New species of hippolytid shrimps (Crustacea: Decapoda: Caridea: Hippolytidae) from a southwest Indian Ocean seamount

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Abstract

Two specimens representing two hippolytid genera were sampled recently from the Coral Seamount, southwest Indian Ocean, at 732 m water depth. *Lebbeus ketophilos* sp. nov. and *Eualus oreios* sp. nov. are described and illustrated and their morphologies are compared with those of previously described species. The new species are closest in morphology to *L. indicus* Holthuis, 1947 and *E. kinzeri* Tiefenbacher, 1990 respectively. They are distinguished clearly from these and other species by a suite of morphological features. This record enhances our present knowledge of seamount biodiversity and species richness of decapod crustaceans in the Indian Ocean.

Key words: *Lebbeus*, *Eualus*, seamounts, chemosynthetic, whale bone, biodiversity.

Introduction

Lebbeus White, 1847 is presently composed of sixty one species, making it the most diverse genus within the family Hippolytidae Spence Bate, 1888 (De Grave & Fransen 2011; Komai *et al.* 2012; Nye *et al.* 2012). The genus displays a wide bathymetric range from shallow to deep waters and cosmopolitan distribution from the tropics to high latitudes, although most species exhibit narrow geographic ranges (Komai *et al.* 2004, 2012; Chang *et al.* 2010). The majority of species are described from the western North Pacific (e.g. Hayashi, 1993; Komai *et al.* 2004; De Grave & Fransen 2011). *Lebbeus* is the only hippolytid known to inhabit chemosynthetic environments; eight species are documented from hydrothermal vents in the Pacific and Caribbean (see Komai *et al.* 2012; Nye *et al.* 2012 and references therein).

The genus *Eualus* Thallwitz, 1892 is represented by 38 species (one of which has two subspecies), distributed primarily in cold and temperate waters of the world oceans at shallow to bathyal depths (De Grave & Fransen 2011; Nye *et al.* 2013). The majority of *Eualus* species have been described from the northern hemisphere (Jensen 2004; Kim *et al.* 2006).

Seamounts (underwater mountains) are ecologically and biologically significant global deep–sea ecosystems but only a few hundred seamounts have been surveyed to date (CBD 2007; Yesson *et al.* 2011). Despite an increasing research effort describing the biological assemblages and assessing the biodiversity and biogeography of seamounts (see Clark *et al.* 2010 for recent review), there have been few studies on the diversity of biological assemblages of the southern the southern Indian Ocean has been highlighted as a significant gap in our present knowledge of global seamount biodiversity (Clark *et al.* 2010).

During a recent research cruise investigating seamounts in the southwest Indian Ocean, two novel species of the hippolytid genera *Lebbeus* and *Eualus* were discovered. This study describes and illustrates the new species and compares their

morphology with previously described species. This record enhances existing knowledge of seamount biodiversity and species richness of decapod crustaceans in the Indian Ocean.

Materials and methods

Specimens were collected from the netting of a whale–bone mooring (deployed in 2009) recovered by the remotely operated vehicle (ROV) 'Kiel 6000', from Coral Seamount in the southwest Indian Ocean (732 m), during the 66th voyage of the RRS 'James Cook' in November 2011. Specimens were placed in 100% ethanol and subsequently transferred to 70% industrial methylated spirits.

Specimens were measured to the nearest 0.1 mm using Vernier callipers. Postorbital carapace length (CL) was measured from the posterior margin of the orbit to the posterior margin of the carapace and is used herein as an indication of specimen size. Individuals were sexed under a Leica EZ4 HD dissecting microscope.

Illustrations were prepared with the aid of a cameral lucida mounted onto a Leica MZ8 steromicroscope, scanned and inked digitally using a WACOM™ digitiser and Adobe® Illustrator® software (as described by Coleman 2003, 2009). Specimens are deposited in the invertebrate collection at the Oxford Natural History Museum (OUMNH), UK. Morphological terminology generally follows Nye *et al.* (2012) and Komai *et al*. (2012).

Systematics

Order Decapoda Latreille, 1802
Infraorder Caridae Dana, 1852
Superfamily Alpheoidea Rafinesque, 1815
Family Hippolytidae Spence Bate, 1888
Genus *Lebbeus* White, 1847

***Lebbeus ketophilos* sp. nov.**
(Figs. 1–3)

Material examined. Holotype: male, CL 6.8 mm. Coral Seamount, southwest Indian Ocean; co-ordinates: 41°22.38S 42°54.64E; water depth: 732 m [OUMNH.ZC.2013-01-002]. Collected on the 66th voyage of RRS 'James Cook', November 2011.

Description. Body moderately robust for genus; integument glabrous, moderately firm.

Rostrum (Figs. 1, 2A–B) long and slender, anterior part curved distinctly upward, 1.0 times CL; reaching to but not exceeding distal margin of antennal scale; laterally compressed, tapering to acute apex; dorsal margin armed with 3 widely spaced postrostral teeth (0 teeth on rostrum proper) along midline of carapace, posteriormost tooth arising at 0.4 CL; ventral margin armed with 5 teeth in distal 0.6, ventral lamina poorly developed.

Carapace (Fig. 1) with low but distinct median portrostral carina extending to posterior two-thirds of carapace; dorsal profile in lateral view gently convex; supraorbital tooth strong, arising level with posterior margin of orbit, directed forward, not reaching tip of antennal tooth; deep V-shaped notch inferior to base of supraorbital tooth; orbital margin weakly concave; suborbital lobe well developed, bluntly triangular; antennal tooth well-developed, acute, exceeding tip of suborbital

lobe. Pterygostomial tooth small, not reaching antennal tooth. Anterolateral margin between antennal tooth and pterygostomial tooth strongly sinuous with deep excavation below antennal tooth.

Abdomen (Fig. 1) rounded dorsally. Second somite with transverse groove on tergum, bordered posteriorly by low ridge; posterodorsal margin of third somite produced; pleura of anterior three somites unarmed marginally, posteroventral margin rounded; fourth pleuron with posteroventral tooth (Fig. 2C); fifth pleuron bearing moderately strong posteroventral tooth (Fig. 2C). Sixth somite 1.5 times longer than fifth; armed with small posteroventral tooth; posterolateral process terminating in acute tooth.

Telson (Figs. 1, 2D–E) length 3.0 times anterior width, 1.3 times longer than sixth abdominal somite in dorsal midline; lateral margins tapering to convex posterior margin, bearing 6/5 (left/right) dorsolateral spines; posterior margin with 2 pairs of lateral spines (mesial pair longer) and 2 median spiniform setulose setae.

Pleopods (Figs. 1, 2F–G) similar to those of other species of the genus, without distinctive feature.

Eyes (Figs. 1, 2A–B) subpyriform with stalk narrowing proximally; cornea distinctly wider than stalk, its maximum width 0.2 times CL; ocellus absent.

Antennular peduncles (Fig. 1, 2A–B) extending approximately to distal 0.2 of antennal scale. First segment as long as distal two segments combined, not quite reaching midlength of antennal scale, dorsodistal margin armed with 2 slender teeth, ventromesial margin armed with 1 prominent subdistal tooth; stylocerite slightly exceeding dorsodistal margin of first peduncular segment, terminating in acute point, mesial margin sinuous. Second segment approximately 0.5 length of first segment; bearing strong distolateral tooth. Third segment less than half as long as second; with small dorsodistal tooth. Lateral flagellum with thickened aesthetasc-bearing portion approximately 0.4 times CL.

Antenna (Figs. 1, 2H) with bascicerite bearing small, acute ventrolateral tooth; carpocerite reaching to approximately distal 0.6 of antennal scale. Antennal scale 0.8 times CL, 3 times longer than wide; lateral margin straight; distolateral tooth slightly exceeding rounded distal lamella of blade.

Mouthparts similar to those of other species of the genus. Third maxilliped (Fig. 3) exceeding antennal scale by approximately 0.2 length of ultimate segment. Antepenultimate segment approximately 0.8 times as long as 2 distal segments combined; bearing a small tooth and long spiniform seta on distolateral margin and a small spine at ventrodistal angle (Fig. 3B); lateral surface bearing row of spiniform setae on blunt ridge parallel to dorsal margin. Ultimate segment approximately 3 times longer than penultimate segment, with dense tufts of setae; tapering distally, with short row of corneous spines distomesially and distolaterally (Fig. 3C).

Strap-like, terminally hooked epipods present on third maxilliped to third pereopod (Figs. 3A, D, F, H); corresponding setobranchs on first to fourth pereopods (Figs. 3D, F, H, I).

