

Two new species of the genus *Floresorchestia* (Crustacea, Amphipoda, Talitridae) from Amphawa Estuary, Samut Songkhram Province, Thailand

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Abstract

Two new species of *Floresorchestia* (Crustacea: Amphipoda) are described from Amphawa Estuary, Samut Songkhram Province, Thailand. *Floresorchestia amphawaensis* **sp. nov.** is a riparian-hoppers living near agricultural and urban areas, being distinguished by the following character states: left mandible lacinia mobilis 4-dentate; gnathopod 2 palm reaching about 34%; telson as broad as long, with four robust setae per lobe. *Floresorchestia pongrati* **sp. nov.** are described as riparian-hoppers living in the moist area near Mae Klong canal banks with a unique left mandible lacinia mobilis 5-dentate; gnathopod 2 palm reaching 30% and telson with seven robust setae per lobe. The status and the problem of diagnostic character states of the genus *Floresorchestia* are discussed.

Key Words

Floresorchestiinae, riparian-hoppers, Southeast Asia, Talitridae

Introduction

Talitridae Rafinesque, 1815 is the only amphipod group adapted to live in terrestrial habitats. They show a global distribution, covering Northern and Southern Hemispheres and present a high diversity with 116 genera and about 358 species (Lowry and Myers 2019). Representatives of this family are also well recorded within the Southeast Asia Region with a total of 24 species (*Asiaorchestia* Lowry & Myers, 2019: 1 species; *Floresorchestia* Bousfield, 1984: 9 species; *Gazia* Lowry & Springthorpe, 2019: 1 species; *Morinaga* Lowry & Myers, 2019: 1 species; *Platorchestia* Bousfield, 1982: 2 species; *Talorchestia* Dana, 1852: 9 species; and *Vietorchestia* Dang & Le, 2011: 1 species) (Azman et al. 2022).

The subfamily Floresorchestiinae Lowry & Springthorpe, 2019 was introduced to re-order the

Floresorchestia-complex, with the division into three genera (*Austropacifica*, *Floresorchestia* and *Gazia*). The three genera share one indicative synapomorphic character in the presence of slits on the epimera (slits may vary on either epimera 1–3, 2 or 2–3). The genus *Floresorchestia* contains 24 valid species confined to the Indo-Pacific (Lowry and Springthorpe 2019) and East Afrotropical realms, comprising five ecological types (Lowry and Springthorpe 2019). Recent discoveries have also found three new terrestrial species, one being from China (*F. xueli* Tong & Hou in Tong, Hao, Liu, Li & Hou, 2021), one from Thailand (*F. kongsemae* Suklom, Danaisawadi & Wongkamhaeng, 2021) and another one from Kenya (*F. mkomani* Bichang'a & Hou in Bichang'a, Kioko, Liu, Li & Hou, 2021).

Although previous studies on terrestrial amphipods in Thailand report four species of Floresorchestiinae,

such as *G. samroyodensis* Azman, Wongkamhaeng & Damrongrojwattana, 2014, *F. boonyanusithii* Wongkamhaeng, Damrongrojwattana & Pattaratumrong, 2016, *F. buraphana* Wongkamhaeng, Damrongrojwattana & Pattaratumrong, 2016 and *F. kongsemae* (Azman et al. 2014; Wongkamhaeng et al. 2016; Suklom et al. 2021), this number is still low given the whole picture of talitrid diversity in Thailand. Here, we describe two new *Floresorchestia* species, *F. amphawaensis* sp. nov. and *F. pongrati* sp. nov. including comparative morphology with four Floresorchestiinae species in Thailand. In addition, an updated key to the male *Floresorchestia* in Southeast Asia is provided.

Materials and methods

This study is based upon material collected from leaf litter in a mangrove forest of Amphawa District, Samut Songkhram Province, Thailand (Fig. 1). Specimens were collected using a pit-fall trap and were then carefully transferred into plastic containers. They were fixed in 70% ethanol and preserved in 95% ethanol. The specimens were

examined under a compound microscope and later selected for dissection. The dissected appendages of specimens were examined and representative figures were produced using camera lucida attached to an Olympus CH30 light microscope. The pencil drawings were scanned and digitally inked using an iPad via the Procreate application. Final plates were prepared using Adobe Photoshop CC 2017. Distributions maps were plotted using SimpleMappr (Shorthouse 2010). The palm measurement length was made following Lowry and Springthorpe (2015) as a percentage of the length of the propodus of male gnathopod 2. The percentage is calculated using the formula $100(1 - a/b)\%$ (Fig. 2), where 'a' is the length of the posterior margin measured from the seta at the corner of the palm to the base of the propodus and 'b' is the length of the propodus measured from the base of the dactylus to the base of the propodus.

Setae and mouthparts were made following Zimmer et al. (2009). Abbreviations for Figs 4–13: **A**, antenna; **EP**, epimera; **G**, gnathopod; **LL**, lower lip; **MD**, mandible; **MX**, maxilla; **MP**, maxilliped; **P**, pereopod; **PL** pleopod; **TL**, telson; **U**, uropod; **UL**, upper lip; **R**, right; **L**, left; ♂, male; ♀, female.



Figure 1. Map showing the sampling area. Red circle represents type locality of *Floresorchestia amphawaensis* sp. nov. and blue circle represents type locality of *F. pongrati* sp. nov.

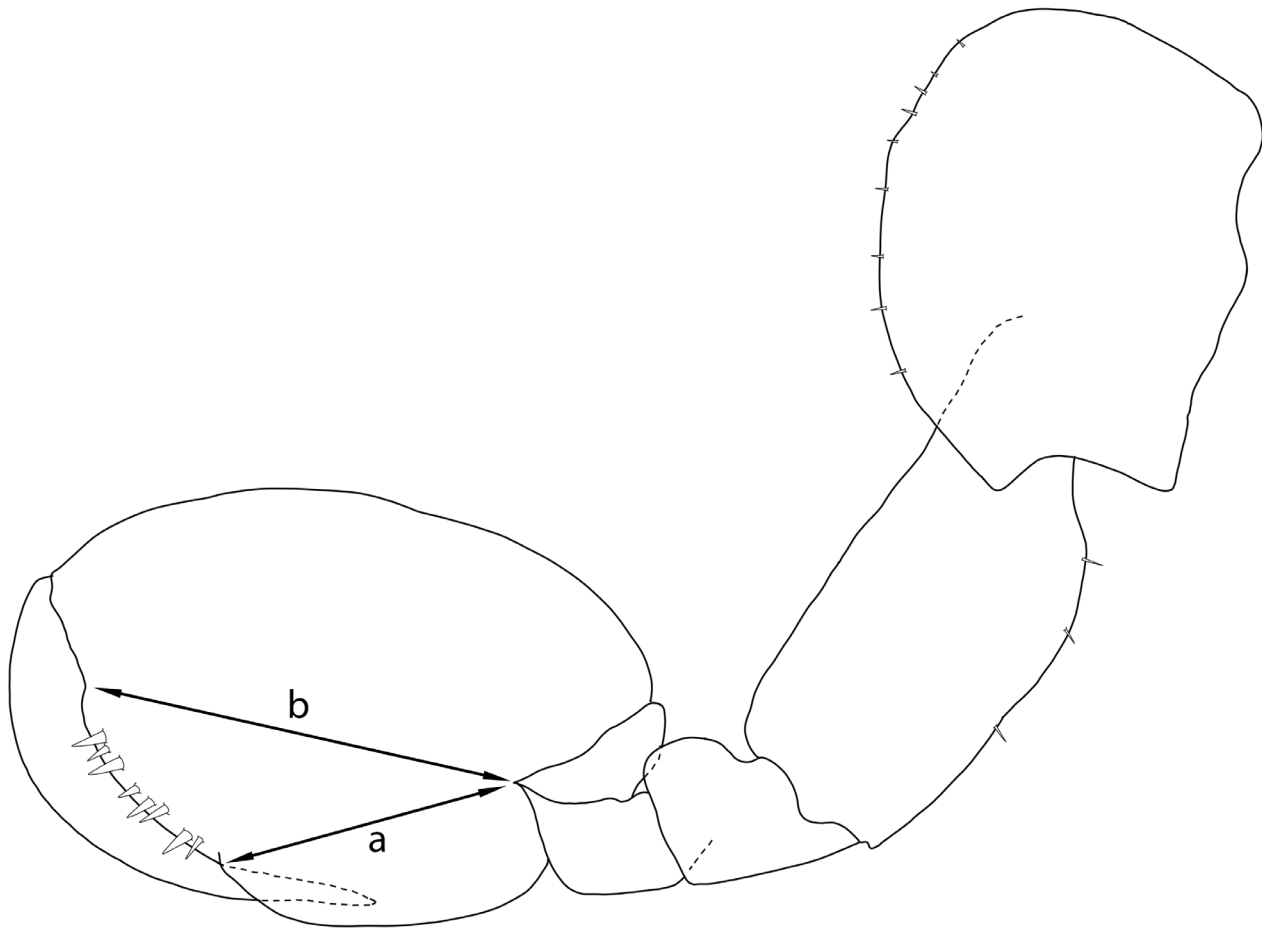


Figure 2. The measurement method for the length of male gnathopod 2 palm and posterior margin of propodus.

Results

Systematics

Superfamily Talitroidea Bulycheva, 1957

Family Talitridae Rafinesque, 1815

Subfamily Floresorchestiinae Myers & Lowry, 2020

***Floresorchestia* Bousfield, 1984**

Orchestia floresiana group Bousfield, 1971: 267.

Floresorchestia Bousfield, 1984: 205.—Miyamoto and Morino 2008:

838.—Lowry and Springthorpe 2009: 121.

Type species. *Orchestia floresiana* Weber, 1892, original designation.

Diagnostic description (modified from Lowry and Springthorpe 2015, 2019). Antenna 1 short, not longer than article 4 of antenna 2 peduncle. Antenna 2 peduncular articles slender; article 3 without ventral process. Mandible left lacinia mobilis 4–5-cuspidate. Maxilliped palp article 2 distomedial lobe well developed, article 4 reduced, button-shaped. Gnathopod 1 subchelate; posterior margin of merus, carpus and propodus each with lobe

covered in palmate setae. Gnathopod 2 subchelate; dactylus distally attenuated (except *Floresorchestia papeari* Lowry & Springthorpe, 2015). Pereopods 3–7 cuspidactylate. Pereopods 6–7 not sexually dimorphic. Pleopods all well developed, biramous. Epimera 1–3, 2–3 or 2 with slits just above ventral margins, vestigial on EP1 (except *F. xeuli* Tong, Hao, Liu, Li & Hou, 2021). Uropods 1 and uropod 2 not sexually dimorphic. Uropod 1 outer ramus without marginal robust setae. Uropod 2 outer ramus with marginal robust setae. Uropod 3 ramus subequal in length to peduncle. Telson with 3–7 robust setae.

Female (sexually dimorphic characters). Gnathopod 1 posterior margin of merus, carpus and propodus each without lobe covered in palmate setae. Gnathopod 2 mitten-shaped. Oostegites on gnathopod 2 to pereopod 5, setae straight.

