

Description of a New Genus with Two New Species of Freshwater Crab (Decapoda: Brachyura: Gecarcinucidae) from the Southwestern Ghats, India

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A new genus of freshwater crab, *Rajathelphusa* gen. nov., and two species, *R. ala* sp. nov. (type species) and *R. muni* sp. nov., are described from the Kerala part of the Western Ghats biodiversity hotspot, India. The new genus is superficially similar to *Arcithelphusa* and *Cylindrotelphusa* from the same hotspot, but can easily be distinguished by the following suite of carapace and gonopod characters: an inflated carapace with distinct epigastric and postorbital cristae; the third maxilliped exopod has a long flagellum; male sternites 2 and 3 separated by a shallow median groove while sternites 3 and 4 are completely fused, demarcated by shallow oblique grooves; a male first gonopod that is almost straight with a short distal conical distal segment; and a male second gonopod that is as long as the first gonopod with a long and slender distal segment. The two new species can be differentiated from each other by the lateral margins of male pleonal somite 6 and the structure of the male first gonopod.

Key words: Taxonomy, New freshwater crab, Gecarcinucoidea, Kerala, Idukki, *Arcithelphusa*, *Cylindrotelphusa*.

BACKGROUND

In India, the Western Ghats biodiversity hotspot is well-known for its rich endemic flora and fauna (Myers 1988; Myers et al. 2000). The region is rich in ancient endemic clades of many animal groups, including cryptic lineages of frogs (Ramesh et al. 2020), arguably the highest global diversity of endemic fish, many with a complex evolutionary history (Britz et al. 2019), and a high proportion of ancient Gondwanan relicts (Karanth 2015; Sidharthan et al. 2020). Although the Western Ghats is an area of high conservation value (Das et al. 2006); anthropogenic impacts have been growing in the

region (Molur et al. 2011), and there is an urgency to better document the fauna there.

With regards to brachyuran crabs, 59 species of freshwater crabs (all Gecarcinucidae) have been reported from this region (see Pati et al. 2020). The fauna, however, remains poorly studied as many parts of the Western Ghats have not been surveyed for freshwater crabs (Rajesh et al. 2017). The southern part of the Western Ghats, which is in the state of Kerala, is home to 37 freshwater crab species in 14 genera, 18 of which are endemic to the state (Pati and Sharma 2013; Pati and Sudha Devi 2015a b; Kumar et al. 2017; Rajesh et al. 2017; Pati et al. 2017 2019 2020).

A survey in the southern Western Ghats recently obtained specimens of a terrestrial crab from burrows and nearby streams in the Rajakumari and Marayoor regions of Idukki district, Kerala state, India. Detailed morphological studies showed that they belong to a new genus, here named *Rajathelphusa*, with two new species, *R. ala* and *R. muni*. The new genus and species are described and compared with allied genera.

MATERIALS AND METHODS

Methods of measurement and terminology follow Ng (1988) and Davie et al. (2015). The sizes of the specimens (in millimetres) refer to the maximum carapace width and length, respectively. The samples are deposited in the Western Ghats Regional Centre, Zoological Survey of India (ZSI/WGRC), Calicut, Kerala and museum collections of the Department of Aquatic Biology and Fisheries, University of Kerala (DABFUK), India. The following abbreviations are used: G1 and G2 = male first and second gonopods, respectively; P2–P5 = pereopods 2–5 (first to fourth ambulatory legs, respectively).

RESULTS

TAXONOMY

Superfamily Gecarcinoidea, Rathbun, 1904

Family Gecarcinidae Rathbun, 1904

Rajathelphusa gen. nov.

urn:lsid:zoobank.org:act:0006A325-FA77-42A5-9290-111BAEC7CDFE

Diagnosis: Carapace high, inflated in frontal view, dorsal surface convex; epigastric cristae low but distinct, not cristate, medially separated by shallow inverted Y-shaped furrow, slightly anterior of postorbital cristae; postorbital cristae distinct, raised, not sharp, confluent with epigastric cristae, joining lateral margin as granules and interrupted striae; cervical grooves distinct, not broad, joining prominent H-shaped and branchial grooves; epibranchial tooth small, separated from external orbital tooth by small cleft, positioned above external orbital tooth in frontal view; orbits subovate, oblique in frontal view; posterior margin of epistome with distinct median triangular tooth, separated from lateral concave lobe by distinct gape; third maxilliped exopod with long flagellum that extends across width of merus; ambulatory legs slender, not elongate, merus without subdistal tooth

or spine; anterior male thoracic sternum transversely narrow; sternites 1 and 2 completely fused to form triangular plate with convex lateral margins; separated from sternite 3 by shallow, median groove, otherwise fused; sternites 3 and 4 fused, demarcated by shallow oblique grooves, suture between sternites 4/5, 5/6 and 6/7 medially interrupted, separated by narrow space; suture between sternites 7/8 complete, with longitudinal groove on sternites 7 and 8, sternite 8 not visible when pleon closed; male sternopleonal cavity deep, narrow, reaching to imaginary line joining median points of cheliped coxae, distal margin on sternite 4 cristate; male pleonal-locking tubercle low, round, positioned on distal third of sternite 5; male pleon triangular, somite 6 subquadrate, telson triangular with concave lateral margins; G1 almost straight, groove for G2 ventral in position; terminal and subterminal segments clearly demarcated, terminal segment relatively short, conical, surface lined with rows of long and short setae which do not obscure surface, gradually tapering to truncate tip; G2 long, as long as G1; with long, slender distal segment, about half length of basal segment; vulvae positioned just adjacent to and pressing into the suture with sternite 5, opening membranous without sternal vulvar cover.

Type species: *Rajathelphusa ala* sp. nov. by present designation.

Etymology: The genus name is derived from the Rajakumari, the type locality of the type species. The word ‘Raja’ in vernacular Malayalam language means King or Prince, and ‘Kumari’ or girl is feminine gender (as opposed to ‘Kumar’ or boy who is masculine), with ‘Rajakumari’ meaning princess. The name is arbitrarily combined with the generic name ‘*Thelphusa*’. The gender of the genus is feminine.