First pereopod (Fig. 3D) moderately stout, extending to distal margin of antennal scale. Chela (Fig. 3E) approximately 1.4 as long as carpus; dactylus approximately 0.6 times as long as palm, strongly curved distally, terminating in 2 corneous claws; fixed finger terminating in 1 corneous claw.

Second pereopod (Fig. 3F) distinctly more slender than first, overreaching antennal scale by approximately 0.2 length of carpus when extended. Chela (Fig. 3G) small; dactlyus terminating in two corneous claws; fixed finger terminating in one corneous claw. Carpus divided into 7 articles.

Third to fifth pereopods (Fig. 3H–J) similar in structure, long and slender, decreasing in length and stoutness posteriorly. Third pereopod (Fig. 3H) overreaching antennal scale by approximately 0.3 length of propodus; dactylus damaged, distal tip missing, armed with 5 accessory spinules on flexor margin; carpus approximately 0.6 length of propodus; propodus with 2 rows of ventral flexor spinules; merus armed with 4/5 (left/right) lateral spines.

Fourth pereopod (Fig. 3I) overreaching antennal scale by approximately 0.2 length of propodus; dactlyus damaged, distal tip missing, armed with 5 accessory spinules on flexor margin; propodus with two rows of ventral flexor spinules; merus armed with 4/3 (left/right) lateral spines.

Fifth pereopod (Fig. 3J) not overreaching antennal scale; dactlyus (Fig. 3K) 0.15 length of propodus, terminating in acute unguis and armed with 6 accessory spinules on flexor margin, distalmost spinule distinctly larger than others, making dactylus tip appear biunguiculate; propodus with two rows of ventral flexor spinules; merus armed with 1 lateral spine.

Colouration in life. Unknown.

Distribution and habitat. Known only from the type locality, the Coral Seamount, southwest Indian Ocean, in 732 m water depth. Collected from the netting of a whale–bone mooring with *Eualus oreios* sp. nov.

Etymology. The species name, *ketophilos*, is the combination of the Greek, "*ketos*" (= whale), and "*philos*" (= loving), in reference to its collection from a whale–bone mooring.

Remarks. *Lebbeus ketophilos* sp. nov. belongs to the group of species within the genus characterised by the presence of epipods on the anterior three pairs of pereopods and absence of armature on the anterior three abdominal pleura. With its long (as long as the carapace), distinctly upturned rostrum, the new species most closely resembles *L. indicus* Holthuis, 1947, described and known only from the Bali Sea in 1018 m water depth (Holthuis 1947; Chace 1997; Fransen 1997).

Lebbeus ketophilos sp. nov. is distinguished from *L. indicus* by the armature of the rostrum (3 dorsal teeth, all postrostral, versus 4 dorsal teeth, including 2 on the rostrum proper; 5 versus 6 ventral teeth) and the third segment of the antennular peduncle (1 versus 2 teeth). The new species is separated further from *L. indicu*s by the presence (versus absence) of a posteroventral tooth on the fourth abdominal pleuron and the absence (versus presence) of setae on the outer margin of the stylocerite. Furthermore, it is differentiated by the proportionally longer antennal scale (reaching tip of rostrum versus not reaching) with distolateral tooth exceeding (versus not reaching) distal lamella, and the proportionally shorter third maxilliped (exceeding antennal scale by approximately 0.2 versus 0.5 length of ultimate segment). The new species also differs from *L. indicus* in the armature of the meri of the third and fifth pereopods (4 or 5 versus 6; 1 versus 2 spines).

Genus *Eualus* Thallwitz, 1892

Eualus oreios sp. nov.

(Figs. 4–6)

Material examined. Holotype: female, CL 6.2 mm. Coral Seamount, southwest Indian Ocean; co-ordinates: 41°22.38S 42°54.64E; water depth: 732 m [OUMNH.ZC.2013-01-003]. Collected on the 66th voyage of RRS 'James Cook', November 2011.

Description. Body (Fig. 4) moderately slender, integument glabrous.

Rostrum (Figs. 4, 5A, B) descending, distal 0.2 distinctly ascending; exceeding distal margin of third segment of antennular peduncle but not reaching distal margin of antennal scale; 0.6 times carapace length; dorsal margin armed with 7 evenly spaced teeth, including 5 on rostrum proper and 2 postrostral teeth along midline of the carapace; posteriormost tooth arising at 0.1 CL; ventral margin with blade becoming somewhat deeper distally, with 5 evenly spaced teeth in distal 0.4.

Carapace (Figs. 4, 5A, B) with low median portrostral carina extending 0.5 of carapace; dorsal profile in lateral view slightly convex. Orbital margin concave; suborbital lobe bluntly triangular, not reaching antennal tooth. Antennal tooth moderately strong, acute, exceeding suborbital lobe and pterygostomial tooth. Pterygostomial tooth small. Anterolateral margin between antennal tooth and pterygostomial tooth straight.

Abdomen (Fig. 4) dorsally rounded, posterodorsal margin of third somite produced. Pleura of anterior four somites broadly rounded, unarmed; fifth pleuron armed with posteroventral tooth (Figs. 4, 5C). Sixth somite approximately 1.4 times longer than fifth, 1.9 times longer than deep, with small posteroventral tooth; posterolateral process terminating in small tooth.

Telson (Figs. 4, 5D) damaged, incomplete distally. Incomplete length 2.1 times anterior width and as long as sixth abdominal somite in dorsal midline; lateral margins parallel in anterior third, tapering posteriorly, bearing 3 dorsolateral spines on each side; shape and armature of posterior margin unknown.

Uropods (Figs. 4, 5D) with broad rami exceeding distal margin of incomplete telson; exopod with distinct transverse suture, bearing small fixed spine and one moveable spine at distolateral angle; endopod shorter and narrower than exopod; posterolateral projection of protopod triangular with acute tip.

Eyes (Figs. 4, 5A, B) subpyriform with stalk narrowing proximally; cornea wider than stalk, its maximum width 0.2 times CL, darkly pigmented; ocellus apparently absent.

Antennular peduncles (Figs. 4, 5A, B) extending to distal 0.7 of antennal scale, not reaching base of dorsolateral tooth of antennal scale. First segment distinctly longer than distal two segments combined, reaching 0.4 of antennal scale, ventromesial margin armed with strong subdistal tooth; stylocerite exceeding beyond distal margin of first segment of antennular peduncle but not reaching distal margin of second segment, terminating in acute point, mesial margin sinuous. Second segment less than half length of first, with promiment distolateral tooth. Third segment approximately 0.5 length of second, with small dorsodistal tooth. Flagellae damaged, detached from peduncles.

Antenna (Figs. 4, 5E) with bascicerite bearing small, acute ventrolateral tooth; carpocerite reaching to distal 0.6 of antennal scale. Antennal scale approximately 0.7 times CL, 2.9 times longer than wide; lateral margin straight; distolateral tooth falling short of rounded distal lamella of blade.

Mouthparts similar to those of other species of the genus, without specific characters. Third maxilliped (Fig. 6A–C) broken, reach unknown. Antepenultimate segment somewhat flattened proximally, approximately 0.9 times as long as two distal segments combined; dorsodistal and distolateral margins armed with a small tooth; small spine at ventrodistal angle (Fig. 6C); lateral surface with row of spiniform setae on blunt ridge parallel to dorsal margin; exopod reaches midlength. Ultimate segment approximately 3.5 times longer than penultimate segment, with dense tufts of setae;

tapering distally, bearing short row of corneous spines distolaterally and distomesially (Fig. 6B).

Strap-like, terminally hooked epipods present on third maxilliped to third pereopod; corresponding setobranchs on first to fourth pereopods (Fig. 5F).

First pereopod (Fig. 6D–E) broken, reach unknown. Chela approximately twice as long as carpus; dactylus approximately 0.6 times as long as palm, weakly curved distally, terminating in two corneous claws; fixed finger terminating in one.

Second pereopod (Fig. 6F–G) broken, reach unknown, distinctly more slender than first. Chela small with subcylindrical palm; dactlyus terminating in two corneous claws; fixed finger terminating in one. Carpus composed of seven articles.

Third pereopod (Fig. 6H) incomplete, reach unknown, slender. Dactylus, propodus, and carpus missing; merus armed with one lateral spine.

Fourth pereopod (Fig. 6I) incomplete, reach unknown, slender. Dactylus, propodus, and carpus missing; merus unarmed.

Fifth pereopod missing.

Colouration in life. Unknown.

Distribution and habitat. Known only from the type locality, the Coral Seamount, southwest Indian Ocean, in 732 m water depth. Collected from the netting of a whale-bone mooring with *Lebbeus ketophilos* sp. nov.