Species composition. *Floresorchestia* contains 27 species + 2 new species: *F. amphawaensis* sp. nov.; *F. andrevo* Lowry & Springthorpe, 2015; *F. anomala* (Chevreux, 1901); *F. anoquesana* (Bousfield, 1971); *F. anpingensis* Miyamoto & Morino, 2008; *F. boonyanusithii* Wongkamhaeng, Dumrongrojwattana & Pattaratumrong, 2016; *F. buraphana* Wongkamhaeng, Dumrongrojwattana & Pattaratumrong, 2016; *F. floresiana*

(Weber, 1892); *F. hanoiensis* Hou & Li, 2003; *F. kalili* Lowry & Springthorpe, 2015; *F. kongsemae* Suklom, Danaisawadi & Wongkamhaeng, 2021; *F. laurenae* Lowry & Springthorpe, 2015; *F. malayensis* (Tattersall, 1922); *F. mkomani* Bichang'a & Hou in Bichang'a, Kioko, Liu, Li & Hou, 2021; *F. oluanpi* Lowry & Springthorpe, 2015; *F. palau* Lowry & Myers, 2013; *F. papeari*; *F. pectenispina* (Bousfield, 1970); *F. pohnppei* Lowry & Myers, 2013; *F. poorei* Lowry & Springthorpe, 2009; *F. pongrati* sp. nov.; *F. samoana* (Bousfield, 1971); *F. serejoae* Lowry & Springthorpe, 2015; *F. seringat* Lowry & Springthorpe, 2015; *F. thienemanni* (Schellenberg, 1931); *F. vitilevana* (J.L. Barnard, 1960); *F. xueli* Tong, Hao, Liu, Li & Hou, 2021; *F. yap* Lowry & Springthorpe, 2015; *F. yehyuensis* Miyamoto & Morino, 2008.

***Floresorchestia amphawaensis* sp. nov.**

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Type material. *Holotype*. ♂, 7.8 mm, THNHM-lv-18763, THAILAND, Amphawa District, Samut Songkhram, Thailand (13°26'27.8"N, 99°57'41.3"E), 21 February 2021, Piyangkun Lueangjaroenkit; THNHM-lv-18764. Allotypes, ♀ collected with holotype; THNHM-lv-18764; *Paratypes* 5 ♂ and 10 ♀ collected with holotype; THNHM-lv-18765.

Type locality. man-made ditch in coconut plantation, Amphawa District, Samut Songkhram, Thailand (13°26'27.8"N, 99°57'41.3"E).

Habitat. Riparian-hoppers living near agricultural and urban areas in Amphawa District.

Etymology. Named for the District of Samut Songkhram, Thailand where the species occurs.

Ecological type. Riparian-hoppers (edges of lakes under stones or in very wet vegetation, near (or in) streams, rivers, creeks, cascades and waterfalls).

Description. Based on holotype, male, 7.8 mm, THNHM-lv-18763.

Head (Fig. 3FA) **Eye** large (greater than 1/2 the length of the head). **Antenna 1** (Fig. 4A1) short, rarely longer than article 4 of antenna 2 peduncle. **Antenna 2** (Fig. 4A2) shorter than half body length; peduncular article slender; article 3 shortest; article 5 longer than article 4; flagellum with 13 articles, final article cone-shaped with an apical cluster of setae.

Upper lip (Fig. 5UL) broad, deep, apex rounded, without robust setae. **Lower lip** (Fig. 5LL) present; without inner plates. **Left mandible** (Fig. 5LMD) incisor 6-dentate; lacinia mobilis 4-dentate and four plumose setae in one row; molar strong with 16 striations and one plumose seta. **Right mandible** (Fig. 5RMD) incisor 5-dentate; lacinia mobilis with numerous cusps, group of three robust setae and cluster of fine setae; molar strong with 18 striations and one plumose seta. **Maxilla 1** (Fig. 5MX1) inner plate slender with two terminal plumose setae; outer plate with seven robust serrated setae; with small 1-articulate palp. **Maxilla 2** (Fig. 5MX2) plates narrow, inner plate

slightly shorter than outer; with 14 subapical robust setae, one plumose seta and 9 facial setae; outer plate with 18 apical robust setae in two rows and five simple setae in outer corner. **Maxilliped** (Fig. 5MP) inner plate apical and subapical margins with plumose setae, robust setae and two large conical robust setae; outer plate with two rows subapical setae and plumose setae; palp article 2 distomedial lobe well developed with numerous setae; article 4 reduced, button-shaped.

Pereon. (Figs 4, 6) **Gnathopod 1** (Fig. 4G1) sexually dimorphic; subchelate, coxa smaller than coxa 2, ventral margin lined with five robust setae, anterior margin straight; basis expanded posteriorly, anterior margin with four setae, posterodistal margin with two setae; posterior of merus, carpus and propodus each with lobe covered in palmate setae; carpus 1.5× longer than propodus, anterior margin with two robust setae, posterior margin with four robust setae; propodus subtriangular with well-developed posterior lobe, anterior side with three groups of coupled robust setae, posterior margin with five robust setae, palm slightly serrated, lined with nine robust setae; dactylus cuspidactylate, shorter than palm.

Gnathopod 2 (Fig. 4G2) sexually dimorphic; subchelate; coxa anterior margin with two setae and ventral margin with seven setae; basis anterior margin smooth, slightly expanded, posterior margin with three robust setae; ischium with rounded lobe on anterior margin; posterior of merus, carpus and propodus glabrous; carpus triangular, reduced, enclosed by merus and propodus, posterior lobe absent; propodus subovate, 1.4× as long as wide, palm reaching about 34%, posteromedial surface of propodus with groove, anterior side naked, palm lined with 11 robust setae; dactylus longer than palm fitted with facial groove, attenuated distally.

Pereopod 3 (Fig. 6P3) coxa longer than broad with posterior process, anterior margin with seven robust setae; basis slightly expanded, anterior margin with three robust setae, posterior margin with three robust setae; ischium shortest; merus longer than ischium, anterior and posterior margin of merus lined with clusters of robust setae; carpus and propodus slightly expanded; carpus posterior margin with cluster of robust setae; dactylus without notch on posterior margin.

Pereopod 4 (Fig. 6P4) slightly shorter than pereopod 3; coxa longer than broad, anterior margin with five robust setae and with small posterior process; basis longest, posterior margin with three robust setae; ischium shortest, posterodistal with two robust setae; merus and carpus shorter than those of pereopod 3; merus distally expanded, longer than carpus and propodus, anterior and posterior margin with five robust setae; carpus shorter than propodus posterior margin with three clusters of robust setae; propodus slender, with three clusters of robust setae in posterior side; dactylus slender and longer than that of pereopod 3, thickened proximally with a notch along posterior margin.

Pereopod 5 (Fig. 6P5) coxa bilobed, anterior lobe distinctly large than posterior lobe; basis anterior margin

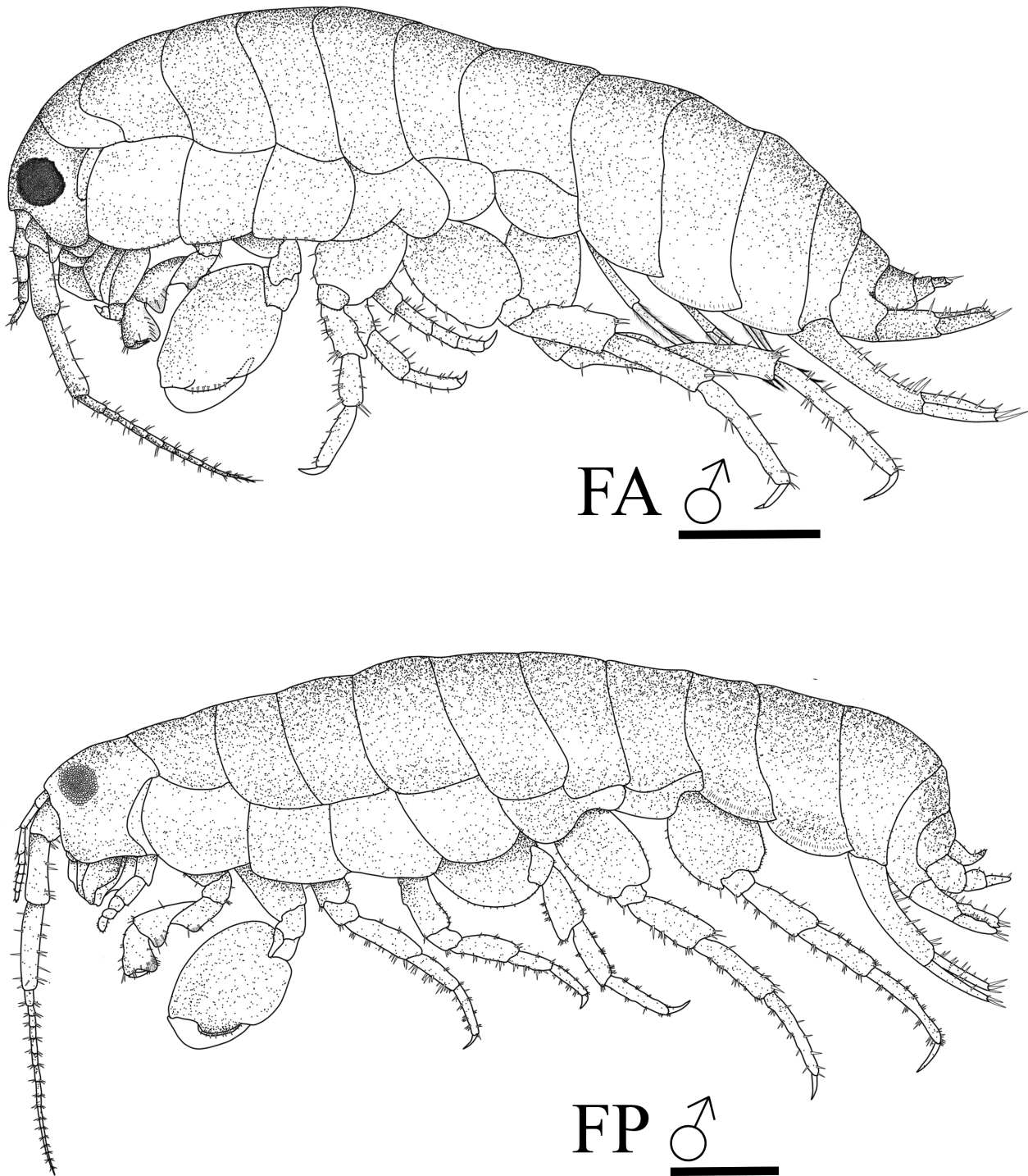


Figure 3. Male habitus of *Floresorchestia* spp. **FA.** *F. amphawaensis* sp. nov. holotype, male, 7.8 mm (THNHM-lv-18763), Amphawa District, Samut Songkhram, Thailand; **FP.** *F. pongrati* sp. nov. holotype, male, 10 mm (THNHM-lv-19369), Amphawa District, Samut Songkhram, Thailand. Scale bars: 1 mm (**FA**, **FP**).

with five robust setae, posterior margin with row of tiny setae; merus and carpus distally expanded; carpus shorter than propodus; propodus slender, longer than merus and carpus.

Pereopod 6 (Fig. 6P6) coxa bilobed, posterior lobe larger than anterior; basis expanded, anterior margin with 10 robust setae, posterior margin with row of tiny setae; ischium shortest; merus distally expanded, anterior side with four clusters of robust setae; carpus expanded less

than merus, anterior margin lined with four clusters of robust setae; propodus slender, longer than merus and carpus; dactylus slender with subapical robust setae.

Pereopod 7 (Fig. 6P7) coxa reduced; posterior margin of basis with distinct minute serration (each serrate with small seta), anterior margin with 10 robust setae; merus and carpus slightly expanded; propodus longer than each merus and carpus; dactylus slender with subapical robust setae.

