

A new species of tree-hole dwelling freshwater crab of the genus *Arachnothelphusa* Ng, 1991 (Crustacea: Decapoda: Brachyura: Gecarcinucidae) from northern Sarawak, Malaysia, Borneo

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Abstract. A new species of tree-hole gecarcinucid freshwater crab, *Arachnothelphusa merarapensis*, is described from a primary dipterocarp forest near Merarap Hot Spring Resort in Lawas, northern Sarawak, Malaysia. This brings the number of species in the genus *Arachnothelphusa* found in Borneo to five, and it is likely that more species will be discovered from this island. The new species has preference for living in water-filled tree-holes, which is the first record of a tree-hole crab for Southeast Asia. The habitat characteristics and distribution of this new species are also discussed.

Key words. Brachyura, Gecarcinucidae, *Arachnothelphusa*, tree-hole, Sarawak, Borneo

INTRODUCTION

Ng (1989, 1991) reviewed the gecarcinucid genus *Thelphusula* Bott, 1969, and transferred a number of long-legged semi-terrestrial species from Borneo to two new genera, *Stygothelphusa* Ng, 1989, and *Arachnothelphusa* Ng, 1991 (see also Tan & Ng, 1998; Ng, 2013; Ng & Grinang, 2014; Grinang & Ng, 2014). Members of *Stygothelphusa* are cavernicolous in habit, have reduced body pigmentation, proportionately longer ambulatory legs, a relatively squarish carapace outline, and distinctly structured male first and second gonopods. This genus currently includes four species viz. *S. bidiense* (Lanchester, 1900), *S. nobilii* (Colosi, 1920), *S. cranbrookii* Ng, 2013, and *S. antu* Ng & Grinang, 2014 (Ng, 1989, 2013; Ng & Grinang, 2014). In comparison, most species of *Arachnothelphusa* are free living, have relatively shorter ambulatory legs, a more transversely ovate carapace outline, and differently proportioned male first and second gonopods. This genus currently contains four species, viz. *Arachnothelphusa melanippe* (De Man, 1899) [central Kalimantan], *A. kadamaiana* (Borradaile, 1900) [northern Sabah], *A. rhadamanthysi* Ng & Goh, 1987 [eastern Sabah], and *A. terrapes* Ng, 1991 [eastern Sabah]. Interestingly, *Stygothelphusa* has only been recorded from limestone caves in western Sarawak, whereas *Arachnothelphusa* is more widely distributed in Borneo. Here we describe a fifth species of *Arachnothelphusa*, *A. merarapensis*, new species, the first member of the genus to be recorded from Sarawak.

MATERIAL AND METHODS

The terminology used essentially follows Ng (1988), with the abbreviations G1 and G2 used for the male first and second gonopods, respectively. Measurements provided (in millimetres) are of the carapace width and length, respectively. Specimens examined are deposited in the Sarawak Biodiversity Centre (SBC), Kuching, Sarawak, Malaysia; the Senckenberg Museum (SMF), Frankfurt am Main, Germany; and the Zoological Reference Collection (ZRC) of the Lee Kong Chian National History Museum (ex Raffles Museum of Biodiversity Research), National University of Singapore.

TAXONOMY

Family Gecarcinucidae Rathbun, 1904

Arachnothelphusa merarapensis, new species

(Figs. 1–3)

Material examined. Holotype: male (22.5 × 16.8 mm) (ZRC), water-filled tree-hole, ca. 100 cm above ground, steep dipterocarp forest, Merarap Hot Spring Resort, Lawas, northern Sarawak, Malaysia, Borneo, 4°22'25.4"N 115°26'10.1"E, 485 m asl, coll. J. Grinang & Y.M. Pui, 31 October 2014. Paratype: 1 female (19.9 × 15.2 mm) (SBC.C.00376), water-filled hole of tree buttress, ca. 90 cm above ground, steep dipterocarp forest, Merarap Hot Spring Resort, Lawas, northern Sarawak, Malaysia, Borneo, 4°22'16.5"N 115°26'12.4"E, 494 m asl, coll. J. Grinang & Y.M. Pui, 1 November 2014; 1 female (22.3 × 16.1 mm) (SBC.C.00377), water-filled hole of tree buttress, ca. 30 cm above ground, same data as paratype, coll. Y.M. Pui, 27 February 2013.