Etymology. The species name, *oreios*, is the Greek for “of the mountains”, in reference to the type locality of the new species.

Remarks. *Eualus oreios* sp. nov. is characterised by the presence of epipods on the anterior three pairs of pereopods and long rostrum exceeding the antennular peduncles. It is therefore most similar to *E. kinzeri* Tiefenbacher, 1990 and *E. leptognathus* (Stimpson, 1860). Although the holotype of the new species is incomplete, it is distinguished easily from these species (see below).

Eualus oreios sp. nov. is morphologically closest to *E. kinzeri*, described from the Weddell Sea in 673–771 m water depth. The new species differs from *E. kinzeri* in the armature and curvature of the rostrum (5 versus 6–9 ventral teeth; regularly versus irregularly spaced dorsal teeth; descending, distal 0.2 distinctly ascending versus directed straight forward or curving very slightly dorsad), and more slender ventral blade. It is differentiated further from *E. kinzeri* by the proportions and armature of the antennular peduncles (first segment distinctly longer than distal two segments combined versus just a little longer; third segment half length of second versus equal in size; 1 dorsodistal spine versus 2 dorsolateral spines on third segment) and the proportions of the antennal scale (length 2.9 versus 2.5 times width) and third maxilliped (ultimate segment 3.5 versus 4 times length of penultimate segment). In addition, the merus of the fourth pereopod is unarmed in *Eualus oreios* sp. nov. (versus bearing 1 spine in *E. kinzeri*).

The new species is distinguished from *Eualus leptognathus* by the shape, length, and armature of the rostrum (0.6 versus >0.9 times CL; 7 evenly spaced dorsal teeth versus 3–5 and unarmed distally; 5 versus 2–4 ventral teeth) and straight (versus sinuous) (see Kim *et al.* 2006: Fig. 3A) anterolateral margin of the carapace. It is separated further by the reach and armature of the antennular peduncles (reaching distal 0.7 antennal scale versus slightly overreaching midlength; first segment unarmed dorsally versus bearing tooth) and armature of meri of the third and fourth pereopods (1 and 0 spines respectively versus 2–7).

Discussion

Morphological analysis of two hippolytid shrimps from the Coral Seamount in the southwest Indian Ocean reveals them to be new species in the genera *Lebbeus* and *Eualus*. The new species are distinguished from previously described species by a combination of morphological features (see above). This record extends the known distribution of these genera and constitutes, to the author's knowledge, the first record of *Lebbeus* to be collected from whale bone. Two species of *Eualus*, however, have been described and recorded previously from whale–fall ecosystems off Japan (Komai & Fujiwara 2012).

The recent exploration and investigation of seamounts in the southwest Indian Ocean has provided an opportunity to enhance existing knowledge of biodiversity in the deep sea. Further characterisation of the faunal assemblages at seamounts in this region has the potential to elucidate the biogeography of this region.

Acknowledgements

The author thanks the Master and ship's company on the 66th voyage of RRS 'James Cook', the crew of the ROV 'Kiel 6000', and those who contributed to collecting the specimens, especially A. Rogers (chief scientist), D. Amon, J. Copley, A. Glover, T. Dahlgren and K. Kemp. Thanks to S. De Grave for reading the manuscript and to C. Fransen and T. Komai whose comments helped to improve this work. V. Nye was supported by a UK NERC award (NE/F017774/1) to J. Copley.

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Figure legends

FIGURE 1. *Lebbeus ketophilos* sp. nov., holotype, male (carapace length 6.8 mm), [OUMNH.ZC.2013-01-002], Coral Seamount, southwest Indian Ocean, 732 m: entire animal, lateral view. Scale bar: 5 mm.

FIGURE 2. *Lebbeus ketophilos* sp. nov., holotype, male (carapace length 6.8 mm), [OUMNH.ZC.2013-01-002], Coral Seamount, southwest Indian Ocean, 732 m: A, anterior part of carapace and cephalic appendages, dorsal view; B, same, lateral view; C, posterolateral margins of left pleura of fourth and fifth abdominal somites, lateral view; D, telson and left uropod, dorsal view; E, posterior part of telson, dorsal view; F, endopod of right first pleopod, ventral view; G, appendix masculina and appendix interna of right second pleopod, mesial view; H, right antennal peduncle and scale, ventral view. Scale bars: 1mm.

FIGURE 3. *Lebbeus ketophilos* sp. nov., holotype, male (carapace length 6.8 mm), [OUMNH.ZC.2013-01-002], Coral Seamount, southwest Indian Ocean, 732 m: A, right third maxilliped, lateral view; B, distal part of antepenultimate segment of right third maxilliped, dorsal (extensor) view; C, distal part of ultimate segment of right third maxilliped, dorsal view; D, right first pereopod, lateral view; E, chela and carpus right first pereopod, mesial view; F, right second pereopod, lateral view; G, chela of right second pereopod, mesial view; H, right third pereopod (dactylus damaged), lateral view; I, left fourth pereopod (dactylus damaged), lateral view; right fifth pereopod, lateral view; dactylus of right fifth pereopod, mesial view. Scale bars: 1mm.

FIGURE 4. *Eualus oreios* sp. nov., holotype, female (carapace length 6.2 mm), [OUMNH.ZC.2013-01-003], Coral Seamount, southwest Indian Ocean, 732 m: entire animal, lateral view. Scale bar: 5 mm.

FIGURE 5. *Eualus oreios* sp. nov., holotype, female (carapace length 6.2 mm), [OUMNH.ZC.2013-01-003], from the Coral Seamount, southwest Indian Ocean: A, anterior part of carapace and cephalic appendages, dorsal view; B, same, lateral view; C, posterolateral margins of left pleura of fourth and fifth abdominal somites, lateral view; D, telson and left uropod, dorsal view; E, left antennal peduncle and scale, ventral view; F, coxae of right first to fourth pereopods, showing presence of epipod on third pereopod and corresponding setobranch on fourth pereopod, lateral view. Scale bars: 1mm.

FIGURE 6. *Eualus oreios* sp. nov., holotype, female (carapace length 6.2 mm), [OUMNH.ZC.2013-01-003], from the Coral Seamount, southwest Indian Ocean: A, antepenultimate and penultimate segments of right third maxilliped, lateral view; B, ultimate segment of right third maxilliped, dorsal view; C, distal part of antepenultimate segment of right third maxilliped, lateral view; D; left first pereopod, ventral view; E, chela and carpus of left first pereopod, mesial view; F, right second pereopod, lateral view; G, chela of right second pereopod, mesial view; H, ischium and merus of incomplete left third pereopod, lateral view; I, coxa, basis, ischium and merus of incomplete left fourth pereopod, lateral view. Scale bars: 1mm.