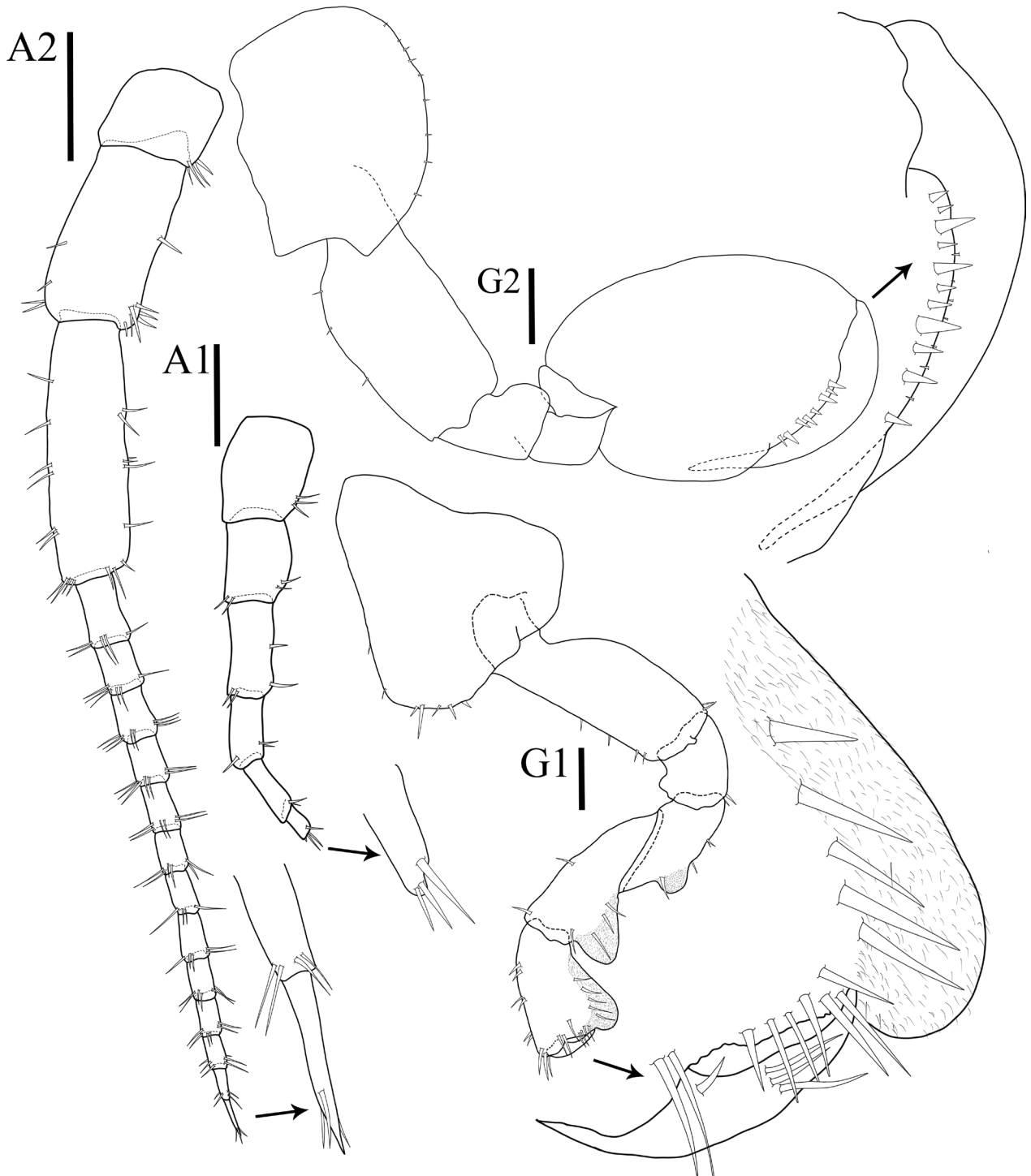


Figure 4. *Floresorchestia amphawaensis* sp. nov. holotype. Scale bars: 0.25 mm (A1, A2, G2); 0.5 mm (G1).

Pleon. (Fig. 7) Pleopods all well developed. **Pleopod 1** (Fig. 7PL1) peduncle without marginal setae; biramous, outer ramus subequal in length to peduncle; inner ramus with 11 articles; outer ramus with seven articles. **Pleopod 2** (Fig. 7PL2) peduncle without marginal setae; biramous, inner ramus subequal to outer ramus, shorter than peduncle; inner ramus with seven articles; outer ramus with six articles. **Pleopod 3** (Fig. 7PL3) peduncle without marginal setae; biramous, inner ramus subequal to outer ramus,

shorter than peduncle; inner ramus with nine articles; outer ramus more than six articles.

Epimera (Fig. 7EP), **Epimeron 1** posterodistal corner slightly protruding, without slit. **Epimera 2** and **3** each with slits above ventral margin, with 21 and 10 slits, respectively. **Epimeron 3** posteroventral corner and ventral margin smooth.

Uropod 1 (Fig. 7U1) peduncle with four robust setae in one row; inner ramus subequal in length to outer

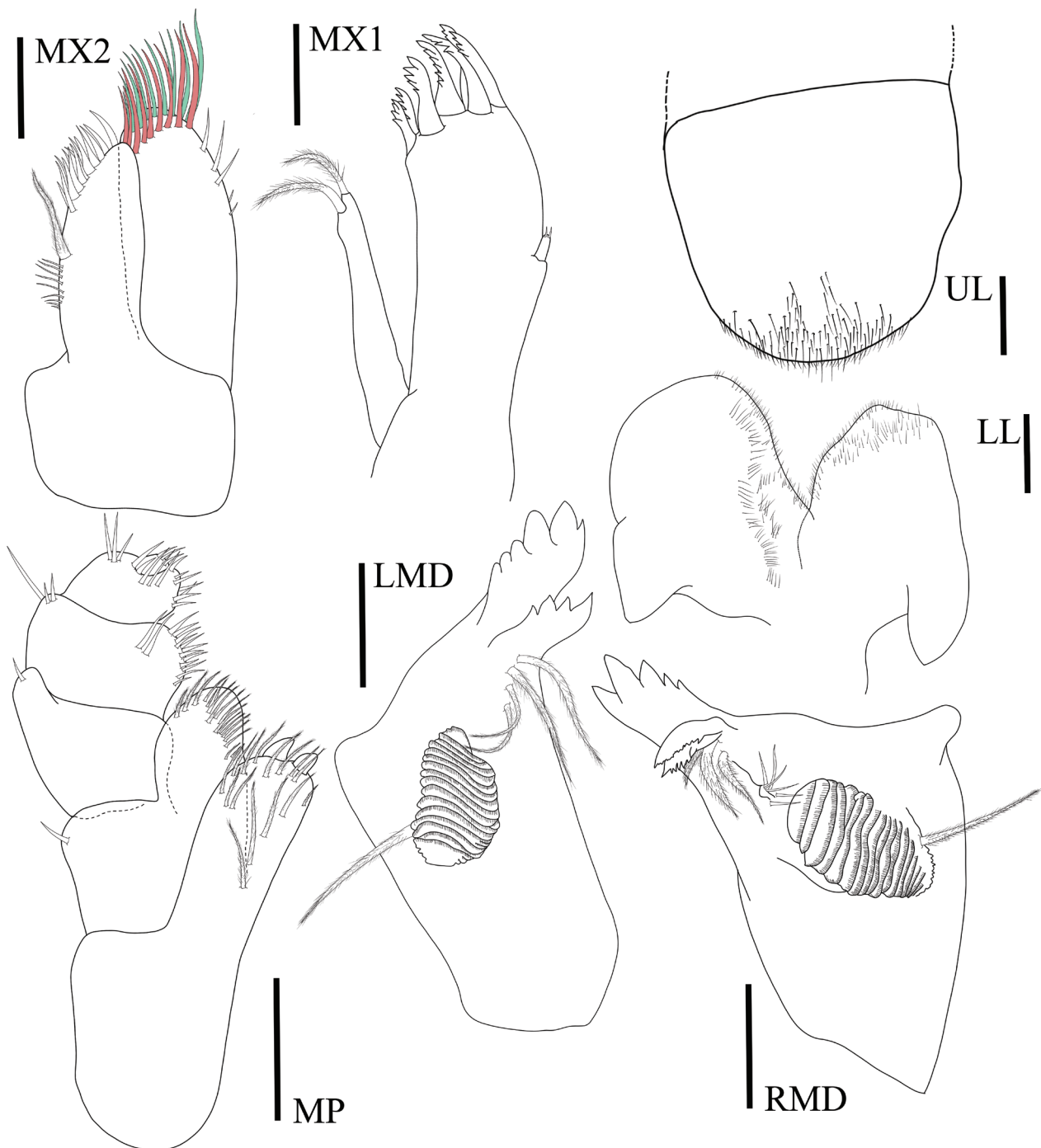


Figure 5. *Floresorchestia amphawaensis* sp. nov. holotype. Scale bars: 0.1 mm (LL, LMD, MP, MX1–2, RMD, UL).

ramus, inner ramus with five marginal robust setae, apical with three robust setae; outer ramus without marginal robust setae, apical with three robust setae. **Uropod 2** (Fig. 7U2) peduncle with three robust setae; inner ramus subequal in length to outer ramus; inner ramus with two marginal robust setae, apical with four robust setae; outer ramus with one marginal robust seta, apical with two robust setae. **Uropod 3** (Fig. 7U3) uniramous, peduncle with four robust setae; ramus subequal to peduncle, without marginal robust setae and three apical robust setae.

Telson (Fig. 7TL) as long as broad, weakly cleft, dorsal mid-line at least halfway, with one marginal, three apical robust setae and two plumose setae.

Female (Sexually dimorphic characters) (Fig. 8). **Type.** Allotype, female, 8.9 mm, THNHM-lv-18764.

Pereon. Gnathopod 1 (Fig. 8G1) merus lacking tumescent lobe, posterior margin with three robust setae; propodus without tumescent protuberance, anterior margin with three clusters of robust setae, posterior margin with six robust setae; palm slightly transverse, dactylus inner lateral posterior margin with four robust setae.

