

Description of a new species of *Quadrivisio* Stebbing, 1907, from Songkhla Lake, Thailand (Crustacea: Peracarida: Amphipoda: Maeridae)

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Abstract. *Quadrivisio meufong*, new species, is described from Songkhla Lake in Thailand and is seen to co-occur with the more widely documented *Q. bengalensis* Stebbing, 1907. Unlike other species of *Quadrivisio* Stebbing, 1907, the dorsal carination pattern is consistent with growth stage in *Q. meufong*, new species. An updated key to the eight species of *Quadrivisio* is provided.

Key words. Amphipoda, *Quadrivisio*, Thailand, taxonomy

INTRODUCTION

Quadrivisio Stebbing, 1907, is an estuarine genus in the family Maeridae Krapp-Schickel, 2008, readily identified by the two clusters of ommatidia on each side of the head and the large leaf-like uropod 3. Only eight species of *Quadrivisio* have been recorded to date, including the new species, *Q. meufong*, described here. The distribution of these eight species is very wide: viz. *Quadrivisio aviceps* (K.H. Barnard, 1940) from Palmiet River Lagoon, near Kleinmond, South Africa; *Q. bengalensis* Stebbing, 1907, from Port Canning, Lower Bengal around the eastern and southern coast to Kerala, India, as well as poorly documented extra-limital reports from Mombasa, Kenya (Chevreux, 1913) and Fiji (Schellenberg, 1938); *Q. bousfieldi* Karaman & Barnard, 1979, from Liei River, Manus Island, Bismarck Archipelago, north of Papua New Guinea; *Q. chevreuxi* Gordon & Monod, 1968, from Machumvi Ndogoro, Zanzibar, northeastern Africa; *Q. lobata* Asari, 1983, from Kalipur, near Diglipur, North Andaman Islands, off the east coast of Thailand; *Q. lutzi* (Shoemaker, 1933) from Georgetown, British Guiana, northeastern South America across to Aruba and Bonaire in the Caribbean (Stephensen, 1933) and *Q. sarina* Lowry & Springthorpe, 2005, from Armstrong Beach, Sarina, Queensland, northeastern Australia. Chilton (1925) was the first to document *Quadrivisio* from Songkhla Lake, on the east coast of Thailand, (then known as Tale Sap), identifying the material as *Q. bengalensis*. The new species, *Q. meufong*, is described from Khu Khut Bird Sanctuary and is the second species of *Quadrivisio* known from Songkhla Lake.

With the exception of the more frequently reported *Q. bengalensis*, only a few individuals are known for all the other species of *Quadrivisio*, and this has hampered previous documentation of intraspecific variation. *Quadrivisio bousfieldi* is known only from a female specimen. Records of *Q. bengalensis* by Schellenberg (1938) from Fiji are of two female specimens. Although 104 specimens of *Q. bengalensis* are reported from Mombasa, Kenya on the east coast of Africa, only one individual is a male (Chevreux, 1913; see also Gordon & Monod, 1968).

The few characters which have been documented as showing intraspecific variation in *Quadrivisio* include the eye splitting from one to two pairs in juveniles to adult *Quadrivisio* has been reported by Chilton (1921). Two characters usually of species-level significance in Amphipoda, the shape of the lateral cephalic lobe and the dorsal carination pattern, have been documented as variable by previous workers. Stephensen (1933) noted changes in the lateral cephalic lobe shape for individuals range in size from 7–10 mm body length. In the 15 specimens of *Q. lutzi* examined by Shoemaker (1933), the dorsal carination pattern varied between males and those of females and juveniles. Southern Indian specimens of *Q. bengalensis* (from Odisha to Kerala) also showed variability in carination, which was confirmed as inconsistent within size and gender (Chilton, 1921; K.H. Barnard, 1935). This form of intraspecific variation was not observed for *Q. meufong*, new species, which has a consistent dorsal carinal pattern across all material examined (+75 specimens).

MATERIAL AND METHODS

Samples used in this study were initially fixed in 5% formalin and transferred to 80% ethanol. Material is deposited in the Princess Maha Chakri Sirindhorn Natural History Museum at the Faculty of Science, Prince of Songkla University (PSU). Specimens were dissected in 80% ethanol and slides were made using Aquatex™ mounting agent. Illustrations