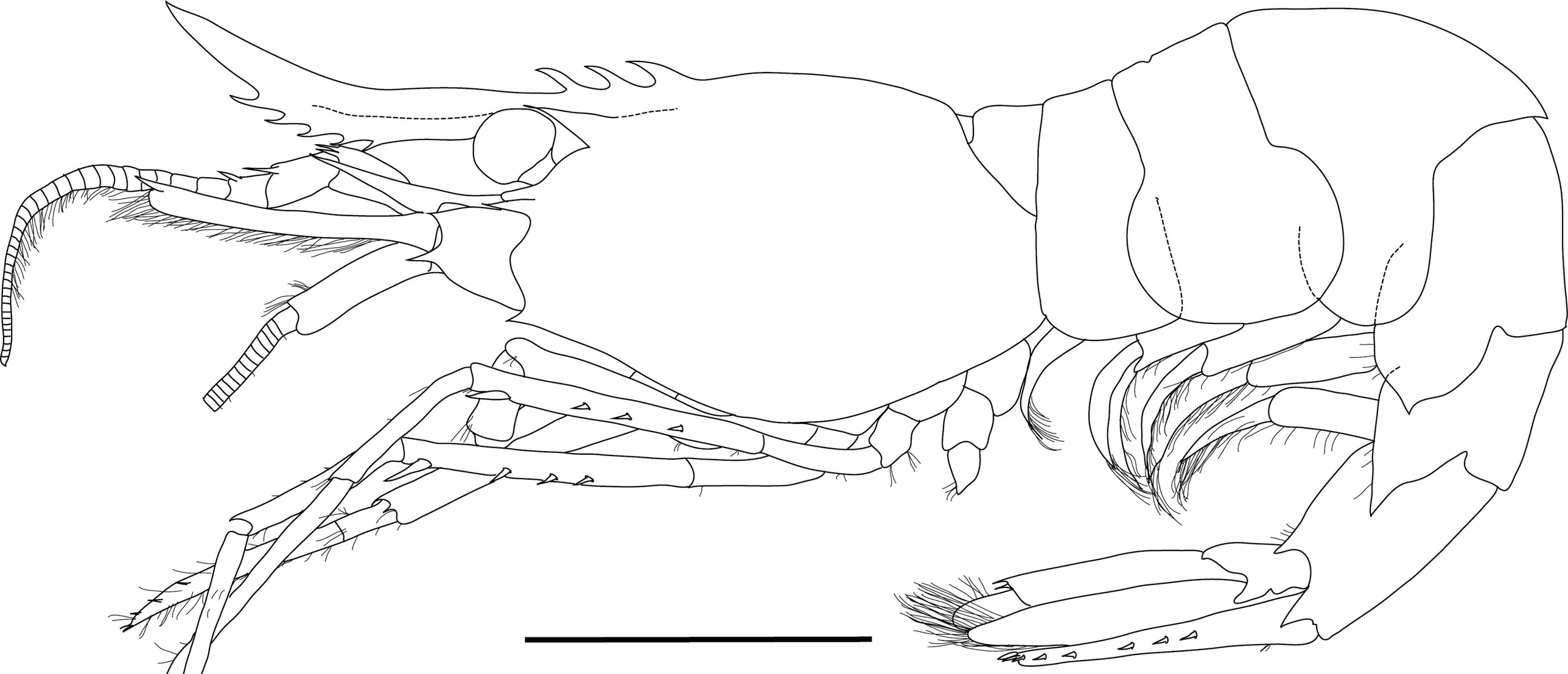
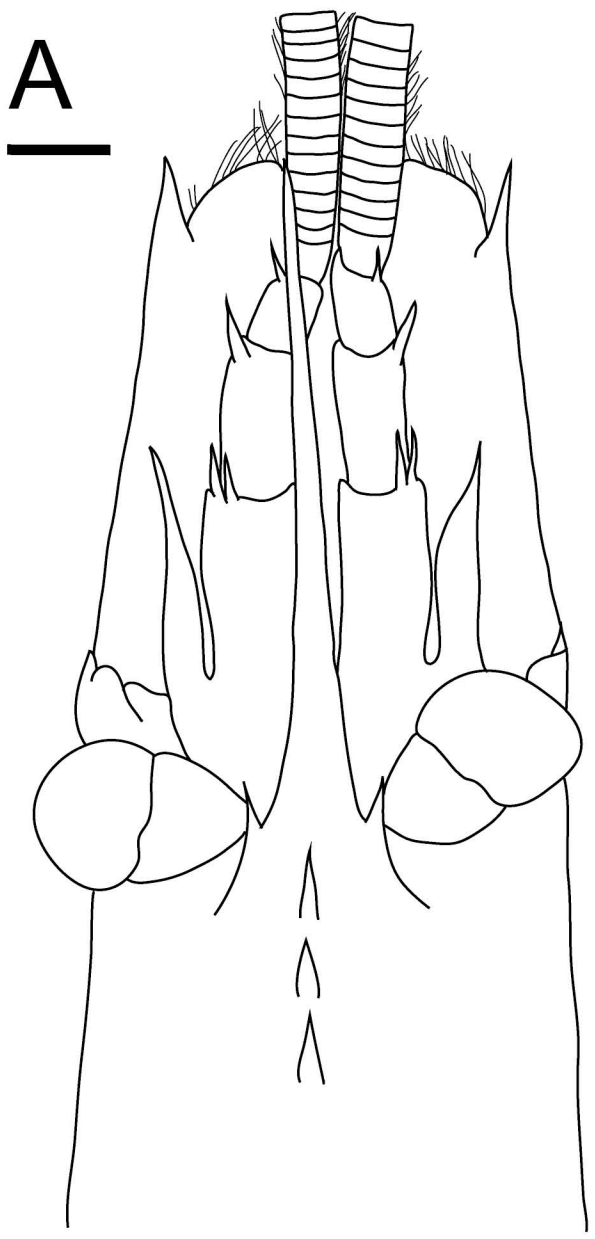
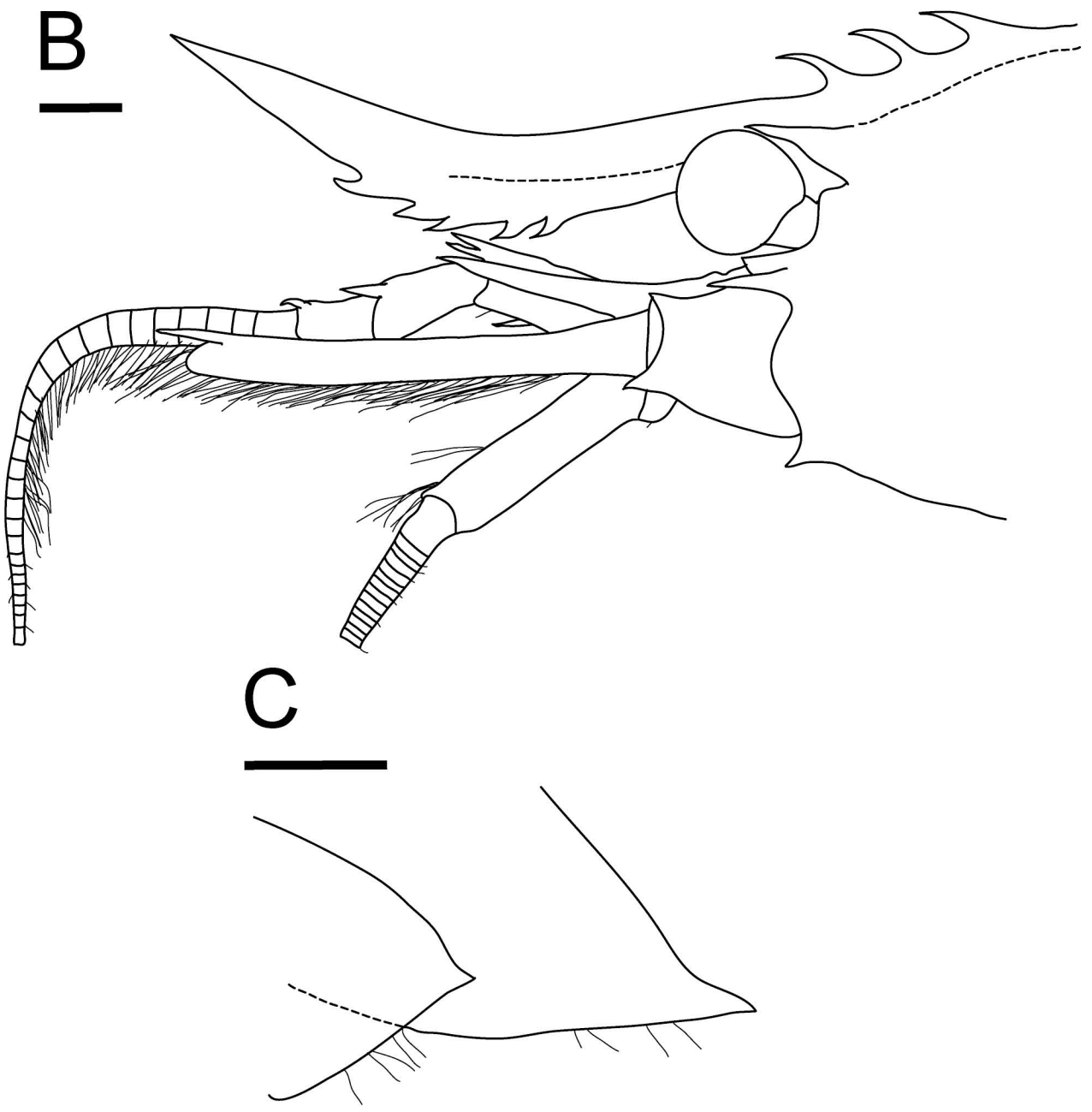
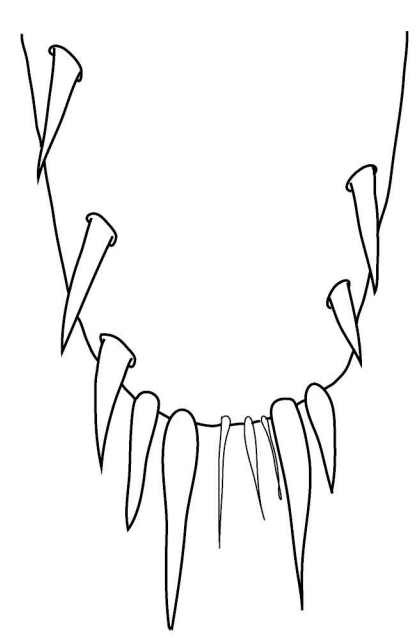