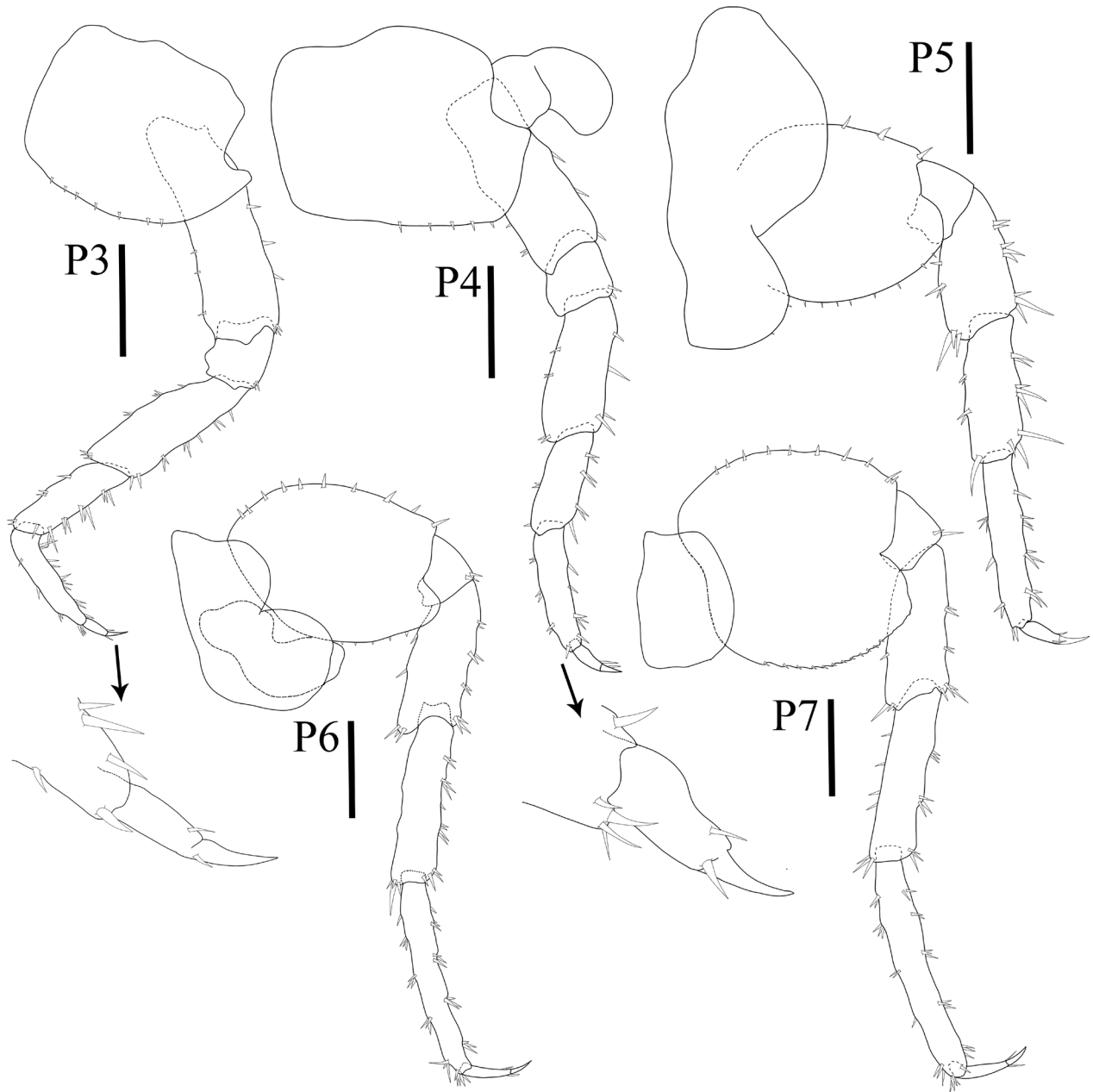


Figure 6. *Floresorchestia amphawaensis* sp. nov. holotype. Scale bars: 0.25 mm (P3–P7).

Gnathopod 2 (Fig. 8G2) mitten-shaped; posterior margin of carpus and propodus each with lobe covered in palmate setae; carpus well developed, posterior lobe projecting between merus and propodus; nearly twice as long as wide; palm obtuse, lined with 10 robust setae, posterodistal corner with two robust setae; dactylus not modified distally, blunt.

Remarks. *Floresorchestia amphawaensis* sp. nov. is similar to *F. malayensis* with which they share characteristics such as: (1) left mandible lacinia mobilis with 4-dentate; (2) gnathopod 1 carpus longer by 1.5× than propodus; (3) gnathopod 2 dactylus posterior margin smooth; (4) gnathopod 2 propodus 1.4× as long as wide; (5) uropod 1 peduncle with 4–6 robust setae; (6) uropod 3 ramus without marginal setae; (7) telson with four robust setae per lobe; (8) epimera 2–3 with slits.

However, *F. amphawaensis* sp. nov. may be distinguished from *F. malayensis* by the following [Characters of *F. malayensis* in brackets]: (1) gnathopod 2 palm reaching 34% [palm reaching 30%]; (2) uropod 1 inner ramus with five marginal setae [four marginal setae]; (3) uropod 1 peduncle with four robust setae [with five robust setae]; (4) uropod 3 peduncle with four robust setae [two robust setae]; (5) telson slightly longer than broad [broader than long].

***Floresorchestia pongrati* sp. nov.**

<https://zoobank.org/FF30E55E-21A0-419A-AB32-D8A6C027654F>

Type material. *Holotype*. ♂, 10 mm, THNHM-lv-19369, THAILAND, Amphawa District, Samut Songkhram, Thailand (13°26'03.8"N, 100°00'36.2"E), 10 April

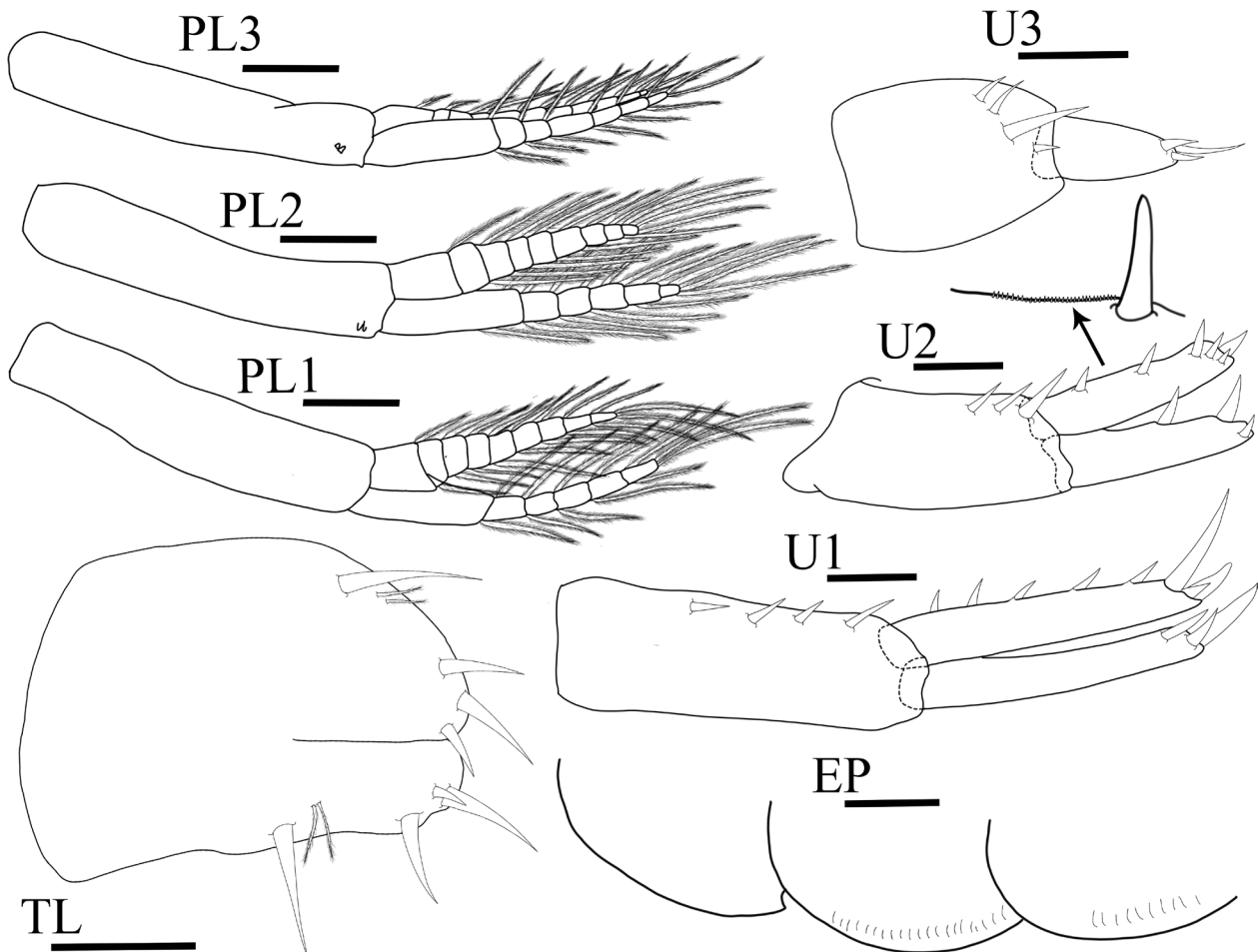


Figure 7. *Floresorchestia amphawaensis* sp. nov. holotype. Scale bars: 0.1 mm (PL1–PL3, U1, U2); 0.2 mm (EP, TL, U3).

2021, Piyangkun Lueangjaroenkit; THNHM-lv-19370, **Paratype**, 1 ♂ and 5 ♀ collected with holotype.

Type locality. Moist area near Mae Klong Canal banks, (13°26'03.8"N, 100°00'36.2"E), Muang Samut Songkhram District, Samut Songkhram, Thailand.

Habitat. Riparian-hoppers living in the moist area near Mae Klong canal banks of Amphawa District, Samut Songkhram, Thailand.

Etymology. The species is named in honour of Assistant Professor Pongrat Dumrongrojwattana from Burapha University, Thailand for his contribution on terrestrial Floresorchestiinae diversity in Thailand.

Ecological type. Riparian-hoppers (edges of lakes under stones or in very wet vegetation, near (or in) streams, rivers, creeks, cascades and waterfalls).

Description. Based on holotype, male, 10 mm, THNHM-lv-19369.

Head. (Fig. 3FP) **Eye** medium (1/3 the length of the head). **Antenna 1** (Fig. 9A1) short, rarely longer than article 4 of antenna 2 peduncle. **Antenna 2** (Fig. 9A2) shorter than half body length; articles slender, article 5 longer than article 4; flagellum with 18 articles, final article cone-shaped with an apical cluster of setae.

Upper lip (Fig. 10UL) broad, deep, apex rounded, without robust setae. **Lower lip** (Fig. 10LL) present; without inner plates. **Left Mandible** (Fig. 10LMD) incisor

6-dentate; left lacinia mobilis 5-dentate and four plumose setae in one row; molar strong with 28 striations and one plumose seta. **Right mandible** (Fig. 10RMD) incisor 5-dentate; lacinia mobilis with numerous dents, three robust setae and cluster of fine setae; molar strong with 22 striations and one plumose seta. **Maxilla 1** (Fig. 10MX1) inner plate slender with two terminals plumose setae; the outer plate with eight robust serrated setae, with small 1-articulate palp. **Maxilla 2** (Fig. 10MX2) plates narrow, inner plate slightly shorter than outer; inner plate with 16 subapical robust setae, one plumose seta and seven facial setae; outer plate with 26 apical robust setae in two rows. **Maxilliped** (Fig. 10MP) inner plate apical and subapical with plumose setae, robust setae and two large conical robust setae; outer plate with two rows subapical setae and plumose setae; palp article 2 distomedial lobe well developed with numerous setae; article 4 reduced, button-shaped.