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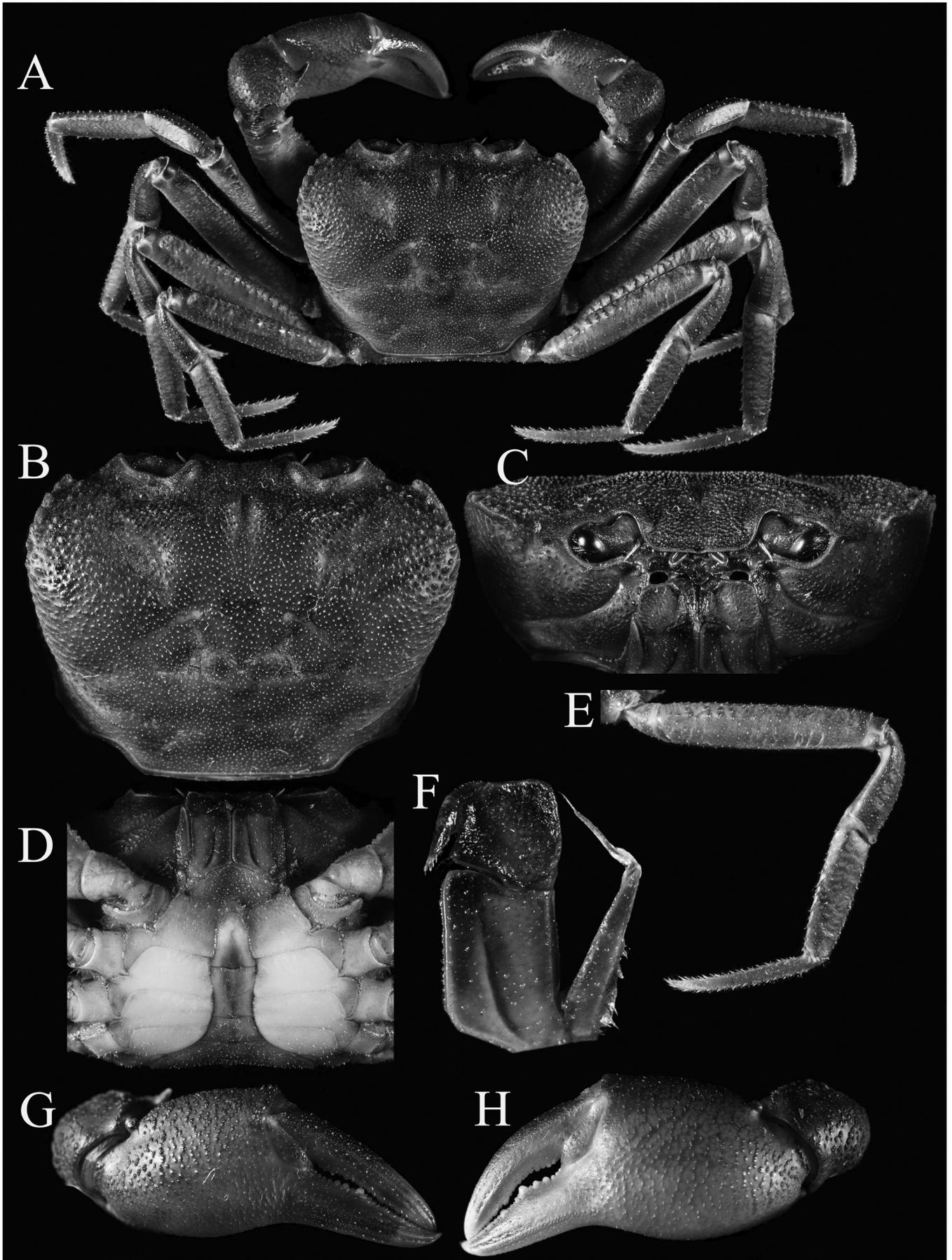