Remarks: *Rajathelphusa* gen. nov. has a suite of characters that differentiates it from all the other gecarcinid genera (see Bahir and Yeo 2007). In its high and inflated carapace, *Rajathelphusa* is superficially most similar to *Arcithelphusa* Pati & Sudha Devi, 2015, and *Cylindrotelphusa* Alcock, 1909. Two species of *Arcithelphusa* are known: *A. cochleariformis* Pati & Sudha Devi, 2015 (type species) and *A. tumpikkai* Pati, Sujila & Sudha Devi, 2019, both from the Wayanad district in northern Kerala. Four species of *Cylindrotelphusa* have been reported from Trivandrum, Ernakulam, Thrissur, Idukki, Kollam, Kozhikode and Pathanamthitta districts in Kerala: *C. breviphallus* Pati, Rajesh, Raj, Sheeja, Kumar & Sureshan, 2017, *C. granulata* (Pillai, 1951), *C. longiphallus* Pati, Rajesh, Raj, Sheeja, Kumar & Sureshan, 2017, and *C. steniops* (Alcock, 1909) (type species).

Rajathelphusa can easily be distinguished from *Arcithelphusa* by the front being gently deflexed (Figs.

3B, 4C, 7C) (vs. front strongly deflexed); with distinct postorbital cristae (Figs. 3A, 4B, 7B) (vs. indistinct postorbital cristae); presence of a long flagellum on the exopod of third maxilliped (Fig. 9A) (vs. short or no flagellum); a G1 with the terminal segment short and conical (Fig. 9B–D, F–H) (vs. curved and elongate); and a G2 with a long distal segment (Fig. 9E, I) (vs. G2 with short distal segment) (cf. Pati and Sudha Devi 2015a: fig. 2A, B, G 3B, D, E, I, Pati et al. 2019: fig. 2A, B, D, E, 3B, D, H, K, N, P, 4A, B, D, E). *Rajathelphusa* can be distinguished from *Cylindrotelphusa* by the anterolateral margins being weakly serrated to smooth (Figs. 2A, 3A, 4B, 7B) (vs. distinctly serrated); male telson triangular (Figs. 3D, 4E, 7E) (vs. distinctly elongate); and the G2 with a long distal segment (Fig. 9E, I) (vs. G2 with short distal segment) (cf. Pati et al. 2017: fig. 11a, b, h, i, 12d, 13a, b, h, i, 14d). These morphological differences are substantial and require the establishment of a new genus.

Distribution: The genus is known only from Rajakumari and Marayoor regions of Idukki district, the southern Western Ghats, Kerala (Fig. 1).

***Rajathelphusa ala* sp. nov.**

(Figs. 2–5, 9A–E)

urn:lsid:zoobank.org:act:78B5F375-FF49-4A67-A479-6706357C4B2B

Material examined: Holotype: male (27.0 × 20.9 mm) (ZSI/WGR/IR.INV./15361), in shallow to deep burrows near Rajakumari, Idukki district, Kerala, 9.966911°N, 77.129715°E, coll. S. Raj, 29 August 2016. Paratypes: 2 males (29.9 × 23.1 mm, 29.5 × 22.1 mm) (DABFUK/AR-BR-100, 101), 12 females (25.1 × 18.9 mm, 26.8 × 20.8 mm, 27.3 × 21.9 mm, 29.2 × 22.2 mm, 30.0 × 21.9 mm, 30.3 × 22.7 mm, 30.4 × 23.2 mm, 30.4 × 23.6 mm, 30.9 × 23.9 mm, 31.0 × 24.0 mm, 31.0 × 24.4 mm, 34.9 × 26.3 mm) (DABFUK/AR-102-113), 3 males (24.2 × 20.8 mm, 26.3 × 20.7 mm, 30.7 × 23.5 mm), 2 females (28.2 × 22.5 mm, 32.0 × 25.3 mm) (DABFUK), same data as holotype.

Diagnosis: Carapace frontal region relatively narrow (Figs. 2A, 3A, B, 4A–C); external orbital tooth with outer margin gently sinuous to almost straight (Figs. 3A, B, 4A–C); male pleonal somite 6 subquadrate with gently convex lateral margins, telson with concave lateral margins (Figs. 3D, 4E); G1 terminal segment relatively short, conical, straight, directed anteriorly, surface lined with rows of long and short setae which do not obscure surface, gradually tapering to truncate tip, ca 0.16 times length of subterminal segment (Figs. 3F, 9B–D).

Description of male holotype: Carapace broader than long, width ca. 1.3 times length; high, inflated

in frontal view, dorsal surface convex (Figs. 2A, 3A, B, 4A–C). Frontal region relatively narrow, surface smooth or with low, flattened granules; lateral parts of anterolateral and posterolateral regions with prominent short oblique striae; suborbital with scattered low granules and striae; pterygostomial regions with distinct low granules of different sizes on margins, glabrous, separated from other regions by low ridge; sub-branchial regions with numerous short striae (Figs. 3B, 4C). Epigastric cristae low but distinct, not cristate, medially separated by shallow inverted Y-shaped furrow, slightly anterior of postorbital cristae; postorbital cristae distinct, raised, not sharp, confluent with epigastric cristae, joining lateral margin as granules and interrupted striae (Figs. 3A, 4A, B). Cervical grooves distinct, not broad, joining prominent H-shaped and branchial grooves (Figs. 3A, 4A, B). External orbital tooth low, tip slightly posterior to orbit, outer margin gently sinuous to almost straight, 3 times longer than inner margin; epibranchial tooth small, but separated from external orbital tooth by small cleft, positioned above external orbital tooth in frontal view (Figs. 3A, B, 4A–C). Anterolateral margins distinctly convex, uneven, striae given impression of margin being gently serrated (Figs. 3A, 4A, B). Posterolateral margins gently concave, converging to almost straight or gently sinuous posterior carapace margin (Figs. 3A, 4A, B). Orbits subovate, oblique in frontal view; eyes filling up most of orbital space, eye peduncle moderately long, stout; cornea large, pigmented (Figs. 3A, B, 4A–C). Supraorbital margin sinuous, complete; suborbital margin concave, lined with small rounded granules (Figs. 3A, B, 4A–C). Antennae short, not reaching cornea of eyes; antennules folding transversely in longitudinally narrow fossa (Figs. 3B, 4C). Posterior margin of epistome with distinct median triangular tooth, separated from lateral concave lobe by distinct gape (Figs. 3B, 4C). Mandibular palp distinctly 2-segmented; terminal article bilobed.