Pereon. Gnathopod 1 (Fig. 9G1) sexually dimorphic; sub-chelate, coxa smaller than coxa 2, ventral margin lined with five robust setae, anterior margin straight; basis slightly expanded, anterior margin with five setae, posterodistal margin with two setae; posterior of merus, carpus and propodus each with lobe covered in palmate setae; carpus longer by 1.2× than propodus, anterior margin with one robust seta and three distal robust setae, posterior

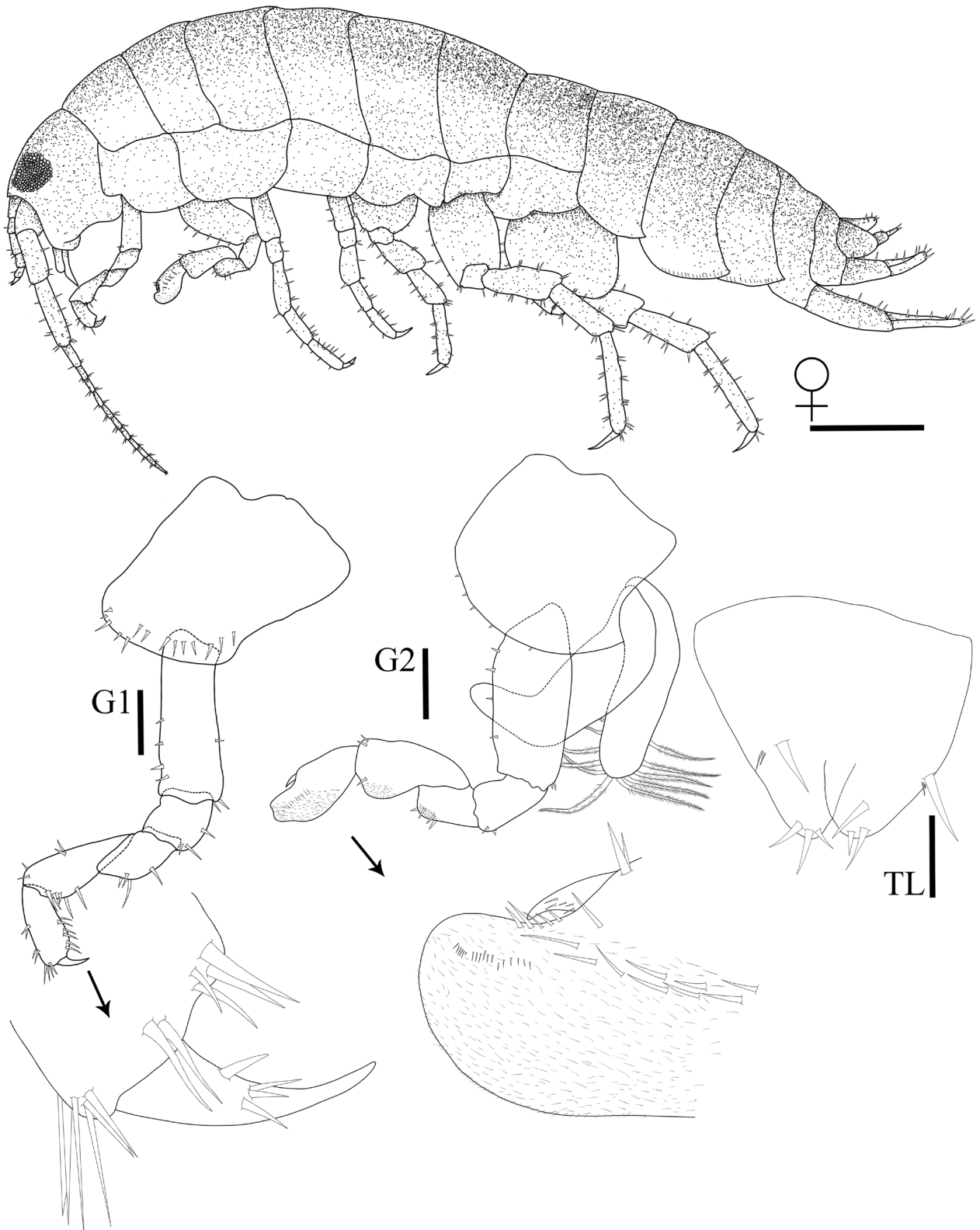


Figure 8. *Floresorchestia amphawaensis* sp. nov. allotype, female 8.9 mm (THNHM-Iv-18764) Amphawa District, Samut Songkhram, Thailand. Scale bars: 0.25 mm (G1, G2, TL); 1 mm for habitus.

margin with three robust setae; propodus subtriangular with well-developed posterior lobe, anterior side with five robust setae, posterior lobe with five robust setae, palm slightly serrated, lined with six robust setae; dactylus cuspidactylate, shorter than palm, with two robust setae.

Gnathopod 2 (Fig. 9G1) sexually dimorphic; subchelate; coxa anterior margin with 13 robust setae; basis anterior margin smooth, slightly expanded, posterior margin with four robust setae; ischium with rounded lobe on anterior margin; posterior of merus, carpus and propodus

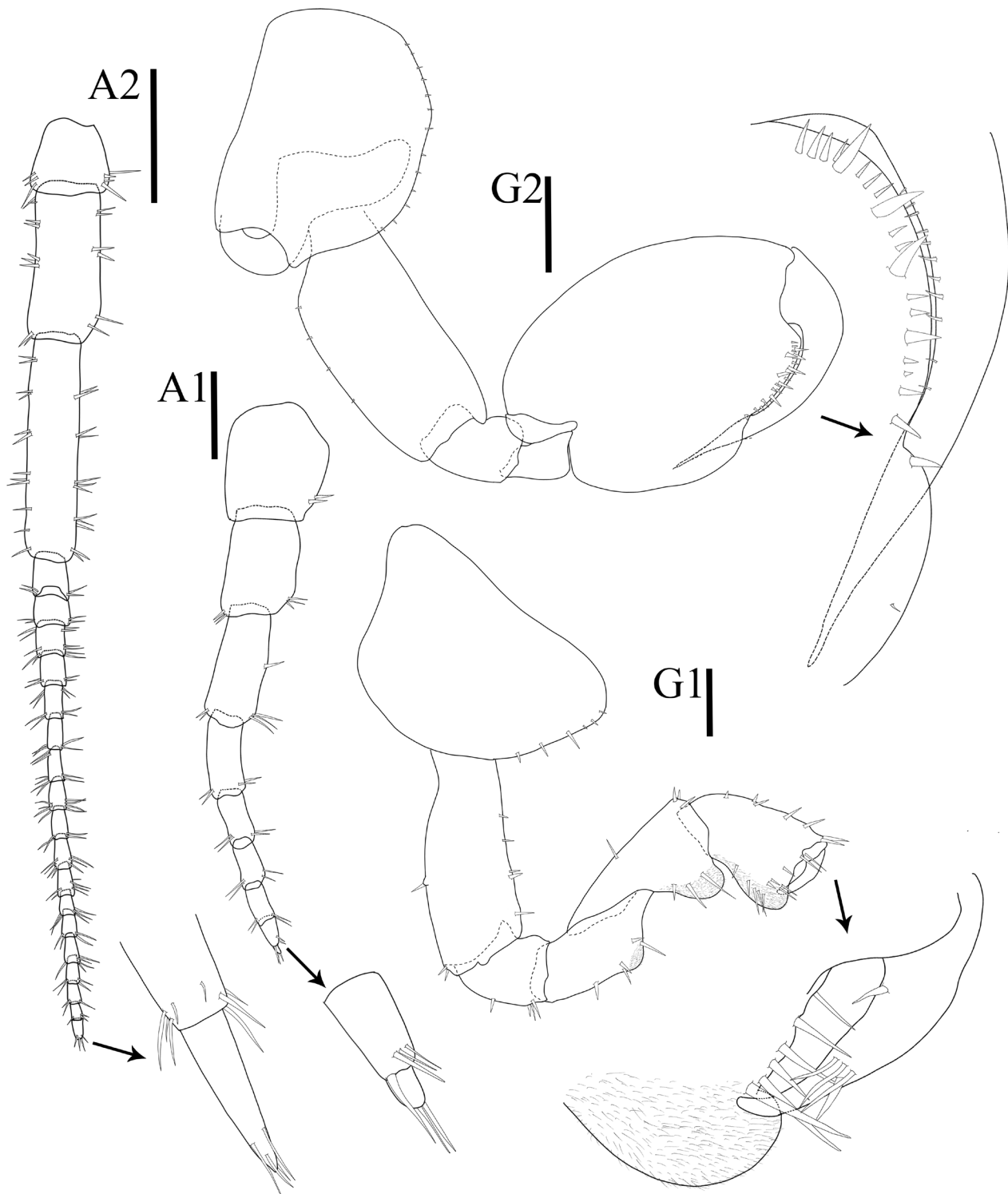


Figure 9. *Floresorchestia pongrati* sp. nov. holotype. Scale bars: 0.25 mm (A1, A2, G2); 0.5 mm (G1).

without lobe covered in palmate setae; carpus triangular, reduced, enclosed by merus and propodus, posterior lobe absent; propodus subovate, 1.4× as long as wide, palm reaching about 30%, posteromedial surface of propodus with groove, anterior side naked, palm lined with 19 robust setae; dactylus longer than palm fitted with facial groove, attenuated distally, inner margin lined with 11 robust setae.

Pereopod 3 (Fig. 11P3) coxa longer than broad with posterior process, anterior margin with nine robust setae; basis

slightly expanded, anterior margin with four robust setae and posterior margin with four robust setae, with two posterodistal robust setae; ischium shortest; anterior and posterior margin of merus lined with four clusters of robust setae; carpus and propodus slightly expanded; carpus posterior margin with three cluster of robust setae; propodus slender and longer than carpus; dactylus without notch on posterior margin.

Pereopod 4 (Fig. 11P4) slightly shorter than pereopod 3; coxa longer than broad, anterior margin with

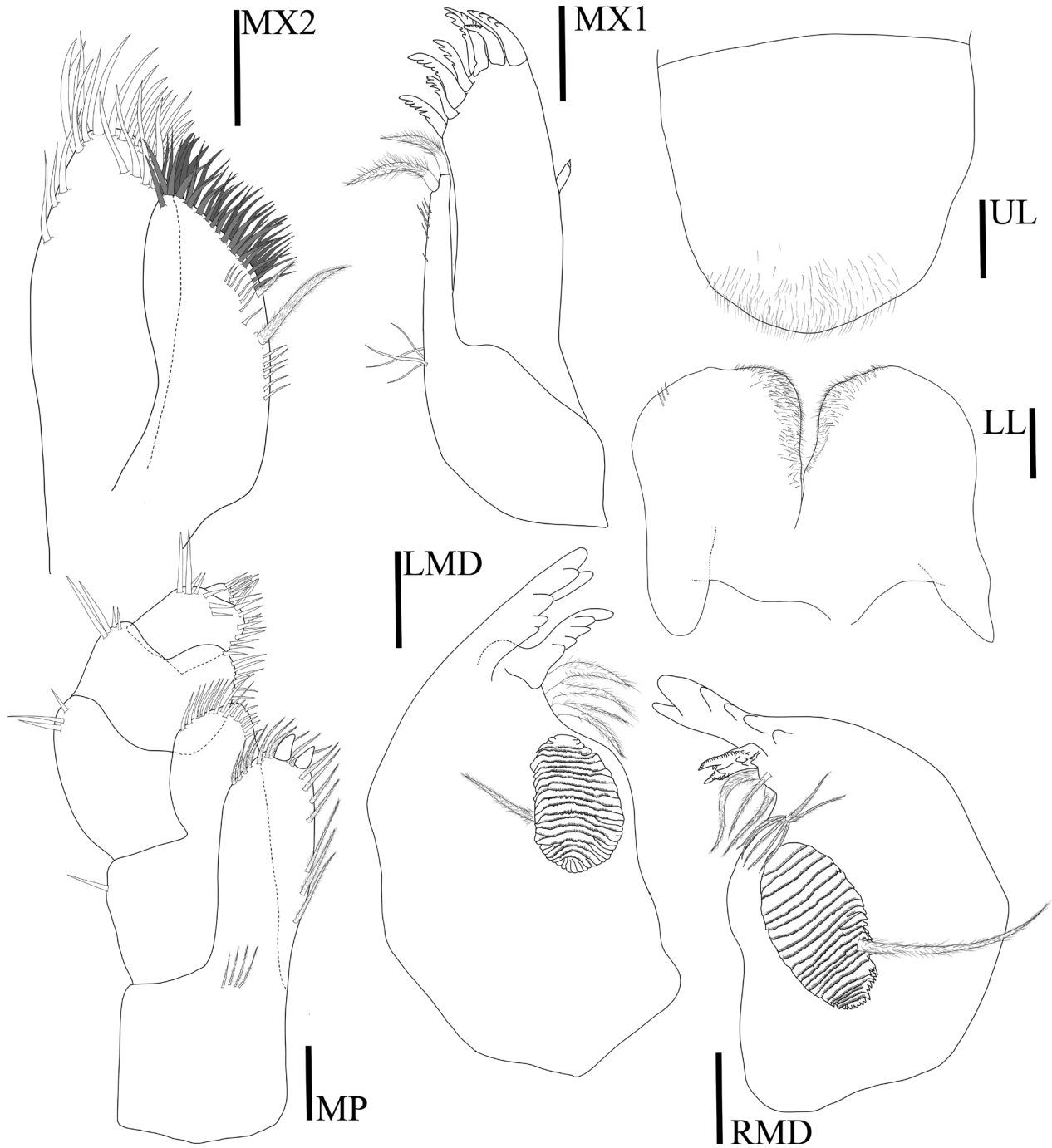


Figure 10. *Floresorchestia pongrati* sp. nov. holotype. Scale bars: 0.1 mm (LL, LMD, MP, MX1, MX2, RMD, UL).