Fig. 1. *Arachnothelphusa merarapensis*, new species, holotype male (22.5 × 16.8 mm) (ZRC), Merarap Hot Spring, Lawas, Sarawak. A, overall dorsal view of habitus; B, dorsal view of carapace; C, frontal view of carapace; D, ventral view showing anterior thoracic sternum and male abdomen; E, outer view of right fourth ambulatory leg; F, left third maxilliped showing exopod; G, outer view of right chela; H, outer view of left chela.

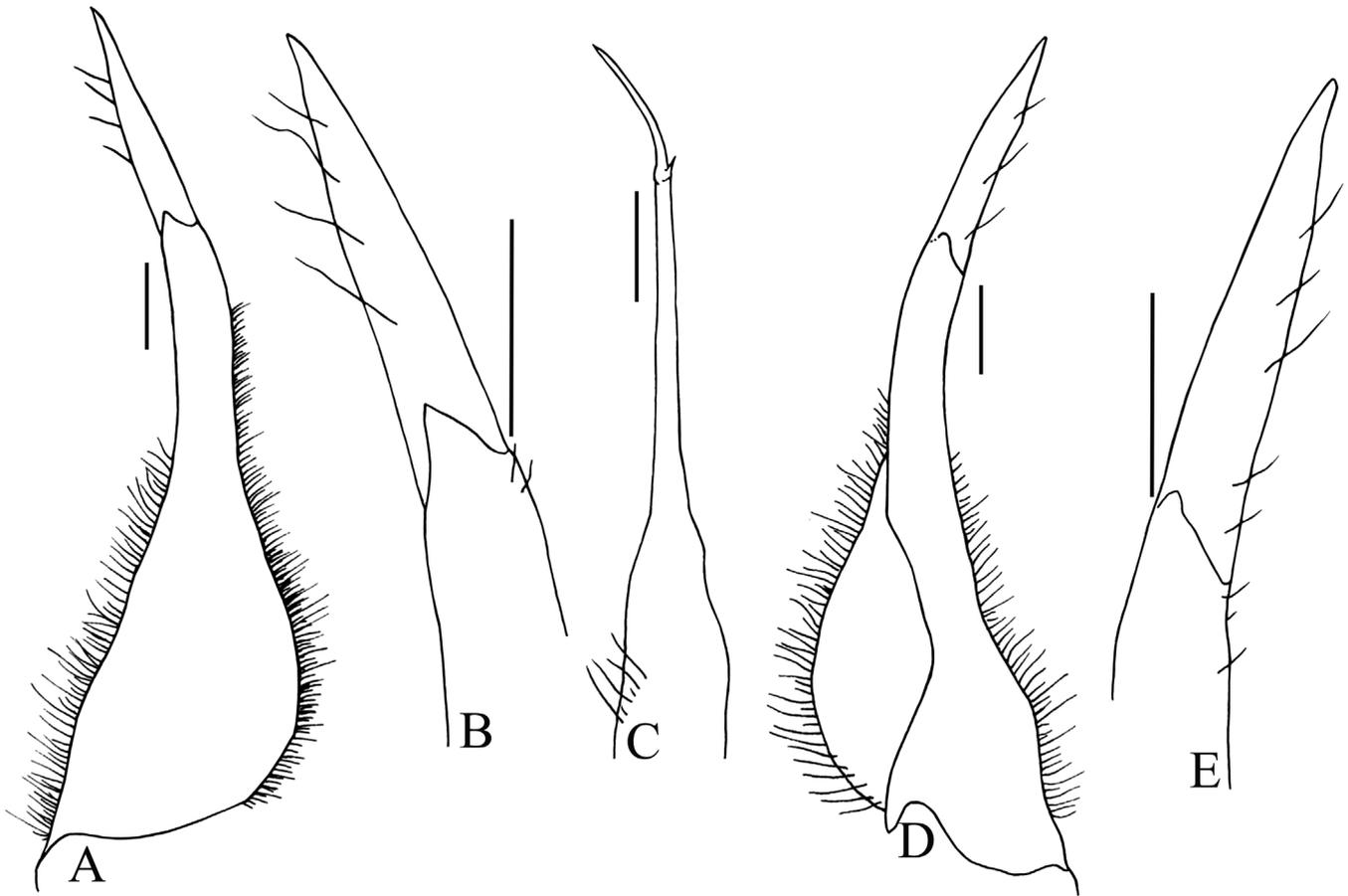


Fig. 2. *Arachnothelphusa merarapensis*, new species, holotype male (22.5 × 16.8 mm) (ZRC), Merarap Hot Spring, Lawas, Sarawak. A, dorsal view of left G1; B, dorsal view of distal part of left G1; C, dorsal view of left G2; D, ventral view of left G1; E, ventral view of distal part of left G1. Scale bars = 0.5 mm.

Comparative material. *Arachnothelphusa kadamaiana* (Borradaile, 1900): Holotype female (18.9 × 13.5 mm) (SMF 4281), Kadamian River, Sabah, Malaysia, Borneo; 1 male (20.1 × 14.9 mm) (SMF 4282), same data as holotype; 1 female (23.2 × 17.1 mm) (ZRC 2009.0094), Poring, Basin 1A, Sabah, Malaysia, Borneo, coll. R.F. Inger et al., 12 August 1992.

Diagnosis. Carapace surface convex, rugose, finely granular; regions distinct, branchial regions slightly inflated; epigastric and postorbital cristae distinct; cervical and H-shaped gastric grooves deep, not confluent; anterolateral margins convex, serrated; antero- and posterolateral regions prominently rugose, covered with numerous coarse granules; epibranchial tooth acutely triangular, distinctly separated from external orbital angle by wide, deep cleft; external