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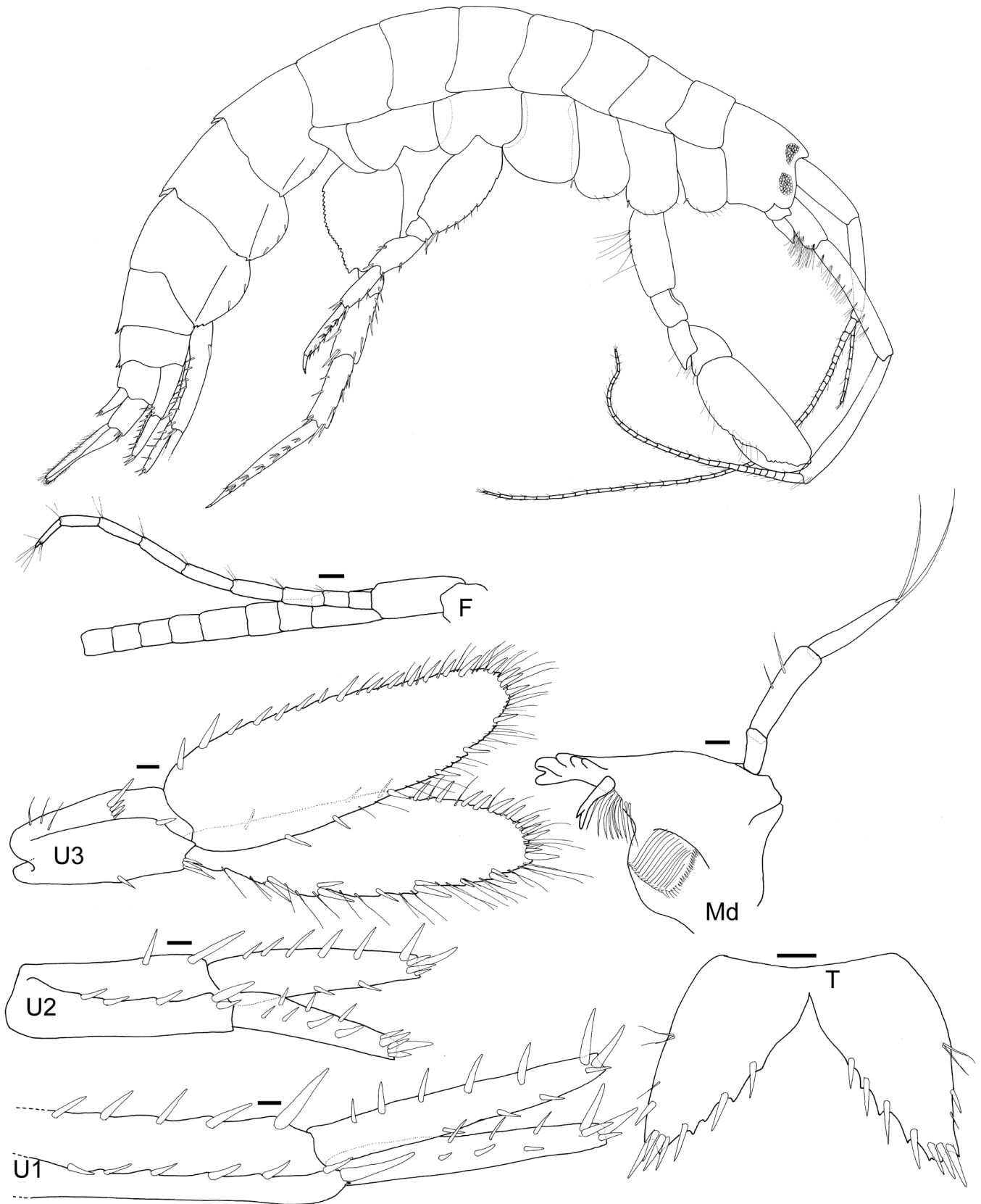


Fig. 1. *Quadrivisio bengalensis* Stebbing, 1907, male, 11 mm, PSUZC-CR 0308, Songkhla Lake, Thailand. Scale bars = 0.1 mm.

were made using Leitz Laborlux K and Wilde Heerbrugg stereomicroscopes fitted with camera lucida. The specimen for confocal laser scanning microscope observation was fixed by ethanol and dehydrated with isopropanol series, and then cleared by BABB (2:1 mixture of benzyl benzoate and benzyl alcohol). Prepared specimen was scanned by Leica TCS SP5 II using autofluorescence. Three-dimensional reconstructions were performed by IMARIS 7.0.0 (Bitplane AG, Switzerland). Standard abbreviations used are: A, antenna; F, accessory flagellum; G, gnathopod; LL, lower lip; Md, mandible; Mx, maxilla; Mxp, maxilliped; P, pereopod; T, telson and U, uropod. Material studied by Chilton, (1925) from Thailand [Tale Sap] is deposited in the Canterbury Museum, New Zealand. Chilton (1925) reported many specimens from various locations. Inquiry about the material established that only one vial and slide mounts of two individuals are extant in the Canterbury Museum collection (Matthew Shaw, assistant curator, pers. comm., February, 2016). With few remaining specimens available, a decision was made not to borrow material for comparison, to investigate the possibility that individuals of the new species were not overlooked in these earlier samples reported by Chilton (1925).

SYSTEMATICS

Maeridae Krapp-Schickel, 2008

Quadrivisio Stebbing, 1907

Quadrivisio bengalensis Stebbing, 1907

(Figs. 1, 2)

Quadrivisio bengalensis Stebbing, 1907: 159–162, plate VII; Chilton, 1921: 537, fig. 6; Chilton, 1925: 534; K.H. Barnard, 1935: 287; Schellenberg, 1938: 63; Nayar, 1959: 26, pl. 9, figs. 1–19; Rabindranath, 1972: 162, figs. 6, 7; Barnard & Barnard, 1983: 619; Ren, 2012: 302–304, fig. 133.

not *Quadrivisio bengalensis*, Chevreux, 1913: in part (= *Q. chevreuxi* Gordon & Monod, 1968); Bousfield, 1971: 260–263, figs 3, 4 (= *Q. bousfieldi* Karaman & Barnard, 1979).