Third maxilliped ischium subrectangular, with distinct median sulcus; merus subquadrate with margins raised, median part depressed; exopod slender, not reaching midlength of merus, flagellum long, reaching about entire width of merus (Figs. 3C, 4D, 9A).

Chelipeds distinctly asymmetrical (Figs. 3A, G, H, 4A, G). Dorsal margin of merus with strong striae, appears unevenly serrated, ventral margin with low granules (Fig. 2). Outer surfaces of carpus rugose, distal angle with prominent sharp tooth with basal tubercle (Figs. 2A, 3A, 4A). Outer surface of chelae unevenly granulated, granules scattered; fingers of major chela curved, with median proximal gape when fingers closed, cutting margin with small teeth and denticles; fingers of minor chela straighter, similar to those of major chela except more slender, without gape (Figs. 3G, H, 4G).

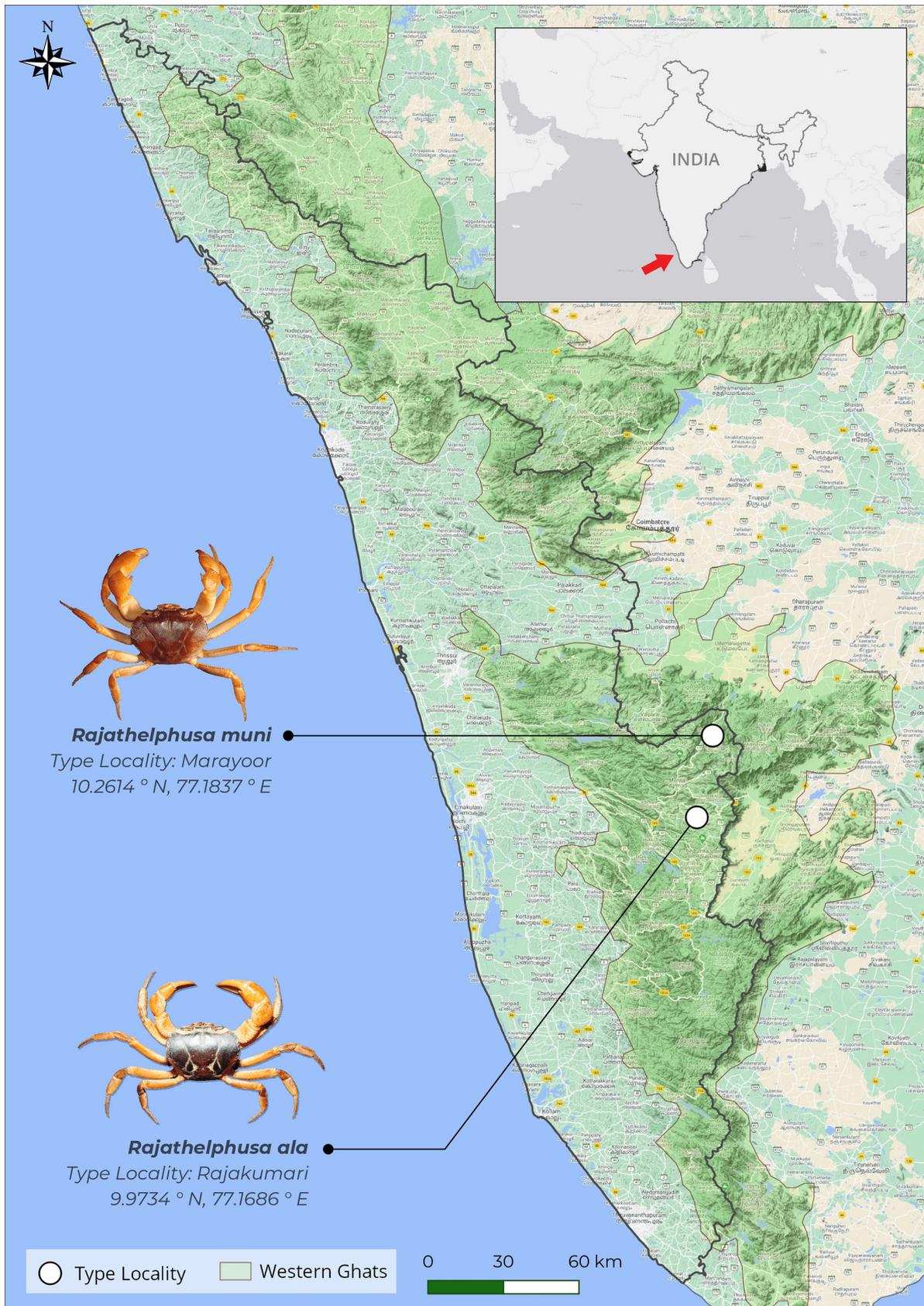


Fig. 1. Map of India showing type localities of *Rajathelphusa ala* gen. nov., sp. nov. and *R. muni* gen. nov., sp. nov. (Map: Josin Tharian).

Ambulatory legs slender, not elongate; P3 longest, P5 shortest (Figs. 2, 3A, 4A). Merus with sharp dorsal and ventral margins but not cristate, margins unevenly serrate but low; carpus with low median crest; propodus subrectangular, with longitudinal median crest, ventral margin serrate; dactylus elongate, gently curved, lined with sharp spines (Figs. 2, 3A, 4A).