orbital angle acutely triangular, outer margin slightly concave, distinctly serrated (Figs. 1A–C, 3). Ischium of third maxilliped rectangular, oblique median sulcus deep (Fig. 1F). Outer surfaces of chelipeds distinctly rugose; carpus rugose, with granules, inner angle with broadly triangular tooth; cutting edge of pollex with larger median tooth (Fig. 1A, G, H). Ambulatory legs long; merus unarmed, dorsal margin gently serrated; outer surface rugose; fourth ambulatory merus subequal to length of carapace (Fig. 1A, E). Male abdomen T-shaped, lateral margins of somites 5 and 6 distinctly concave; somite 6 subequal to length of telson; lateral margins of telson

concave (Fig. 1D). G1 slender, sinuous, gently curving outwards; terminal segment cylindrical, tapering, about half of length of subterminal segment (Fig. 2A, B, D, E). G2 with short distal segment, about a quarter length of basal segment (Fig. 2C).

Size. All species of *Arachnothelphusa* are relatively small, with the largest recorded male a freshly moulted specimen of *A. terrapes* measuring 25.7 mm by 18.6 mm (Ng, 1991). The holotype male of *A. merarapensis*, new species, is 22.5 mm by 16.8 mm.

Variation. The two female paratypes agree well with the holotype male, differing only in minor non-sexual characters: the cervical and H-grooves are proportionately deeper in the larger female, and the ambulatory legs slightly longer. The antero- and posterolateral regions also have relatively more coarse granules in the larger female specimen.

Etymology. The species is named after Merarap, the type locality where it was collected.