Type locality. Port Canning, Lower Bengal, India.

Material examined. 1 male, 11 mm, dissected, 5 slides, PSUZC-CR 0308; 3 males, 17 juveniles and females (6–11 mm), PSUZC-CR 0309, Khu Khut Bird Sanctuary, Songkhla Lake Basin, Thailand, approx. 7°27'N, 100°24'E, inshore, 13 December 1999, coll. J.K. Lowry and V. Lhekchim; 3 females, PSUZC-CR 0310, Songkhla Lake, Thailand, 1987–1989.

Remarks. In the genus *Quadrivisio* the morphology of subadult male is similar across species. The male specimens examined here are considered mature however there remains the possibility that a more mature male morphotype remains unobserved.

Distribution. India: Bengal, Kerala, Samal Island, Barkul, Satpara, Ghiakhala region, Adyar, Vizagapatam, Travancore (Stebbing, 1907; Chilton, 1921; K.H. Barnard, 1935; Nayar, 1959). Kenya: Mombasa (Chevreux, 1913). Fiji

(Schellenberg, 1938). Thailand: Songkhla Lake [Tale Sap] (Chilton, 1925; current study). South China Sea (Ren, 2012)

Quadrivisio meufong new species

(Figs. 3–6)

?*Quadrivisio bengalensis*, Bussarawich, 1985: 4, 5, fig. 3; Lowry, 2000: 319 (checklist).

Type material. Holotype, male, 9.8 mm, dissected, 4 slides, PSUZC-CR 0301, Khu Khut Bird Sanctuary, Songkhla Lake, Thailand, 7°27'21.14"N, 100°24'20.21"E, in shore, on *Schoenoplectus subulatus* (Vahl) Lye (original label *Scirpus litoralis* Schrad.), coll. J.K. Lowry & V. Lhekchim, 13 December 1999. Paratypes: male, 13.5 mm, PSUZC-CR 0302; male, 12.3 mm, PSUZC-CR 0303; female, 10.5 mm, dissected, 1 slide, PSUZC-CR 0304; 40+ juveniles and females, PSUZC-CR 0305; all from same location as holotype.

Additional material examined. 10 juveniles and females, PSUZC-CR 0306, Khu Khut Bird Sanctuary, Songkhla Lake Basin, Thailand, 7°27'N, 100°24'E, *Hydrilla verticillata* (L. f.) Royle, 13 December 1999, coll. J.K. Lowry and V. Lhekchim; 3 males, 29 juveniles and females, AM P. PSUZC-CR 0307, Songkhla Lake, Thailand, 1987–1989 (several collections combined).

Type locality. Khu Khut Bird Sanctuary, Songkhla Lake, Thailand, 7°27'21.14"N, 100°24'20.21"E.

Etymology. From the Thai 'meu' - hand and 'fong' - bubble, in reference to the adult male gnathopod 2 propodus palm expanded cuticle.

Diagnosis. Antenna 1 accessory flagellum long, with 9–10 articles. Mandibular palp with 2 apical setae. Gnathopod 2 palm subacute, two thirds length of propodus posterior margin, subrectangular distomedial shelf with robust setae, midpalm dominated by expanded cuticle covered in fine setae, palmar margin defined by rounded corner with 2 robust setae; dactylus without posteroproximal shelf, closing along and equal to length of palm. Pereonite 7 without carina. Pleonites 1–3 bicarinate. Epimeron 1–2 posterodistal corner with 3 serrate teeth Epimeron 3 ventral margin serrate, posterodistal corner with 2 teeth. Urosomites 1–3 bicarinate. Telson each lobe with 2 long and 1–2 short apical robust setae, inner margins smooth.

Description. Based on holotype male, 9.8 mm, PSUZC-CR 0301. Head. Eyes ommatidia split into two pairs on each side of head; lateral cephalic lobe broad, truncated, anteroventral margin with notch/slit. Antenna 1 longer than antenna 2; peduncular article 1 shorter than article 2, without robust setae along posterior margin; article 2 longer than article 3; flagellum articles longer than broad, with 38 articles; accessory flagellum long, with 9–10 articles. Antenna 2 peduncular article 2 cone gland not reaching to end of peduncular article 3; article 4 shorter than article 5; flagellum with 34 articles. Maxilla 1 inner plate unknown;

