

A new species of the genus *Arachnothelphusa* Ng, 1991 (Crustacea: Decapoda: Gecarcinucidae) from a limestone cave in Sarawak (Malaysian Borneo)

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Abstract. A new species of cavernicolous gecarcinucid crab, *Arachnothelphusa sarang*, is described from a limestone cave in northern Sarawak, Malaysian Borneo. This increases the number of *Arachnothelphusa* species to six. It is the second member in the genus that is known to primarily occupy limestone caves, the other being *A. rhadamanthysi* Ng & Goh, 1987, from Gomantong in Sabah. Both species appear to be cavernicolous species with pale body colouration in life.

Key words. Brachyura, taxonomy, Oriental region, freshwater crab, cavernicolous crab

INTRODUCTION

Currently, the Bornean gecarcinucid genus *Arachnothelphusa* Ng, 1991, is represented by five species, viz. *A. melanippe* (De Man, 1899) [central Kalimantan], *A. kadamaiana* (Borradaile, 1900) [northern Sabah], *A. rhadamanthysi* Ng & Goh, 1987 [eastern Sabah], *A. terrapes* Ng, 1991 [eastern Sabah], and *A. merarapensis* Grinang, Pui & Ng, 2015 [northern Sarawak] (Grinang et al., 2015; Ng & Ng, 2018). Members of *Arachnothelphusa* live in a wide range of habitats, from tree-holes to the interior of limestone caves. Of the five species, only *A. rhadamanthysi* has been recorded from limestone caves in Gomantong in Sabah. We here describe a sixth species of *Arachnothelphusa*, *A. sarang*, new species, and the second cavernicolous member from a limestone cave system in Sarawak.

MATERIAL AND METHODS

The terminology used essentially follows Ng (1988) and Davie et al. (2015), 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 Zoological Reference Collection, Lee Kong

Chian National History Museum (former Raffles Museum of Biodiversity Research), National University of Singapore (ZRC); Sarawak Biodiversity Centre, Sarawak, Malaysia (SBC); Naturalis Biodiversity Center (former Rijksmuseum van Natuurlijke Historie), Leiden, The Netherlands (RMNH); and Senckenberg Museum und Forschungsinstitut, Frankfurt am Main, Germany (SMF).

TAXONOMY

Family Gecarcinucidae Rathbun, 1904

Arachnothelphusa Ng, 1991

Type species. *Potamon (Potamon) melanippe* De Man, 1899, by original designation.

Arachnothelphusa sarang, new species (Figs. 1A–F, 2A–G, 3A–E, 4A)

Material examined. Holotype: male (20.4 × 14.7 mm) (ZRC 2020.0098), limestone cave, Bukit Sarang, Bintulu, Sarawak, Malaysia, coll. H.H. Tan et al., 20 August 2005. Paratypes: 1 male (18.7 × 14.8 mm), 4 females (15.8–19.8 × 12.0–15.8 mm) (ZRC 2020.0099), same data as holotype; 10 males (7.4–11.2 × 5.8–9.6 mm), 7 females (7.5–12.7 × 5.8–9.9 mm) (ZRC 2020.0100), limestone cave, Batu Gelam, Bukit Sarang, Bintulu, Sarawak, Malaysia, coll. H.H. Tan, 20 August 2005; 1 male (12.1 × 9.9 mm), 1 female (12.9 × 10.4 mm) (ZRC 2020.0351), limestone cave, Batu Kelelut, Bukit Sarang, Bintulu, Sarawak, Malaysia, coll. H.H. Tan et al., 18 August 2005.

Comparative material. *Arachnothelphusa merarapensis* Grinang, Pui & Ng, 2015: Holotype male (22.5 × 16.8 mm) (ZRC 2016.0297), water-filled tree-hole, ca. 100

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Fig. 1. *Arachnothelphusa sarang*, new species. A, male (12.1 × 9.9 mm) (ZRC 2020.0351), Batu Rusa cave, Bukit Sarang, Bintulu, Sarawak, Malaysia; B, female (12.9 × 10.4 mm) (ZRC 2020.0351), Batu Kelelut, Bukit Sarang, Bintulu, Sarawak, Malaysia, specimen; C–E, paratype male (18.7 × 15.3 mm) (ZRC 2020.0099), Bukit Sarang, Bintulu, Sarawak, Malaysia; F, paratype female (15.8 × 11.8 mm) (ZRC 2020.0099), Bukit Sarang, Bintulu, Sarawak, Malaysia. A, B, photographed in situ; C, F, overall dorsal habitus; D, ventral view of cephalothorax; E, frontal view of cephalothorax and chelae. Photographs: Tan Heok Hui.