six robust setae and with small posterior process; basis longest posterior margin with five robust setae; ischium shortest, posterodistal with three robust setae; merus and carpus shorter than those of pereopod 3; merus distally expanded, longer than carpus and propodus, anterior and posterior margin with three and four clusters of robust setae, respectively; carpus shorter than propodus, posterior margin with one cluster of robust setae; propodus slender, with four clusters of robust setae in posterior side; dactylus slender and longer than that of pereopod 3, thickened proximally with a notch mid-way along posterior margin.

Pereopod 5 (Fig. 11P5) coxa bilobed, anterior lobe distinctly large than posterior lobe, posterior lobe with

five robust setae on ventral margin; basis anterior margin with four robust setae and two anterodistal robust setae, posterior margin with serrate and small setae; merus and carpus distally expanded; carpus shorter than propodus; propodus slender, longer than merus and carpus.

Pereopod 6 (Fig. 11P6) coxa bilobed, posterior lobe larger than anterior; basis expanded, anterior margin with 10 robust setae, posterior margin with row of tiny setae; ischium shortest; merus distally expanded, anterior side with four clusters of robust setae; carpus expanded less than merus, anterior margin lined with five clusters of robust setae; propodus slender, longer than merus and carpus; dactylus slender without subapical robust setae.

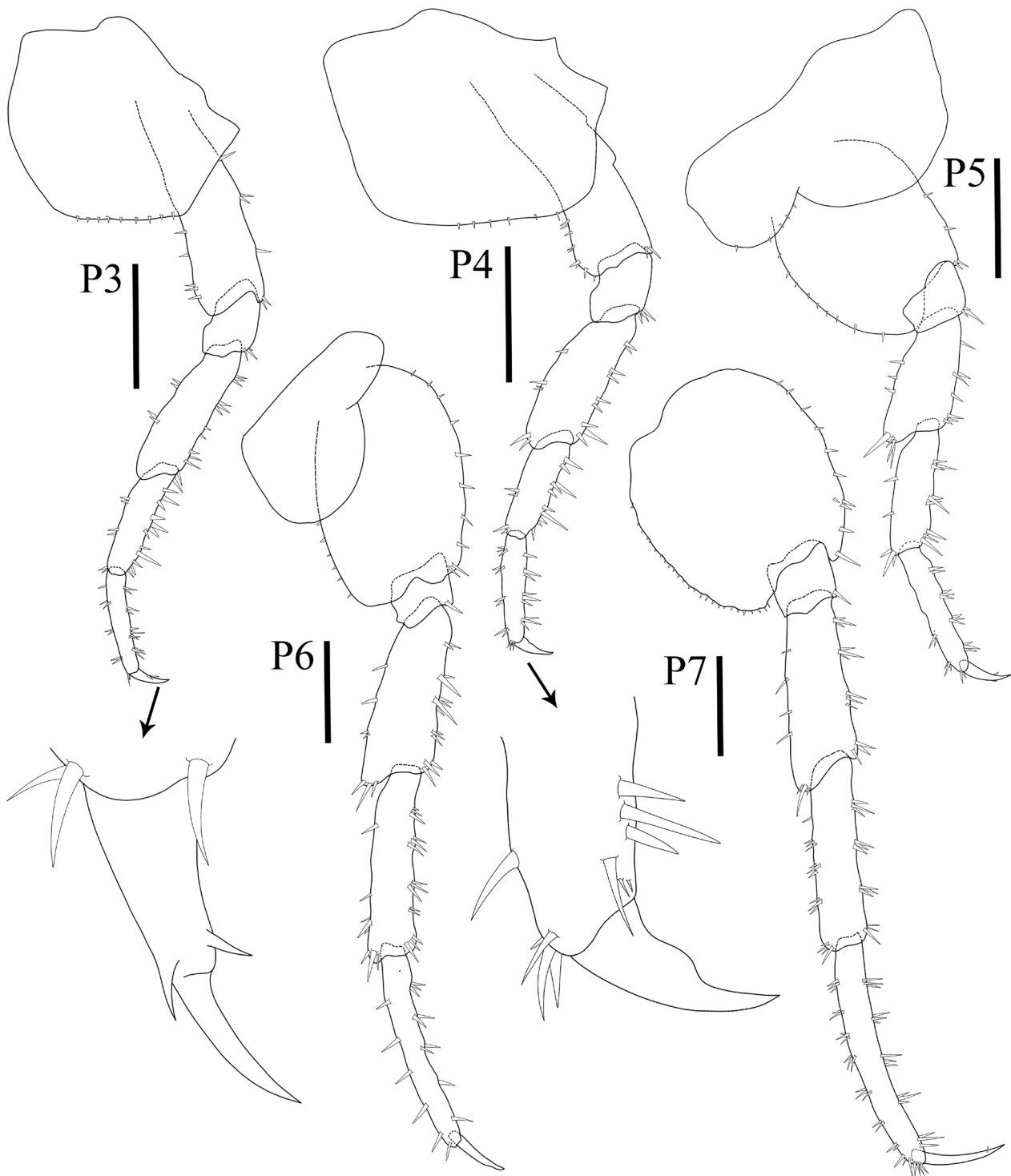


Figure 11. *Floresorchestia pongrati* sp. nov. holotype. Scale bars: 0.25 mm (P3–P7).

Pereopod 7 (Fig. 11P7) coxa reduced; posterior margin of basis with distinct minute serration (each serrate with small seta), anterior margin with 11 robust setae; ischium distally expanded; merus and carpus expanded; propodus longer than merus and carpus; dactylus slender with subapical robust setae.

Pleon. (Fig. 12) Pleopods all well developed. **Pleopod 1** (Fig. 12PL1) peduncle without marginal setae; biramous, outer ramus shorter than peduncle; inner ramus with 13 articles; outer ramus with 10 articles,

first article lined with four plumose setae. **Pleopod 2** (Fig. 12PL2) peduncle without marginal setae; biramous, outer ramus shorter than peduncle, inner ramus subequal to outer ramus, shorter than peduncle; inner ramus with 10 articles; outer ramus with 12 articles. **Pleopod 3** (Fig. 12PL3) peduncle without marginal setae; biramous, inner ramus subequal to outer ramus, shorter than peduncle; inner ramus with 11 articles; outer ramus 10 articles, first article lined with five plumose setae, shorter than peduncle.

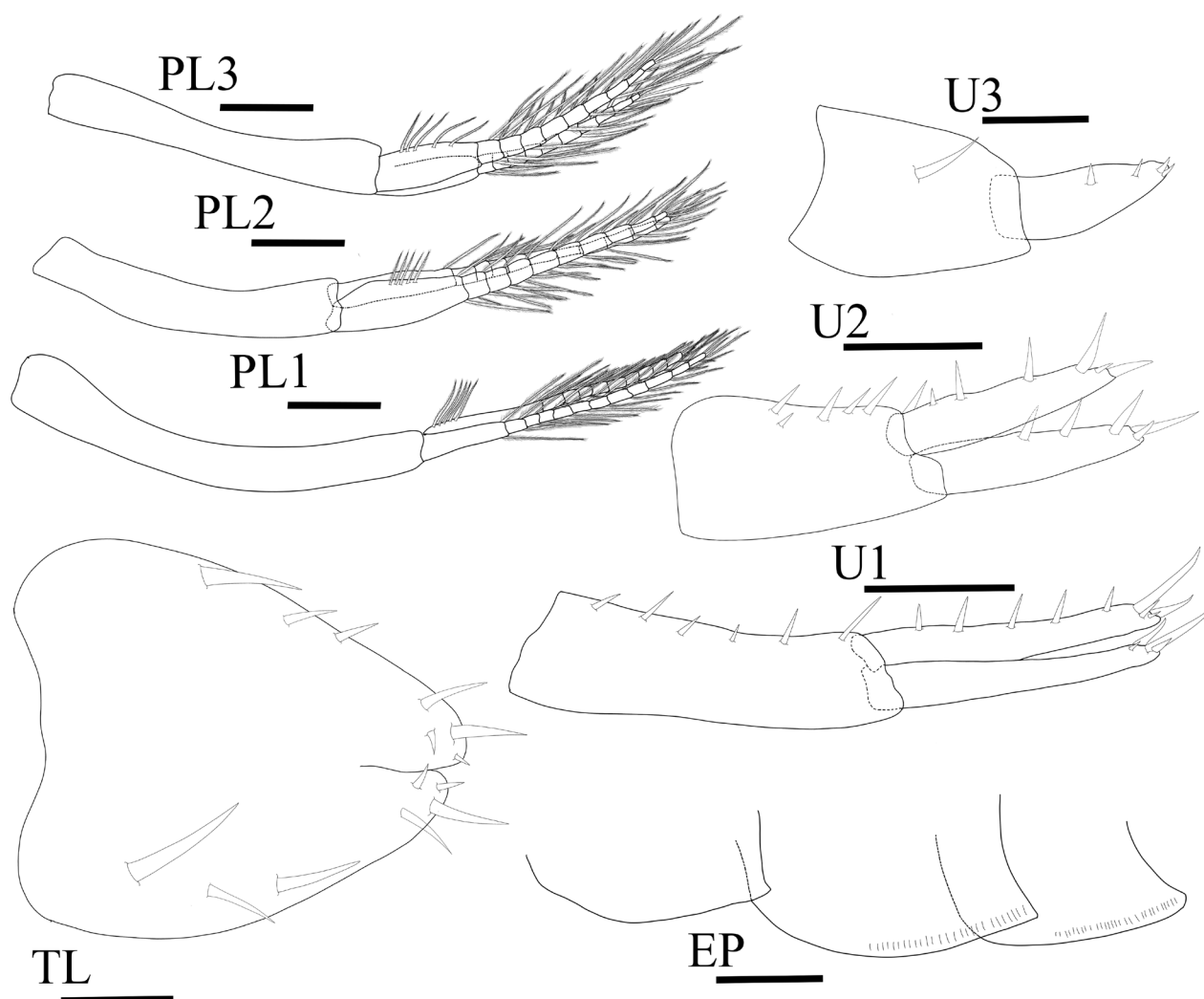


Figure 12. *Floresorchestia pongrati* sp. nov. holotype. Scale bars: 0.1 mm (TL, U1–U3); 0.2 mm (PL1–PL3, EP).