Fig. 1







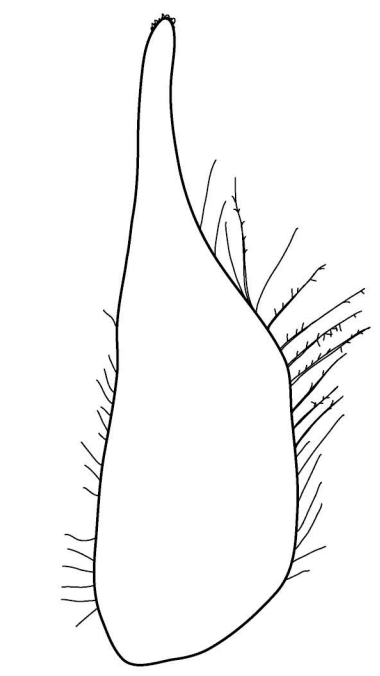
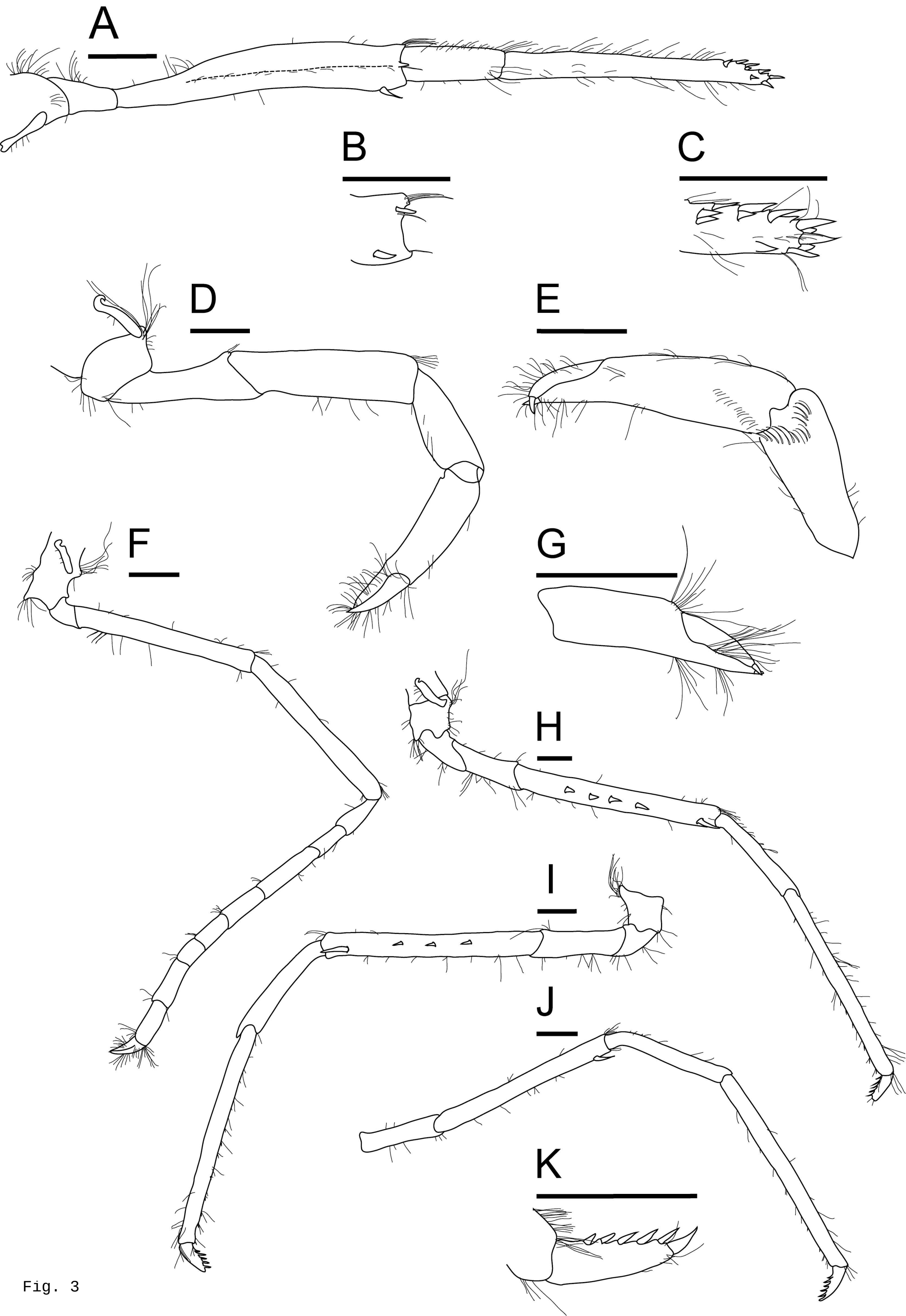