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 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. *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, Borneo, coll. R.F. Inger et al., 12 August 1992; 3 males (21.1 × 15.8 mm, 22.8 × 16.5 mm, 25.3 × 18.5 mm) (ZRC 2002.0097), Crocker Range, Sabah, 5°27'N 116°03'E, coll. I. Das, 24 April 2001. *Arachnothelphusa* aff. *kadamaiana*: 1 female (19.0 × 14.2 mm) (ZRC 2002.0098), Bako National Park, Sarawak, coll. I. Das & L. Grismer, 27 March 2001. *Arachnothelphusa terrapes* Ng, 1991: Holotype male (17.6 × 13.3 mm) (ZRC 1992.7918), Danum Valley Field Centre, station 507, in dry stump on ridge, Lahad Datu, Sabah, Borneo, leg. H.K. Voris, 23 October 1990; paratype female (25.7 × 18.6 mm) (ZRC 1992.7919), Danum Valley, Lahad Datu, Sabah, Borneo, leg. S.C. Choy, 21 July 1989; others: 1 male (30.8 × 20.5 mm), 1 female (30.1 × 20.5 mm, with 26 juvenile crabs) (ZRC 2017.1205), from water-filled tree

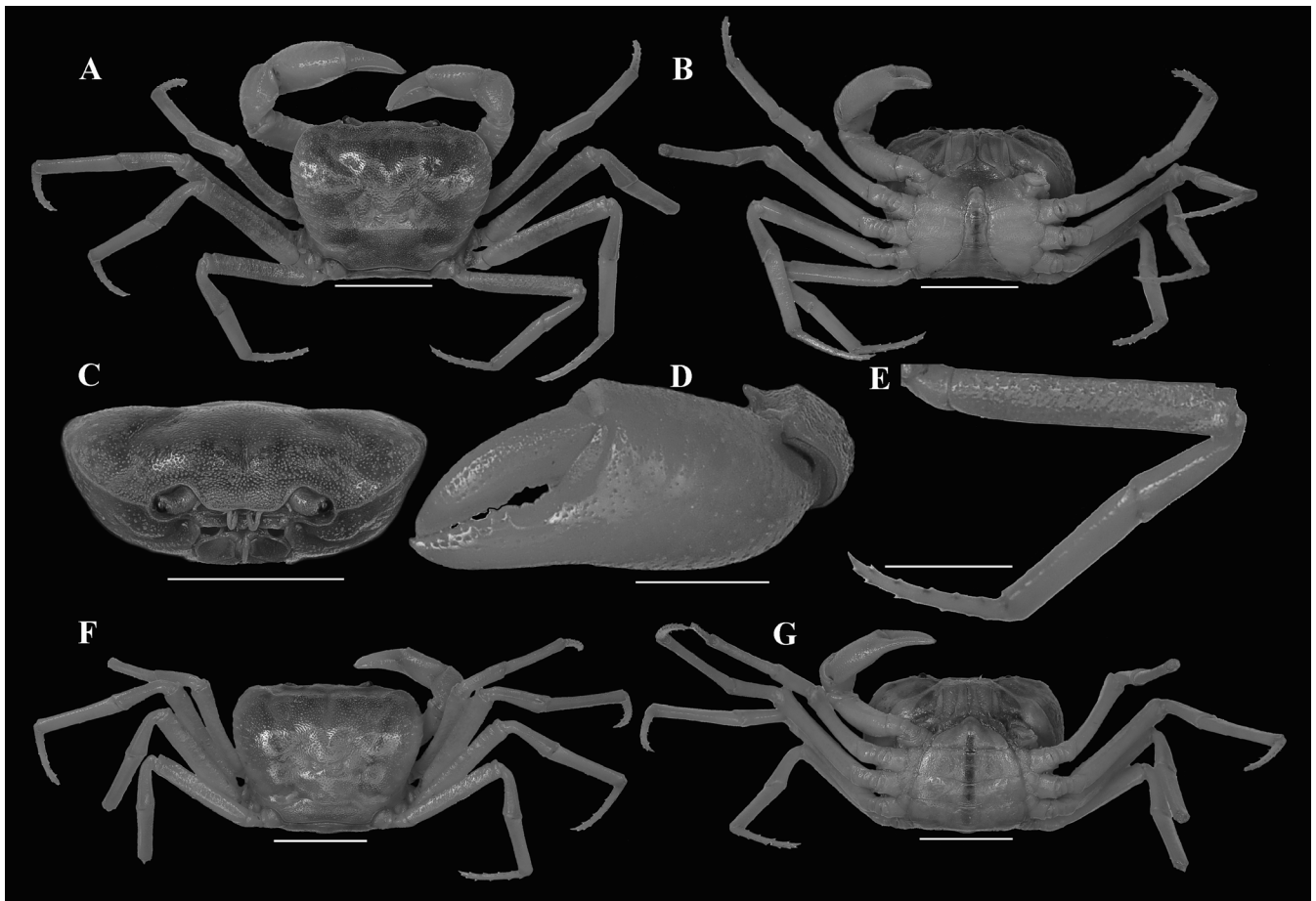


Fig. 2. *Arachnothelphusa sarang*, new species. A–E, holotype male (20.4 × 14.7 mm) (ZRC 2020.0098), Bukit Sarang, Bintulu, Sarawak, Malaysia; F, G, paratype female (19.8 × 15.8 mm) (ZRC 2020.0100), Bukit Sarang, Bintulu, Sarawak, Malaysia. A, F, dorsal view of habitus; B, G, ventral view of carapace showing pleon; C, frontal view of cephalothorax; D, outer view of left chela; E, outer view of right fourth ambulatory leg. Scales: A, B, C, F, G = 10 mm; D, E = 5 mm.

buttress, ca. 35 cm above ground Danum Valley, Lahad Datu, Sabah, Borneo, Malaysia, 20 July 2017. *Arachnothelphusa melanippe* (De Man, 1899): Lectotype male (18.9 × 14.4 mm) (RMNH D1303a), Liang Koebung Mountains, Kalimantan, leg. 1897; paralectotype female (21.4 × 16.7 mm) (RMNH D1303b), same as lectotype.