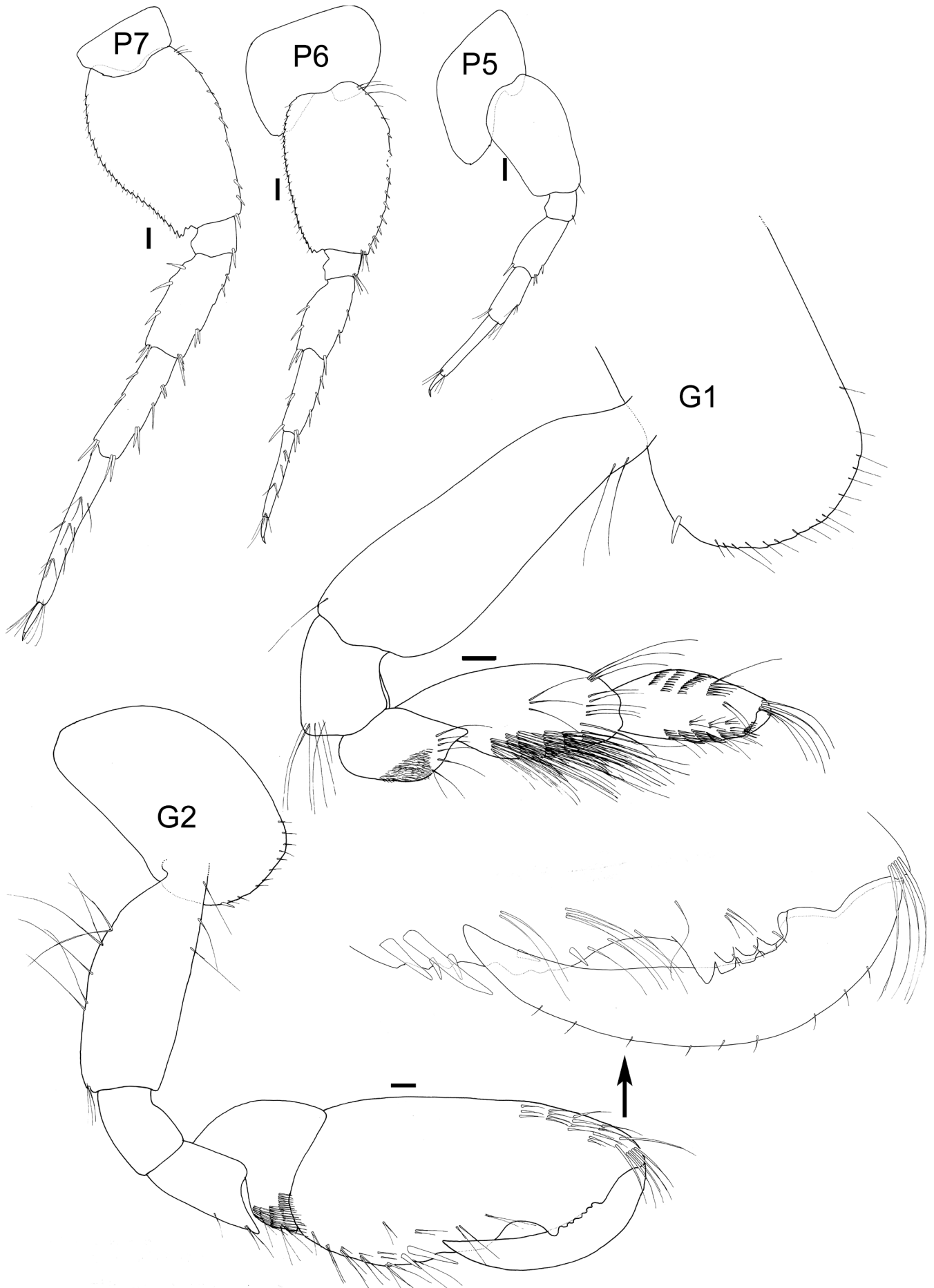


Fig. 2. *Quadrivisio bengalensis* Stebbing, 1907, male, 11 mm, PSUZC-CR 0308, Songkhla Lake, Thailand. Scale bars = 0.1 mm.