Epimera (Fig. 12EP), **epimeron 1** posterodistal corner slightly protrudes, without slit. **Epimera 2** and **3** each with slits above ventral margin with 27 and 29 slits, respectively. **Epimeron 3** posteroventral corner and ventral margin smooth.

Uropod 1 (Fig. 12U1) peduncle with six robust setae in one row; inner ramus subequal in length to outer ramus, inner ramus with marginal five robust setae in one row, apical with four robust setae; outer ramus without marginal robust setae, apical with four robust setae. **Uropod 2** (Fig. 12U2) peduncle with five robust setae; inner ramus subequal in length to outer ramus; inner ramus with four marginal robust setae, apical with three robust setae; outer ramus with two marginal robust setae, apical with three robust setae. **Uropod 3** (Fig. 12U3) uniramous, peduncle with one robust seta; ramus shorter than peduncle, with one marginal robust seta and three apical robust setae.

Telson (Fig. 12TL) longer than broad, weakly cleft, dorsal mid-line at less than halfway, with four marginal and three apical robust setae.

Female (Sexually dimorphic characters) (Fig. 13). **Type.** Paratype, female, 8.5 mm, THNHM-lv-19370.

Pereon. Gnathopod 1 (Fig. 13G1) merus lacking tumescent lobe, posterior margin with five robust setae; propodus without tumescent protuberance, anterior margin with two robust setae, posterior margin with three clusters of robust setae; palm slightly transverse, dactylus inner lateral posterior margin with five robust setae.

Gnathopod 2 (Fig. 13G2) mitten-shaped; posterior margin of carpus and propodus each with lobe covered in palmate setae; carpus well developed, posterior lobe projecting between merus and propodus; nearly twice as long as wide; palm obtuse, lined with 10 robust setae, posterodistal corner with two robust setae; dactylus not modified distally, blunt.

Telson (Fig. 13TL) as broad as long, weakly cleft, dorsal mid-line less than halfway, with two marginal and three apical robust setae.

Remarks. *Floresorchestia pongrati* sp. nov. is closely similar to *F. papeari* which has synapomorphic character states such as: (1) left mandible lacinia mobilis 5-dentate; (2) gnathopod 2 dactylus posterior margin smooth; (3) gnathopod 1 carpus significantly longer (1.2×) than propodus; (4) gnathopod 2 propodus (1.4×) as long as wide; (5) uropod 3 ramus with marginal setae; (6) telson longer than broad

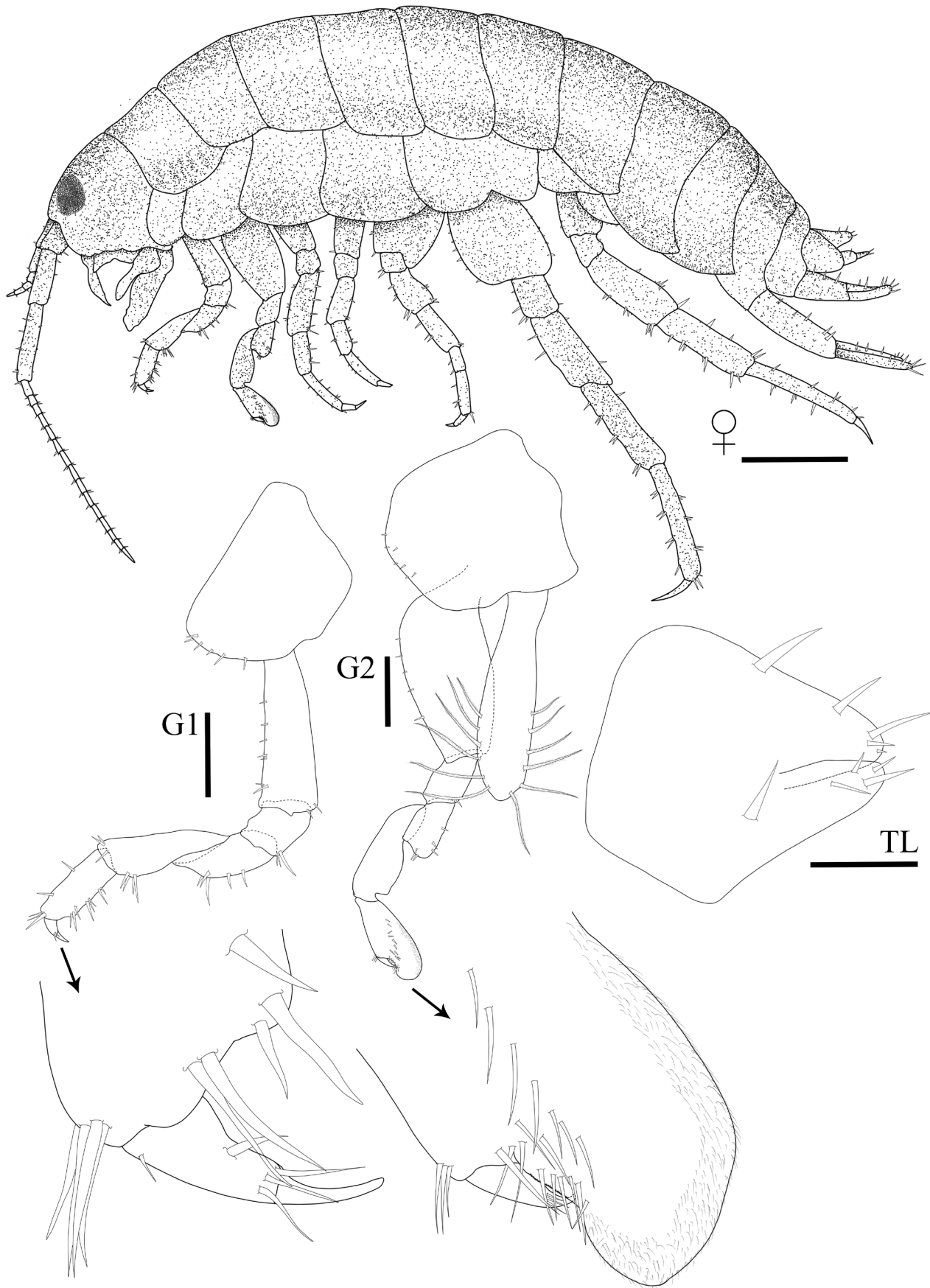


Figure 13. *Floresorchestia pongrati* sp. nov. paratype, female 8.5 mm (THNHM-Iv-19370 Amphawa District, Samut Songkhram, Thailand. Scale bars: 0.1 mm (TL); 0.25 mm (G1, G2); 1 mm for habitus.

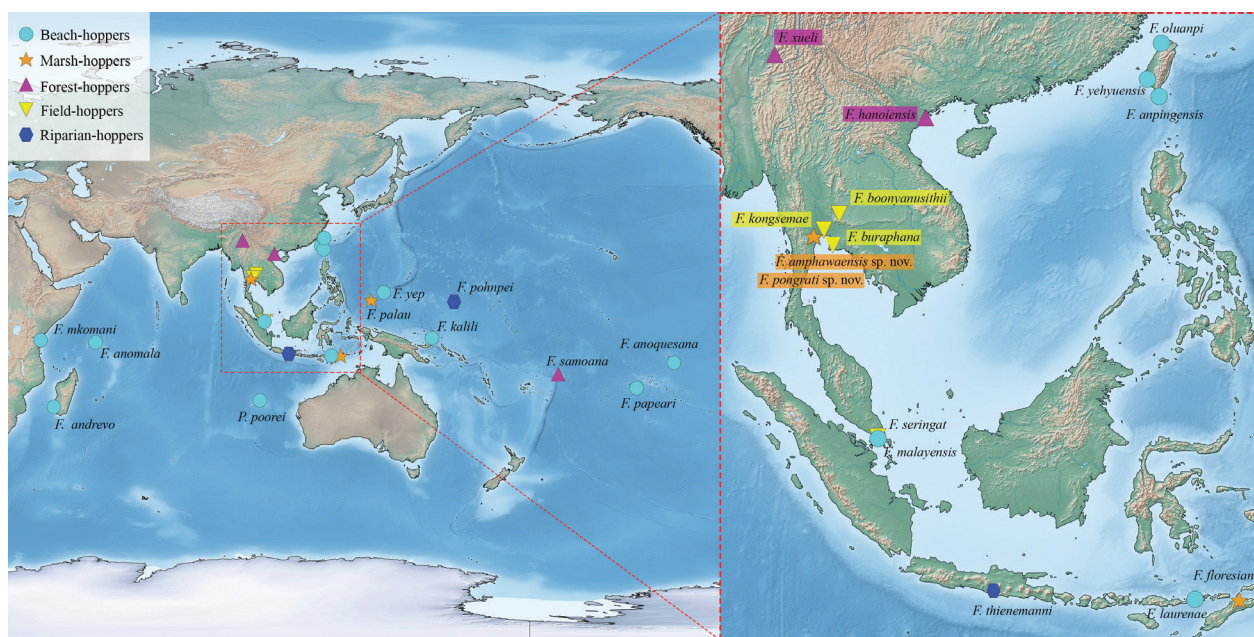


Figure 14. Distribution of the genus *Floresorchestia* spp.

and (7) epimera 2–3 with slits. They are distinguished by the following [characters of *F. papeari* in brackets]: (1) antenna 2 less than half body length [shorter than head and first three pereonites]; (2) gnathopod 2 dactylus posterior margin smooth, proximal tooth absent [with proximal tooth]; (3) gnathopod 2 distally acute or attenuated [not modified distally, blunt]; (4) gnathopod 2 palm without protuberance near dactylar hinge [with rounded protuberance near dactylar hinge]; (5) uropod 1 inner ramus with five marginal setae [four marginal setae]; (6) uropod 3 peduncle with one robust seta [five robust setae]; (7) telson with seven robust setae per lobe [five robust setae per lobe].

Discussion

The genus *Floresorchestia* is one of the talitrid amphipods that can occupy both coastal and terrestrial habitats (Bousfield 1984; Lowry and Springthorpe 2015, 2019). Moreover, in terrestrial habitats, they also occupy a large range of habitats including marsh-hoppers, beach-hoppers, field-hoppers, riparian-hoppers and forest-hoppers (Lowry and Springthorpe 2015). The beach-hoppers are the largest group with 13 species, followed by forest-hoppers with five species and field-hoppers represented by three species. The present study increases the number of riparian-hoppers to four species. The wide variety of habitats implies the high adaptation ability which many studies presumed that the terrestrial species had a coastal *Floresorchestia* ancestor (Bousfield 1984; Lowry and Springthorpe 2015, 2019).

Floresorchestia amphawaensis sp. nov. and *F. pongrati* sp. nov. are sympatric. However, both species present different adaptations. *F. amphawaensis* sp. nov. inhabits dry areas including the coconut plantation, man-made ditch and the man-made

pond in the Bang Prom temple, while *F. pongrati* sp. nov. is limited to the river bank and attached to aquatic plants during high tide instead of migrating into drier places in the urban areas.