Diagnosis. Carapace surface convex, rugose, finely granular; anterolateral margins convex, serrated; antero- and posterolateral regions prominently rugose, covered with numerous coarse granules; epibranchial tooth very low or indistinct; external orbital tooth very low, broadly triangular, outer margin slightly concave, distinctly serrated; epigastric and postorbital cristae distinct; cervical and H-grooves deep, not confluent (Fig. 2A, C); ambulatory legs long, merus of fourth ambulatory legs subequal to length of carapace (Fig. 2A, B, E); carpus of chelipeds rugose, with fine granules, inner angle with broadly triangular tooth (Fig. 2A, D); chela relatively short, fingers as long as palm, cutting teeth on pollex not prominent (Fig. 2D). Male pleon T-shaped, somite 6 subequal to length of telson (Fig. 2B). G1 slender, sinuous, gently curving outwards; terminal segment cylindrical, tapering, about one third length of subterminal segment (Fig. 3A–D). G2 with short distal segment, less than a quarter length of basal segment (Fig. 3E).

Females. The females differ in minor non-sexual characters by the carapace being slightly broader and lower (Fig. 2F, G). Female pleon broad, round, somite 6 subequal to length of telson, tip of telson round pointed (Fig. 2G). In larger specimens of both sexes, the antero- and posterolateral regions have relatively more coarse granules. The vulvae are transversely ovate, large, without obvious sternal vulvar covers and are positioned on the median part thoracic of sternite 6.

Variation. The numerous paratype specimens agree well with the holotype male in non-sexual characters.

Colour. In life, the species is pale purplish brown to yellowish in both sexes on the dorsal surfaces, the ventral surfaces being pale yellow to dirty white. The corneas of the eyes are large and fully pigmented (Fig. 1).

Etymology. The species is named after the locality where the holotype was collected. The name is used as a noun in apposition.

Remarks. *Arachnothelphusa sarang*, new species, is easily distinguished from *A. merarapensis*, *A. terrapes*, *A. melanippe*, and *A. rhadamanthysi* by its very low to indistinct epibranchial tooth as well as the very low, broad