Anterior thoracic sternum transversely narrow; sternites 1 and 2 completely fused to form triangular plate with convex lateral margins; separated from sternite 3 by shallow, median groove, otherwise fused; sternites 3 and 4 fused, demarcated by shallow oblique grooves; dense short setae on grooves between sternites

2 and 4. Suture between sternites 4/5, 5/6 and 6/7 medially interrupted, separated by narrow space; suture between sternites 7/8 complete, with longitudinal groove on sternites 7 and 8; sternite 8 completely covered by closed pleon (Figs. 3E, F, 4F). Sternopleonal cavity deep, narrow, reaching to imaginary line joining median points of cheliped coxae, distal margin on sternite 4 cristate (Figs. 3E, 4F). Male pleonal-locking tubercle low, round, positioned on distal third of sternite 5 (Fig. 3F). Penis on condyle of coxa of fourth ambulatory leg.

Pleon triangular, all somites and telson free; somites 1 and 2 longitudinally narrow, subequal in width, both less wide than somite 3; somite 3



Fig. 2. Colour in life. *Rajathelphusa ala* gen. nov., sp. nov., holotype male (27.0 × 20.9 mm) (ZSI/WGR/IR.INV./15361) Live specimen. A, overall dorsal view; B, ventral view of cephalothorax.

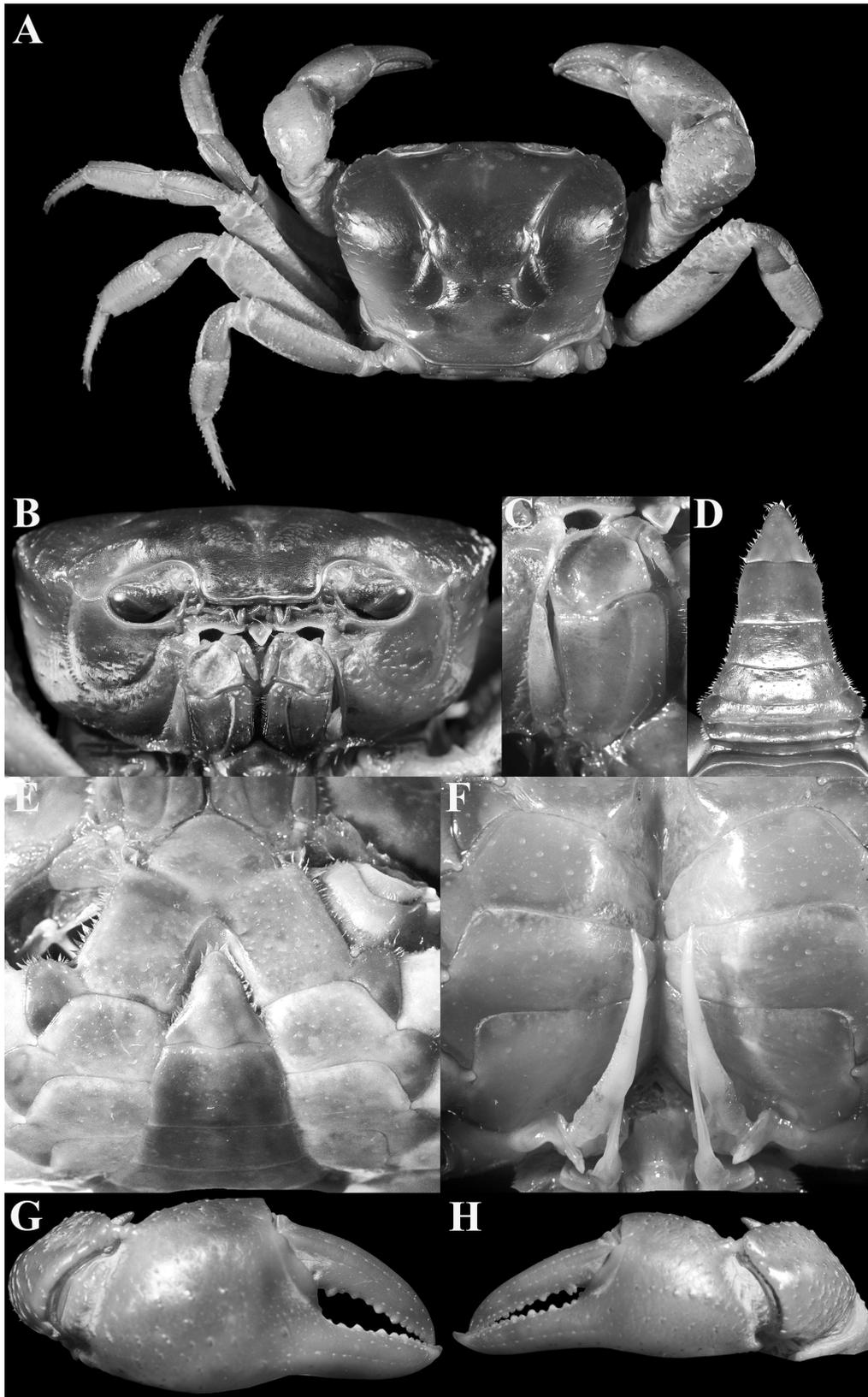


Fig. 3. *Rajathelphusa ala* gen. nov., sp. nov., holotype male (27.0 × 20.9 mm) (ZSI/WGR/IR.INV./15361). Preserved. A, overall view; B, frontal view of cephalothorax; C, right third maxilliped; D, pleon; E, anterior thoracic sternum and pleon; G, outer view of right chela; H, outer view of left chela.

trapezoidal, reaching to coxae of fourth ambulatory legs; somites 4 and 5 trapezoidal; somite 6 subquadrate with gently convex lateral margins, slightly wider than long; telson triangular with concave lateral margins, slightly wider than long (Figs. 3D, 4E).