Currently, a total of 15 species are distributed in the Southeast Asia region which presents more than 50% of known *Floresorchestia* in the world. As shown in Fig. 14, it is clear that coastal *Floresorchestia* species are more dominant than their terrestrial counterparts (and predominantly inhabit oceanic islands). Only *F. kongsemiae*, *F. boonyanusithii*, *F. malayensis* and *F. xueli* were recorded in the mainland and some of them can establish their population in urban areas which are classified as field- and forest-hoppers (Wongkamhaeng et al. 2016; Lowry and Springthorpe 2019; Suklom et al. 2021; Tong et al. 2021). Previous collecting efforts were substantially focused along the marine coastline while overlooking the inland areas that could certainly lead to low numbers of terrestrial species in the regions. Lowry and Springthorpe (2015) mentioned that each terrestrial species independently appeared on land and there is no phylogenetic link between the species. During our observation, both *F. amphawaensis* sp. nov. and *F. pongrati* sp. nov. occasionally attached to floating substrates, indicating their possible mode of dispersal. This strategy implies that further observation along the river basins might fit with the terrestrial species migratory pattern (Barnard 1971).

At the beginning of this study, Azman et al. (2022) reported a total of three species (*F. boonyanusithii*, *F. buraphana* and *F. kongsemiae*) from Thailand; two additional new ones (*F. amphawaensis* sp. nov. and *F. pongrati* sp. nov.) are here described, bringing the number of known species from Thailand up to five species, respectively (Table 1). The Thai *Floresorchestia* spp. have character states such as: (1) gnathopod 1 palm angle

Table 1. Summary of diagnostic characteristic of terrestrial amphipods in Thailand.

Species	Antenna 2	Left mandible lacinia mobilis	Male gnathopod 1	Male gnathopod 1 carpus	Male gnathopod 2	Male gnathopod 2 propodus	Uropod 1	Uropod 3	Slit on epimera 2 and 3	Telson
<i>Floresorchestia amphawaensis</i> sp. nov.	Less than half body length	4-dentate	Palmate lobe on merus, carpus and propodus each covered in palmate setae	Carpus slightly longer (1.2×) than propodus	Palm extending between 34 and 39% along posterior margin	Propodus 1.4× as long as wide	Inner ramus with four marginal robust setae	Peduncle with four robust setae, rami without marginal setae	21 and 10 slits	Telson as long as broad, four robust setae and two plumose setae per lobe
<i>Floresorchestia pongrati</i> sp. nov.	Shorter than head and first three pereonite	5-dentate	Palmate lobe on merus, carpus and propodus each covered in palmate setae	Carpus slightly longer (1.2×) than propodus	Palm extending between 30 and 36% along posterior margin	Propodus 1.4× as long as wide	Inner ramus with five marginal robust setae	Peduncle with one robust seta, rami with one marginal seta	27 and 29 slits	Telson longer than broad, eight robust setae per lobe
<i>Floresorchestia boonyanusithii</i> Wongkamhaeng, Damrong rojwattana & Pattaratum rong, 2016	Less than half body length	4-dentate	Palmate lobe on merus, carpus and propodus each covered in palmate setae	Carpus weakly longer (1.5×) than propodus	Palm extending between 31 and 35% along posterior margin	Propodus 1.5–1.6× as long as wide	Inner ramus with four marginal robust setae	Peduncle with two robust setae, rami without marginal setae	27 and 20 slits	Telson longer than broad, four robust setae per lobe
<i>Floresorchestia buraphana</i> Wongkamhaeng, Damrong rojwattana & Pattaratum rong, 2016	Less than half body length	5-dentate	Palmate lobe on merus, carpus and propodus each covered in palmate setae	Carpus slightly longer (1.2×) than propodus	Palm extending between 36 and 40% along posterior margin	Propodus 1.5–1.6× as long as wide	Inner ramus with three marginal robust setae	Peduncle with two robust setae, rami without marginal setae	25 and 15 slits	Telson longer than broad, five robust setae per lobe
<i>Floresorchestia kongsemae</i> Suklom, Danai sawadi & Wong kamhaeng, 2021	Shorter than head and first three pereonites	5-dentate	Palmate lobe on merus, carpus and propodus each covered in palmate setae	Carpus subequal in length to propodus	Palm reaching about 33% along posterior margin	Propodus 1.5–1.6× as long as wide	Inner ramus with three marginal robust setae	Peduncle with three robust setae, rami with or without marginal setae	23 and 16 slits	Telson longer than broad, four robust setae per lobe
<i>Gazia samroioidensis</i> Azman, Dam rongrojwattana & Wongkamhaeng, 2014	Less than half body length	Male 4-dentate, female 6-dentate	Posterior lobe on carpus and propodus, each covered in palmate setae	Carpus slightly longer (1.2×) than propodus	Palm reaching about 32% along posterior margin	Propodus 1.4× as long as wide	Inner ramus with four marginal robust setae	Peduncle with two robust setae, rami with two marginal setae	21 and 13 slits	Telson as long as broad, five robust setae per lobe

transverse; (2) gnathopod 1 merus with well-developed palmate lobe; (3) gnathopod 2 palm reaching 30–40%; (4) gnathopod 2 dactylus posterior margin smooth, proximal tooth absent; (5) gnathopod 2 palm without protuberance near dactylar hinge; (6) gnathopod 2 distally attenuated; (7) pereopod 4 dactylus slightly to strongly thickened proximally, with notch mid-way along posterior margin and (8) epimera 2–3 with slits. On the other hand, they can be separated by nine combination characteristics (abbreviations in brackets represent species following; *F. amphawaensis* sp. nov. [FAM], *F. boonyanusithii* [FBO], *F. buraphana* [FBU], *F. kongsemae* [FKO] and *F. pongrati* sp. nov. [FPO]), consisting of: (1) antenna 2 less than half body length [FAM, FBO, FBU], shorter than head and first three pereonite [FKO, FPO]; (2) left mandible lacinia mobilis four dentate [FAM, FBO], five dentate [FBU, FKO, FPO]; (3) male gnathopod 1 carpus slightly longer (1.2×) than propodus [FAM, FBU, FPO], weakly longer (1.5×) than propodus [FBO]; subequal in length to propodus [FKO]; (4) male gnathopod 2 propodus 1.4× as long as wide [FAM, FPO], 1.5–1.6× as long as wide [FBO, FBU, FKO]; (5) uropod 1 inner ramus with three marginal robust setae [FBU, FKO], with four marginal robust setae [FAM, FBO], with five marginal robust setae [FPO]; (6) uropod 3 peduncle with one robust seta [FPO],

with two robust setae [FBO, FBU], with three robust setae [FKO], with four robust setae [FAM]; (7) uropod 3 rami without marginal setae [FAM, FBO, FBU, FKO], with marginal setae [FPO, FKO]; (8) telson as long as broad (FAM), longer than broad [FBO, FBU, FKO, FPO]; and (9) telson with four robust setae per lobe [FAM, FBO, FKO], with 5–7 robust setae per lobe [FBU, FPO].

There has been concern about the status of *Floresorchestia xueli* which was described from Yunnan, China (Tong et al. 2021) and the *F. vitilevana* (J.L. Banard 1960) from Nandaivatu and Mt. Victoria, Fiji (Lowry and Springthorpe 2015). The authors mentioned the distinct characteristics of the species on coxal gills complexly lobed and convoluted; and epimeral plates without slits. According to the diagnostic description of the subfamily Floresorchestiinae, all members including the genus *Austropacifica*, *Floresorchestia* and *Gazia* present maxilliped palp article 2 with distomedial lobe; article 4 reduced, button-shaped or fused to article 3 and epimera 1–3 slits present on at least one plate (Myers and Lowry 2020). Even other characteristics of *F. xueli* fit with the diagnosis of the genus *Floresorchestia*, except for the epimera 1–3 without slit. For this reason, *F. xueli* should be reclassified and assigned to another subfamily and genus.

Key to species of the *Floresorchestia* in Southeast Asia and neighbouring regions

- 1 Gnathopod 1 carpus subequal or less than (1.7×) to propodus 2
 – Gnathopod 1 carpus longer 1.7× than propodus *F. thienemanni* (Schellenberg, 1931)
- 2(1) Gnathopod 1 carpus significantly longer (1.2–1.5×) than propodus 3
 – Gnathopod 1 carpus subequal in length to propodus 12
- 3(2) Gnathopod 1 carpus significantly longer (1.2×) than propodus 4
 – Gnathopod 1 carpus significantly longer (1.5×) than propodus 7
- 4(3) Gnathopod 2 propodus (1.3–1.4×) as long as wide, Gnathopod 2 propodus 1.4× as long as wide 5
 – Gnathopod 2 propodus (1.5–1.8×) as long as wide 7
- 5(4) Uropod 1 peduncle without robust setae *F. malayensis* (Tattersall, 1922)
 – Uropod 1 peduncle with 4–6 robust setae 6
- 6(5) Left lacinia mobilis 5-dentate *F. pongrati* sp. nov.
 – Left lacinia mobilis with 4-dentate *F. amphawaensis* sp. nov.
- 7(4) Left lacinia mobilis 5-dentate; Uropod 1 peduncle without marginal setae; Uropod 3 ramus without marginal robust setae *F. yehyuensis* Miyamoto & Morino, 2008
 – Left lacinia mobilis 4-dentate; Uropod 1 peduncle bearing more than six robust setae; Uropod 3 ramus with one marginal seta *F. buraphana* Wongkamhaeng, Damrongrojwattana & Pattaratumrong, 2016
- 8(3) Epimera 2–3 with slits 8
 – Epimera 1–3 with slit *F. laurenae* Lowry & Springthorpe, 2015
 – Epimera 1–3 without slits *F. xueli* Tong & Hou, 2021
- 9(8) Gnathopod 2 propodus 1.4× as long as wide 9
 – Gnathopod 2 propodus 1.5–1.6× as long as wide 10
- 10(9) Telson broader than long; Gnathopod palm without protuberance near dactylar hinge; Uropod 3 ramus without marginal robust setae *F. hanoiensis* Hou & Li, 2003
 – Telson longer than broad; Gnathopod palm with rounded protuberance near dactylar hinge; Uropod 3 ramus with marginal robust setae *F. floresiana* (Weber, 1892)
- 11(9) Gnathopod palm reaching 40–50% 11
 – Gnathopod palm reaching 30–40% .. *F. boonyanusithii* Wongkamhaeng, Damrongrojwattana & Pattaratumrong, 2016
- 12(11) Uropod 2 outer ramus with two marginal setae *F. anpingensis* Miyamoto & Morino, 2008
 – Uropod 2 outer ramus with two marginal setae *F. oluanpi* Lowry & Springthorpe, 2015
- 13(2) Telson about as long as broad; Antenna 2 longer than head and first three pereonites
 *F. seringat* Lowry & Springthorpe, 2015
 – Telson longer than broad; Antenna 2 shorter than head and first three pereonites
 *F. kongsemiae* Suklom, Danaisawadi & Wongkamhaeng, 2021

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Supplementary material 1

Figure S1

Authors: Anotai Suklom, Tosaphol Saetung Keetapithchayakul, Azman Abdul Rahim, Koraon Wongkamhaeng

Data type: TIF file

Explanation note: Figure S1. Live *Floresorchestia amphawaensis* sp. nov. in their natural habitat.

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Link: <https://doi.org/10.3897/zse.98.83749.suppl1>

Supplementary material 2

Figure S2

Authors: Anotai Suklom, Tosaphol Saetung Keetapithchayakul, Azman Abdul Rahim, Koraon Wongkamhaeng

Data type: TIF file

Explanation note: Figure S2. Live *Floresorchestia pongrati* sp. nov. in their natural habitat.

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Tosaphol Saetung, Suklom Anotai

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