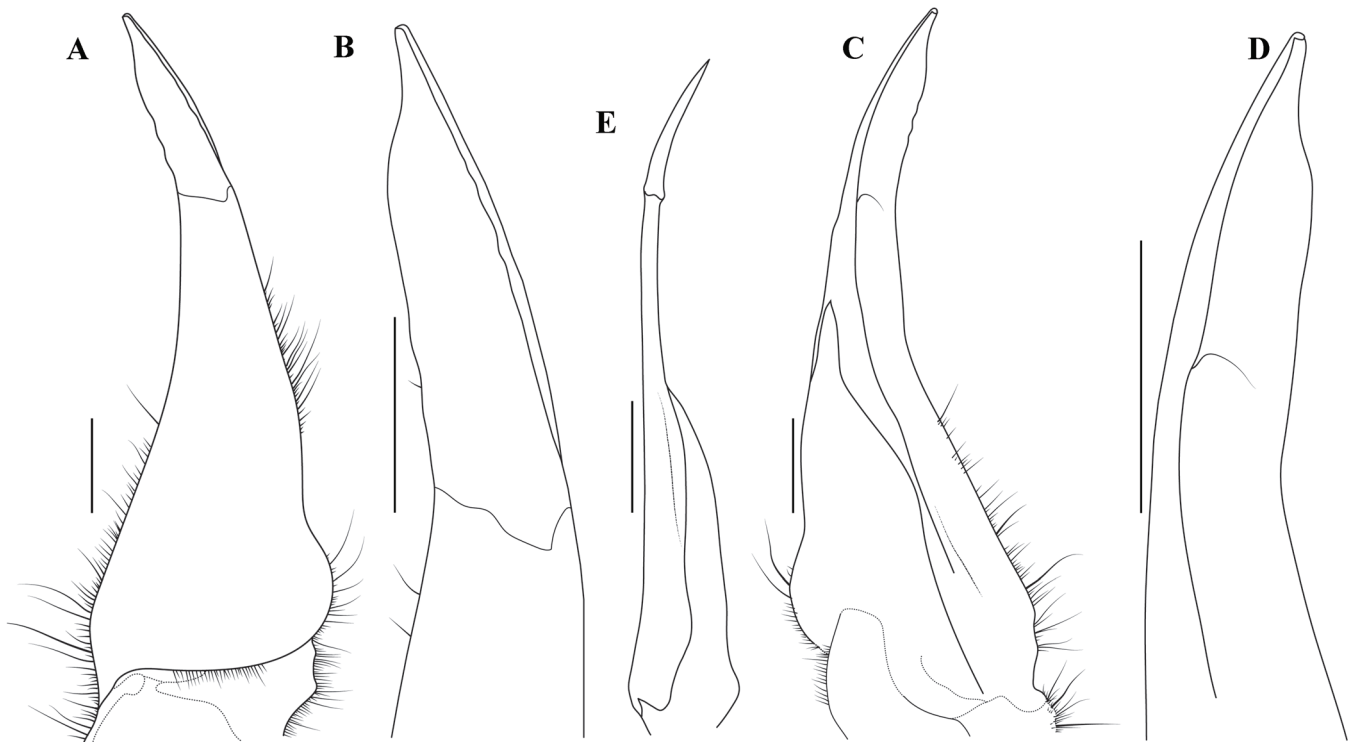


Fig. 3. *Arachnothelphusa sarang*, new species, holotype male (20.4 × 14.7 mm) (ZRC 2020.0098), limestone cave, Bukit Sarang, Bintulu, Sarawak, Malaysia. A, dorsal view of left G1; B, dorsal view of distal part of left G1; C, ventral view of left G1; D, ventral view of distal part of left G1; E, dorsal view of left G2. Scales = 0.5 mm.

external orbital tooth (Figs. 1C, F, 2A–C, F, G, 4A). In *A. merarapensis*, the epibranchial tooth is acutely triangular, separated from the external orbital tooth by a wide and deep cleft and the external orbital tooth is acutely triangular (Fig. 4B; cf. Grinang et al., 2015: fig. 1A–C). In *A. terrapes*, the epibranchial tooth is distinct on both sides, separated from the external orbital tooth by a deep and broad U-shaped cleft and the external orbital tooth is triangular (Fig. 4C; cf. Ng, 1991: fig. 3 [incorrectly printed as fig. 5]; cf. Ng & Ng, 2018: fig. 5B–F). In *A. melanippe*, the epibranchial tooth is distinct but relatively small and separated from the external orbital tooth by a small cleft, with the external orbital tooth broadly triangular (Fig. 4E; cf. De Man, 1899: pl. 9 fig. 11; Ng, 1991: fig. 1). In *A. rhadamanthysi*, the epibranchial tooth is distinct on both sides with the external orbital tooth triangular (cf. Ng & Goh, 1987: pl. 3A, B). In carapace features, *A. sarang* is perhaps closest to *A. kadamaiana*, but they can be distinguished by the presence of a distinct epibranchial tooth and a relatively more anteriorly projecting and acute apex of the external orbital tooth for the latter (Figs. 2A–C, F, G, 4A versus Fig. 4D; cf. Grinang et al., 2015: fig. 6A). The anterolateral region of *A. sarang* is distinctly less rugose with fine granules, whereas this region is prominently rugose with coarse granules for congeners (Fig. 4A versus 4B–E). The structure of the G1 of *A. sarang* differs from that of *A. terrapes* and *A. melanippe* in gently curving outwards (Fig. 3A–D) versus distinctly curving outwards in the latter two species (Fig. 5F–I, O–R). In the G1 structure, *A. sarang* is similar to *A. merarapensis* and *A. kadamaiana*, but they can be distinguished by the following features: the terminal segment of the G1 of *A. sarang* and *A. kadamaiana* is about one-third the length of the subterminal segment (Figs.