Colour. In life the carapace, chelipeds, and walking legs are bright purple; the ventral surfaces of the ambulatory legs and chelipeds are lighter coloured, and the distal parts of the fingers are cream-white (Fig. 3A, B).

Remarks. The high density of granules and roughness of the dorsal carapace surface of *A. merarapensis* (Fig. 1A, B) easily distinguishes it from its other congeners which have a relatively smoother dorsal carapace surface covered with small granules and scattered striae (cf. Fig. 5; De Man, 1899: pl. 9 fig. 11; Ng & Goh, 1987: pl. 3A; Ng, 1991: figs. 1, 3–5 [incorrectly labelled as fig. 5 with next two figure captions not printed]). The acutely triangular external orbital tooth separated by a wide and deep cleft is diagnostic for *A. merarapensis* (Fig. 1A, B). In *A. melanippe* the epibranchial tooth is distinct but relatively small and separated from the broadly triangular external orbital tooth by a small cleft (cf. De Man, 1899: pl. 9 fig. 11; Ng, 1991: fig. 1); in *A. kadamaiana* the epibranchial tooth is low and the external orbital tooth is broad, with these two teeth appearing almost confluent with hardly any indication of a cleft (Figs. 5A, 6A); in *A. rhadamanthysi* the external orbital and epibranchial teeth are both relatively broad due to the wide carapace (Ng & Goh, 1987: pl. 3A, B); and in *A. terrapes* there is a deep and broad U-shaped cleft separating the epibranchial tooth from the obtuse and truncate external orbital angle (Ng, 1991: fig. 3 [incorrectly printed as fig. 5]). The terminal segment of the G1 is long in *A. merarapensis*, about half the length of the subterminal segment (Fig. 2A, B, D, E); it is about one-third the length of the subterminal segment in *A. melanippe* (cf. Ng, 1991: fig. 2C–F), and only a quarter of the length of the subterminal segment in *A. kadamaiana* and *A. terrapes* (Fig. 6C–F; Ng, 1991: fig. 6D–G). The G1 terminal segment of *A. terrapes* is also distinct from all congeners in that it is gently curved upwards (Ng, 1991: fig. 6D–G). The G1 of *A. rhadamanthysi* is not known because no males of this species have been collected as yet.

The live colours of *A. melanippe* and *A. kadamaiana* are not known. *Arachnothelphusa terrapes* has brown to reddish-brown carapace, chelipeds, and walking legs (Ng, 1991: figs. 4, 5 [erroneously not labelled in original paper]) while *A. rhadamanthysi* has a straw yellow coloured carapace and pereopods (Ng & Goh, 1987: 326). The live colour of the carapace and pereopods of *A. merarapensis* is bright purple (Fig. 3A, B).

The taxonomy of genus *Arachnothelphusa* has been discussed at length by Ng (1991). One poorly known Sarawakian species provisionally included in the genus by Ng (1991), *Parathelphusa (Liothelphusa) nobilii* Colosi, 1920, was later shown to be a species of *Stygothelphusa* Ng, 1989 (see Ng & Álvarez, 2000; Ng, 2013). The new species, *A. merarapensis*, described here is clearly member of *Arachnothelphusa* because it has long ambulatory legs, a transversely ovate carapace, convex anterolateral margins, rugose antero- and posterolateral carapace regions, a slender G1 whose terminal segment is elongated and at least a quarter the length of the subterminal segment, and an elongate G2 with a short distal segment (Ng, 1991: 2).

All species of *Arachnothelphusa* are semi-terrestrial in habit and have been recorded from limestone caves and high elevation habitats (Ng, 1991). Although a specimen of one species, *A. terrapes*, was found on a tree stump (Ng, 1991:



Fig. 3. The colour in life of *Arachnothelphusa merarapensis*, new species, holotype male (22.5 × 16.8 mm) (ZRC), Merarap Hot Spring, Lawas, Sarawak. A, dorsal view; B, frontal view.