Fig. 2



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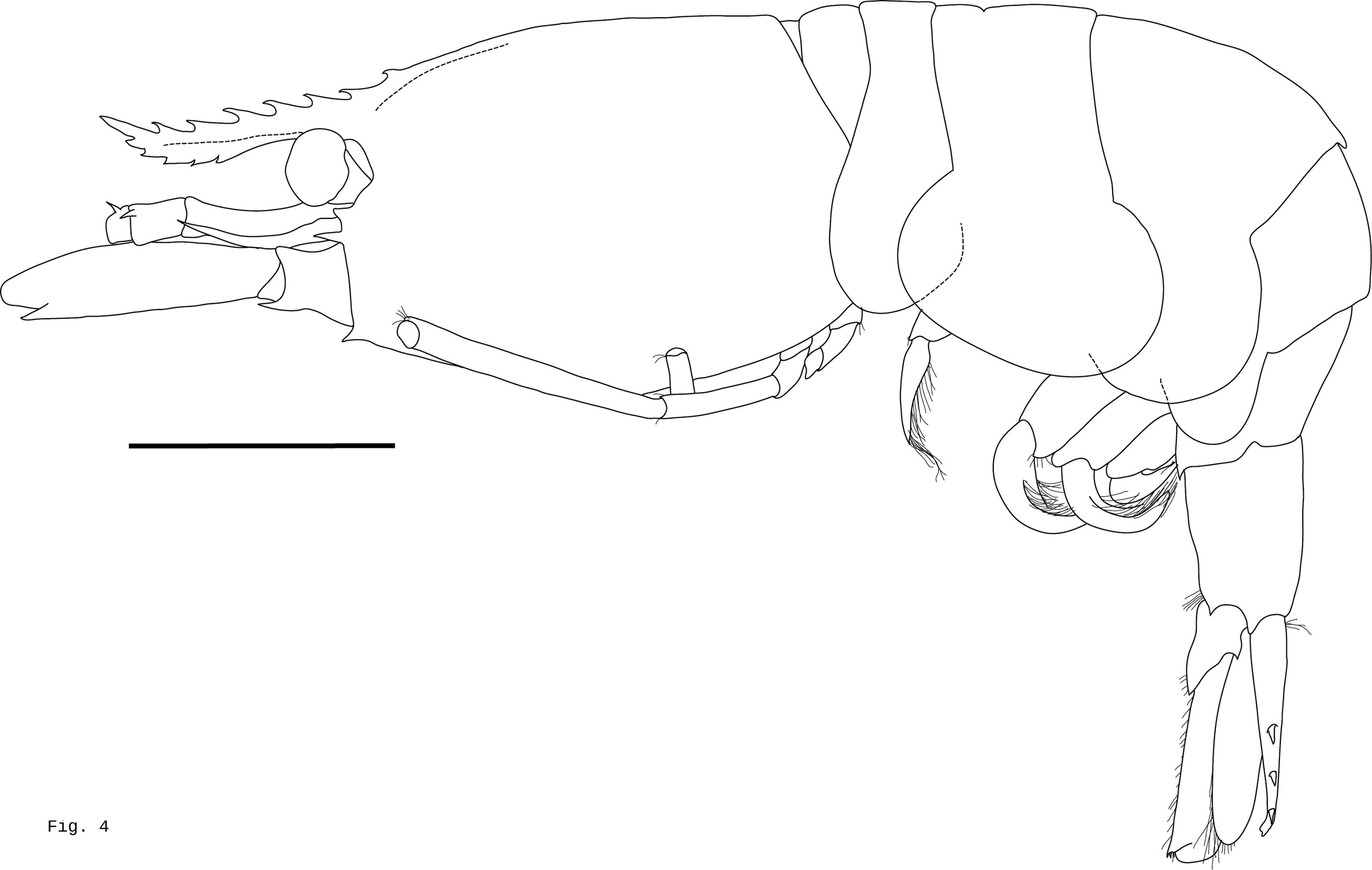
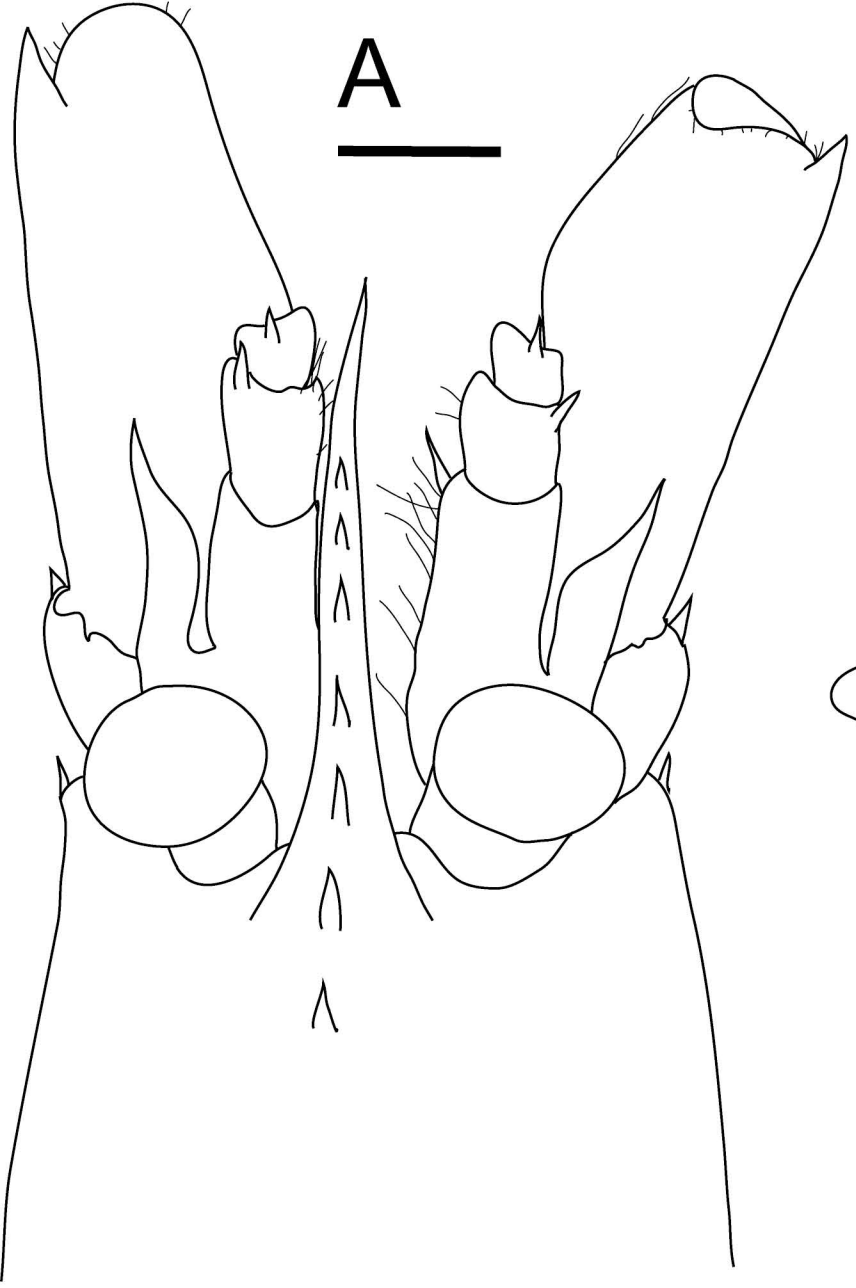
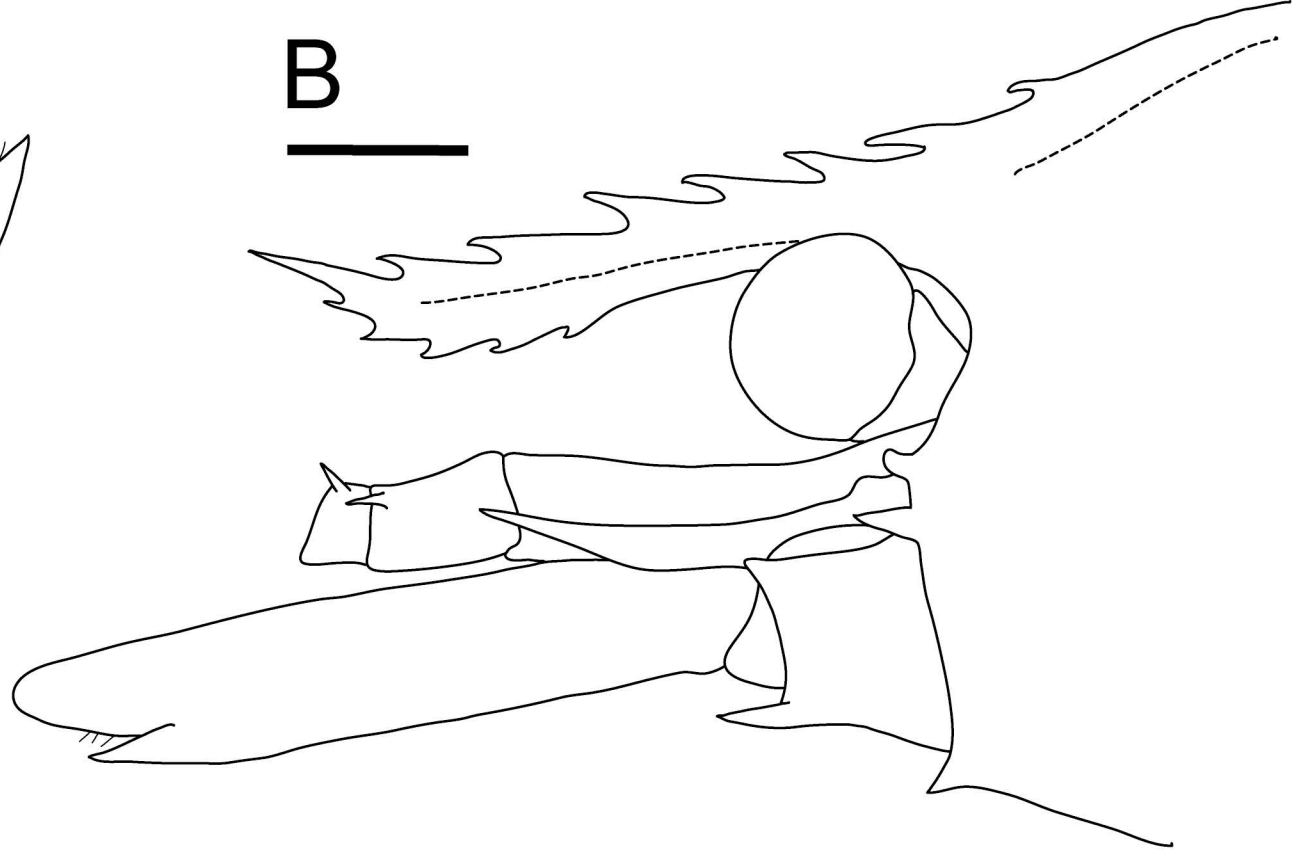
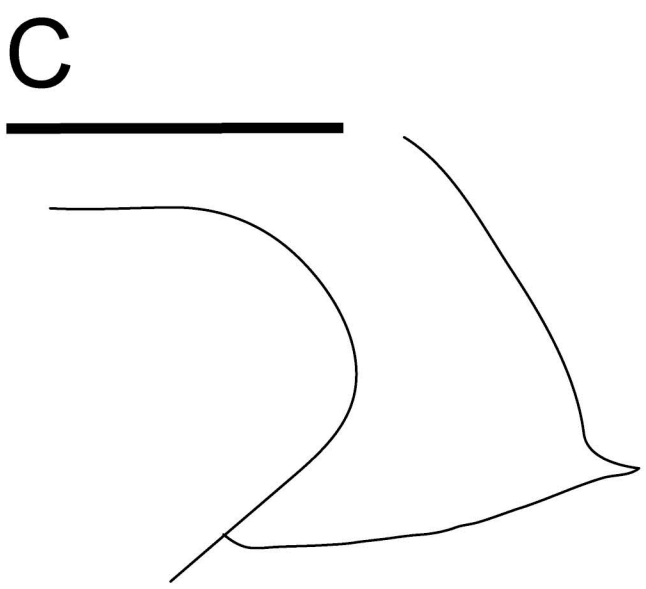
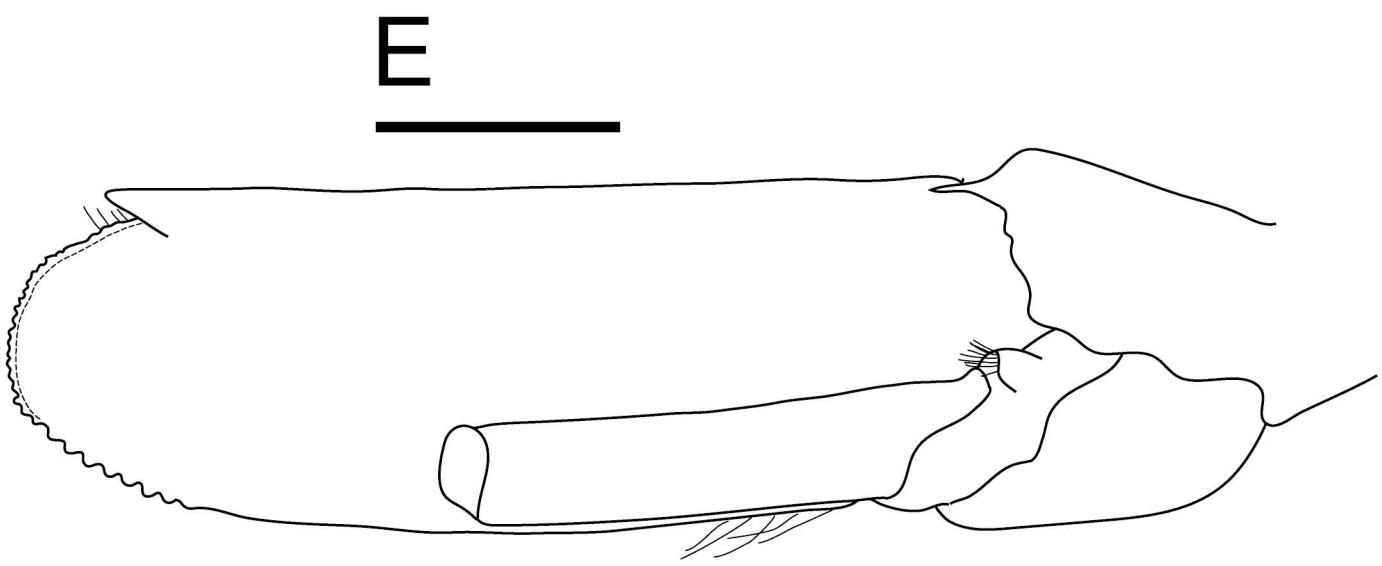