3A–D, 5K–M); while that of *A. merarapensis* is about half the length of the subterminal segment (Fig. 5A–D). The distal segment of the G2 of *A. sarang* and *A. merarapensis* is less than a quarter the length of the basal segment (Figs. 3E, 5E), but in *A. kadamaiana*, it is less than one-fifth the length of the basal segment (Fig. 4N). The gonopods of *A. rhadamanthysi* are not known.

The live colouration of the two cave species differs markedly from those of the epigeal species. The live colouration of *A. sarang*, new species, ranges from light purplish to yellowish brown (Fig. 1). This is similar to that known for the other cavernicolous species, *A. rhadamanthysi*, which is pale straw-yellow with white legs (Fig. 6; cf. Ng & Goh, 1987: 326). *Arachnothelphusa merarapensis* is bright purple overall (cf. Grinang et al., 2015: fig. 3A, B), whereas *A. terrapes* is brown to reddish-brown (cf. Ng, 1991: figs. 4, 5 [not labelled in original paper]; Ng & Ng, 2018: fig. 5B–E). The habits and live colouration of *A. melanippe* and *A. kadamaiana* are not known.

The habitat, pale colouration in life, and general appearance of *Arachnothelphusa sarang*, new species, are also similar to those of the genus *Stygothelphusa* Ng, 1989, which contains four species, all from limestone caves in Sarawak (Ng, 1991, 2013; Ng & Grinang, 2014). The carapace of *Stygothelphusa*, however, is generally more quadrate (versus more transversely ovate in *Arachnothelphusa*), the ambulatory legs are proportionately even longer, and most significantly, the G2 is much longer than the G1, with the distal segment long and flagelliform (versus G2 shorter than G1, with the distal segment short in *Arachnothelphusa*).