11), until the present report there has been no evidence that these freshwater crabs are arboreal and live in tree holes. *Arachnothelphusa merarapensis*, new species, is therefore the first species of this genus known to be a true phytotelm crab. All known *Arachnothelphusa* species seemed to display a discrete distribution, but future molecular studies are needed to enhance our knowledge on their phylogeographic pattern in this region.

Habitat. The habitat of *A. merarapensis* is a steep primary dipterocarp forest with a closed canopy, near the thermal springs area of the Merarap Hot Spring Resort. The holotype male was caught from a water-filled tree-hole, ca. 22 cm deep, ca. 15 cm in diameter, and ca. 100 cm above ground (Fig. 4). The bottom layer of the tree-hole consists of finely decomposed organic material (plant and arthropod debris), with the other two-thirds filled with water which increases after heavy rain. The two other specimens were caught from the water-filled crevices of tree buttresses. One buttress-crevice had a diameter of about 26 cm, was 60 cm deep, and 90 cm above the ground, and contained tightly compacted roots and leaf litter, with a hole dug into this that was apparently constructed by the crab. The other buttress-crevice runs along the side of the buttress and is about 30 cm above ground, shallow (15 cm), horizontal, and 30 cm deep. For two consecutive nights, the first two authors examined more than 15 tree-holes and crevices of different form, size, and conditions (either water-filled, dry, or debris-filled tree-holes), but we were only able to locate three specimens. This species is nocturnal and highly sensitive to light. We did not find any burrows on the soil around the tree-holes, suggesting the crab is a tree-hole specialist.

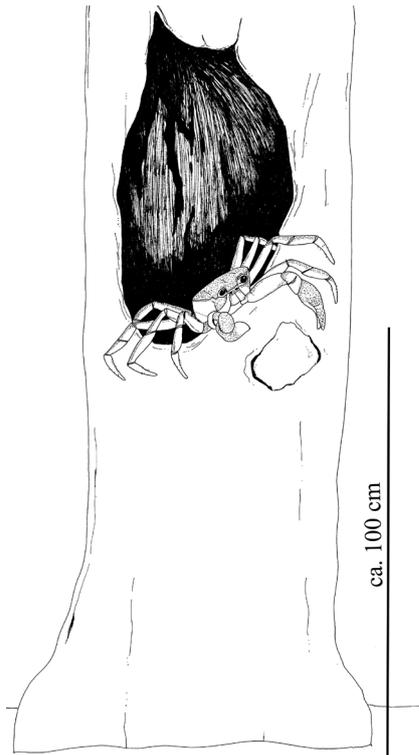


Fig. 4. Illustration of *Arachnothelphusa merarapensis*, new species, holotype male (22.5 × 16.8 mm) (ZRC), emerging at night from its filled-water tree-hole in primary dipterocarp forest, Merarap Hot Spring, Lawas, Sarawak.