G1 almost straight, groove for G2 ventral in position; terminal and subterminal segments clearly demarcated by distinct membranous suture; subterminal segment with proximal part broader, gradually tapering to more slender section along distal half, outer margin gently sinuous; terminal segment relatively short, conical, straight, directed anteriorly, surface lined with

rows of long and short setae which do not obscure surface, gradually tapering to truncate tip, ca 0.16 times length of subterminal segment (Figs. 3F, 9B–D). G2 long, as long as G1; with long, slender distal segment, about half length of basal segment (Fig. 9E).

Females: The adult paratype female specimens (largest 34.9 × 26.3 mm, DABFUK/AR-BR-113) resemble the holotype in most non-sexual characters, with the major chela less swollen compared to similarly-sized males, although the surface is relatively more rugose (Fig. 5A). Its pleon is ovate, with all the somites and telson free, covering most of the thoracic sternum

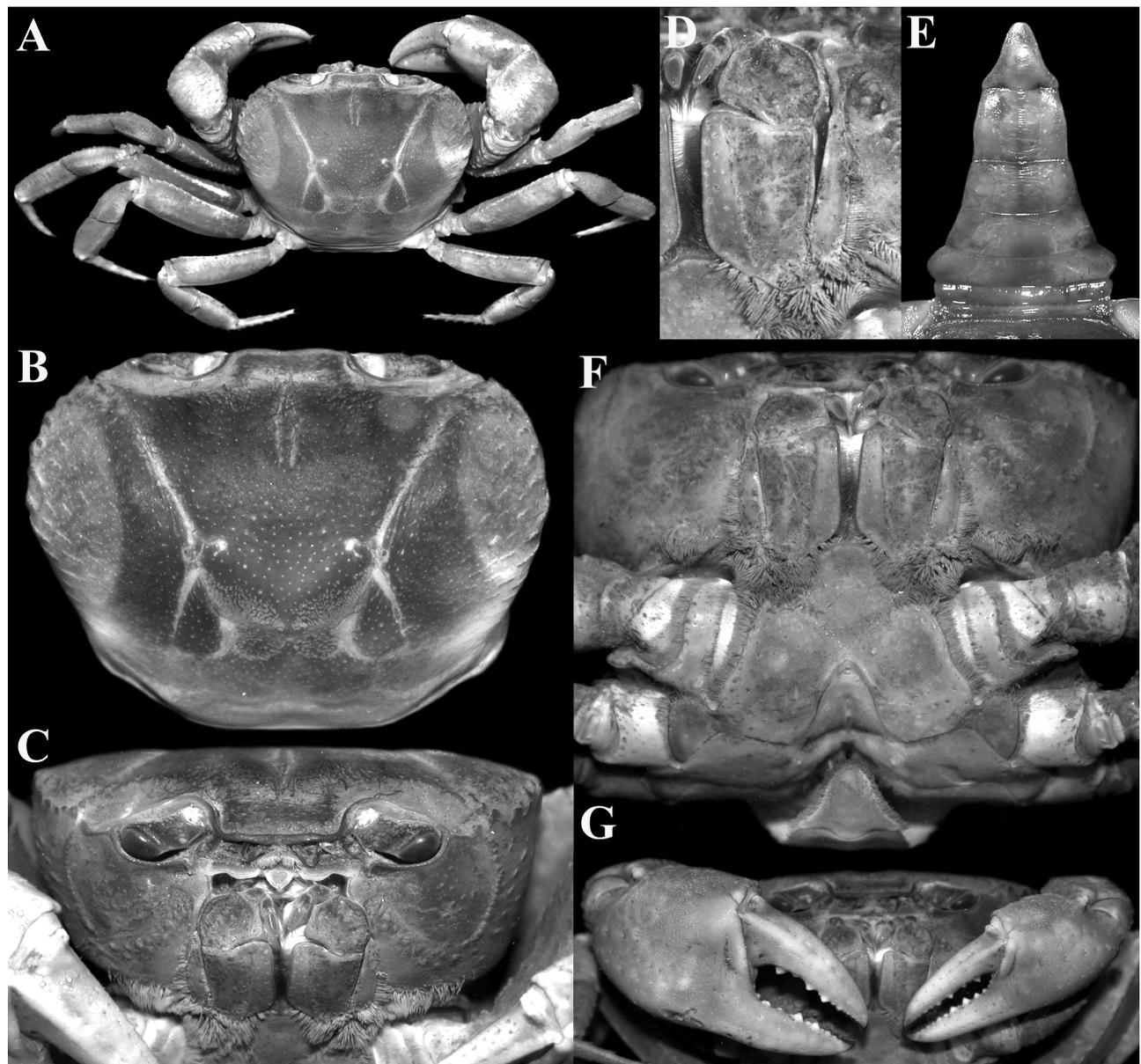


Fig. 4. *Rajathelphusa ala* gen. nov., sp. nov., paratype male (26.3 × 20.7 mm) (DABFUK). A, overall view; B, dorsal view of carapace; C, frontal view of cephalothorax; D, left third maxilliped; E, pleon (setae denuded); F, buccal cavity and anterior thoracic sternum; G, outer view of chelae.