Fig. 4









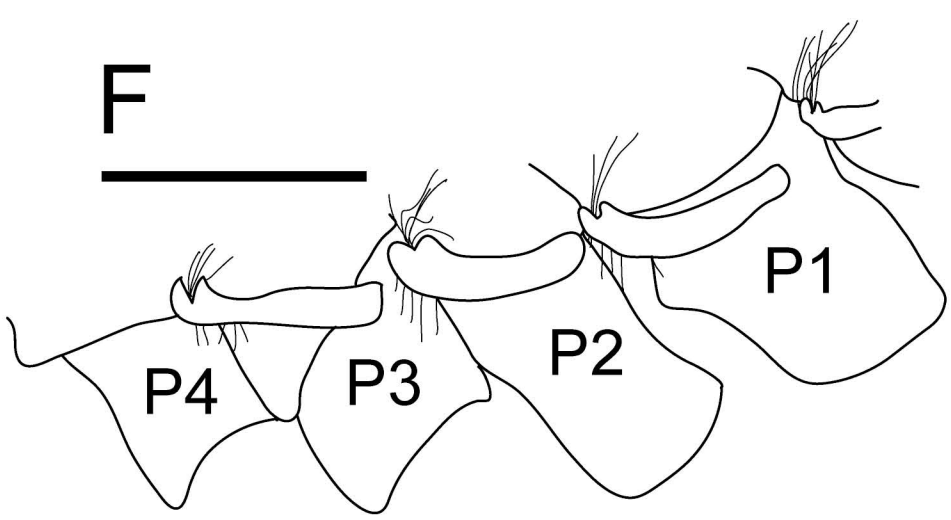
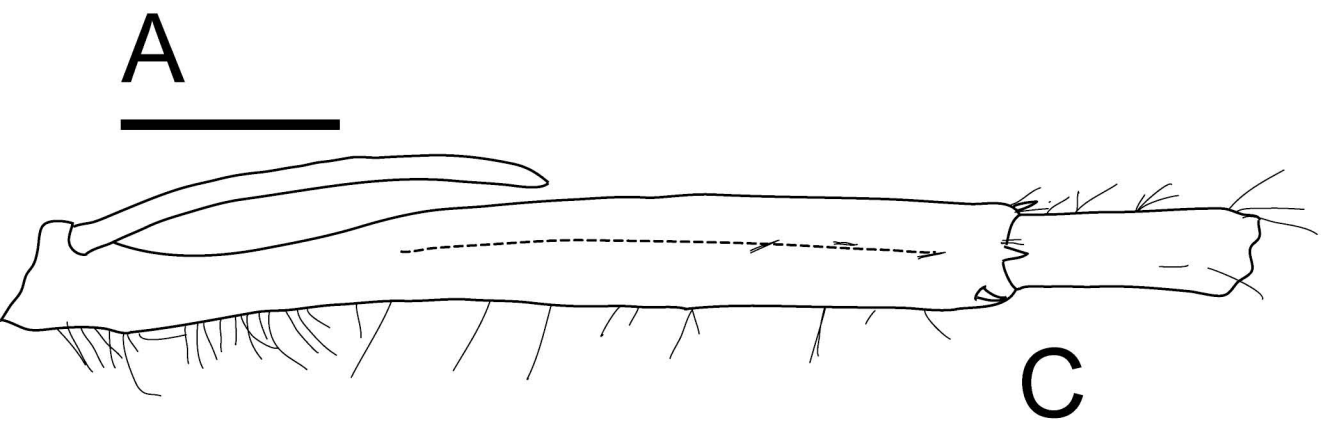
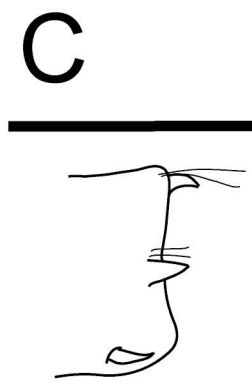
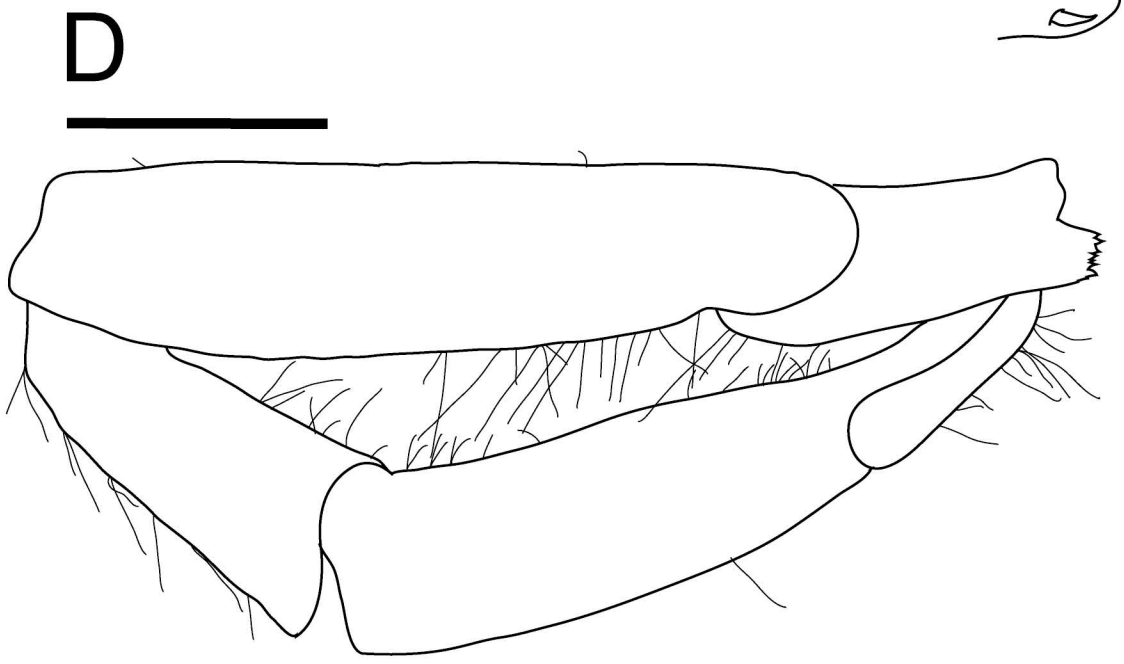
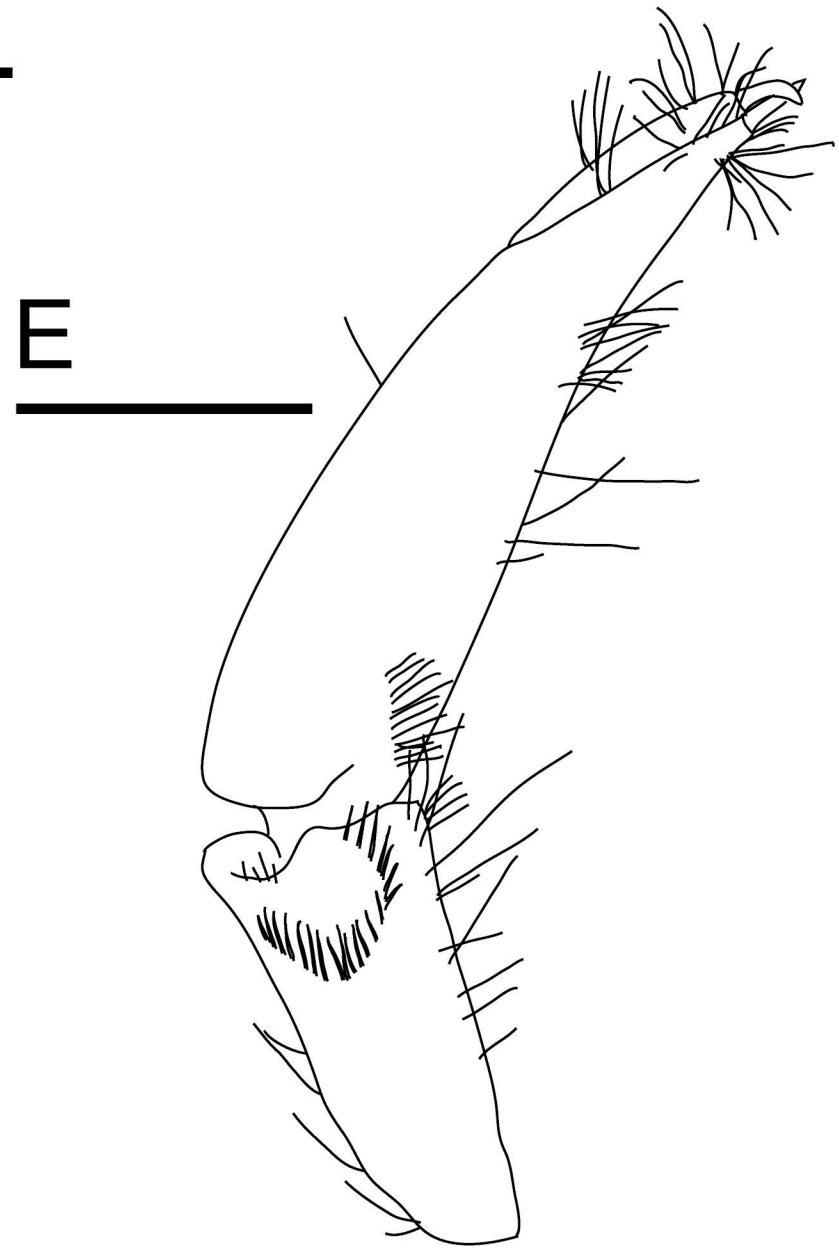