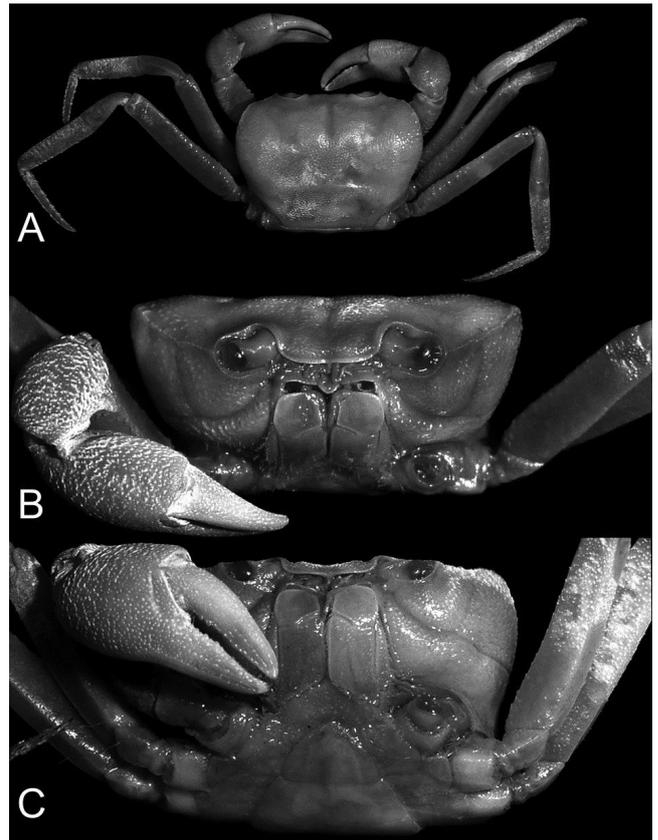


Fig. 5. *Arachnothelphusa kadamaiana* (Borradaile, 1900), holotype female (18.9 × 13.5 mm) (SMF 4281), Kadamian River, Sabah. A, overall dorsal view of habitus; B, frontal view of carapace; C, ventral view showing abdomen, third maxillipeds and chelae.