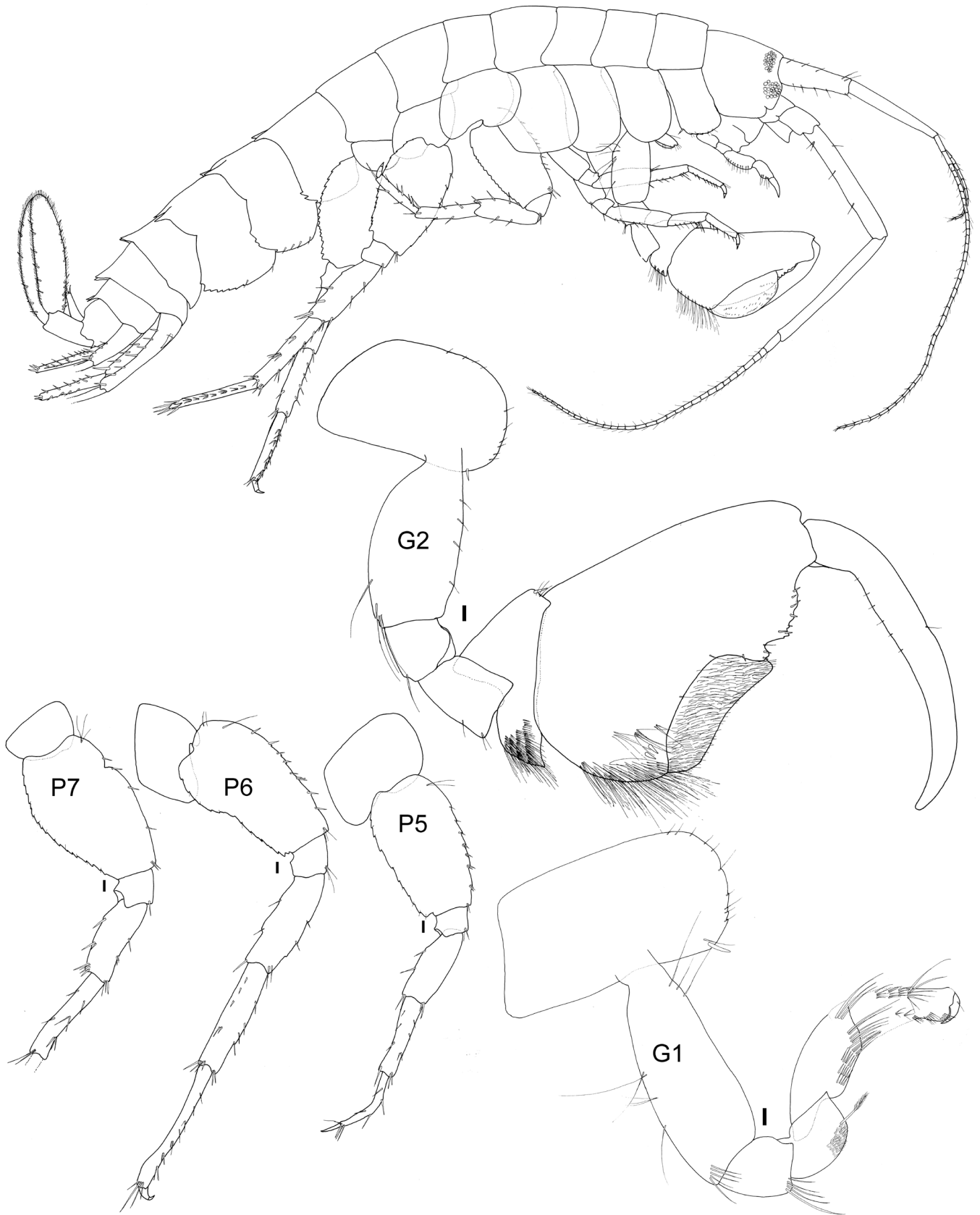


Fig. 3. *Quadrivisio meufong*, new species, holotype, male, 9.8 mm, PSUZC-CR 0301, Songkhla Lake, Thailand. Scale bars = 0.1 mm.

