG2 <sup>b</sup>	0.16	0.12 <sup>a</sup>	0.15 <sup>a</sup>

a, after Shy et al. (1994); b, by dissecting microscope.

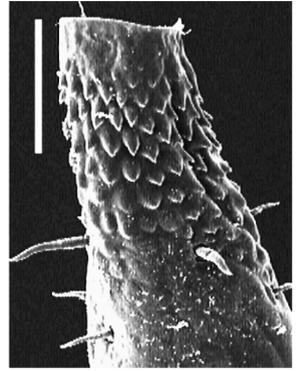




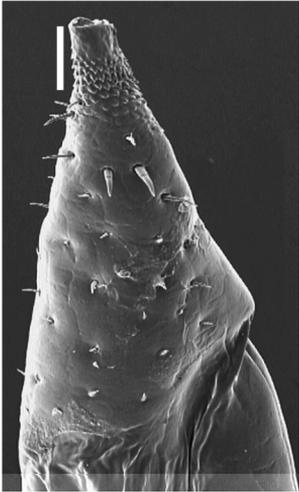
A1



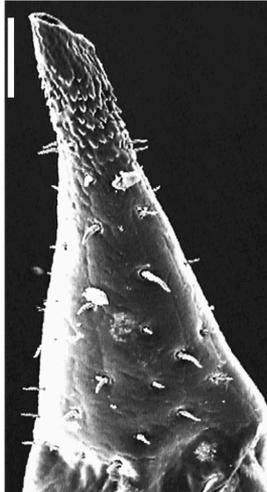
B1



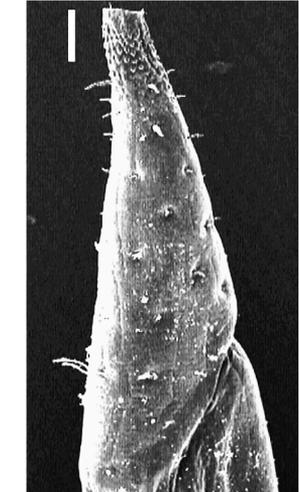
C1



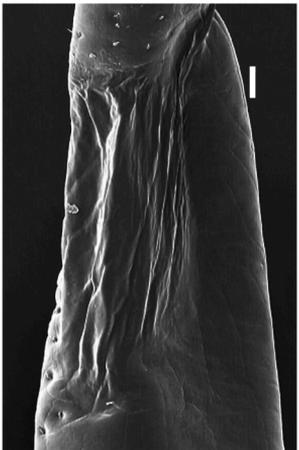
A2



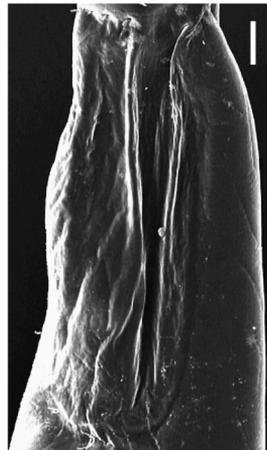
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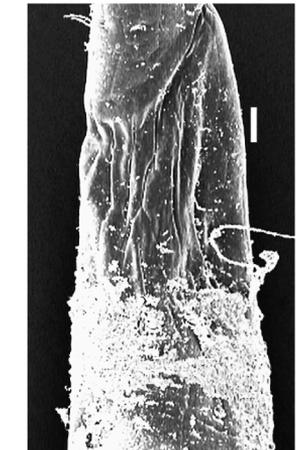
C2



A3



B3



C3

membrane is 2.6 times its width, against 2.9 and 2.8 times in *G. takuan* and *G. monticola*, respectively; in *G. haituan* and *G. monticola*, the terminal segment of G1 is straight and curves slightly outwards, whereas in *G. takuan* it curves inwards. (2) Molecular characters: with regard to a fragment of their COI DNA sequence of mtDNA, they can easily be separated by their distinct genotype. There are 55 different sites in a 658-bp portion of the mitochondrial COI gene among them (table II). There are 27 different sites (4.10%) between *G. takuan* and *G. monticola*, 54 such sites (8.21%) between *G. takuan* and *G. haituan*, and 42 such sites (6.38%) between *G. monticola* and *G. haituan*. The Kimura 2-parameter pairwise distance ( $\pm$ S.E.) (Kimura, 1980) between any two genotypes varied from  $0.043 \pm 0.008$  (*G. takuan* and *G. monticola*) to  $0.069 \pm 0.011$  (*G. monticola* and *G. haituan*), and  $0.066 \pm 0.011$  (*G. takuan* and *G. haituan*).