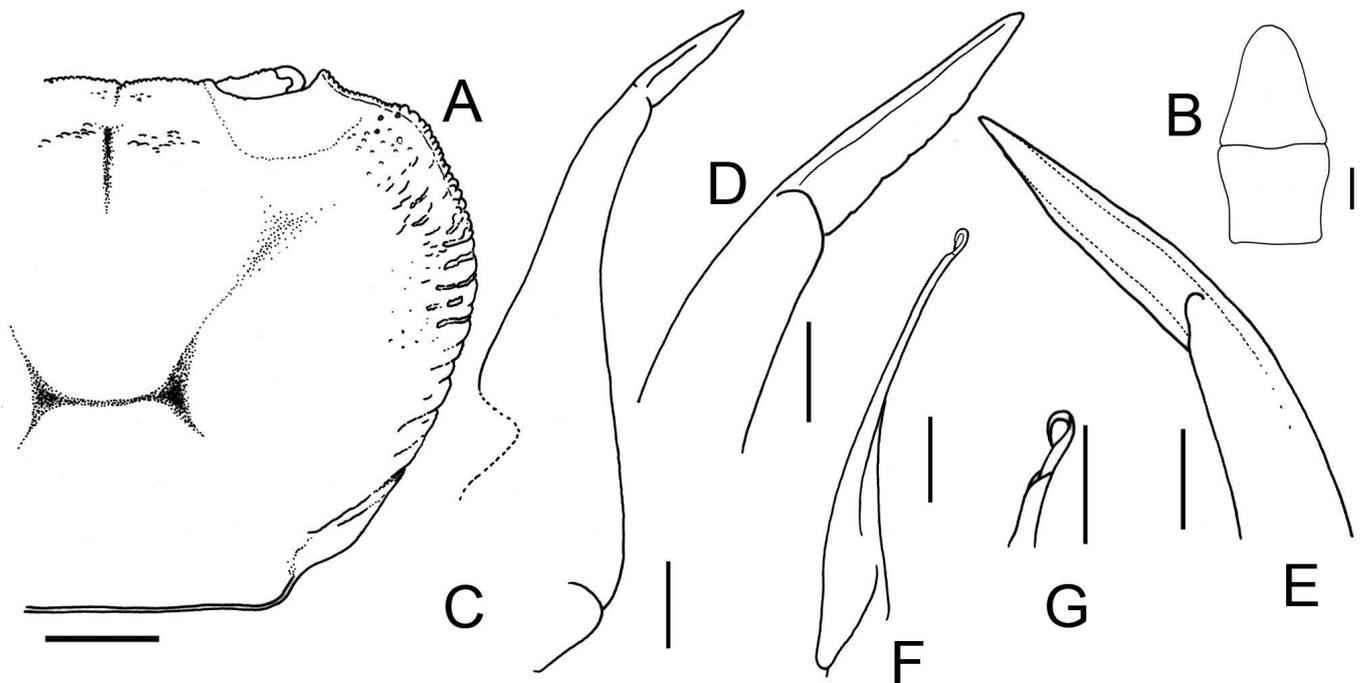


Fig. 6. *Arachnothelphusa kadamaiana* (Borradaile, 1900), male (20.1 × 14.9 mm) (SMF 4282), Kadamian River, Sabah. A, right side of carapace; B, male abdominal somite 6 and telson; C, ventral view of left G1; D, ventral view of terminal segment of left G1; E, dorsal view of terminal segment of left G1; F, left G2; G, distal segment of left G2. Setae denuded for all structures. Scale bars: 3.0 mm (A); 1.0 mm (B); 0.5 mm (C, F); 0.25 mm (D, E, G).

Other true freshwater crabs from the Old World showing similar phytotelmic behaviour are *Potamonautes raybouldi* (Cumberlidge & Vannini, 2004) (Potamonautidae) in Tanzania, East Africa; *Globonantes macropus* (Rathbun, 1898) (Potamonautidae) in Liberia, West Africa; *Malagasya goodmani* (Cumberlidge, Boyko & Harvey, 2002) (Potamonautidae) in Madagascar; and *Perbrinckia scansor* (Ng, 1995) (Gecarcinucidae) in Sri Lanka (Ng, 1995; Cumberlidge & Sachs, 1991; Bayliss, 2002; Cumberlidge et al., 2002, 2005; Cumberlidge & Vannini, 2004; Bahir et al., 2008). In Sarawak, the sesarmid crab *Scandarma splendidum* has been reported climbing forest trees at night in western Sarawak (Naruse & Ng, 2007), but it is not known to be a phytotelm crab.

Conservation status. Considering unique habitat and probable limited distribution, *A. merarapensis* will easily be threatened by human activities, especially logging. The type locality is not protected but the forest is currently safe because it is part of the Merarap Hot Spring Resort. However, the forest in the vicinity is part of a concession allocated to logging companies and the future of the species is therefore uncertain. As such, we recommend that *A. merarapensis* should at least be listed as “Vulnerable” in the IUCN Red List of Threatened Species (cf. Cumberlidge et al., 2009).

Key to the species of *Arachnothelphusa*

1. Carapace surface covered with rough granules; external orbital angle separated from epibranchial tooth by deep, broad cleft.2
- Carapace surface smooth, slightly or distinctly rugose; external orbital angle separated from epibranchial tooth by narrow cleft, teeth sometimes almost confluent.3
2. External orbital angle separated from epibranchial tooth by wide, deep cleft; terminal segment of G1 long, about half of the length of subterminal segment; distal segment of G2 short, about a quarter length of basal segment (Sarawak).*A. merarapensis*
- External orbital tooth separated from epibranchial tooth by deep U-shaped cleft; terminal segment of G1 distinctly curved upwards, short, a quarter length of subterminal segment; distal segment of G2 very short, about 0.1 times length of basal segment (Sabah).*A. terrapes*
3. Carapace smooth, strongly inflated; branchial regions swollen; outer margin of external orbital angle slightly convex; G1 not known; (Sabah).*A. rhadamanthysi*
- Carapace slightly to distinctly rugose; surface and branchial regions convex but not strongly inflated; outer margins of external orbital angle straight or slightly concave.4
4. Outer margins of external orbital angle smooth; epibranchial tooth well developed, sharp; terminal segment of G1 short, one-third length of subterminal segment (central Borneo).*A. melanippe*
- Outer margins of external orbital angle serrate; epibranchial tooth very low, blunt, almost confluent with external orbital angle; G1 very slender; terminal segment of G1 short, a quarter of length of subterminal segment (Sabah).*A. kadamaiana*

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