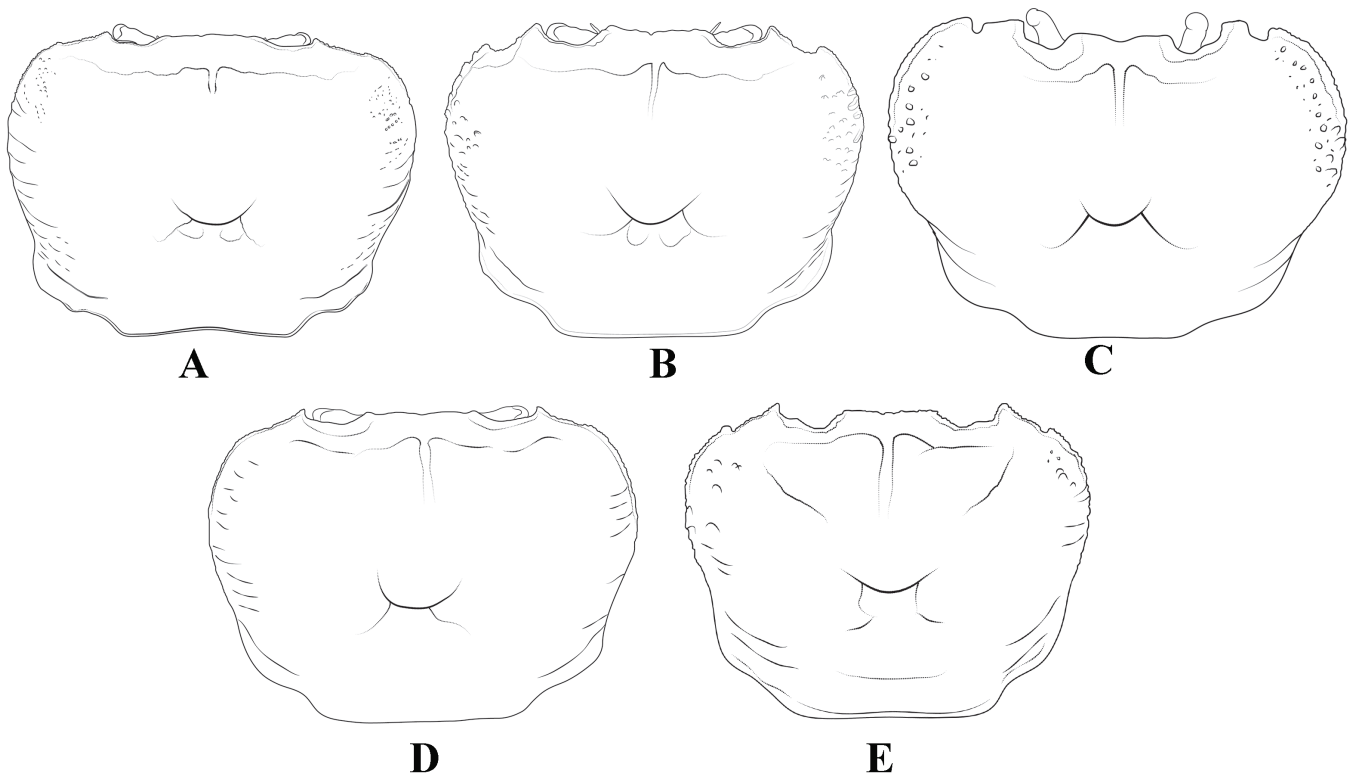


Fig. 4. Carapace morphology of *Arachnothelphusa* species. A, *A. sarang*, new species, holotype male (20.4×14.7 mm) (ZRC 2020.0098), limestone cave, Bukit Sarang, Bintulu, Sarawak; B, *A. merarapensis* Grinang, Pui & Ng, 2015, holotype male (22.5×16.8 mm) (ZRC 2016.0297), Merarap Hot Spring, Lawas, Sarawak; C, *A. terrapes* Ng, 1991, male (30.8×20.5 mm) (ZRC 2017.1205), Danum Valley, Lahad Datu, Sabah; D, *A. kadamaiana* (Borradaile, 1900), male (20.1×14.9 mm) (SMF 4282), Kadamian River, Sabah; E, *A. melanippe* (De Man, 1899), paratype female (21.4×16.7 mm) (RMNH D1303b), Mt. Liang Koebeng, Kalimantan, Indonesia. E after Ng (1991).