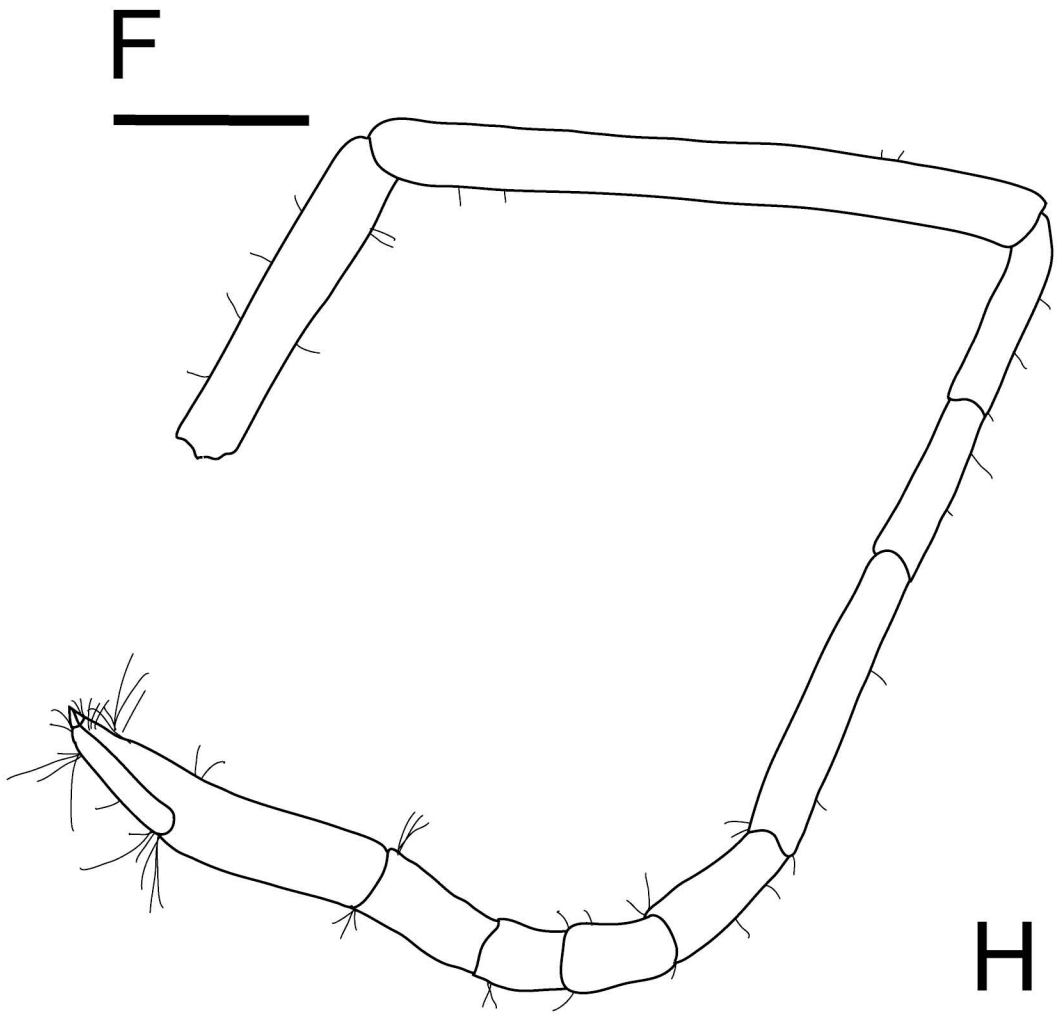
Fig. 5











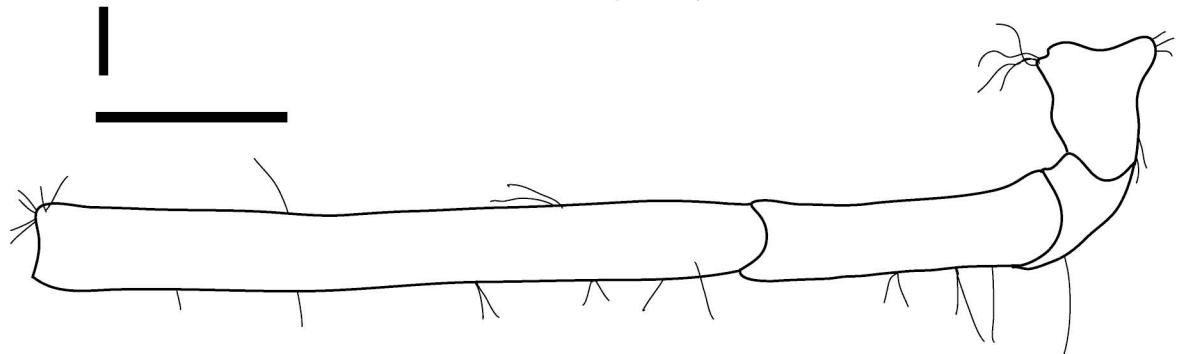


Fig.6