#### NOTES ON THE MICROMORPHOLOGICAL CHARACTERISTICS OF G1 UNDER SEM

### ***Geothelphusa haituan* sp. nov.**

(fig. 4A)

Material examined. — Holotype: male (18.4 by 13.9 mm), NSYSU F91101901, Haituan, Taidong county, 2000 m a.s.l., 23.14°N 120.59°E, coll. W.-J. Chen & Z.-S. Sun, 19 Oct. 2002.

Diagnosis. — Total length of G1 about 4.7 mm. Terminal segment curved outwards ( $TD = 103^\circ$ ) and above sternal condyle, distal part with 4 or 5 rings of scales (fig. 4A1) and a mean maximum diameter of  $200.1 \mu\text{m}$ ; dorsal view of terminal segment with 11 long simple setae and 26 short simple setae (fig. 4A2); diameter of apical opening of ejaculatory canal about  $49.2 \mu\text{m}$ ; length and width of base about 0.8 mm and  $390.0 \mu\text{m}$ , respectively.

Subterminal segment straight, width about 1.8 mm; with length to width ratio of synovial membrane about 2.6, margin of base demarcated by low, V-shaped notch, upper margin slightly concave (fig. 4A3); with a protuberance on outer proximal margin. Proximal margin and base of subterminal segment setose, outer margin with plumose setae more sparsely distributed than on inner margin.

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Fig. 4. Micromorphology of the right G1 of freshwater crabs of the genus *Geothelphusa* Stimpson, 1858 by SEM. A, *G. haituan* sp. nov., holotype male, NSYSU F91101901, 18.4 by 13.9 mm; B, *G. takuan* Shy, Ng & Yu, 1994, NSYSU F92070902, 17.4 by 13.0 mm; C, *G. monticola* Shy, Ng & Yu, 1994, NSYSU F92030104, 18.3 by 14.1 mm; 1, dorsal view of terminal segment, distal part magnified; 2, dorsal view of terminal segment; 3, synovial membrane. Scales =  $100 \mu\text{m}$ .

***Geothelphusa takuan* Shy, Ng & Yu, 1994**  
(fig. 4B)

Material examined. — Male (17.4 × 13.0 mm), NSYSU F92070902, Fuhsing, Takuan, Taoyuan county, coll. W.-J. Chen & C.-F. Tseng, 9 July 2003.

Diagnosis. — G1 under SEM: Total length of G1 about 4.6 mm. Terminal segment curved inwards (TD = 60°) and above sternal condyle, distal part with 6 or 7 rings of scales (fig. 4B1) and a mean maximum diameter of 210.8 μm; dorsal view of terminal segment with 13 long simple setae and 20 short simple setae (fig. 4B2); diameter of apical opening of ejaculatory canal about 43.8 μm; length and width of base about 0.8 mm and 341.7 μm, respectively.

Subterminal segment straight, width about 1.9 mm; with length to width ratio of synovial membrane about 2.9, margin of base demarcated by low, broadly concavity, upper margin horizontal (fig. 4B3); with a protuberance on outer proximal margin. Proximal margin and base of subterminal segment setose, inner margin with plumose setae more densely distributed than on outer margin.

***Geothelphusa monticola* Shy, Ng & Yu, 1994**  
(fig. 4C)

Material examined. — Male (18.3 × 14.1 mm), NSYSU F92030104, Hoping, Songmao, Taichung county, coll. W.-J. Chen & Z.-S. Sun, 1 March 2003.

Diagnosis. — G1 under SEM: Total length of G1 about 4.7 mm. Terminal segment curved outwards (TD = 102°) and slightly above sternal condyle, distal part with 4 or 5 rings of scales (fig. 4C1) and a mean maximum diameter of 169.9 μm; dorsal view of terminal segment with 4 long simple setae and 19 short simple setae (fig. 4C2); diameter of apical opening of ejaculatory canal about 51.7 μm; length and width of base about 1.0 mm and 298.8 μm, respectively.

Subterminal segment straight, width about 2.1 mm; with length to width ratio of synovial membrane about 2.8, margin of base demarcated by low, narrow concavity, upper margin oblique (fig. 4C3); with a low protuberance on outer proximal margin. Proximal margin and base of subterminal segment setose, plumose setae more densely distributed on inner margin.

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