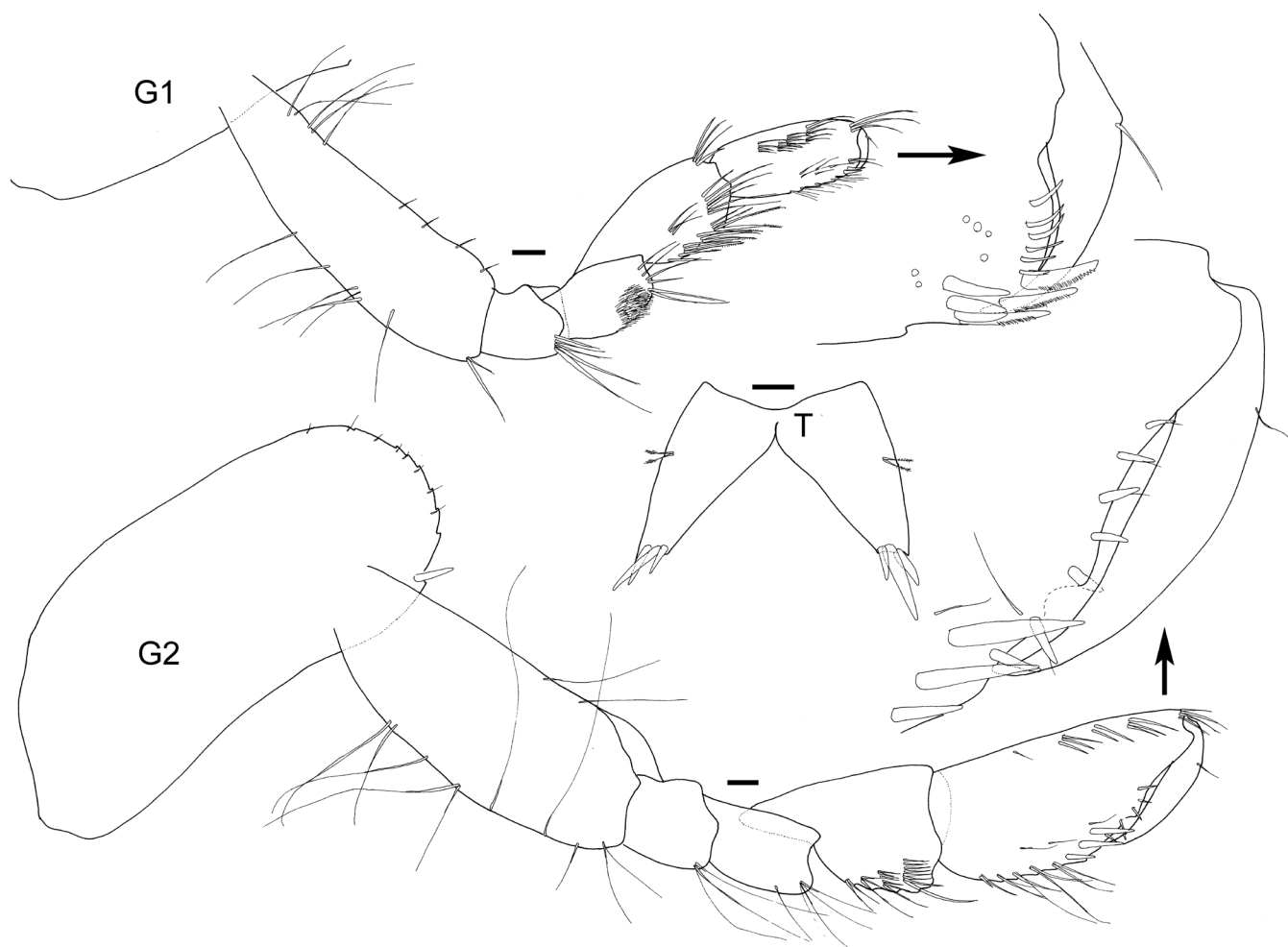


Fig. 4. *Quadrivisio meufong*, new species, holotype, male, 9.8 mm, PSUZC-CR 0301, Songkhla Lake, Thailand. Scale bars = 0.1 mm.

palp 2-articulate with 6 apical robust setae. Lower lip inner and outer lobes apically setose; mandibular lobes apically subacute. Mandible accessory setal row well developed with 8 setae; molar well developed, columnar, triturative; mandibular palp well developed, 3-articulate; article 1 length 1.8 times as long as broad, 0.8 times article 2; article 2 length subequal to article 3, without setae; article 3 rectilinear, short (3.5 times as long as broad), 1.4 times article 1, with 2 apical setae. Maxilliped basal endite with 4 short apical robust setae; ischial endite medial margin lined with robust setae; palp 4-articulate, article 4 lined with slender setae, unguis preset.

Pereon. Gnathopod 1 coxa anterior margin straight concave, anteroventral corner not produced, rounded, posteroventral margin with a few serration and robust seta; carpus 2.8 times as long as broad, longer than propodus; propodus medial surface with comb, palm near transverse, convex, entire, defined by posterodistal corner, with 4 robust setae. Gnathopod 2 subchelate; coxa posteroventral margin with robust seta; basis slender, anterodistal corner without lobes; ischium anterior margin without lobes; merus distoventrally truncate; carpus compressed, lobate, projecting between merus and propodus with rows of dense setae; propodus massive, palm subacute, two thirds length of propodus posterior margin, subrectangular distomedial shelf with robust setae, midpalm dominated by expanded cuticle

covered in fine setae, palmar margin defined by rounded corner with 2 robust setae, posterior proximal margin lined with long slender setae; dactylus without posteroproximal shelf, closing along and equal to length of palm. Pereopod 4 coxa posteroventral lobe well developed, with subrectangular posteromedial corner. Pereopods 5–6 basis weakly expanded, posterior margin straight; merus and carpus not broadened. Pereopod 7 basis expanded, posterior margin convex; merus and carpus not broadened. Pereonite 7 without carina.

Pleon. Pleonites 1–3 bicarinate. Epimeron 1–2 posterodistal corner with 3 serrate teeth Epimeron 3 ventral margin serrate, posterodistal corner with 2 teeth. Urosomites 1–3 bicarinate. Uropod 1 peduncle with 1 basofacial seta, longer than rami; outer ramus subequal to inner ramus with apical and marginal robust setae. Uropod 2 peduncle longer than rami, outer ramus shorter than inner ramus with apical and marginal robust setae. Uropod 3 peduncle shorter than rami; rami foliaceous, subequal in length, lined with short robust and slender setae. Telson deeply cleft (90%), longer as broad, tapering distally, with short inner and long outer apical cusps, apical conical extension reaching less than one third along longest seta, each lobe with 2 long and 1–2 short apical robust setae, inner margins smooth.

Female (sexually dimorphic characters), based on paratype female, 7.3 mm, PSUZC-CR 0304. Gnathopod 2 coxa