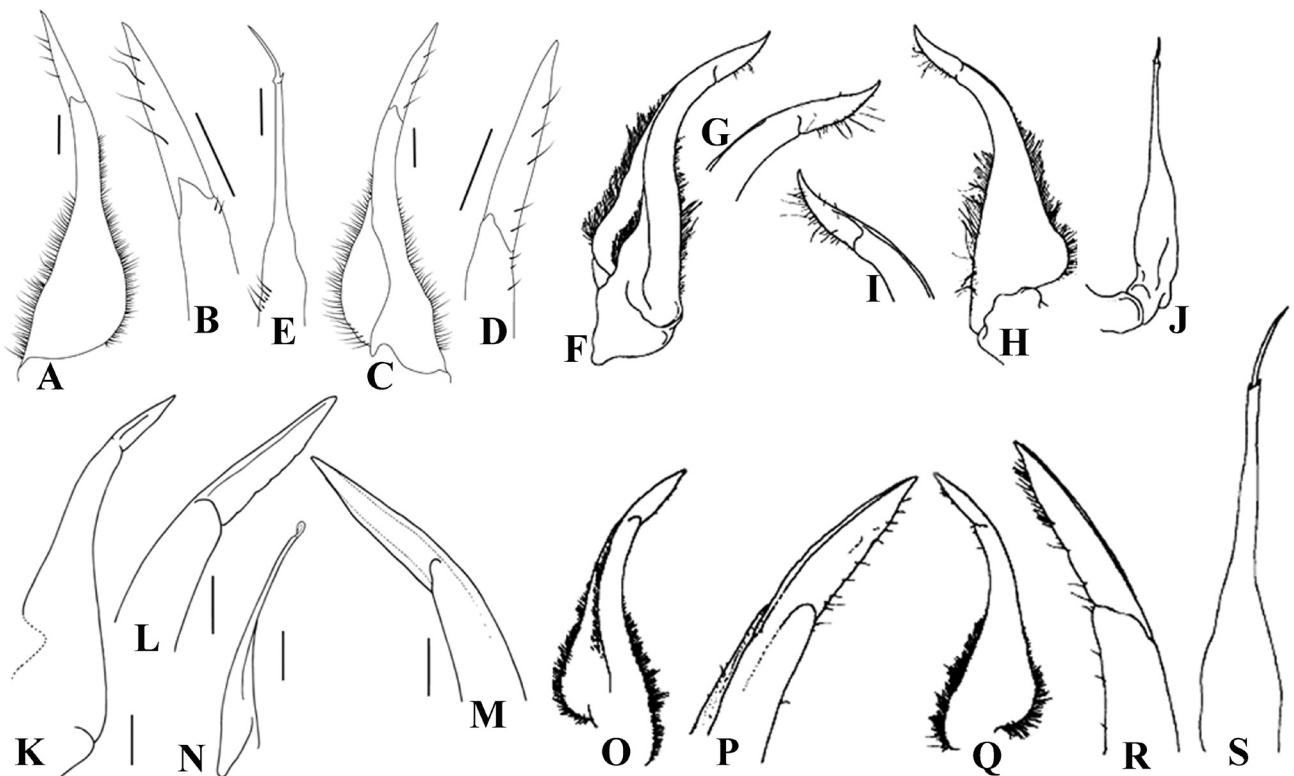


Fig. 5. Gonopod morphology of *Arachnothelphusa* species. A–E, *A. merarapensis* Grinang, Pui & Ng, 2015, holotype, male (22.5×16.8 mm) (ZRC 2016.0297), Merarap Hot Spring, Lawas, Sarawak; F–J, *A. terrapes* Ng, 1991, holotype, male (17.6×13.3 mm) (ZRC 1992.7918), Danum Valley, Lahad Datu, Sabah; K–N, *A. kadamaiana* (Borradaile, 1900), male (20.1×14.9 mm) (SMF 4282), Kadamian River, Sabah; O–S, *A. melanippe* (De Man, 1899), lectotype, male (18.9×14.4 mm) (RMNH D1303a), Mt. Liang Koebeng, Kalimantan, Borneo. C, F, K, O, ventral view of left G1; D, G, L, P, ventral view of distal part of left G1; A, H, Q, dorsal view of left G1; B, I, M, R, ventral view of distal part of left G1; E, J, N, S, left G2. A–E, K–N after Grinang et al. (2015); F–J, O–S after Ng (1991).

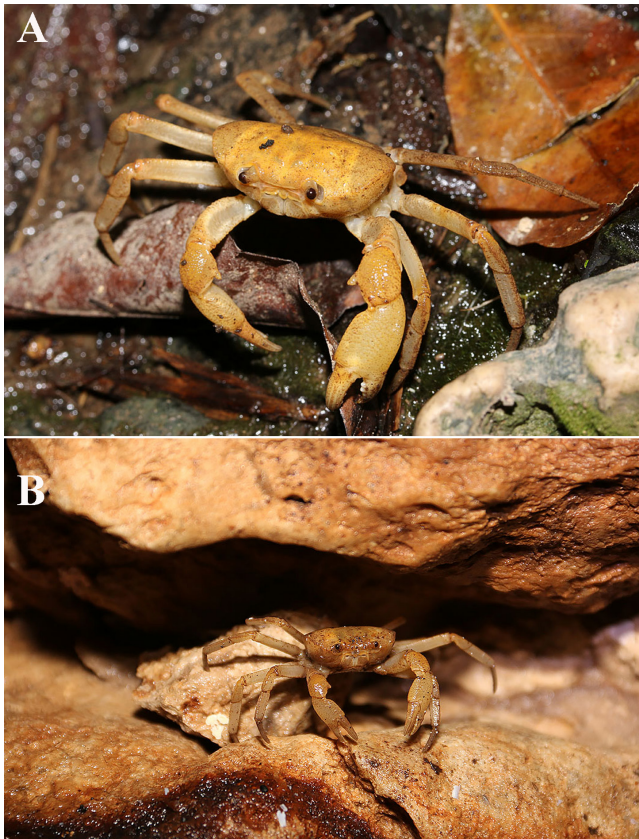


Fig. 6. Live colours of *Arachnothelphusa rhadamanthysi* from Gomantong limestone cave in Sabah, specimen not collected. A, male, from outside of the cave; B, inside of cave. Photographs: Keith Christenson.