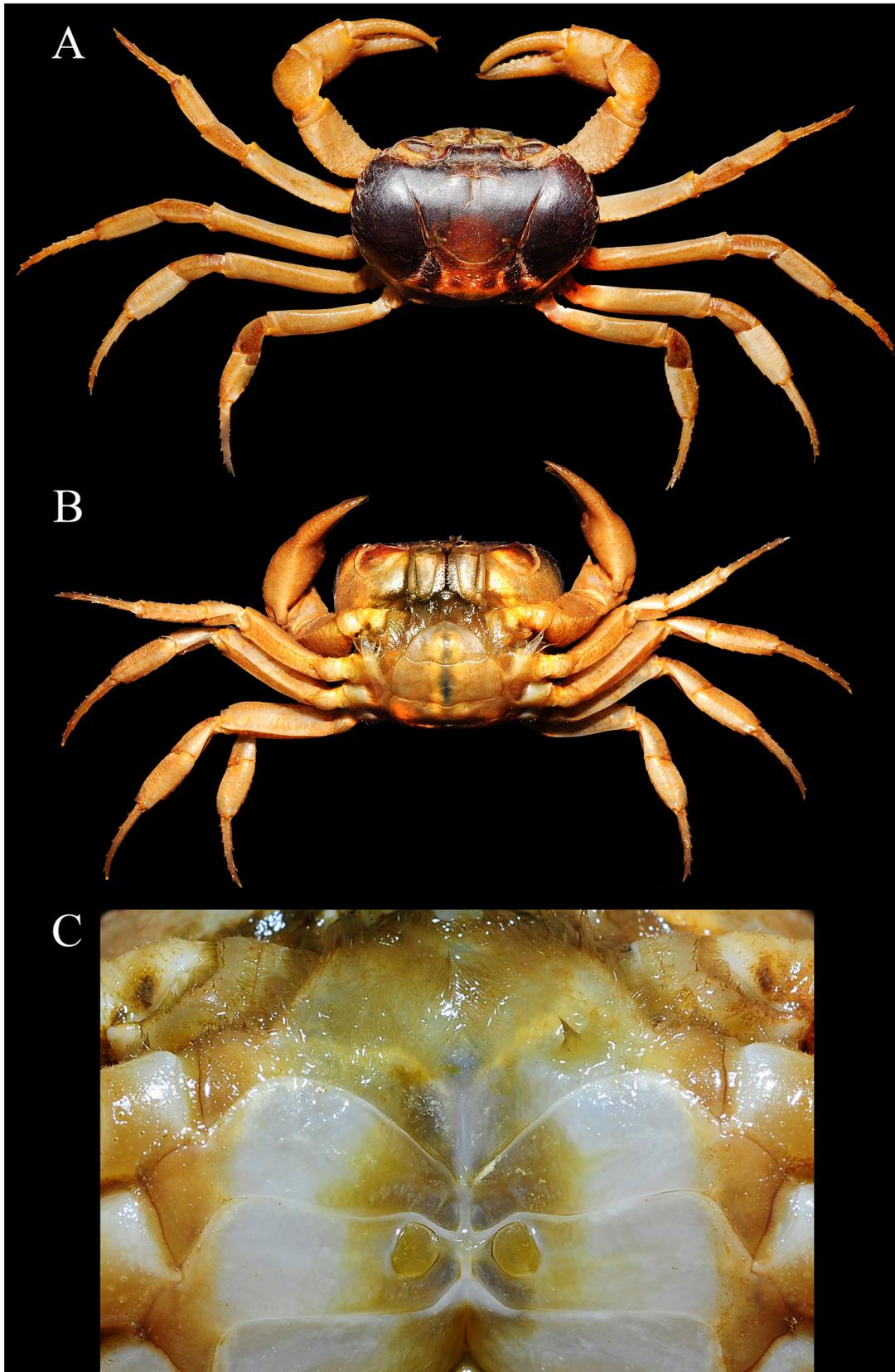


Fig. 5. Colour in life. *Rajathelphusa ala* gen. nov., sp. nov., paratype female (34.9 × 26.3 mm) (DABFUK/AR-BR-113). A, overall dorsal view; B, ventral view of cephalothorax and pleon; C, sternopleonal cavity and vulvae.

except the lateral edges and distal parts of sternite 3 when closed (Fig. 5B). The vulvae, on somite 6 are large, subovate, positioned just adjacent to and pressing into the suture with sternite 5, the opening being membranous without any sternal vulvar cover (Fig. 5C).

Variation: The exopod of the third maxilliped usually has a long flagellum (Fig. 9A), but in a number of specimens, this structure is missing; almost certainly the result of it being broken off. In most of these cases, only one of the third maxillipeds lacks the flagellum, the other being present. There is no variation in the length of the flagellum when present. The distal segment of the G2 varies in shape, from being straight to slightly curved in the specimens examined.

Colour: The carapace is dark brown in life, with the chelipeds and ambulatory legs light brown (Figs. 2, 5, 6D).

Etymology: The name of the species, which lives in deep burrows, alludes to the deep rock shelters tribal people in the region used to live in, which they name as ‘alas’ (ala, singular). The name is used as a noun in apposition.

Distribution: The species is only known from

Rajakumari (9.973453°N, 77.168647°E), a village about 1000 m above mean sea level, Idukki district of Kerala.

Remarks: For differences with *R. muni* sp. nov., see remarks for that species.

Ecology: The species lives in deep to shallow burrows along the sides of the streams and also away from water (Fig. 6A–C). The burrows, which are always away from the stream itself, are relatively deep.

***Rajathelphusa muni* sp. nov.**

(Figs. 7, 8, 9F–H)

urn:lsid:zoobank.org:act:BCEADCAB-2A47-42A3-AF55-5223AE837E68

Material examined: Holotype: male (30.2 × 22.6 mm) (DABFUK/AR-BR-115), in deep burrows near to Kovilkadavu, Idukki district, Kerala, 10.261413°N, 77.183799°E, coll. S. Raj, 20 August 2016. Paratype: 1 male (carapace detached, 26.3 × 20.0 mm) (DABFUK/AR/-BR-114), same data as holotype.

Diagnosis: Carapace frontal region relatively wider (Fig. 7A, B); external orbital tooth with outer margin



Fig. 6. Habitat of *Rajathelphusa ala* gen. nov., sp. nov., Cardamom plantation area; Rajakumari, Idukki, Kerala, India. Specimen not preserved.

convex (Fig. 7A, B); male pleonal somite 6 subquadrate with almost straight lateral margins, telson with concave lateral margins, sometimes distinctly so (Fig. 7E, F); G1 terminal segment relatively shorter, conical, tip directed obliquely inwards towards median line, surface lined with rows of long and short setae which do not obscure surface, gradually tapering to truncate tip, ca 0.14 times length of subterminal segment (Fig. 9F–H).

Colour: The carapace is reddish-brown in life, with the chelipeds and ambulatory legs yellowish-brown (Fig. 8).