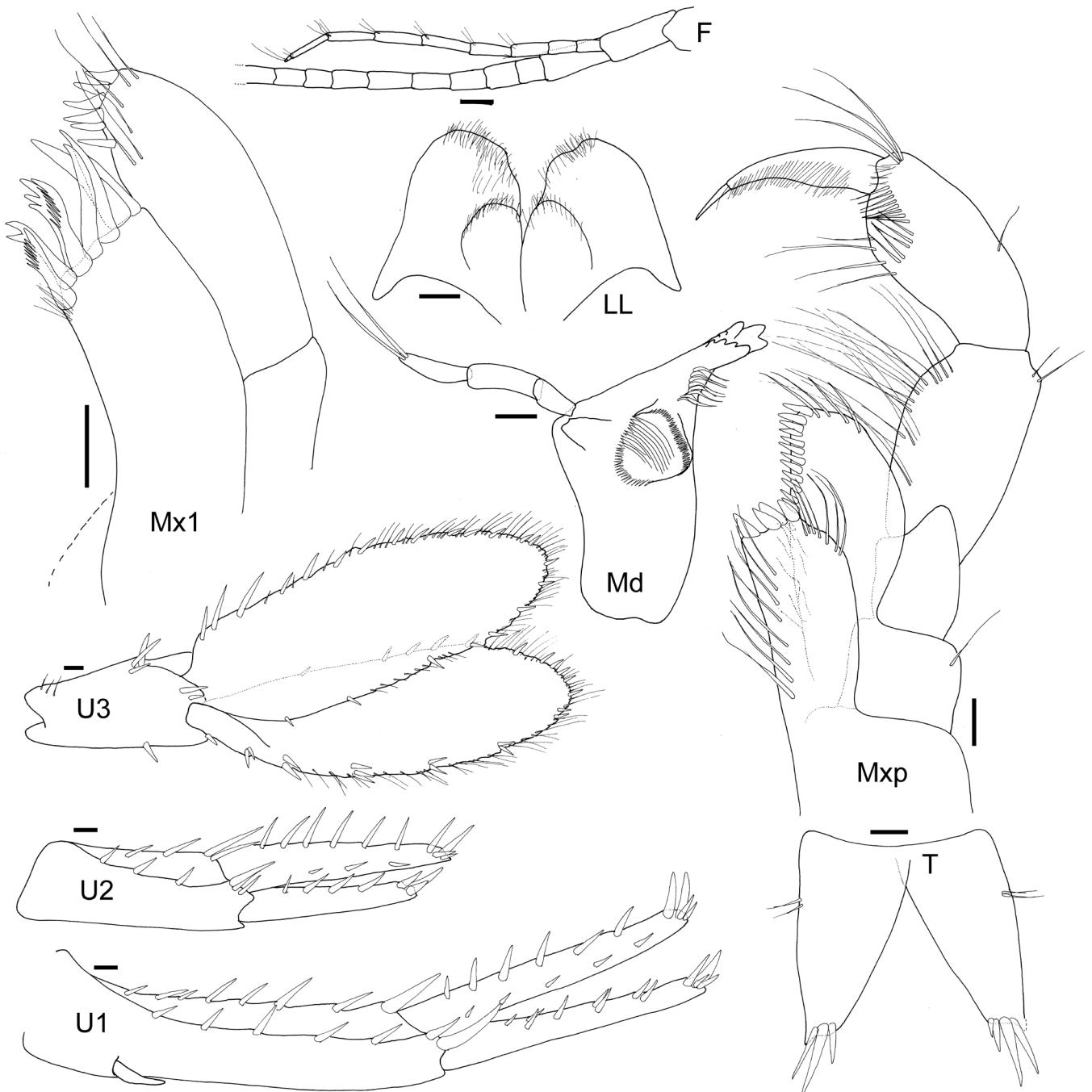


Fig. 5. *Quadrivisio meufong*, new species, paratype, female, 10.5 mm, PSUZC-CR 0304, Songkhla Lake, Thailand. Scale bars = 0.1 mm.

posterodistal corner with robust seta; carpus subtriangular, 0.9 times propodus length; propodus rectilinear, palm subacute, without distomedial shelf, palmar margin irregular, entire, lined with short robust setae, defined by posteroventral corner, with 3 spaced long robust setae; dactylus weakly recurved, closing short of palm, margins smooth. Telson lobes with 1 long and 2 short apical robust setae.

Variation. Uropod 3 increases with growth stage (often regenerating or missing, broken off during sample processing).

Remarks. The male gnathopod 2 propodus palm of *Q. meufong*, new species, has a large bubble-like expanded cuticle covered in fine setae. In the few male specimens on hand, the expanded palm cuticle may be collapsed or

inflated, and it is unclear if this is related to preservation technique (with the tegument collapsing during fixation/preservation) or growth stage (larger males have a more inflated structure) (Figs 4, 6). The palmar structure is enclosed by an outer and inner layer of cuticle (Fig. 6B), and there are no hemolymphal connection to propodus observed. The cuticular layers are seemingly peeled and inflated structure derived from ordinary cuticular composition, that is the inner layer might be comparable to endo and exocuticle, while the outer layer is comparable with epicuticle.

Quadrivisio meufong, new species, is strikingly similar to *Q. lutzi* (Shoemaker, 1933) from Georgetown, British Guiana on the northern coast of South America. Both species have a similarly shaped palm of the male gnathopod 2. The