Members of *Arachnothelphusa* occur in a wide variety of habitats ranging from tree-holes to caves. The only other species of *Arachnothelphusa* known from caves is *A. rhadamanthysi*. *Arachnothelphusa sarang* inhabits exclusively deep interior of cave systems of Bukit Sarang in northern Sarawak. *Arachnothelphusa rhadamanthysi* on the other hand, has been found in more exposed areas near the cave entrance of Gomantong limestone cave in western Sabah (Fig. 6). Both species, however, are not troglitic species as neither have their eyes reduced and the corneas are still completely pigmented, and *A. rhadamanthysi* at least has been found at cave entrances. In this respect, the habits of the two species are the same as species of *Stygothelphusa*, which are regarded as troglitic taxa instead (Ng, 1991, 2013; Ng & Grinang, 2014). Another cavernicolous gecarcinucid from Borneo, *Balssiathelphusa phasma* Ng & Guinot, 2014, from eastern Kalimantan in Indonesia, is also regarded as troglitic (Ng & Guinot, 2014). As such, the only true stygobitic crabs in Borneo are the two species of *Cerberusa* Holthuis, 1979, from northern Sarawak (family Potamidae) (Holthuis, 1979) and the monotypic *Guaplax* Naruse, Ng & Guinot, 2008, from southern Kalimantan (family Hymenosomatidae) (Naruse et al., 2008).

Habitat. The habitat of *A. sarang*, new species, is a limestone outcrop. Bukit Sarang in Bintulu is an isolated limestone

hill surrounded by peat swamp, comprises a complex of small caves with different names, most of which are almost certainly with subterranean interconnections, and is part of the Tatau River basin. All the specimens of *A. sarang* were found in water pools with fine substrates, and co-existing with whelk snails, several hundred metres from the cave entrance; none were observed near the cave mouth (H. H. Tan, pers. comm.). The limestone cave of Bukit Sarang is a protected area and important for sustainable edible bird-nest production. The harvesting of bird-nests will have to be done carefully so as not to pollute or disturb the habitat if the crab is to be conserved.

Key to species of *Arachnothelphusa* of Borneo

1. Epibranchial tooth very low or indistinct; external orbital tooth very low, broad; anterolateral region less rugose, fine granules, carapace surface smooth (Figs. 1C, F, 2A, B, C, F, G, 4A); G1 gently curving outwards, terminal segment about one-third length of subterminal segment; distal segment of G2 less than a quarter length of basal segment (Fig. 3A–E).....
..... *A. sarang*, new species (northern Sarawak)
- Epibranchial tooth distinct, triangular; external orbital tooth triangular; anterolateral region prominently rugose, coarse granules, carapace surface rugose (Fig. 4B–E); G1 gently or strongly curving outwards, terminal segment either half, one-third or a quarter length of subterminal segment; distal segment of G2 either a quarter or one-fifth length of basal segment (Fig. 5).....2
2. Epibranchial tooth distinct, acutely triangular; G1 strongly curving outwards (Fig. 5F, H, O, Q).....3
- Epibranchial tooth distinct, relatively blunt; G1 gently curving outwards (Fig. 5A, C, K).....4
3. Epibranchial tooth acutely triangular, distinctly separated from external orbital tooth by wide, deep cleft; external orbital tooth acutely triangular (Fig. 4B); terminal segment of G1 about half of length of subterminal segment; distal segment of G2 about quarter length of basal segment (Fig. 5A–E).....
..... *A. merarapensis* (northern Sarawak)
- Epibranchial tooth distinct but relatively small, separated from external orbital tooth by small cleft; external orbital tooth broadly triangular (Fig. 4E); terminal segment of G1 about one-third of length of subterminal segment; distal segment less than a quarter length of basal segment (Fig. 5O–S).....
..... *A. melanippe* (central Kalimantan)
4. Epibranchial tooth distinct; external orbital tooth broadly triangular (Fig. 4D); terminal segment of G1 about a third length of subterminal segment (Fig. 5K–M).....
..... *A. kadamaiana* (northern Sabah)
- Epibranchial tooth distinct; external orbital tooth triangular; terminal segment of G1 about a quarter length of subterminal segment.....5
5. Epibranchial tooth distinct on both sides, separated from external orbital tooth by deep, broad U-shaped cleft; external orbital tooth triangular (Fig. 4C); G1 with cone-shaped terminal segment, about a quarter length of subterminal; distal segment of G2 less than fifth length of basal segment (Fig. 5F–J).....
..... *A. terrapes* (eastern Sabah)
- Epibranchial tooth distinct on both sides, small, blunt, not separated from external orbital tooth by cleft.....
..... *A. rhadamanthysi* (eastern Sabah)

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