Etymology: The species is named after the saints

(in Malayalam, ‘muni’) who used to take shelter in the dolmens (locally known as ‘muniyara’) in Kovilkadavu, a historic place in the Idukki district of Kerala where the new species was found. The name is used as a noun in apposition.

Distribution: The species is known only from Kovilkadavu (10.261413°N, 77.183799°E), a village near Marayoor, about 1000 m above sea level in Idukki district of Kerala

Remarks: *Rajathelphusa muni* sp. nov. is very close to *R. ala* sp. nov., but differs clearly in that the lateral margins of male pleonal somite 6 are almost

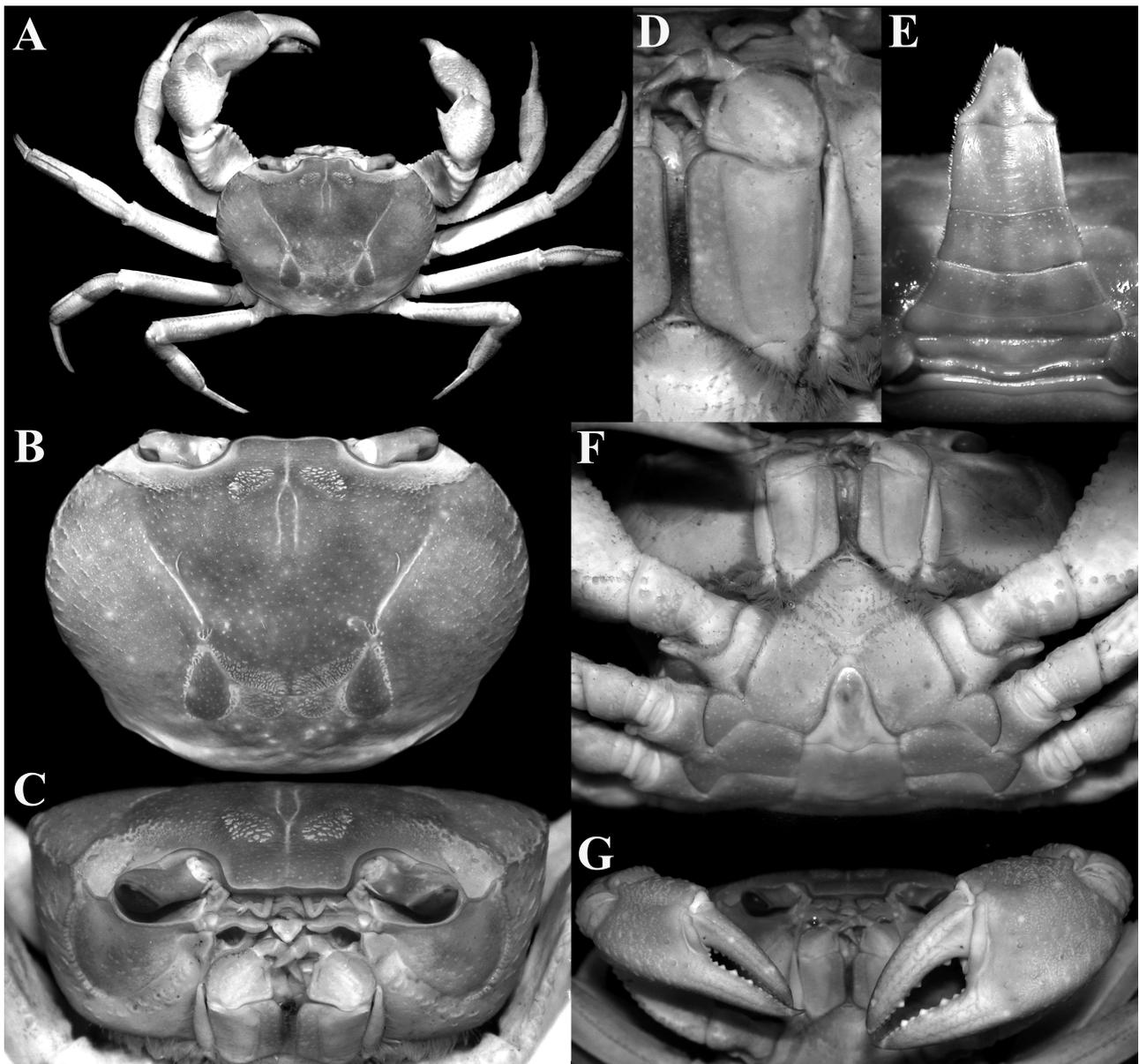


Fig. 7. *Rajathelphusa muni* gen. nov., sp. nov., holotype male (30.2 × 22.6 mm) (DABFUK/AR-BR-115). A, overall view; B, dorsal view of carapace; C, frontal view of cephalothorax; D, left third maxilliped; E, pleon (setae denuded); F, buccal cavity and anterior thoracic sternum; G, outer view of chelae.

straight (Fig. 7E) (vs. lateral margins of male pleonal somite 6 are convex in *R. ala*; Figs. 3D, 4E) and the G1 has the terminal segment proportionately shorter with the distal part turned inwards towards the median groove of the thoracic sternum (Fig. 9F–H) (vs. G1 terminal segment more elongate and straighter in *R. ala*; Fig. 9B–D). The differences are subtle, but the good series of specimens of *R. ala* demonstrate that the characters are consistent. Geographically, the type localities of the two species are only about 35 km apart (measured in a straight line, 84 km by road) but the terrain between the two locations is very uneven, with many small hills and high mountains.

Ecology: The species was collected from deep burrows near the river.

DISCUSSION

Rajathelphusa gen. nov. belongs to the terrestrial group of gecarcinucids (like *Cylindrotelphusa* and *Arcithelphusa*), which usually live in deep burrows and are usually active only at night or during the wet season. As such, they are not easy to collect; the present specimens of the two species required substantial local labour to dig them out. It is therefore perhaps not surprising that we found a new genus of these crabs in Kerala. Based on the structures of the G1 and G2, *Rajathelphusa* appears to be phylogenetically distinct

from *Cylindrotelphusa* and *Arcithelphusa*, despite their similar carapace forms. As in most freshwater crabs, carapace and pereopod characters are subject to substantial convergence, and as such, the G1 and G2 structures are considered more useful in defining monophyletic groups (see Cumberlidge and Ng 2009).