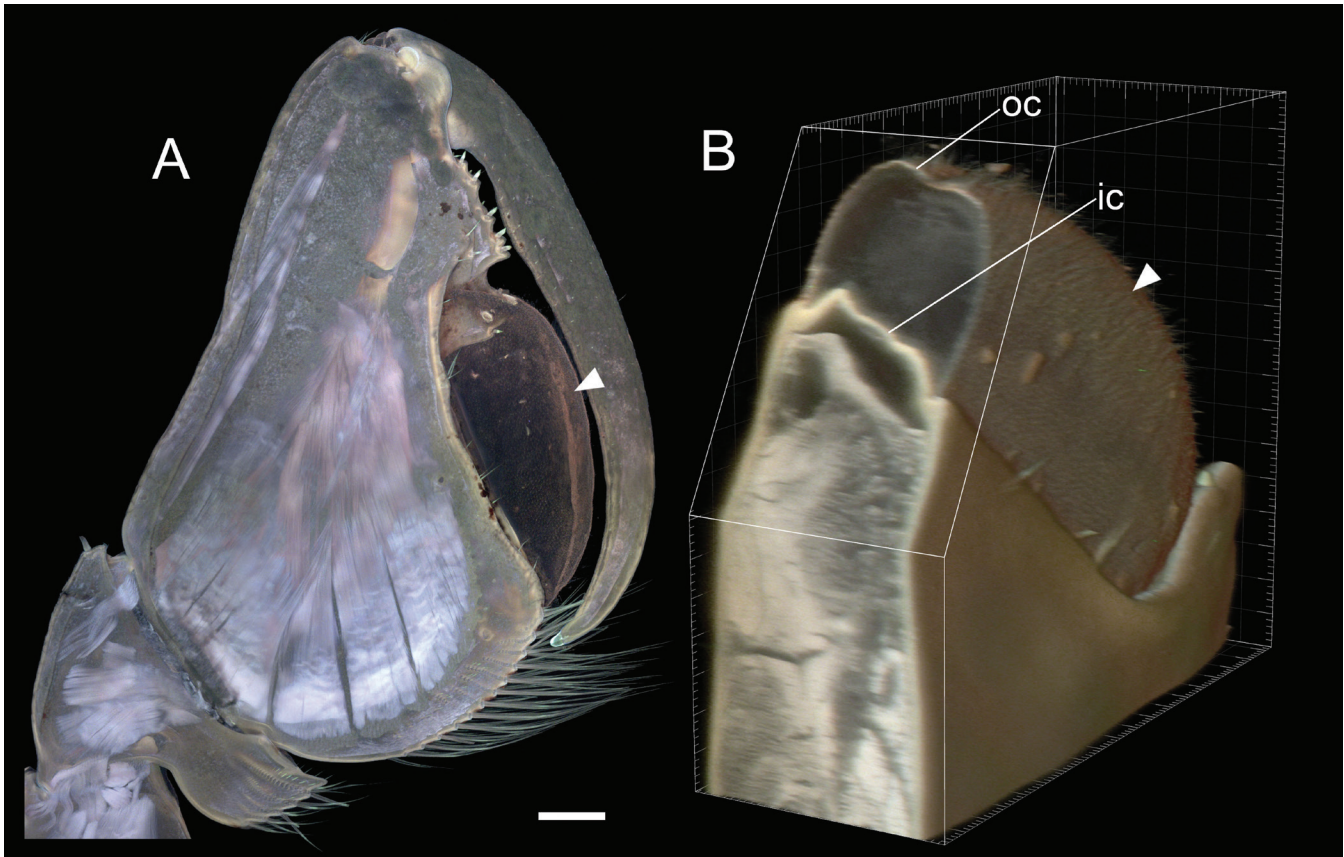


Fig. 6. 3D reconstructed male gnathopod 2 of *Quadrivisio meufong*, new species, male 13.5 mm, PSUZC-CR 0302. A, overall image of carpus, propodus, and dactylus of the male gnathopod 2; B, magnified, proximal view of the expanded palm cuticle. Arrow heads indicate expanded palm structure; oc, outer layer of cuticle; ic, inner layer of cuticle. Scale bars = 0.1 mm.

presence of two carinae on pleonites 1–3 and urosomite 1 separate *Q. meufong* from *Q. lutzi*, which has no carinae on the pleonites, two carinae on urosomite 1, and four carinae in urosomite 2 in female and juveniles and, notably, a smooth dorsum in males (i.e., carina formula 2-2-2-2-0 vs 0-0-0-2-4 or 0-0-0-0-0, respectively).

Material identified as *Q. bengalensis* by Bussarawich (1985) from Thailand do not have robust setae lining the inner margin of the telson and, therefore, may represent juveniles of *Q. meufong*, instead.

Distribution. Thailand. Songkhla Lake (current study). Ao Yon, Ao Nam Bor, Klong Pak Pan (Bussarawich, 1985).

Key to world *Quadrivisio* species
(modified after Karaman & Barnard, 1979)

1. Carina absent on pleonites or urosome in males and females2
- Carina present on pleonites or urosome in males and females.....5
2. Male gnathopod 2 propodus palm without posterodistal shelf*Q. chevreuxi* Gordon & Monod, 1968
- Male gnathopod 2 propodus palm with posterodistal shelf...3
3. Male gnathopod 2 dactylus short, not reaching end of palm ..
.....*Q. aviceps* (K.H. Barnard, 1940)
- Male gnathopod 2 dactylus subequal to palm length4

4. Urosome and telson covered in dense setae; male gnathopod 2 propodus anterior margin produced into lobe.....*Q. lobata* Asari, 1983
- Urosome and telson without dense setae; male gnathopod 2 anterior margin not produced.....
.....*Q. sarina* Lowry & Springthorpe, 2005
5. Telson with robust setae along inner margins of each lobe....
.....*Q. bengalensis* Stebbing, 1907
- Telson without setae along inner margin of each lobe.....6
6. Epimeron 3 margins with several teeth.....7
- Epimeron 3 margins smooth.....*Q. lutzi* (Shoemaker, 1933)
7. Accessory flagellum with 7 articles; mandibular palp articles 2–3 without setae*Q. bousfieldi* Karaman & Barnard, 1979
- Accessory flagellum with 9–10 articles; mandibular palp articles 2–3 with setae.....*Q. meufong* sp. nov.

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