The monsoonal climate of India is particularly suitable for terrestrial forest crabs like *Rajathelphusa*, which need to keep their gills moist at all times. Their high carapaces allow them to have larger gill chambers that contain more water to help them respire, even during the dry season. In periods of serious drought, the crabs aestivate at the bottom of the burrows and do not forage, even at night. The similar carapace shapes of the three genera are almost certainly due to convergence, an adaptation to allow them to cope with the seasonal dry weather.

CONCLUSIONS

A new gecarcinucid genus, *Rajathelphusa*, with two new species, *R. ala* and *R. muni*, are described from the Western Ghats in the southern Indian state of Kerala. In its high carapace, this new terrestrial genus is superficially most similar to *Cylindrotelphusa* and *Arcithelphusa*, also from the Western Ghats, but is markedly different in the form of the male first and second gonopods.



Fig. 8. *Rajathelphusa muni* gen. nov., sp. nov., holotype male (30.2 × 22.6 mm) (DABFUK/AR-BR-115), colour in life.

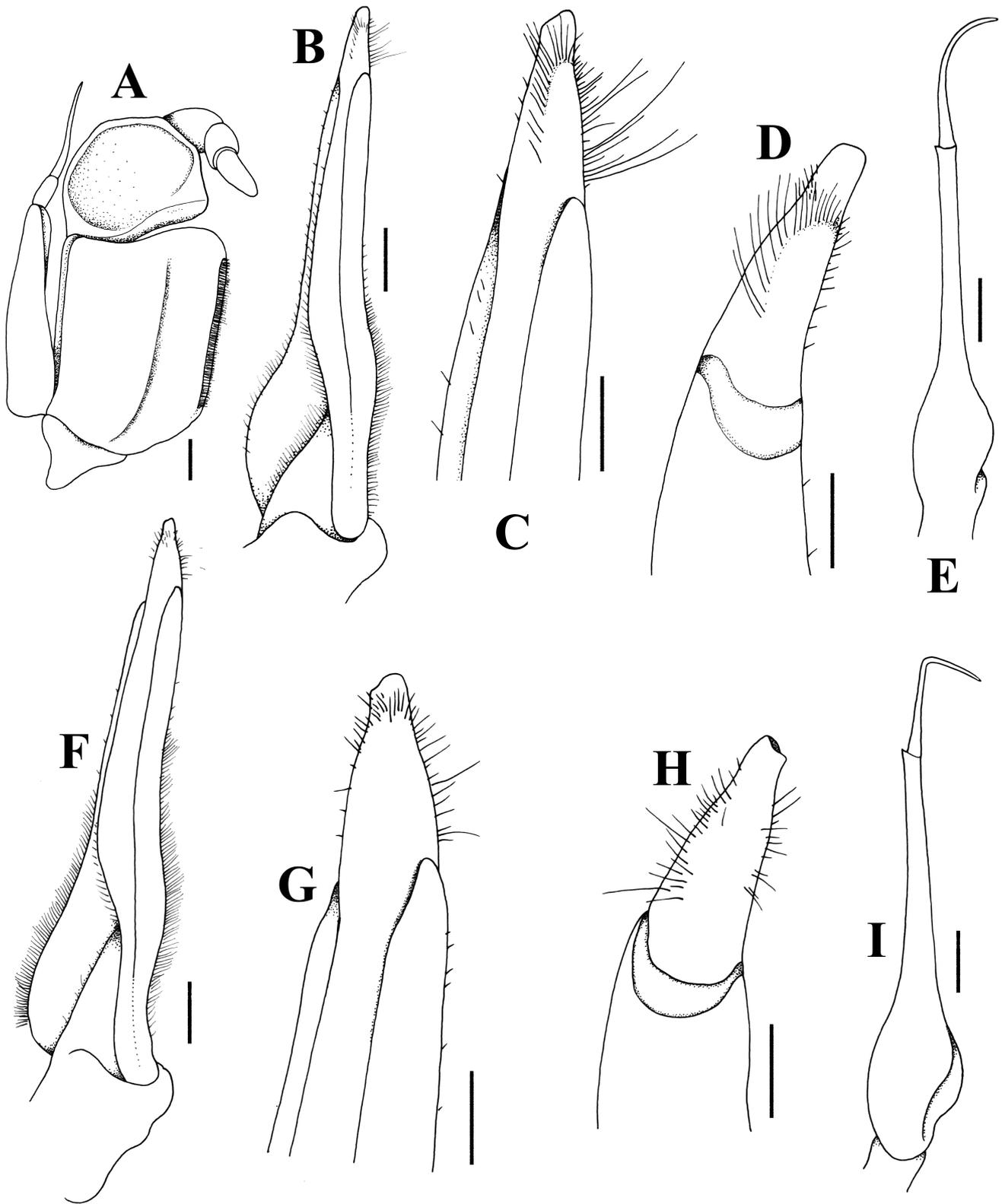


Fig. 9. A–E, *Rajathelphusa ala* gen. nov., sp. nov., paratype male (26.3 × 20.7 mm) (DABFUK); F–I, *Rajathelphusa muni* gen. nov., sp. nov., holotype male (30.2 × 22.6 mm) (DABFUK/AR-BR-115). A, right third maxilliped; B, F, left G1 (ventral view); C, G, distal part of left G1 (ventral view); D, H, distal part of left G1 (dorsal view); E, I, left G2. Scales bars: A, B, E, F, I = 1.0 mm; C, D, G, H = 0.5 mm.

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Authors' contributions: SR collected and processed the samples, compared the material and performed the morphological comparisons. ABK conceived the study and assisted with the discussion. PKLN provided some of the figures and added to the discussion on the taxonomy. All authors drafted, read and approved the final manuscript.

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Ethics approval consent to participate: Not applicable.

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